SIMCO:24:812

September 26, 2024

Mr. Michael Gerle, Director
Environmental Regulatory Compliance Division
Carlsbad Field Office
U.S. Department of Energy
P.O. Box 3090
Carlsbad, NM 88221-3090

Subject: CONTRACT 89303322DEM000077, TRANSMITTAL OF THE WASTE ISOLATION PILOT PLANT ANNUAL SITE ENVIRONMENTAL REPORT FOR 2023

Dear Mr. Gerle:

The purpose of this letter is to provide you with the Waste Isolation Pilot Plant Annual Site Environmental Report (ASER). The report was reviewed as prescribed in CBFO procedure MP 4.2 and comments have been resolved. Pursuant to DOE O 231.1B, Chg. 1, *Environment, Safety and Health Reporting,* the ASER must be made available to the public by October 1 of each year for the preceding calendar year. Accordingly, the ASER for 2023 will be posted to the WIPP Home Page website by October 1, 2024.

Per 2023 ASER guidance DOE Heads of Field Elements should distribute ASERs to pertinent Heads of Headquarters Elements, the Office of Scientific and Technical Information, the EPA, State agencies, and other relevant agencies, organizations, or individuals. An electronic file of the approved 2023 ASER should be submitted to Ms. Una Song (una.song@hq.doe.gov) in the Office of Sustainable Environmental Stewardship (EHSS-21). EHSS-21 will provide further notification and distribution within the Office of Environment, Health, Safety and Security.

If you have any questions or comments, please contact Mr. D. Ganaway at Extension 8449.

Sincerely,

RICHARD CHAVEZ (Affiliate)
Digitally signed by RICHARD CHAVEZ (Affiliate)
Date: 2024.09.26 17:01:27 -06'00'

R. R. Chavez, Environmental Program Manager
SIMCO

Enclosure

cc: CBFO Distribution

J. Adkins
G. Basabilvazo
B. Forinash
Z. Lepchitz
M. Navarrete
A. Ward

bcc: SIMCO Distribution

R. Chavez	ED
M. Edwards	ED
R. Flynn	ED
M. Gonzales	ED
T. Harrison	ED
M. Jones	ED
R. Salness	ED
J. Settle	ED
S. Strong	ED
A. Waldram	ED
G. Yocum	ED

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R. J. Chavez	ED
M. Cook	ED
D. Ganaway	ED
J. Haschets	ED
W. Jaco	ED
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J. Nelson	ED
M. Serrano	ED

DOE/WIPP-24-3591

Waste Isolation Pilot Plant Annual Site Environmental Report for 2023

Revision 0

U.S. Department of Energy
Carlsbad Field Office
September 25, 2024



This document has been submitted as required to:

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Reader Survey – Annual Site Environmental Report for 2023

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
If you selected "no," is it: ☐ Too technical ☐ Too detailed ☐ Not detailed enough

☐ Other_____

Is the report comprehensive? ☐ Yes ☐ No
(Please identify issues you believe are missing in the comments section.)

	Yes	**No**
Do the illustrations help you understand the text better?	☐	☐
Are the illustrations understandable?	☐	☐
Are there enough?	☐	☐
Are the data tables sufficient?	☐	☐
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?	☐	☐

How do you use the WIPP Annual Site Environmental Report (ASER) (check all that apply)?

To obtain general information about DOE activities at WIPP	☐	☐
To obtain compliance information	☐	☐

Other (please specify): _____
Comments: _____
_____

Please return this survey to: Director of Environmental Regulatory Compliance Division,
U.S. Department of Energy, Carlsbad Field Office, P.O. Box 3090, Carlsbad, NM 88221-3090.

Optional Information:

Name_____ Occupation_____

Address_____

CHANGE HISTORY SUMMARY

Revision Number	Date Issued	Description of Changes
0	9/25/2024	Initial issue. This report was prepared to meet the annual reporting requirement prescribed in (DOE) Orders 231.1B and 458.1.



EXECUTIVE SUMMARY

REPORT PURPOSE AND DEVELOPMENT

The purpose of the Waste Isolation Pilot Plant (WIPP) Annual Site Environmental Report (ASER) is to meet the requirements of DOE Order 231.1B, *Environmental, Safety, and Health Reporting*, and DOE Order 458.1, *Radiation Protection of the Public and the Environment,* to assure that the public is informed of any WIPP activities that could adversely affect the health and safety of the public, Site personnel, or the environment.

In January 2023, Nuclear Waste Partnership LLC (NWP) managed and operated the WIPP facility as the management and operating contractor (MOC) under contract DE-EM0001971. In November 2022, the DOE contract was awarded to a new contractor: Salado Isolation Mining Contractors (SIMCO) under contract number 89303322DEM000077, SIMCO assumed control of WIPP operations in February 2023. In addition, the Regulatory Environmental Services (RES) function was transitioned from Amentum Technical Services LLC, a subcontractor to NWP, to Los Alamos Technical Associates, Inc. (LATA). LATA developed this report.

WIPP MISSION AND WASTE EMPLACEMENT

The WIPP Project's 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 489 shipments of TRU waste received in the calendar year (CY), yielding a total emplaced volume of TRU mixed waste volume totaling 3,321.08 cubic meters (m^3) during the CY. As of the end of 2023, the total TRU mixed emplaced waste inventory is 105,374.08 m^3, the Land Withdrawal Act (LWA) total volume is 75,489.39 m^3. The LWA limit is 175,564 m^3, leaving 100,074.61 m^3 of volume remaining for waste emplacement.

Monitoring for Environmental Impacts

The DOE contractors collect data needed to detect and quantify potential impacts of WIPP facility operations 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. It discusses the WIPP facility quality assurance/quality control (QA/QC) program as it relates to environmental monitoring.

In the CY, results of these programs, including observations and analytical data, demonstrated that (1) compliance with applicable environmental requirements was maintained at the WIPP facility, and (2) human health and the environment have not been adversely impacted by operations at the WIPP facility. In the CY, TRU radionuclides in environmental samples were detected only in effluent air samples by the National Emission Standards for Hazardous Air Pollutants (NESHAP) program.

These detections were less than 1 percent of regulatory limits.

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. All documents regarding the Permit, *WIPP Discharge Permit* (DP-831), U.S. Environmental Protection Agency (EPA), and Carlsbad Field Office (CBFO) were submitted as required. 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 WIPP Environmental Management System (EMS) is 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.

The WIPP Site—excluding waste generated from capital construction projects—generated 291.66 metric tons of municipal solid waste, wood waste, and recyclable materials in fiscal year (FY) 2023. Of that, 220.7 metric tons, or 75.67 percent was recycled and diverted from being landfilled.

SUMMARY OF RELEASES AND RADIOLOGICAL DOSES TO THE PUBLIC

Doses to the Public and the Environment

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

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 far away from the WIPP facility operations. Drinking water has an extremely low chance of being contaminated due to 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 any individual received dose from WIPP-related TRU radionuclides from the ingestion of meat from game animals. Furthermore, TRU-waste disposal has not impacted the surrounding area’s soil, surface

water, sediments, and vegetation.

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. Chapter 4 of this report presents figures and tables that provide the effective dose equivalent (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

In 2022, WIPP released one item (TRU-Pact 148) containing residual radioactive material. The radioactive material was contained within a chemical matrix and upon notification the item was returned to WIPP. No exposure from radiation was incurred by members of the public. There were no items released containing residual radioactive material 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.

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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
ATWIR	Annual Transuranic Waste Inventory Report
AWMS	Advanced Waste Management Systems
BECR	Biennial Environmental Compliance Report
BCG	biota concentration guides
BEV	battery electric vehicle
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
BRPE	Brine-water Retention Pond East
BRPW	Brine-water Retention Pond West
CAA	*Clean Air Act*
CAR	Corrective Action Report
CBFO	Carlsbad Field Office (DOE)
C&D	construction and demolition
CDX	Central Data Exchange
CEMRC	Carlsbad Environmental Monitoring and Research Center
CFR	Code of Federal Regulations
cfm	cubic feet per minute
cm	centimeter
CRA	Compliance Recertification Application
CWA	*Clean Water Act*
CY	calendar year (2023, 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
EOC	Emergency Operations Center

EPA	U.S. Environmental Protection Agency
EPCRA	*Emergency Planning and Community Right-to-Know Act*
EPEAT	Electronic Product Environmental Assessment Tool
ES&H	Environment, Safety, and Health
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 (2022: 10/1/2021 to 9/30/2022; 2023: 10/1/2022 to 9/30/2023)
GC/MS	gas chromatography/mass spectrometry
GHG	greenhouse gas
GSTR	Generator Site Technical Review
HEAL	Hall Environmental Analysis Laboratory
HEPA	high-efficiency particulate air (filter)
HEMSF	high-energy mission specific facility
HWFP	Hazardous Waste Facility Permit
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)
LATA	Los Alamos Technical Associates, Inc.
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LEPC	Local Emergency Planning Committee
LLW	low-level waste
LMP	*Waste Isolation Pilot Plant Land Management Plan*
LUR	land use request
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 (also M&O)
MOU	Memorandum of Understanding
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
ND	not detected/non-detect
NEPA	*National Environmental Policy Act*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NM	New Mexico
NMAC	New Mexico Administrative Code
NMDHSEM	New Mexico Department of Homeland Security and Emergency Management
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
PA	Performance Assessment
PABC	Performance Assessment Baseline Calculation
PAS	portable air sampler

PAW	Perched Anthropogenic Water
PCB	polychlorinated biphenyl
Permit	WIPP Hazardous Waste Facility Permit
PEST	parameter estimation (software)
PFAS	per- and polyfluoroalkyl substance
PIC	Potential Impact Category
PIP	production-injection packer
PPA	Property Protection Area
ppbv	parts per billion by volume
ppmv	parts per million by volume
PQL	Practical Quantitation Level
PT	proficiency testing
pptv	parts per trillion by volume
PV	photovoltaic
Q	qualifier
QA	quality assurance
QA/QC	quality assurance/quality control
QAO	quality assurance objective
QC	quality control
RCRA	*Resource Conservation and Recovery Act*
REC	Renewable Energy Certificate
RER	relative error ratio
RES	Regulatory Environmental Services
RMSE	root mean square error
RPD	relative percent difference
SARA	*Superfund Amendments and Reauthorization Act of 1986*
SDS	safety data sheet
SEC	Site Environmental Compliance
SERC	State Emergency Response Commission
SGS	SGS North America Inc.
SHS	Salt Handling Shaft
SIMCO	Salado Isolation Mining Contractors
SMP	Safety Management Program
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
TENORM	Technologically Enhanced Naturally Occurring Radioactive Material
TID	Technical Incompleteness Determination
TKN	total Kjeldahl nitrogen
TPQ	threshold planning quantities
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
Cl	chlorine
Co	cobalt
Cs	cesium
K	potassium
Na	sodium
Pu	plutonium
Sr	strontium
U	uranium

CHAPTER 1 – INTRODUCTION

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, 2023). It is available to the public electronically at the following website: WIPP Home Page at https://www.wipp.energy.gov/.

Specifically, this ASER presents a summary of 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 performance indicators and/or performance measures that reflect the size and extent of programs at the WIPP Site, including progress toward the DOE Environmental Sustainability Goals made through implementation of the WIPP EMS.
- Summarize property clearance activities, including authorized limits, results of radiological monitoring and surveys of cleared property, types, and quantities of property cleared, and independent verification program results in accordance with DOE Order 458.1.

Located in southeastern New Mexico (NM), 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 *Waste Isolation Pilot Plant Land Withdrawal Act* (Public Law 102-579, as amended by Public Law 104-201) (LWA) 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; or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste." The waste must meet the applicable criteria in the *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.



Figure 1 – Utility Shaft Number 5, Photography by Roy Neese

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. The WIPP repository is currently serviced by four shafts extending to the surface. A fifth shaft, Utility Shaft Number 5 (Shaft 5) (Figure 1), is under construction during this reporting period and will connect the underground facility to the surface. All shafts will be sealed after the WIPP disposal phase. One of the main attributes of salt at the depth of the WIPP repository, as a rock formation to isolate radioactive waste, is the characteristic of the salt to creep; that is, to deform continuously over time until emplaced waste is encapsulated. 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 and 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 evaluated stable geological formations that could be used to contain radioactive wastes for thousands of years. In 1957, salt deposits were recommended as a promising medium for the disposal of radioactive waste.

Salt deposits were selected as the host for nuclear waste disposal for several reasons. Most salt deposits 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 current, 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 fractures because it behaves plastically under lithostatic pressure. This means salt formations at depth will slowly and progressively fill mined areas and 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 NM 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 halite (NaCl). The Salado 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.

Congress authorized the construction of the WIPP facility in 1979, and the DOE constructed it 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.

1.3 SITE DESCRIPTION

Located in Eddy County in the Chihuahuan Desert of southeastern NM (Figure 1.1), the WIPP Site encompasses 16 square miles (mi^2). This part of NM is relatively flat and is sparsely inhabited, with little surface water. The center of the Site is approximately 26 mi east of Carlsbad, NM, in an area known as Los Medaños.

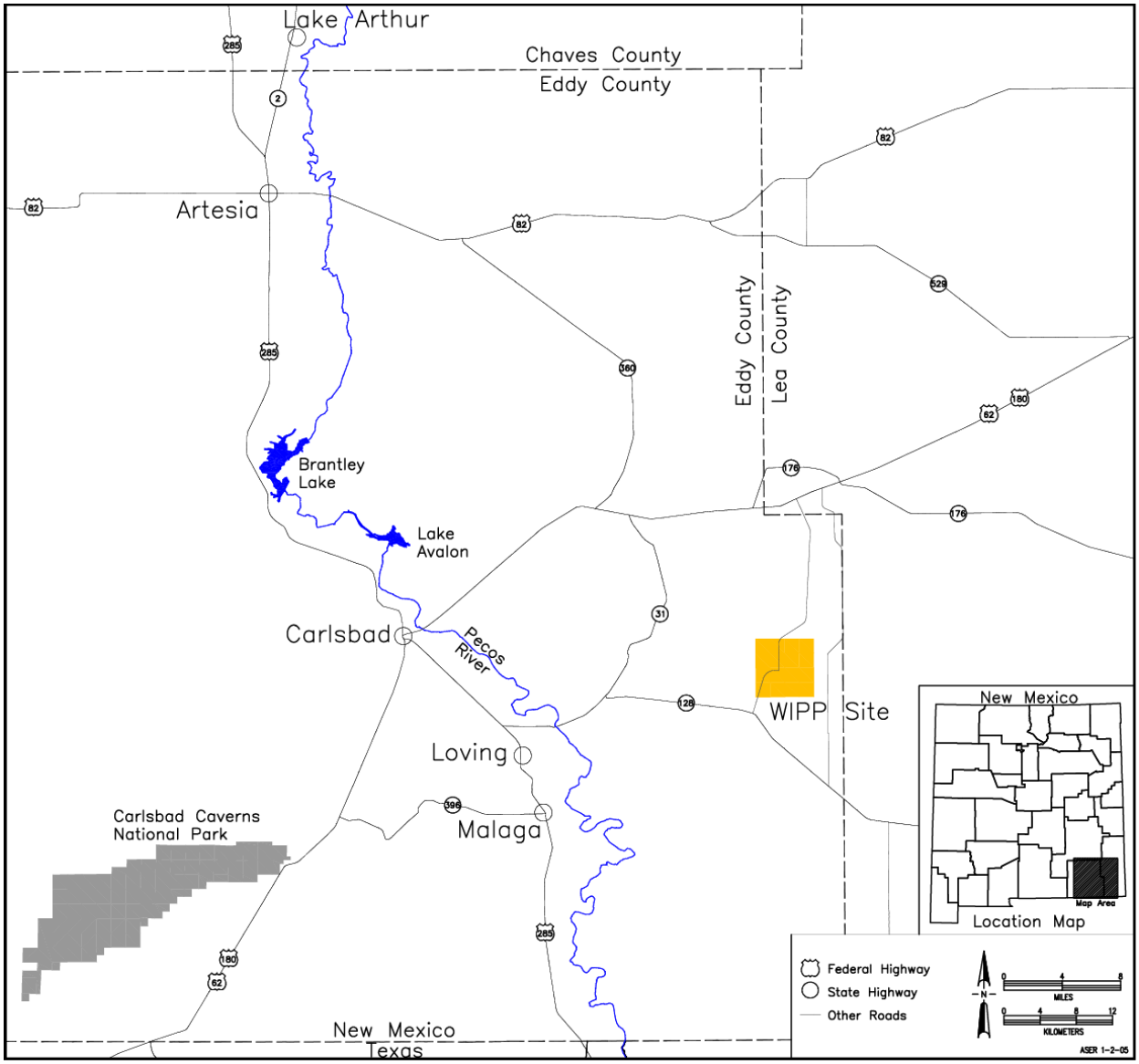

Figure 1.1 – WIPP Site Location

Most of the lands near 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. Property or functional areas are designated within the WIPP Site boundary (Figure 1.2).

Property Protection Area

The active portion of the facility, established as the Property Protection Area (PPA) in the Permit, encompasses approximately 0.05 mi^2 without the New Filter Building and approximately 0.07 mi^2 with the New Filter Building, and is surrounded by a permanent security barrier posted with warning signs and is continuously monitored and controlled in accordance with Permit requirements. This area provides security and protection for all major surface structures. Portions of this PPA were reconfigured during the CY to support ongoing Site improvements. A second PPA consisting of a nominal 0.03 mi^2 surrounds Utility Shaft Number 5.

Exclusive Use Area

The Exclusive Use Area (EUA) comprises approximately 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 to support the project. This area is marked by warning signs (e.g., “No Trespassing”) and is patrolled by WIPP facility security personnel to detect unauthorized activities or uses.

Off-Limits Area

The Off-Limits Area boundary defines the exclusion zone. In the Off-Limits Area, the unauthorized entry and introduction of weapons or dangerous materials is prohibited (as provided in 10 CFR §860.3 and §860.4). 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 2.27 mi^2. Livestock grazing and limited public thoroughfare will continue in this area unless these activities present threaten 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 open to public recreation within the LWB. Livestock grazing and public access for recreational use (e.g., hunting) will continue unless these activities threaten the security, safety, or environmental quality of the WIPP Site. Additional details for the property areas and access restrictions may be found in the *Waste Isolation Pilot Plant Land Management Plan* (LMP).

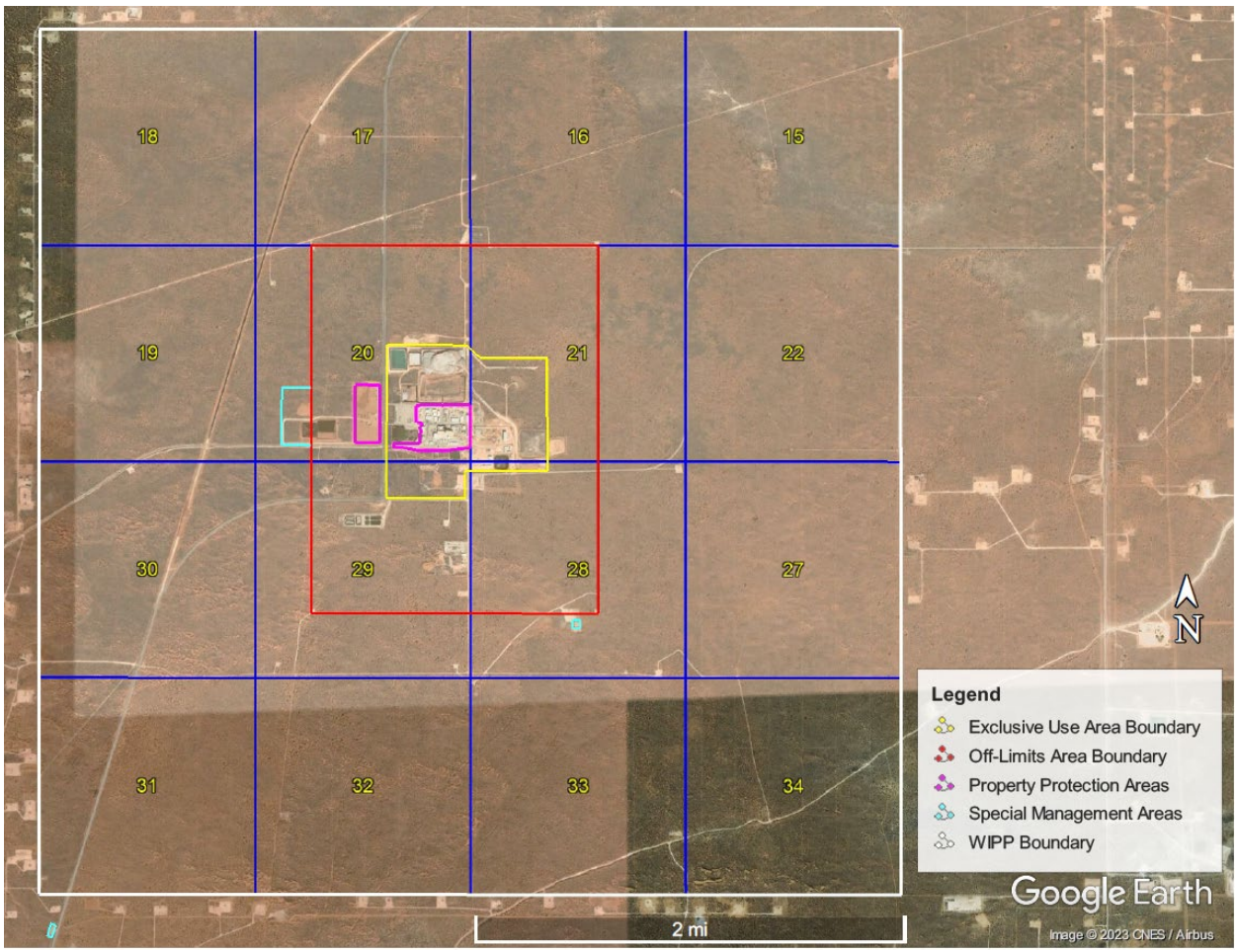

Figure 1.2 – WIPP Property Areas

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.

Several areas are considered special management areas due to safety hazards or ongoing construction. Evaporation Pond H-19 (H19), located in section 28, is removed from public access with fencing and postings. The western portion of the Shaft 5 construction area in section 20 is removed from public access by a barbed-wire fence. The salt storage pond within the Shaft 5 area is fenced and posted to prevent

unauthorized entry. The final special management area is an equipment storage area located southeast of section 31. This area, formerly used during WIPP road construction, is fenced and posted to prevent unauthorized entry.

1.3.2 Population

The number of permanent residents living within 10 mi (16 km) of the WIPP Site is very small (less than 30). This permanent population is associated with ranching. The majority of the local population within 50 mi (80.5 km) of the WIPP Site is concentrated in and around Carlsbad, Hobbs, Eunice, Loving, Jal, Lovington, and Artesia, NM. According to the 2020 census data, the population within this radius is 106,174. The nearest community is the village of Loving, 18 mi (29 km) west-southwest of the WIPP Site, with a population of 1,390. The nearest major populated area is Carlsbad, 26 mi (42 km) west of the center 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, 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 NM environment. Effluent monitoring, environmental surveillance, land management, and assessments are conducted to verify 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 plan’s purpose is to describe the 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[c] particulate	11	Weekly
	(3) Liquid effluent	Waste Handling Shaft sump and other collection points	As needed
	(4) Biotic (wild fauna): Quail species, Catfish species, Rabbits (Desert Cottontail), Javelina (Collared Peccary), Mule Deer	Per permit authorizing collection	As available
	(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, as available
	(10) Groundwater[b]	6	Annual
Non-radiological	(12) Meteorology	1	Continuous
	(13) 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 number of active panel disposal rooms	Routinely once every 2 weeks; increasing to weekly as needed per Permit conditions
	(14) Groundwater[b]	6	Annual
	(15) Perched anthropogenic water (DP-831, conditions 57, 58, and 59)	15 Sampled (PZ-16, PZ-17a, PZ-18, PZ-19a were dry and not sampled)	Minimum one sample within first year of DP-831 and semi-annual from PZ-1, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, PZ-13, PZ-14, PZ-15, PZ-16, PZ-17a, PZ-17b, PZ-18, PZ-19a, C-2507, C-2811, WQSP-6a
	(16) H19 and Salt Storage Pond 4[d] (DP-831, condition 40)	2	Semi-annual
	(17) Effluent Lagoon A (DP-831, condition 34)	1	Semi-annual

Program	Type of Sample	Sampling Locations[(a)]	Sampling Frequency
	(18) Effluent Lagoon B and C (DP-831, condition 35)	2	Only after industrial wastewater has been discharged into the impoundment(s).
	(19) Storm Water Ponds 1, 2, and 3 (DP-831, condition 39)	3	Annually after a significant storm event.
	(20) Salt Storage Ponds 1, 2, 3, and 5 (DP-831, condition 47)	4	Annually after a significant storm event.
	(21) H19 inorganics and organics (DP-831, conditions 41 and 42, respectively)	1	Minimum one sample within the first year of DP-831.
	(22) Brine-water Retention Pond East (BRPE) and Brine-water Retention Pond West (BRPW)[(e)] (DP-831, condition 44). When SSCVS ponds are completed.	2	Quarterly rotation, minimum of four consecutive quarterly sampling events

Notes:

(a) Counts do not include duplicates. Access restrictions or location conditions can impact the number of certain types of samples taken. For example, during dry periods there may be no surface water or infiltration control water to sample and some wells may be dry. 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) Detection Monitoring Wells. Sampling includes radiological and non-radiological program components.

(c) Seven legacy locations have two samplers running simultaneously generating a primary sample and an additional sample which is used for event evaluation or backup. Four locations are sampled only for use in an event evaluation. Each week this results in 18 samples, but routinely only seven samples are analyzed (one from each legacy location). Weekly legacy samples are then combined into quarterly composites.

(d) Salt Storage Pond 4 has been constructed but is not operational and has not yet been put into operation.

(e) BRPE and BRPW have been constructed but are not yet operational.

The Environmental Monitoring Plan describes the monitoring of naturally occurring and specific anthropogenic 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 volatile organic compounds (VOCs), groundwater chemistry, other non-radiological environmental parameters, and meteorological data collection.

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 the 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 managed at the WIPP facility and includes Carlsbad and ranches. Non-radiological environmental monitoring activities at the WIPP Site consist of sampling and analyses designed to detect and quantify the impacts of operational activities and verify compliance with applicable requirements.

1.5 ENVIRONMENTAL PERFORMANCE

DOE Order 436.1A, *Departmental Sustainability,* describes the DOE's commitment to environmental protection and to implement sound stewardship practices that protect the air, water, land, and other natural and cultural resources. The provisions of DOE Order 436.1A are implemented via the WIPP Project environmental policy and the WIPP EMS. Sustainability goals, as directed by this order, are achieved through the *Site Sustainability Plan* (SSP) (U.S. Department of Energy, 2022) and the WIPP EMS (see Chapter 3).

Implementing the *Waste Isolation Pilot Plant Environmental Monitoring Plan* (DOE/WIPP-99-2194) fulfills the environmental monitoring requirements of DOE Order 436.1A. The remaining chapters include detailed information on the WIPP Project's environmental programs.

CHAPTER 2 – COMPLIANCE SUMMARY

The DOE must comply with the applicable regulations promulgated pursuant to federal and state statutes, DOE orders, and executive orders (EOs) regarding the WIPP facility. Facility plans and implementing procedures ensure compliance with regulatory requirements. Methods used to maintain compliance with environmental requirements include 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-22-3526). 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 Act, and the *Superfund Amendments and Reauthorization Act of 1986* (SARA) establish a comprehensive federal strategy for responding to and determining 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* [EPCRA]), which is implemented pursuant to 40 CFR Parts 350 through 399, to submit (1) a list of hazardous chemicals present at the facility over the threshold planning quantities (TPQ) or 10,000 pounds for which Safety Data Sheets are required; (2) an Emergency and Hazardous Chemical Inventory Form (Tier II Form) that provides types, quantities and locations of hazardous chemicals stored each year at WIPP; and (3) notification to the State Emergency Response Commission (SERC), the Local Emergency Planning Committee (LEPC), and fire departments with jurisdiction over the facility in the case of an emergency event at the Site. Submitting a list of hazardous chemicals or hazardous chemical safety data sheets (SDSs) meeting or exceeding the applicable thresholds is a one-time notification, provided no new hazardous chemicals are stored at or above applicable reporting threshold levels or existing hazardous chemical SDSs are significantly revised. Any new hazardous chemical subject to reporting requirements or a significantly revised SDS is reported within three months after discovery and within 30 days of any request made by the LEPC.

The SARA Tier II Report, due annually on March 1, provides State and local officials and the public with specific information on the amounts and locations of hazardous chemicals present at WIPP during the previous calendar year. Specifically, for WIPP, the SARA Tier II Report must be sent to the New Mexico Department of Homeland Security and Emergency Management (NMDHSEM), Eddy County LEPC, and cities of Carlsbad and Hobbs fire departments. As a courtesy, the report is also provided to volunteer fire departments in Otis and Joel. The CY 2023 Tier II Report for the WIPP facility was submitted electronically utilizing the EPA online Tier2 Submit™ Software prior to March 1, 2024, as required by 40 CFR Part 370, "Hazardous Chemical Reporting: Community Right-To-Know" and in compliance with EPCRA, Section 312. This report included the revised physical and health hazard classifications associated with the WIPP facility on-site chemical inventory (see Table 2.1).

Title 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 disposed of or released at the facility more than established threshold amounts. The CY 2023 Toxic Release Inventory (TRI) Report was submitted electronically on the EPA Central Data Exchange (CDX) website utilizing the software TRIMEweb™ before July 1, 2024. Utilizing the CDX website submits the TRI report to EPA the report to the SERC, or NMDHSEM. Table 2.1 presents the CY 2023 EPCRA regulatory sections, reporting requirement(s), and corresponding submission status.

Table 2.1 – Emergency Planning and Community Right-to-Know Act Reporting (EPCRA) Requirements

***Emergency Planning and Community Right-to-Know Act* Sections**	**Facility Reporting Requirements**	**Submission Status**
EPCRA Section 302-303 (40 CFR Part 355 Subpart B)	Emergency Planning & Emergency Response Notification	Further notification not required at this time *
EPCRA Section 304 (40 CFR Part 355, Appendices A & B)	Notification of a Hazardous Substance Release or Extremely Hazardous Substance Release Above Reportable Quantities	Not required; Facility did not have any hazardous substance released of reportable quantity.
EPCRA Section 311-312 (40 CFR Part 370)	Hazardous Chemical Reporting (Tier II Report)	Yes **
EPCRA Section 313 (40 CFR Part 372)	Toxic Chemical Release Reporting (TRI Report)	Yes **

* The facility is subject to emergency planning requirements; however, further notification is only required when significant changes are implemented to the existing plan.
** Reporting notification requirements were satisfied and submitted by the applicable deadline.

2.1.2 Unplanned Releases of Reportable Quantities of Hazardous Substances

There were no unplanned releases of hazardous substances or extremely hazardous substances exceeding the reportable quantity thresholds during the CY 2023.

2.2 RESOURCE CONSERVATION AND RECOVERY ACT

The *Resource Conservation and Recovery Act* (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 to protect 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 NM 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 NM 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 to store TRU mixed waste. Ten underground hazardous waste disposal units (HWDUs) or panels are currently permitted to dispose of contact-handled and remote-handled TRU mixed waste.

The NMED Hazardous Waste Bureau performed a RCRA WIPP facility inspection. This inspection was initiated on April 17, 2023. The inspection focused on the 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 April 19, 2023. During this reporting period, the Permittees had not received the final RCRA inspection results from the NMED.

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 remains 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 a 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. On March 17, 2022, the Permittees submitted the updated redline strikeout version of the renewal application. On April 20, 2022, NMED held an informal stakeholder meeting to provide and gather information on Renewal issues and concerns. On April 28, 2022, the Permittees held a town hall meeting to provide information on the submittal. On May 13, 2022, NMED issued a Technical Incompleteness Determination (TID) for the Renewal Application and requested additional information for NMED to complete its review and prepare a draft Permit. The TID requested two separate response time frames. The Permittees submitted the 45-Day TID Response on June 27, 2022, and the 60-Day TID Response on July 12, 2022. The NMED issued the draft Permit for public comment on December 20, 2022. From June 19 through 23, 2023, the NMED, the Permittees and interested parties who filed requests for hearing met in negotiations to discuss the contested issues of the hearing requests. The NMED, the Permittees and the interested parties agreed to stipulate that certain conditions would be placed in the Draft Permit to resolve the contested issues. The NMED, the Permittees and the interested parties agreed to the Proposed Final Renewal Hazardous Waste Facility Permit (Proposed Final Permit), and the interested parties and the Permittees agreed to withdraw their hearing requests. The stipulations are outlined in the June 23, 2023, Settlement Agreement and Stipulation on Draft Permit, which resolved contested issues without needing a public hearing on the Draft Permit. On June 26, 2023, the Cabinet Secretary signed a Notice of Rescindment of Hearing and Hearing Officer Appointment. On August 15, 2023, the NMED issued the Proposed Final Permit. On October 4, 2023, the NMED issued the final Waste Isolation Pilot Plant Hazardous Waste Facility Permit for the Ten-Year Renewal. The new Permit became effective on November 3, 2023.

On October 20, 2022, waste emplacement was completed in Panel 7. In accordance with Permit Attachment G, the Permittees have 180 days to close a panel. Closure of Panel 7 was completed on February 11, 2023. The following deliverables were submitted to the NMED documenting the closure of Panel 7:

- Notification of Closure, submitted June 15, 2022
- Survey Plat, submitted March 27, 2023
- Certification of Closure by Professional Engineer, submitted April 27, 2023

- Disposal Unit Record of TRU Mixed Waste, submitted May 15, 2023
- Closure Report, submitted August 23, 2023

2.2.2 Modification Requests

In CY 2023, 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 CY 2023

Class	Description	Date Submitted
1	Revise Permit Part 4, Table 4.1.1, Underground Hazardous Waste Disposal Units Update to Permit Attachment E, Section E-1, Inspection Schedule	January 12, 2023
1	Update Carlsbad Field Office (CBFO) Manager and Management and Operating Contractor (M&O) Start Date in Permit Attachments A and B Update Permit Attachment D, Table D-1, Resource Conservation and Recovery Act Emergency Coordinators	February 6, 2023
1	Update Department of Energy (DOE) Carlsbad Field Office (CBFO) Manager Title and phone number in Permit Attachments A, B, and G	May 15, 2023
1	Update Attachments A2, B, D, G, and K to Address Panel 7 Closure; Update Permit Attachment B, Appendix B1, Other Environmental Permits; and Update Permit Attachment D, Resource Conservation and Recovery Act Contingency Plan	August 2, 2023
1*	Addition of four new Shielded Containers	January 12, 2023

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 EPA has authorized the NMED 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 did not inspect the UST system during the CY. The USTs are nearing the end of their lifespan; therefore, aboveground storage tanks (AST) are being emplaced. Three diesel tanks and one gasoline tank are replacing the two underground tanks. The ASTs have 1,000 gallons capacity and have their own transfer pump to fuel vehicles. This keeps the tanks from being manifolded together. Per 20.5.101.2.D, any AST with a capacity of 1,320 gallons or less and are not manifolded together are excluded from regulations. When these ASTs are tested, they will come online, and the USTs will be removed.

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 known or suspected to contain hazardous constituents) is generated at the WIPP facility because 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 storage area) on the surface, and a Central Accumulation Area (less-than-90-days storage area) underground. Mixed low-level (radioactive) waste is segregated from hazardous waste, and low-level waste (LLW) is managed as mixed low-level waste (MLLW).

Mixed low-level waste is managed to comply with DOE Order 435.1, Administrative Chg. 2, *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 samples were analyzed by GEL Laboratories, LLC, Charleston, SC. 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. The results of other noncompliance were reported as required, in the annual October Noncompliance Report.

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. This report was submitted to the NMED in November 2023.

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. A report was not required during this CY.

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 not utilize CH Bay surge storage in this CY; thus, notification or report was unnecessary in this CY.

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; 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 submitted the annual Geotechnical Analysis Report in October 2023, representing results for July 1, 2021, through June 30, 2022.

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 VOC contract laboratory, to participate in a proficiency testing (PT) program. For determining proficiency, the laboratory's PT results are compared to the standard concentrations from the audit sample reported by the PT provider. The introduced standard is varied by components and concentrations for each testing round. The Carlsbad Environmental Monitoring and Research Center (CEMRC) participated in one quarterly PT in the CY, as described in Section 7.2.4 of this ASER. The newly contracted laboratory, SGS North America Inc. (SGS), participated in one quarterly PT for the CY, as described in Section 7.4.4 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 submitted semi-annual VOC reports in April 2022, representing results for July 1, 2022, through December 31, 2022. NMED granted a 120-day extension for the October 2023 semi-annual report. This report was submitted in February 2024, representing results for January 1, 2023, through June 30, 2023.

Permit Part 4, Section 4.6.4.2, Reporting Requirements, requires a report annually in October presenting the data results and analysis of the mine ventilation rate monitoring program. The Permittees submitted the annual report in October 2023, representing results for July 1, 2021, through June 30, 2022.

Permit Part 5, Section 5.10.2.1, Data Evaluation Results, requires a report annually by November 30 of the analytical results for the 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 45 was submitted to the NMED in November 2023. 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. These reports were submitted to the NMED in May and November 2023. 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 2023.

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. Panel 7 was closed during this reporting period. The certification of closure was provided to the NMED on April 27, 2023.

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. Panel 7 was closed during this reporting period. The survey plat was filed at the Eddy County Clerk’s Office on March 9, 2023, and submitted to the NMED on March 27, 2023.

The renewed Permit which became effective November 3, 2023, added two new reports, neither which were submitted in CY2023 but will be submitted in CY2024.

Permit Part 2, Section 2.14.3, Repository Siting Annual Report, requires submission of an annual report summarizing its progress toward siting another repository for TRU waste in a state other than NM.

Permit Part 4, Section 4.2.1.4, Prioritization and Risk Reduction of New Mexico Waste, requires that within 15 days of DOE publishing the Annual Transuranic Waste Inventory Report (ATWIR), the Permittees shall certify to the NMED there is sufficient TRU Mixed Waste Volume capacity in permitted HWDUs to dispose of the NM generator/storage site waste detailed in the ATWIR.

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 preparation of 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 by implementing a NEPA compliance plan and procedure. In the CY, 156 proposed projects were submitted through the NEPA screening and approval process. Four of the projects required Land Use Request evaluation and CBFO NEPA Compliance Officer approval. Of the 156 projects, 15 required NEPA approvals. The remaining 141 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 2023, DOE did not issue any Supplement Analyses, Environmental Assessments, Environmental Impact Statements, or Categorical Exclusions because no new projects were proposed that should require any of these documents.

2.4 CLEAN AIR ACT

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

In 1993, a *New Mexico Air Quality Control* (NMSA 1978 §74-2) Regulation 702 Operating Permit (recodified in 2001 as 20.2.72 NMAC, "Construction Permits") was obtained 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 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 managing 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.

On June 9, 2023, New Source Review Permit Number 0310-M3 was cancelled since all diesel generators were removed from the project areas and returned to the rental companies.

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 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 stormwater runoff into the waters of the United States. It is not subject to regulation under the National Pollutant Discharge Elimination System program. Wastewaters generated at the WIPP facility are disposed of off-site or managed on-site in lined evaporation ponds. Stormwater runoff is also collected in lined retention ponds. The management of wastewater and stormwater 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 developing regulations to protect NM 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 NMED Groundwater Quality Bureau issued the DP-831 permit for the operation of the WIPP sewage treatment facility in January 1992 for 5 years. It was most recently renewed in January 2022 to include the Safety Significant Confinement Ventilation System (SSCVS), new shaft project, new storm water ponds and a salt cell (Figure 2).

The modifications also included one-time radium and uranium analysis in the Perched Anthropogenic Water (PAW) wells.



Figure 2 New Salt Storage Cell for SSCVS, Photography by Roy Neese

In accordance with the DP in effect during the CY, monthly inspections are conducted at each of the storm water ponds, salt storage ponds, and salt storage cells to ensure proper maintenance. When deficiencies are observed, such as liner tears or significant erosion, appropriate repairs are conducted. Regarding facility operation, the sewage lagoons and Evaporation Pond 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, stormwater ponds, and salt storage ponds are monitored regularly. The 2022 DP renewal added the requirement of inspecting the leak detection sumps in Salt Storage Ponds 2, 3, 4, and 5.

The DP requires the sewage lagoons and Evaporation Pond 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 Evaporation Pond H19 is analyzed for only TDS, sulfate, and chloride. The stormwater ponds and salt storage ponds must be sampled annually after 2 inches of rain in 24 hours 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 three years after the new DP is issued. These sludge measurements occurred on July 7, 2023, for Salt Storage Ponds 1, 2, and 3, September 16, 2023, for the Sewage Setting Lagoons 1 and 2, and December 20, 2023, for Evaporation Pond H-19. All sludge measurements were less than one-third the volume of the ponds and lagoons. These sludge levels were reported to the NMED in the Semi-Annual Report for July – December 2023.

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 stormwater discharge volumes. Both semi-annual reports were submitted, one in July 2023 for the reporting period of January 1, 2023, through June 30, 2023, and the other in January 2024, for the reporting period of July 1, 2023, through December 31, 2023. There were no inspections at the WIPP facility in 2023 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 drinking water sources. 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, NM. The WIPP facility's water system (NM3598008) is classified as a non-transient, non-community water system subject to NM drinking water regulations.

Bacterial samples are collected, and residual chlorine levels are tested monthly. Free chlorine levels are reported to the NMED twice each month. Bacteriological analytical results have been below the *Safe Drinking Water Act* regulatory limits, and residual chlorine levels met safe drinking water requirements.

Facilities personnel conduct disinfectant by-products testing per 40 CFR §141.132, "Monitoring Requirements," annually. In September 2023, 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 disinfection by-products, trihalomethanes, and haloacetic acids.

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." Lead and copper sampling occurred in August 2023 at 10 locations throughout the drinking water system. All samples resulted in lead and copper as "non-detected" except for two locations at the Guard and Security Building, which resulted at or above action levels. The Drinking Water Bureau was notified of these exceedances of the action level along with a plan to remediate. Two valves containing lead were

replaced. Action levels were exceeded for lead in these two samples, but the regulatory limit was not exceeded.

In July 2023, the Drinking Water Bureau presented training on the Federal Lead and Copper Rule Revisions, which required water systems to create a service line inventory of lead lines and fittings within their water system along with a plan to replace them within five years. This inventory and plan must be submitted to the State by October 16, 2024. The WIPP Engineering Department began the survey in September 2023.

2.8 NATIONAL HISTORIC PRESERVATION ACT

The *National Historic Preservation Act*, 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 the State of New Mexico's 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, the land use request (LUR), and the Environmental Compliance Review (see Section 5.2). Planning/ management policies pertaining to cultural resources within the WLWA are conducted in accordance with regulations and guidelines included in Appendix F, *Implementing Regulations Regarding Cultural Resources*, of the LMP. The objectives of the policies are to protect and preserve the full array of cultural resources within the WLWA for the benefit of scientific and socio-cultural use by present and future generations.

To protect cultural resources, projects proposed on previously undisturbed areas require the submittal of an LUR. For WIPP-related projects, an Environmental Compliance Review form is also required. These documents are reviewed by personnel cognizant of regulatory requirements. They are used to determine if air, water, hazardous waste, or land use permits are required for the activity as well as documenting potential impacts to wildlife, vegetation, and cultural resources. Projects that could potentially impact cultural sites may require additional surveys to minimize any impacts. No cultural surveys were required 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 chemical manufacturing, processing, import, use, and disposal.

The *Toxic Substances Control Act* regulates polychlorinated biphenyls (PCBs). 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 5 years 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 effective for 5 years. On July 20, 2022, a letter requesting re-authorization was sent to the EPA Region IV. The EPA provided an extension through September 30, 2023. The EPA extended the previous approval through April 15, 2024. The required PCB annual report, containing information on PCB waste received and disposed of at the WIPP facility during 2022, was submitted to EPA Region VI in accordance with 40 CFR Part 761 prior to the July 15, 2023 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, “Federal Insecticide, Fungicide, and Rodenticide Act Regulations”). Applications of restricted-use pesticides at the WIPP facility are conducted by commercial pesticide applicators who must 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 Cells, 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*, as amended (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. It 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 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.), enacted in 1978 to protect the state's threatened and endangered wildlife. On November 25, 2022, the USFWS published a final rule listing two Distinct Population Segments of the lesser prairie-chicken (*Tympanuchus pallidicinctus*) (Figure 3) under the act. A correction to the prohibitions prescribed in the rule document was published on December 2, 2022. The final rule listed the Southern Distinct Population Segment of the lesser prairie-chicken as endangered, and the Northern Distinct Population Segment as threatened. The original effective date of January 24, 2023, was extended to March 27, 2023, to allow the USFWS to finalize conservation tools and guidance documents to avoid confusion and disruption for landowners, federal partners, and industry within the lesser

prairie-chicken's five-state range. The WIPP Site is within the 10-mile buffer of the estimated occupied range of the Southern Distinct Population Segment. Biologists with the BLM have also identified areas suitable to the species and included the WIPP Site in the agency's habitat evaluation area. Utilizing the main concept from the BLM's definition, this could be described as an area where habitat characteristics support the species and could provide connectivity to adjacent ecosystems and migration corridors for isolated populations.



Figure 3 Lesser Prairie-Chicken, Photo Courtesy of Greg Kramos, USFWS

During the CY, no imperiled species protected by the *Endangered Species Act* or New Mexico *Wildlife Conservation Act* were identified as occurring within the WLWA. However, considerations pertaining to protected species are implemented in accordance with the LMP (see Section 5.2) during the deliberation and administration of projects conducted on WIPP lands. In the CY, no permits, biological assessments, or formal consultations were required. Additional details on wildlife population monitoring are presented in Section 5.2.2 and the LMP.

2.12 MIGRATORY BIRD TREATY ACT

The *Migratory Bird Treaty Act* (16 U.S.C. §703, et seq.) is intended to protect birds with 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”). Hunting allowances within the WLWA continued except for the areas that are posted against trespass. Hunts for migratory bird species within unrestricted areas is per federal and state laws.

In a notice published in 78 Federal Register 219, the DOE informed the public of the availability of its Memorandum of Understanding (MOU) with the USFWS regarding the implementation of Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. The Executive order was published in 66 Federal Register 3853. This MOU expired in 2018, but the DOE signed an addendum to extend the MOU past this date. The MOU and the Executive order commit DOE to take specific actions to implement the Migratory Bird Treaty Act.

In the September 19, 2023, edition of the WIPP Morning Summary distributed by WIPP Communications, a wildlife handling reminder was provided to WIPP employees. An excerpt of that distribution, as follows, is an example of wildlife information outreach during the CY.

YOUR WIPP NEWS

Wildlife handling reminder

If you find sick or injured birds or wildlife at your home or during your trip into work, it is advisable not to handle the wildlife. This is for your safety and the safety of the wildlife. You should never transport sick or injured animals onto the WIPP site. If you find sick or injured wildlife already at the WIPP site, contact the CMR or the Site Environmental Compliance, Monitoring & Hydrology Department.



You should never transport wildlife to any location without first contacting New Mexico Department of Game and Fish dispatch at (505) 841-9256. In the case of migratory birds, transport is against the law without a permit. Most birds are protected by the Migratory Bird Treaty Act (MBTA), which prohibits the taking (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service.

The DOE has implemented management objectives to protect birds and their habitats in the WIPP LMP. Exemplary protective measures completed during the CY include the installation of netting over open containers of brine water near the exhaust-shaft ductwork. This netting eliminates a potentially hazardous condition for birds. Groundwater well WQSP-3 is located within 45 yards of an artificial nesting platform. Best management practices were implemented to ensure nesting birds would not be impacted by groundwater monitoring activities.

During the bird-nesting season, routine inspections of equipment at the WIPP are performed to monitor for early signs of nest building in critical areas and on critical equipment. When established nests are discovered, subsequent mitigative actions depend on specific species, situations, state and federal regulations, and authorizations and conditions of the MOC relocation permit. All requests for the use of WIPP lands outside the WIPP PPA are contingent on environmental walk-downs and confirming that nesting birds do not occupy the requested land, including ground-nesting species. When nests are found, projects may be delayed or paused, or measures (e.g., buffer zones) are implemented to minimize impact.

The MOC, under the purview of the DOE, was granted a USFWS relocation permit which allows for conditional relocation of nests, eggs, and or fledglings of migratory birds if located in a critical area that will impact their safety. Relocation was not needed during the CY and there was no reported intentional or unintentional take of migratory birds. The required annual report for the CY was submitted to USFWS on January 2, 2024, and this report documented no activity.

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, 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. Appendix B1 of Permit Attachment B includes a list of active right-of-way permits. 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 in a manner consistent with the terms of the right-of-way when they are no longer needed.

For the CY, no reclamations were completed for rights-of-way granted as per this act. Nevertheless, one right-of-way granted by the New Mexico State Land Office was reclaimed and is presented in Chapter 5, Section 5.2.3.

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 developing and producing nuclear weapons, promoting 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 the 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, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," 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 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 five 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 fourth Compliance Recertification Application (CRA) for the WIPP Project (DOE/WIPP-19-3609) was submitted to the EPA on March 19, 2019. On May 3, 2022, EPA recertified the WIPP facility, confirming that it continued to comply with the agency's radioactive waste disposal regulations at 40 CFR Part 191, Subparts B and C, as well as with the WIPP Compliance Criteria at 40 CFR Part 194. The final recertification decision is published in 87 Federal Register 26126.

2.15 EPA ECHO DATABASE, LIST OF FACILITIES FOR WIPP

The EPA Enforcement and Compliance History Online (ECHO) 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 listings for the CY 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, violation type is undetermined for the CY.
2. **WIPP Safety Significant Confinement Ventilation System –** *Clean Water Act* (CWA): Non-Major, Permit Expired, (NMR1001Y9), FRS ID:110070528602, no violations identified.
3. **USI –** *Clean Water Act* (CWA): Non-Major, Permit Expired, (NMR100207), FRS ID:110070530291, no violations identified.
4. **WIPP North Access Road Bypass –** *Clean Water Act* (CWA): Non-Major, Permit Expired, (NMR1001WV), FRS ID:110070519468, 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 International Organization for Standardization (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, EO 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, implemented by DOE Order 436.1A.

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. 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 WIPP registration certification (number E0206) dated November 21, 2021, remains in effect until May 28, 2024. Two, 6-month surveillance audits were performed during the CY: ES43 on May 16-18, 2023, and ES44 on December 6-8, 2023. ES43 resulted in one minor nonconformance: the WIPP environmental objectives were not clearly defined and therefore pathways for communication of those objectives and their progress were also not clearly defined. This resulted in the creation of an issue notice (WIPP-ISSUE-23-1066) that was tracked through WIPP's Issues Management Program, which has been adequately addressed and corrected. ES44 resulted in zero nonconformities. Despite one minor nonconformity during CY 23, the WIPP EMS remains suitable, adequate, and effective. The continual improvement of WIPP's EMS and environmental performance continues to be managed, monitored, and evaluated by the Environmental Management System Steering Committee (EMSSC) to document leadership commitment.

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 489 shipments received in the CY, yielding a total emplaced volume of TRU mixed waste and LWA TRU waste volume totaling 3,321.08 and 2,963.66 m^3, respectively. At the end of the CY, the TRU mixed waste and LWA TRU waste volumes in the underground totaled 105,374.08 m^3 and 75,489.39 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 CY 2023 were limited. Some sustainability-related EMS goals included the installation of building load meter monitoring (carried over from the previous year) which was partially completed in July 2023, increasing and developing WIPP-specific sustainable acquisition training among P-card holders (still underway), acquiring three battery electric vehicles (BEVs) and charging stations for use by Site personnel, and planning a solar element for the WIPP Site.

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM HIGHLIGHTS

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

Environmental Policy	The WIPP Environmental Policy Statement was reviewed by SIMCO leadership, signed, and issued on June 14, 2023; 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), completed at initial hire and every 24 months after that. 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 communicate the commitment to protect the environment publicly and is on an as-needed revision cycle as determined 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 (including renewables) and Water Efficiency Sustainable Procurement Solid Waste – Pollution Prevention (P2) Hazardous Waste – Reduction Sustainable Building Management/Design Fleet Management – BEV Acquisition and Utilization

Legal and Other Requirements	On March 31, 2020, the Permittees submitted the Resource Conservation and Recovery Act Ten-Year Renewal Application for the Waste Isolation Pilot Plant Hazardous Waste Facility Permit to the New Mexico Environment Department Hazardous Waste Bureau. The Renewal Application was submitted to the NMED pursuant to Permit Part 1, Section 1.7.3., Duty to Reapply. The NMED received numerous comments during the public review period, and these were addressed by the NMED. During June 20-23, 2023, the Permittees in conjunction with the NMED, held formal confidential negotiations with Parties who had submitted a hearing request and were opposed to specific contested issues in the Draft Permit. On June 23, 2023, the parties signed a Settlement Agreement and Stipulation on Draft Permit which eliminated the need for a public hearing, but also the Agreement stipulated certain conditions that would be placed in the Draft Permit to resolve the contested issues. On October 4, 2023, the NMED issued the renewed WIPP Hazardous Waste Facility Permit (Permit). The renewal Permit became effective on November 3, 2023, after a 30-day implementation period. The issue Permit incorporated the changes agreed to due to the negotiation and the Settlement Agreement and Stipulation on Draft Permit. Additionally, during the CY the WIPP Site's U.S. Fish and Wildlife Service Permit was renewed and effective on April 1, 2023.
Objectives, Targets, and Program(s)	Significant impacts and aspects are documented in the WIPP EMS Planning Matrix, which drives the creation of the WIPP Project strategic level environmental objectives and project targets. This is documented and made public by the WIPP Environmental Policy Statement and the EMS Planning Matrix via the internal EMS website. The SSP contributes to establishing 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, ecologically sensitive areas, and 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 the 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, 13 environmental targets were pursued and reported in the SSP in FY 23. Of those 13 targets, four were successfully completed during the CY and six more were close to completion. Progress toward DOE sustainability goals is gained by completing of EMS environmental targets. Targets are tracked and reported in support of the WIPP Environmental Policy Statement in the EMS Planning Matrix and reported to senior management via the Annual Management Review, which took place on November 15, 2023.
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, which is mandatory for WIPP Project personnel, MOC subcontractors, and embedded subcontractors every 24 months. Every WIPP employee completes an in-depth initial General Employee Training and annual refresher as well as a 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 includes EMS-specific information for new employees, including the requirement to take the ENV-100 course. During an internal full-scale audit of the EMS in September 2023, it was identified that there was a less than adequate completion rate of GTFE-01 and ENV-100, which resulted in WIPP-ISSUE-23-1726. This issue was assigned to the Training department and has been addressed and corrected. At the end of CY 2023, GTFE-01 and ENV-100 completion rates had increased to 88.5 percent of SIMCO personnel.
Operational Control	Operational controls are established, and changes are controlled, reviewed, and planned in accordance with the WIPP Conduct of Operations and Conduct of Engineering Programs. The Conduct of Operations Program ensures processes are designed and technology is used for control as appropriate and operations are planned and executed in a formal, disciplined manner that protects people and the environment. Changes to physical equipment and configuration are managed through

	the Conduct of Engineering Program. This program ensures that proposed changes are analyzed for potential impacts. Changes to administrative controls such as programs, plans, and procedures are addressed via the document control process. Quality Assurance programs provide an integral function that supports operational controls. Comprehensive CBFO and WIPP QA programs have been implemented to ensure that work is performed in a manner that meets or exceeds quality and regulatory requirements. In CY 2023, The QA and CBFO organization conducted audits and surveillances including, but was not limited to: issue notice effectiveness reviews, nuclear safety, design engineering, conduct of operations, technical training, emergency management, VOC monitoring, radiation protection, environmental management, Central Characterization Program packaging and container management, dosimetry, DP-831 permit monitoring, waste confirmation, groundwater detection and monitoring, and packaging and transport of radioactive material.
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 2023, 27 drills and exercises were conducted that provided training opportunities specific to underground and building evacuations, Central Monitoring Room operations, emergency response and Emergency Operations Center (EOC) functionality, and the practice of surface protective actions at the WIPP Site and the Skeen-Whitlock Building. This included a full-scale drill in October 2023 with a severe weather event scenario that resulted in an unfiltered release. The planning for drills and exercises is based on the data from the Emergency Planning Hazards Survey, which is used 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 Eddy and Lea County Sheriff's Offices and emergency management offices to prepare 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 developing and scheduling of emergency training for the hospitals in response to a contaminated injured victim from the WIPP facility. The purpose of the drills and exercises is to ensure that the WIPP facility and emergency response personnel are adequately trained in the event of an

	emergency at the WIPP Site. The WIPP Emergency Management Annual Exercise is designed for testing or validating the effectiveness of the on-site response in accordance with WIPP emergency plans and procedures as well as the communication and coordination of offsite response agencies providing assistance and resources to a WIPP Operational Emergency. The Emergency Management Section updates applicable plans and procedures in conjunction with their Memoranda of Understanding with local, regional, state, and federal agencies. The Fire Department (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 the 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 2023, audits and/or surveillances were performed in the following environmental areas: VOC Monitoring Program, Environmental Management System Program, DP-831 Permit Monitoring & Reporting, and Groundwater Detection & Monitoring Program. This included checks for compliance with environmental requirements related to various environmental parameters. These areas were selected because QA has an independent assessment schedule with the schedule of surveillances/audits determined by requirements and/or management recommendations. • No Management Assessments were performed in the Environmental Program Organization in CY 2023. Management Assessments are scheduled and tracked on the DevonWay software platform. There was one Safety Management Program (SMP) Health Assessment completed during CY 2023 in place of a regularly scheduled Management Assessment: Chapter 9. Radioactive and Hazardous Waste Management Program. This SMP assessment focused on the implementation of Site generated non-radioactive hazardous waste management programs, as well as the implementation of pollution prevention and waste minimization programs on-site and the controls related to associated inventories, configurations, locations, and quantities of site generated wastes. The present SMP health was reported as “good,” implying the SMP is fully functional and effective, and

	any associated issues are of low significance or risk and are adequately managed. Two additional SMPs were initiated during CY 2023 within the Environmental Services department: (1) Chapter 18. Waste Stream Profile Form and (2) Chapter 18. TRU Waste Confirmation. The chapters relate back to the Documented Safety Analysis. Safety Management Programs are Programmatic Administrative Controls that are assessed on a yearly basis within DevonWay. These assessments have been initiated but were not yet closed in the DevonWay system at the end of the calendar year. • In addition, a team of environmental staff consistently reviews 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 correct an inspection form and coach those performing inspections on the core value element for continuous improvement.
Nonconformity, Corrective Action, and Preventive Action	The CBFO continued to apply two programs related to corrective actions and preventive actions: 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 414.1D, *Quality Assurance*, DOE Order 422.1, *Conduct of Operations*; DOE/CBFO-94-1012, *Quality Assurance Program Document*; and DOE/CBFO-04-3299, *Carlsbad Field Office Contractor Oversight Pla*n. 61 ICE forms were assigned to the MOC, and 68 were closed during CY 2023. The Corrective Action Report (CAR) program identifies conditions that are adverse to quality and provides 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 33 CARs issued during CY 2023, none involving any groups within the Environmental Program Organization. The WIPP issues management and CAR programs continue to be robust: WIPP personnel use the 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, *Quality*

	Assurance Program Description. In May 2021, the MOC and CBFO transitioned to utilizing Hanford's DevonWay integrated Contractor Assurance System. 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 the MOC and CBFO options to further integrate and optimize other programs and processes at the WIPP Site under a single enterprise software platform. There were 2,052 Issue Notices generated, and 2,159 Issue Notices closed during CY 2023.
Internal Audit	The QA organization completed a full-scale internal audit of the EMS on September 11-21, 2023, in accordance with the Quality Assurance Independent Assessment Schedule. The results of this audit indicate that the WIPP EMS program is adequate and effectively implemented. The audit resulted in three findings, no conditions corrected during the assessment, and five observations. The findings were as follows: 1. The EMSSC meeting held on August 29, 2023, did not meet the requirements for a quorum. 2. ENV-100 and/or GTFE-01 is not completed by all employees. 3. Sections of the EMS Planning Matrix at the time of the audit needed review. All observations and findings were entered into the DevonWay Issues Management System and have been adequately addressed and corrected. Additionally, a third-party accreditor, AWMS, performed two surveillance audits with one non-conformance identified. The audits determined that the EMS continues to be effective, relevant, and applicable for the scope of certification. The WIPP EMS program, as implemented, remains suitable, adequate, and effective according to the standard.
Management Review	The EMS Coordinator and the Environment, Safety, and Health (ES&H) Senior Manager conducted a management review on the status of the WIPP EMS in November 2023, which was signed November 30, 2023.

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 specifically emphasizes the nine-township area, including 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, biota, 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

Environmental compliance obligations are evaluated biennially by the MOC through the Biennial Environmental Compliance Report (BECR) preparation process and as part of the preparation of the ASER. WIPP implements several other processes that incorporate varying degrees of compliance evaluation, including MOC self-evaluations, such as management assessments, senior supervisory watches, system walkdowns and inspections; MOC independent evaluations performed by QA audits and surveillances; and CBFO evaluations.

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 management and oversight of WIPP lands under their jurisdiction, as well as lands used for WIPP activities outside of the LWB. It contains protocols used for managing and overseeing 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 that the DOE considers and addresses other environmental compliance requirements and sustainability prior to implementing work.

3.2.7 Sustainability

The sustainability program promotes the acquisition and use of Federal Energy Management Program (FEMP) and Energy Star rated appliances, Electronic Product Environmental Assessment Tool (EPEAT) rated electronics, WaterSense rated plumbing fixtures, Significant New Alternatives Policy (SNAP) and Safer Choice labeled chemicals, BioBased/BioPreferred materials, and SmartWay logistic providers. These actions support the WIPP EMS regarding utility efficiency, reduction of greenhouse gas (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 helps ensure compliance requirements are met for waste 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 that 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 satisfies requirements in the Hazardous Waste Facility Permit (HWFP) and Documented Safety Analysis.

3.2.11 Waste Management

The Waste Management program includes the framework for ensuring that site-generated hazardous, universal, NM 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 the 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 by extensive environmental monitoring for 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

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

The EMS Coordinator 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.

At the end of CY 2023, it was determined that the EMS continued to be suitable, adequate, and effective in implementing the strategic principles outlined in the WIPP Environmental Policy Statement.

3.3.3 Sustainability Progress (Continuous Improvement)

The annual WIPP 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 that the CBFO/MOC achieved "green" status. Overall, "green" status indicates that at least 80 percent of reporting EMS topics are rated as green (at least three As, the rest Bs).

The WIPP SSP details the environmental performance specific to supporting federal sustainability goals. Refer to the FY SSP for details regarding energy, water, fleet management, clean and renewable energy projects, sustainable acquisition and procurement, investments for improvement measures, workforce, and the community, fugitive emissions and refrigerants, and organizational adaptation and resilience.

For FY 2023, the DOE had eight overarching sustainability categories goals (taken from the DOE Sustainable Performance Office's Sustainability Dashboard):

1. Scope 1&2 Greenhouse Gas Emissions: Reduce direct GHG emissions by 65 percent by FY 2030 relative to FY 2008 baseline.
2. Scope 3 Greenhouse Gas Emissions: Reduce indirect GHG emissions by 25 percent by FY 2025 relative to FY 2008 baseline.
3. Energy Intensity: Reduce energy intensity by 50 percent by FY 2030 relative to FY 2021 baseline. Per the 2024 Sustainability Strategic Plan, reduce energy intensity by 15 percent by FY 2025 relative to the FY 2021 baseline.
4. Renewable Energy: Use 30 percent renewable energy as a percentage of overall facility electricity use by FY 2025.
5. Potable Water Intensity: Reduce potable water intensity by 36 percent by FY 2025 relative to FY 2007 baseline.
6. Fleet Petroleum: Reduce fleet petroleum use by 20 percent by FY 2015 and thereafter relative to FY 2005 baseline.
7. High Performance Sustainable Buildings: Ensure 15 percent (18 percent by gross square feet) of buildings meet the Guiding Principles for Sustainable Buildings by FY 2025.
8. Fleet Greenhouse Gas Emissions/Mile: Reduce per-mile greenhouse gas emissions by 30 percent by FY 2025 relative to FY 2014 baseline.

Progress toward the following sustainability goals was accomplished during FY 2023 according to DOE's Comprehensive Scorecard:

Greenhouse Gas Management

- Scope 1 & 2 Greenhouse Gas Emissions: reduce direct GHG emissions by 50 percent by FY 2025 relative to FY 2008 baseline. The Site's scope 1 and 2 GHG emissions have been reduced by 36.4 percent from the FY 2008 baseline.
- Scope 3 Greenhouse Gas Emissions: reduce indirect GHG emissions by 25 percent by FY 2025 relative to the FY 2008 baseline. The Site's scope 3 GHG emissions have been reduced by 15.6 percent from the FY 2008 baseline.

Waste Management

- Municipal Solid Waste: divert at least 50 percent of non-hazardous solid waste (excluding construction and demolition debris). The Site diverted 72.8 percent of its non-hazardous solid waste from being landfilled in FY 2023.

Electronics Stewardship

- Electronics Acquisition: 100 percent of eligible electronics procurements must be environmentally sustainable (e.g., EPEAT). During FY 2023, 99.4 percent of eligible electronics procurements were EPEAT-registered to the highest available level. The WIPP Site was awarded an EPEAT Purchaser Award in 2023 by the Global Electronics Council.
- Electronics Recycling: Dispose of 100 percent of electronics through government programs and certified recyclers. The WIPP Site generated 12.84 metric tons of electronics to be disposed of in FY 2023, and 100 percent were either recycled

through the Federal Prison Industries program (operating under the trade name UNICOR), a certified electronics recycler or donated to the local community.

- Power Management: Implement and actively use power management features on 100 percent of eligible computers (personal computers and laptops) and monitors. The WIPP Site owns just under 5,500 computer monitors and central processing units as of 2023, all of which actively use power management features.
- Duplex Printing: Implement and actively use duplex printing features of 100 percent of eligible printers. The WIPP Site actively uses duplex printing features on all eligible printers as a default printing setting.

3.3.4 Reduce Greenhouse Gas Emissions

The WIPP Site used 21,274.54 megawatt hours of electricity in FY 2023, an increase of 11 percent compared to FY 2022. The increase is due to the number of shipments doubling over the same time period. With the addition of new systems and equipment, and the expansion of the Site footprint along with an increase in shipments, WIPP's energy usage will grow significantly. WIPP will be expanding the Site's power capacity over the same time period to support the additional loads.

WIPP has begun to explore the installation of renewable energy and battery energy storage systems at the Site. It has completed a power study and a 30 percent design for a solar photovoltaic (PV) array coupled with a battery energy storage system. In parallel with the effort, the DOE's Cleanup to Clean Energy program aims to repurpose parts of DOE-owned lands, portions of which were previously used in the nation's nuclear weapons program, into sites for clean energy generation; the WIPP Site has been named as one of the five potential development sites. The WIPP Site does not use natural gas in any of its systems. One of the subsidiary offices in Carlsbad, NM, uses natural gas for water heating.

WIPP is also installing advanced metering and monitoring equipment, starting at the substation level and then working down to the building level. The meters are being permanently installed and are recording at one-minute intervals. At the moment, they do not transmit data, but the planned data system will use a local area network to transmit information to a remote location, for further transfer to interested divisions. Metering will allow for Site personnel to conduct both internal and external benchmarking.



Figure 4 – Construction of the SSCVS, Photography by Roy Neese

WIPP is constructing two systems that will dramatically increase the site's energy usage: the SSCVS (Figure 4) and the corresponding utility shaft. The SSCVS will increase airflow to the

underground area from 170,000 cubic feet per minute (cfm) to 540,000 cfm. The corresponding new utility shaft will provide air to the SSCVS. Although the site does not have any high-energy mission specific facilities (HEMSFs), the installation of the SSCVS and the corresponding new utility shaft may be considered an HEMSF and will substantially impact sustainability metrics, including GHGs.

Options to reduce GHGs include purchasing renewable energy; purchasing renewable energy certificates (REC); building onsite renewable energy generation; and continuing to install retrofit and replace equipment with energy-efficient equivalents. The first option is currently unavailable, the third option is costly and time consuming, and the last option cannot reduce emission to zero, leaving RECs as the remaining alternative.

Renewable energy certificates represent the energy generated by renewable energy sources, such as solar or wind power facilities. Buying RECs is not equivalent to buying electricity. Instead, RECs represent the clean energy attributes of renewable electricity that is generated elsewhere. RECs can be purchased to offset the GHGs attributed to site energy usage. The most economical way for WIPP to achieve Scope 1 and 2 GHG reduction goals is by purchasing RECs.

Given the facility's lack of access to alternative fuels, the facility will continue to use electricity or diesel to power mobile and light-duty equipment and vehicles. WIPP is currently working to reduce and electrify non-fleet vehicles and equipment at the Site. Light-duty trucks using gasoline have been replaced with electric equivalents, and infrastructure to charge these vehicles is being added and planned.

3.3.5 Water Efficiency and Management

As it is in a remote location on the edge of the Chihuahuan Desert, water, consumption, and discharge are important to site operations. WIPP has instituted purchasing guidelines for water-using equipment for both current systems and equipment and new buildings and installations. It plans to install WaterSense-labeled and other high-efficiency restroom fixtures through retrofit and replacement strategies. Water lines are being tested, water leaks are being identified and pipes repaired, and water usage is tracked. WIPP is planning the installation of water meters at the building level to measure and monitor water consumption and to support benchmarking efforts. As a result, water usage during CY 2023 has been reduced by 9.1 percent compared to usage during 2022 (Table 3.1).

The WIPP facility is using a demand-side strategy to address the water efficiency of systems and equipment currently in place. Surveys of buildings, systems, and equipment at the site began at the end of CY 2023 and will continue through the first few months of CY 2024. The surveys, once completed, will identify the water using systems at the Site and detail strategies and measures to reduce water usage and discharge. Potential projects include adopting water conservation equipment and measures in the heating, ventilation and air-conditioning systems, bathrooms, showers, deep sinks, and kitchen equipment. On the supply side, the facility is ensuring that newly purchased water-using equipment and systems are efficient. The facility does not have significant water usage to support operations, with most of the water being

consumed by personnel; therefore, strategies and subsequent measures will have to address a significant quantity of very small users to reduce usage.

Despite being in the Chihuahuan desert, the facility suffers from neither water shortages nor excessive water costs. Currently the site embraces Xeriscaping and has a robust stormwater runoff system. If future climate issues result in water shortages or increased water costs, WIPP may have to adjust its strategies to increase conservation efforts.

Table 3.1 – WIPP Total Yearly Water Use (Data provided by the City of Carlsbad Water Department
note: kgal = thousand gallons)

Year	Use (kgal)
2023	5,551
2022	6,104
2021	6,809
2020	4,409
2019	3,749
2018	6,738
2017	3,687
2016	5,182
2015	4,271
2014	3,258
2013	3,350
2012	4,596

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, construction and demolition (C&D), hazardous, universal, and NM special waste streams. Non-hazardous site generated waste recycled by the P2 program includes lead acid batteries, alkaline batteries, aluminum, cardboard, ink and toner cartridges, paper, number 1 polyethylene terephthalate plastics, wood pallets, hard hats, 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 electronic wastes (computers, 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 2023, a total of 551.31 metric tons of municipal solid waste, wood waste, and recyclable materials were generated at the WIPP Site and associated construction & demolition-related activities. The WIPP Site successfully diverted 49.93 percent, or 275.28 metric tons, of that waste from the local landfill (inclusive of waste generated from capital construction projects).

The WIPP Site—excluding waste generated from capital construction projects—generated a total of 291.66 metric tons of municipal solid waste, wood waste, and recyclable materials in FY 2023. Of that, 220.7 metric tons, or 75.67, percent was

recycled and diverted from being landfilled. Capital construction projects (Shaft 5 and SSCVS construction) generated 259.65 metric tons of municipal solid waste and recyclable materials (metal), 54.58 metric tons or 21.02 percent of which was recycled (Figure 3.1).

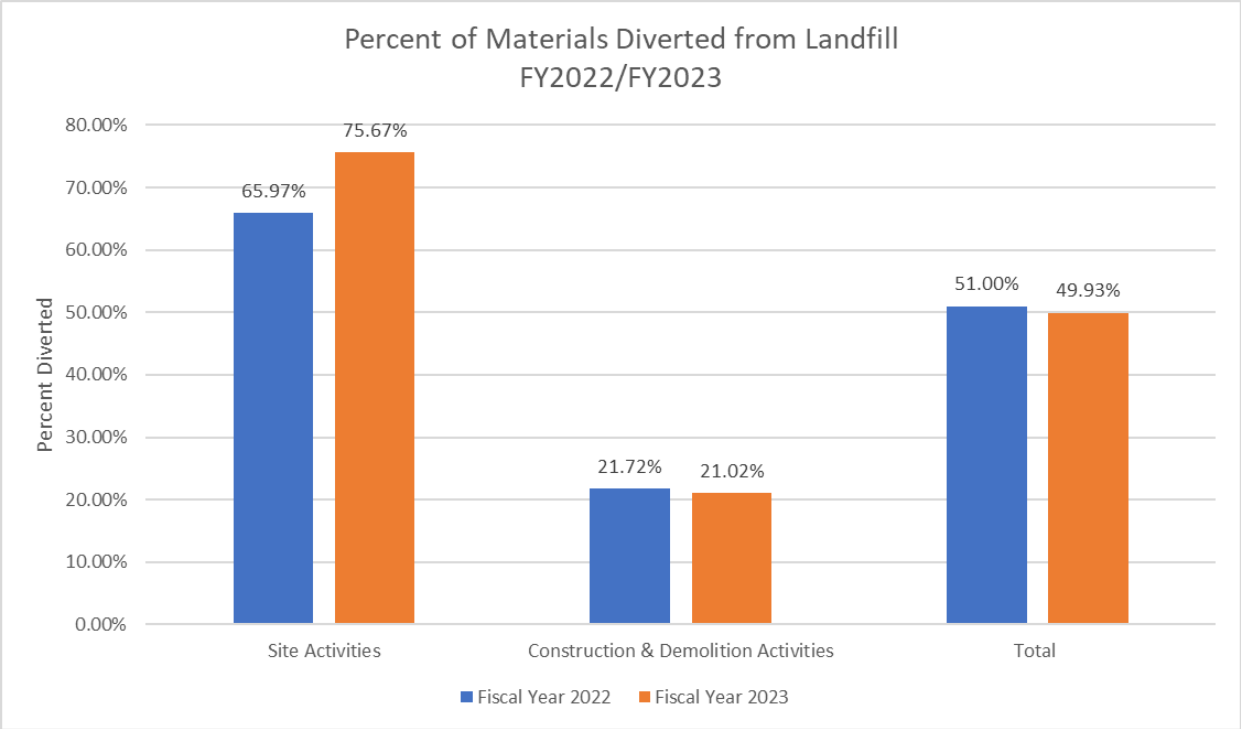

Figure 3.1 – Percent of Materials Diverted from Landfill, FY 2022 / FY 2023

3.3.6.1 Plans and Projected Performance

Efforts toward making continual improvements to maintaining and ultimately improving the Site's waste diversion rate are focused on employee awareness and training along with continued efforts to identify new recycling pathways.

For FY 2024, actions to improve waste diversion rates and source reduction include:

- Monitoring the placement areas and maintenance of the recycling bins around the Site.
- Recycling wood pallets through pallet vendors.
- Finding new vendors for recycling waste that is yet to be recycled, such as wood shipping crates and recyclable office waste.
- Educating Site personnel on the P2 and Waste Minimization Program. Site Environmental Compliance (SEC) personnel will continue distributing regular communications through WIPP Communications and Morning Summaries and

will continue to develop resources for Site personnel to educate and encourage recycling and source reduction participation.

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 purchasing and using sustainable products, goods, and services.

The implementation to expand the EMS with emphasis on sustainability in procurement standards was started during FY 2017 and is still applicable. 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 ozone-depleting substances (ODSs).

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

During the CY 2023, efforts to improve the acquisition of sustainable products included increasing site personnel's awareness of sustainable acquisition and reporting requirements. This included efforts to create a WIPP-specific Sustainable Acquisition Training (still underway) and the creation of a new Sustainability SharePoint site. SEC personnel review all credit card purchases at the Site to ensure applicable purchasing requirements are being met when feasible and appropriate documentation is generated when it is not. To better track sustainable purchases for end-of-year reporting, SEC personnel are working with representatives from Procurement and the Information Resource Management departments to update the Integrated Financial Management System procurement database to create streamlined data reports of all applicable sustainable purchases.

3.3.7.1 Plans and Projected Performance

The EMS will continue to focus on increasing the use of sustainable products to meet projected FY 2024 goals. Actions to help achieve this include:

- Completing WIPP-specific Sustainable Acquisition training and requiring its completion among P-card holders and requisitioners.

- Continuing to review and update sustainable acquisition-related resources available to Site personnel on the new Sustainability SharePoint site.

- Continuing to review and monitor the Site's credit card purchases for opportunities to buy sustainable products when feasible.

- Working with the Procurement Initiative Team to better incorporate sustainable purchasing requirements into all procurement pathways at the Site, including purchases made through all mechanisms outside of a credit card purchase.

3.3.8 Electronics Stewardship and Data Centers

The CBFO/MOC applies sustainable lifecycle management by requiring applicable products, goods, and services to meet management expectations as required, in part, by the WIPP Electronic Management Policy. In September 2020, the CBFO/MOC adopted and issued an update to the *Waste Isolation Pilot Plant 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 expectations 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 that the paper used to produce Site generated printed material shall be printed on 30 percent recycled content copy paper.

The policy requirements continue to ensure that the disposition of surplus electronics is conducted in a manner that meets federal expectations. The CBFO/MOC documents that 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 2023, the WIPP collected 28,298.54 pounds of surplus electronics and electronics needing disposal—about 300 pounds of which was donated to local schools. The collection of old/used electronics will continue through 2024 and will be delivered to UNICOR for refurbishment and reuse or will be donated to the local community.

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 including expanded accountability and documentation expectations.

CHAPTER 4 – ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM INFORMATION

The purpose of Department of Energy Order 458.1, Chg. 4 is to establish requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of the Department of Energy (DOE) pursuant to the *Atomic Energy Act of 1954*, as amended. The objectives of this Order are;

- To conduct DOE radiological activities so that exposure to members of the public is maintained within the dose limits established in this Order;
- To control the radiological clearance of DOE real and personal property;
- To ensure that potential radiation exposures to members of the public are as low as is reasonably achievable;
- To ensure that 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;
- To provide protection of the environment from the effects of radiation and radioactive material.

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 effluent and ambient 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*. 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 must comply with environmental radiation protection standards in 40 CFR § 191.03, Subpart A, which applies to the 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 0.25 mSv (25 mrem) to the whole body and 0.75 mSv (75 mrem) to any critical organ. In a 1995 MOU, 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 0.1 mSv (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. The baseline was established from 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 isotopes of uranium (^{238}U, ^{235}U, and ^{234}U) and potassium (^{40}K) are naturally occurring and not a result of WIPP operations, the data is presented in Appendix G for completeness. The americium and plutonium isotopes make up the majority (> 99 percent based on the Annual Transuranic Waste Inventory Report of 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 the inherent characteristics of the analytical equipment. The MDC represents the minimum radionuclide concentration 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 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.

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 analyzed the 10 target radionuclides in environmental radiological samples. Highly sensitive radiochemical analysis and detection techniques were used resulting in very low detection limits. This allowed the 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 from 1985 through 1989, before 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 in accordance with 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. The following sections describe these two programs.

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 high-efficiency particulate air (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,

Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities.

The supplemental ventilation system (SVS) was operated during this reporting period. 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 the 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 analyzing 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 that is ubiquitous in the Earth’s crust, was also monitored because of its possible enhancement in southeastern NM 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 if 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 air volume 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). Approximately 19,417 cubic feet (ft^3) (550 m^3) of air was sampled each week through the acrylic copolymer membrane filters at Station B. 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, operation of the 700-C fan (i.e., unfiltered exhaust fan) continued. The 700-C fan ran for approximately 3% of the year. The amount of air filtered through the Station B and H acrylic copolymer membrane filters during the CY was 1,009,708 ft^3 (28,592 m^3) and 30,510 ft^3 (864 m^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 1,606 ft^3 (45 m^3) of air passed through each air filter at the average annual sample flow rate of 2 ft^3/min at Station H. 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 214,352 ft^3 (6,070 m^3). Even though there were brief periods where sampling associated with Station C was interrupted during the CY, the 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 to maintain isokinetic sampling conditions.

The Station C effluent air sampling system was designed in accordance with ANSI Standard N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*. 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. 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, indicates 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 the absence of radioactive materials in forms and quantities not conforming to prescribed specifications and limits during this reporting period. Radiochemical analyses were conducted to verify that detected radionuclides remained below an action level indicating 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 4.1.1.0, 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 0.25 mSv (25 mrem) to the whole body and 0.75 mSv (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 0.1 mSv/yr (10 mrem/yr) limit, as specified in 40 CFR §61.92, and the 0.001 mSv/yr (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 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 the typical breathing zone. Location codes are shown in Appendix C.

Weekly samples are composited quarterly for analysis. Assuming no downtime and a stable flow rate, for each week approximately 20,160 ft^3 (571 m^3) of air is sampled through a 1.85-in (4.7-centimeter [cm]) 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), the volume of air for best-case scenario conditions is approximately 262,459 ft^3 (7,423 m^3).

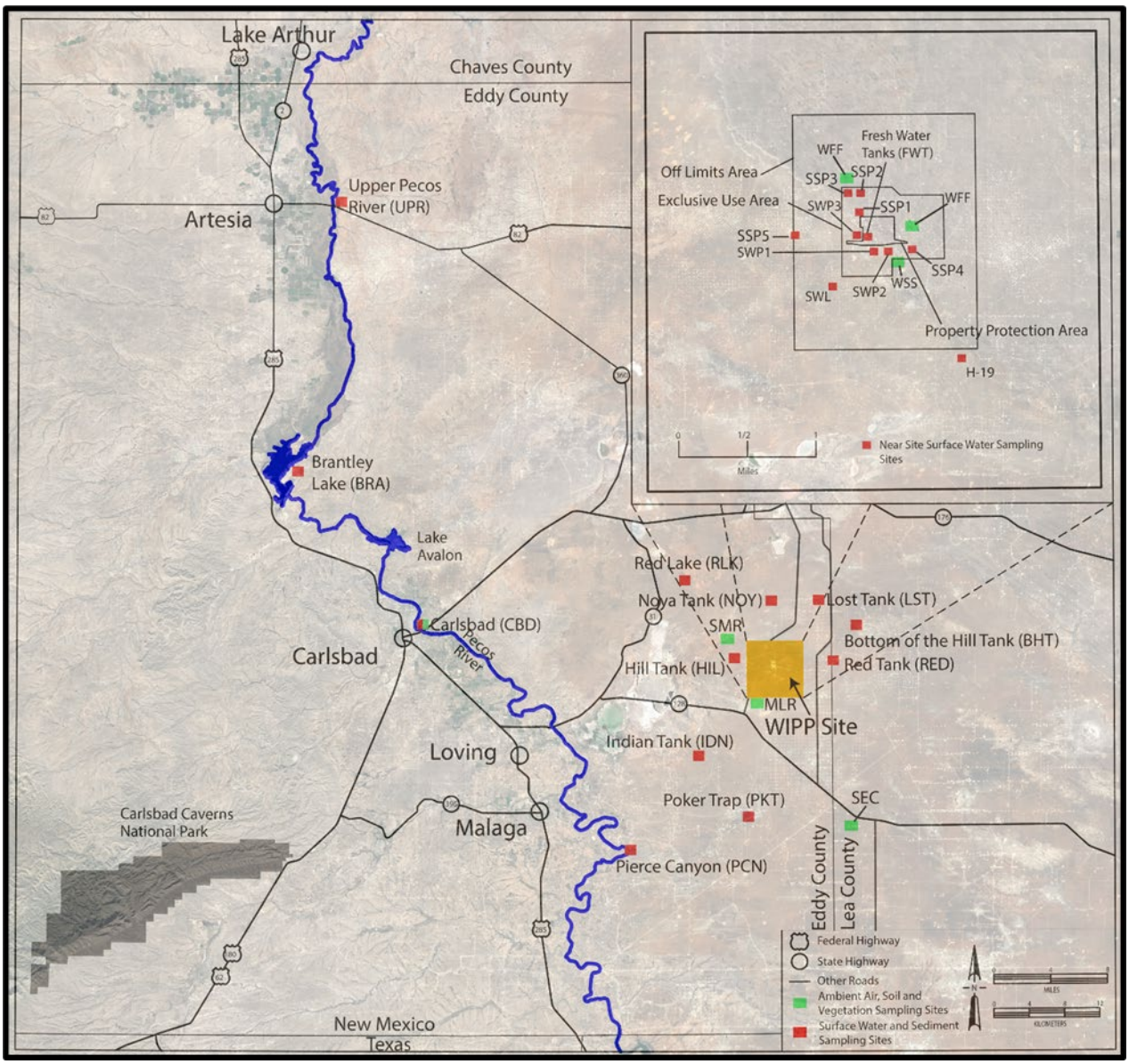

Figure 4.1 – Ambient Air, Soil, Vegetation, Surface Water, and Sediment Sampling Locations on and Near the WIPP Site

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. 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. Appendix G, Table G.4, contains the results in Bq/sample for the quarterly air filter composite samples. A “Q” (qualifier) column is included 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). 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 $^{239/240}Pu$, ^{241}Am, ^{137}Cs, ^{60}Co, are shown in figures below and current levels are within the range of the normal background concentrations. During the fourth quarter there was a power outage at the Smith Ranch location preventing the sampling of the first 11 weeks at which point the solar power sampler was placed in service.

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 after February 18, 2014, were below MDC and returned to background levels (see Figures 4.2a and 4.2b). The data from samples individually analyzed for the release event are provided in DOE/WIPP-15-3547, *WIPP Environmental Radiological Field Sampling Analytical Summary February 2014 to February 2015*. Figures 4.3a and 4.3b show the historical concentrations of gamma-emitting radionuclides at the seven sampling locations.

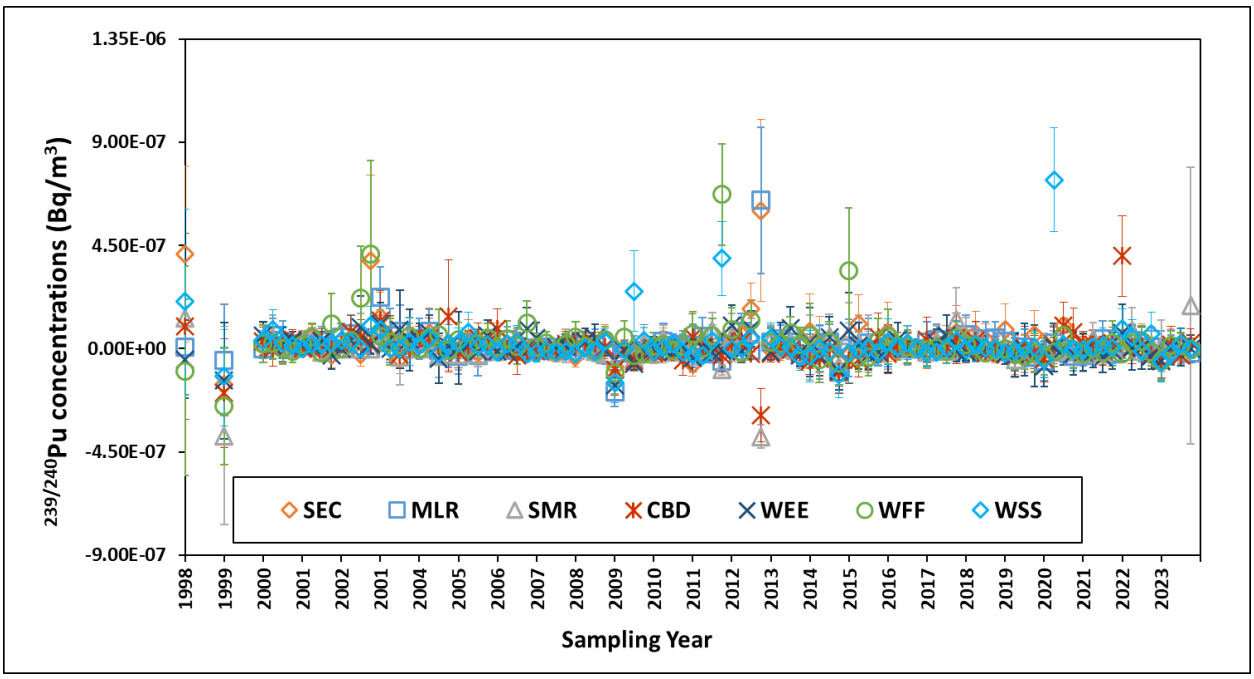

Figure 4.2a – Historical Concentrations of $^{239/240}$Pu at Seven Air Sampling Locations

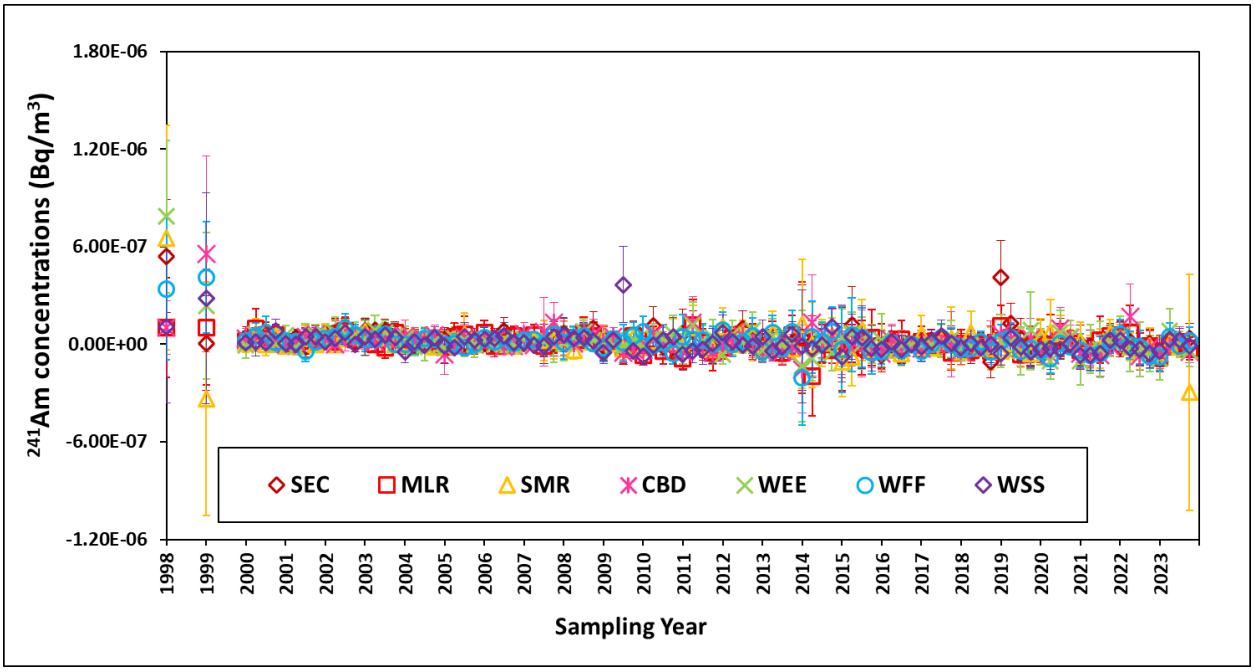

Figure 4.2b – Historical Concentrations of ^{241}Am at Seven Air Sampling Locations

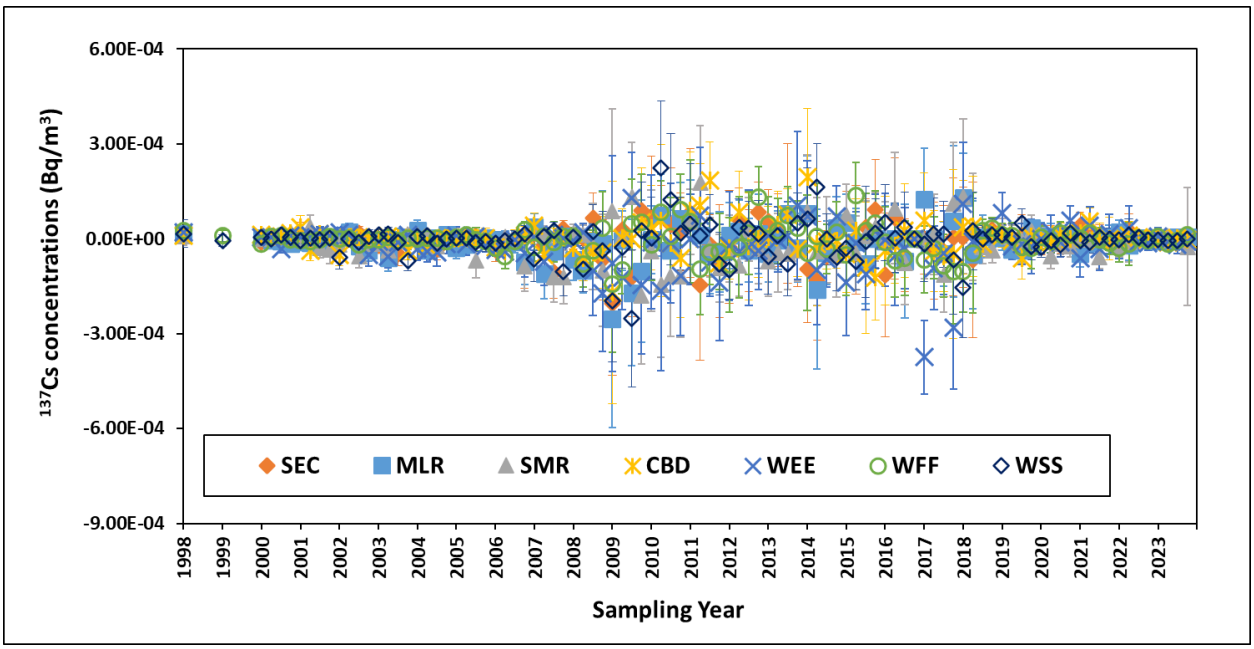

Figure 4.3a – Historical Concentrations of ^{137}Cs at Seven Air Sampling Locations

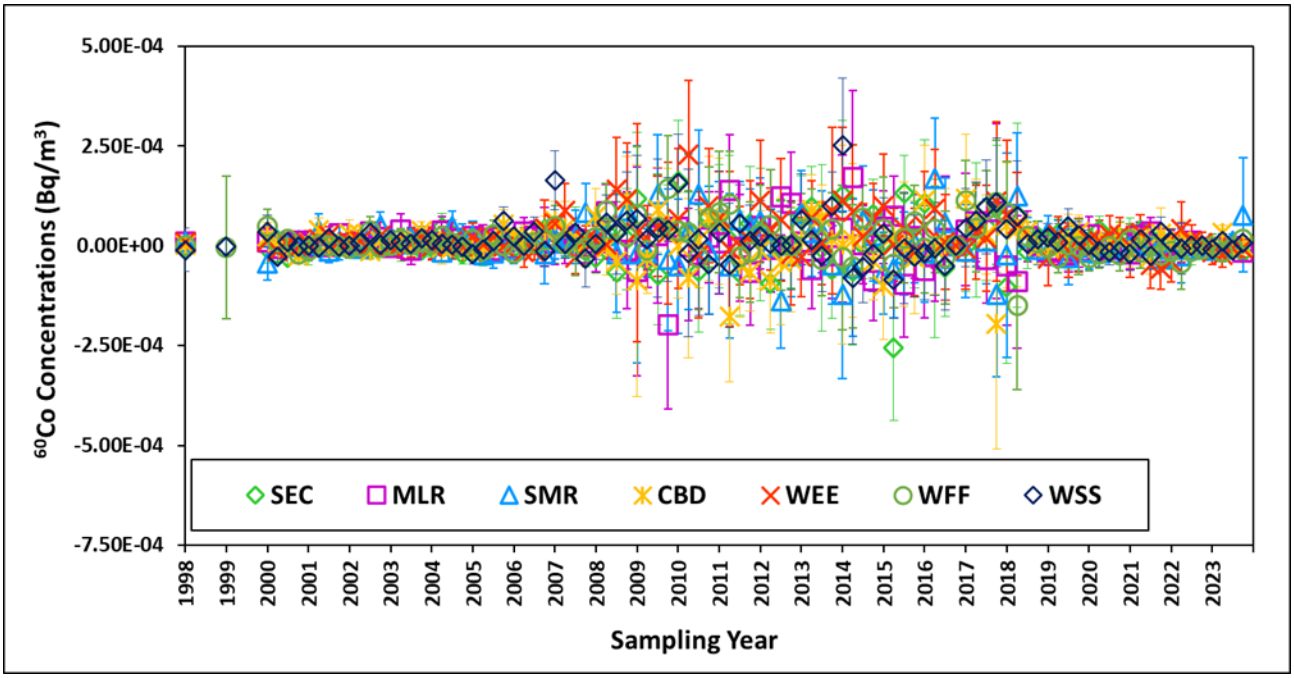

Figure 4.3b – Historical Concentrations of ^{60}Co at Seven Air Sampling Locations

4.3 SURFACE WATER

4.3.1 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 4.1 (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 4.4.

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 the major bodies of surface water and potential livestock uptake locations in the WIPP vicinity. There are four sampling locations on the Pecos River: the Upper Pecos River near Artesia (UPR), Brantley Lake (BRA), Carlsbad (CBD), and Pierce Canyon (PCN). Area ranches used eight dirt tanks (earthen catchment basins) to collect precipitation runoff water for livestock. These tanks are Tut tank (TUT), Noya (NOY), Red (RED), Indian (IDN), Lost (LST), Bottom of the Hill (BHT), Poker Trap (PKT), and Hill (HIL). One other type of surface water sample consisted of water from the WIPP sewage lagoons (SWL). Another sample collected is from the 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. The sample duplicate for the CY was collected as the LST location.

4.3.2 Results and Discussion

The surface water samples were 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 2023. The analysis data for the gamma isotopes and ^{90}Sr are presented in Appendix G, Table G.9.

4.4 SEDIMENTS

4.4.1 Sample Collection

Sediment samples were collected from 12 locations around the WIPP Site (Figure 4.1), and duplicate samples were collected from RED, for a total of 13 samples. See Appendix C for location codes. Evaporation pond H-19 was not sampled in the CY due to an insufficient amount of water in the pond and no rainfall events of 2 inches in a 24-hour period occurred.

4.4.2 Results and Discussion

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 4.4a and 4.4b show historical concentrations of $^{239/240}$Pu at the sampling locations, and the activities measured undetected.

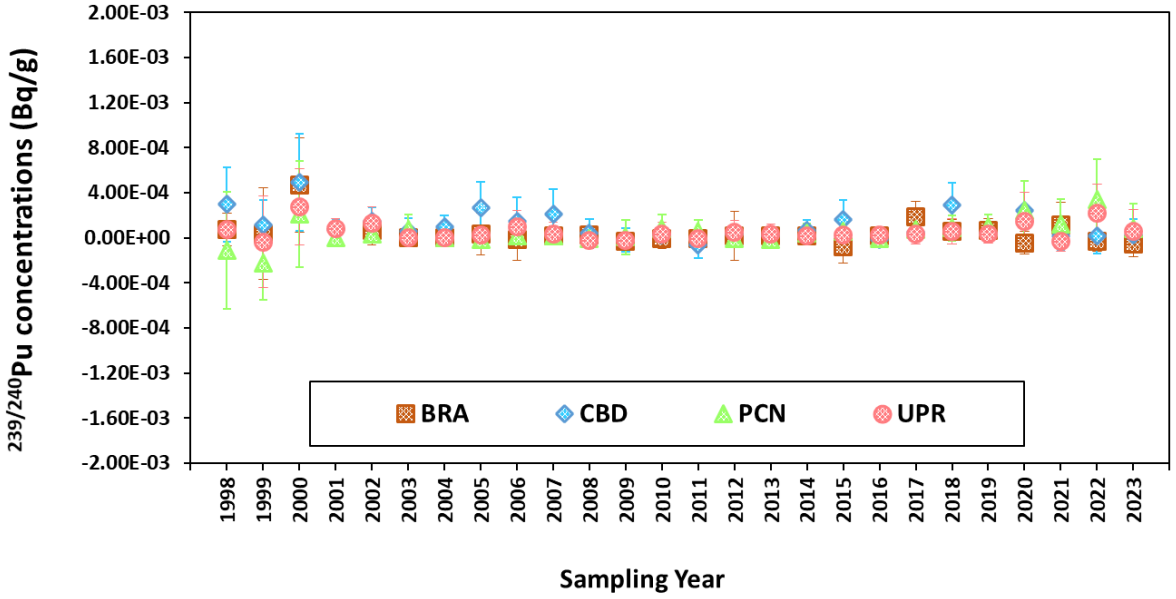

Figure 4.4a – Historical Concentrations of $^{239/240}$Pu in Sediment Samples at Pecos River and Associated Bodies of Water

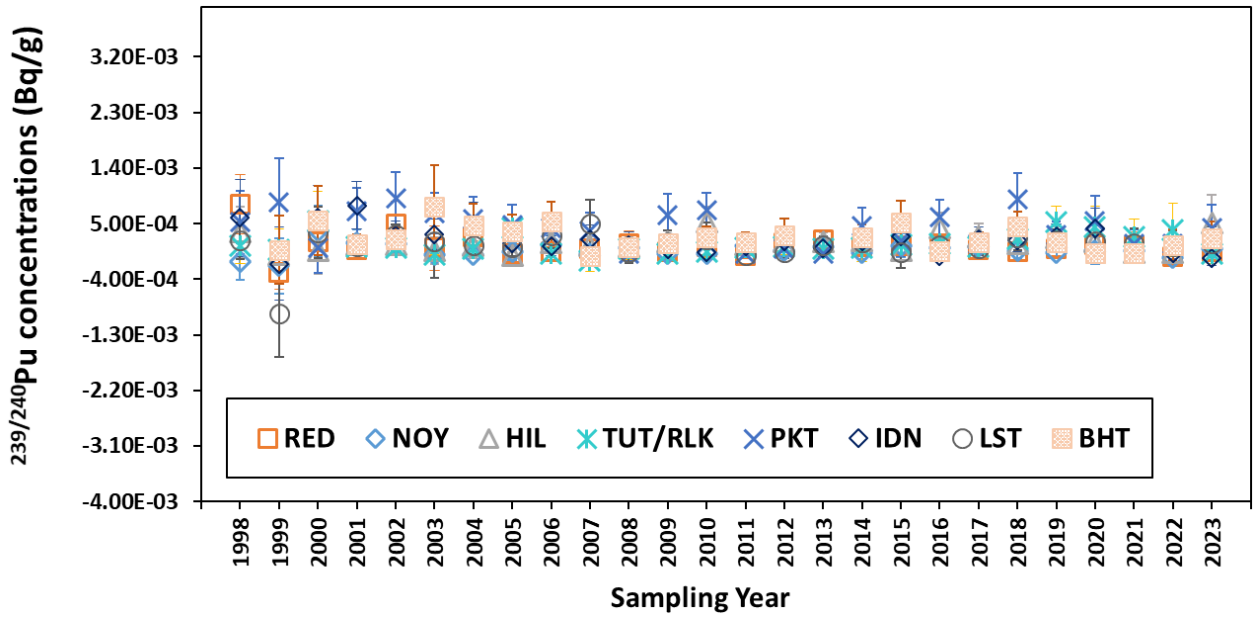

Figure 4.4b – Historical Concentrations of $^{239/240}$Pu in Sediment Samples at Tanks and Tank-like Structures

The sediment analysis results for the gamma radionuclides and ^{90}Sr are shown in Appendix G, Table G.12. ^{137}Cs was detected in NOY, PKT, and BHT. 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 PKT with 9.23E-03 Bq/g (Figure 4.5) which is below the baseline concentration of 3.50E-02 Bq/g.

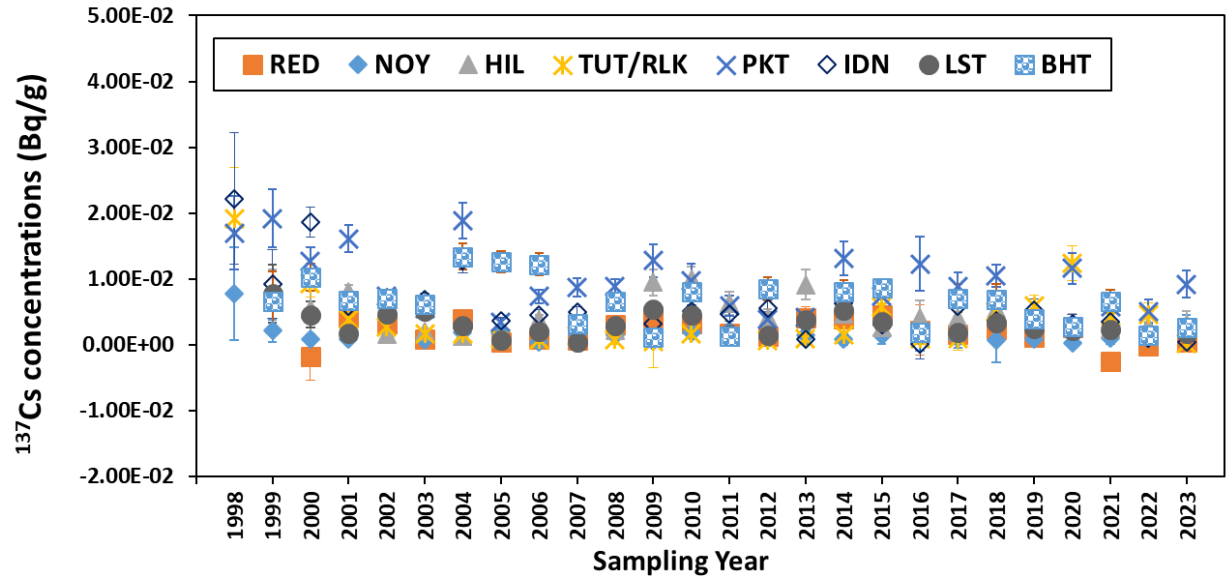

Figure 4.5 – Historical Concentrations of ^{137}Cs in Sediment Samples at Tanks and Tank-like Structures

4.5 SOIL SAMPLES

4.5.1 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 4.1). 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.

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 WFF and MLR on March 16, 2023, WEE (Primary and Duplicate) on March 22, 2023, SMR, SEC, and WSS on April 6, 2023.

4.5.2 Results and Discussion

There were no detections of plutonium isotopes or americium at any of the locations this CY. Appendix G, Table G.14, presents the analysis data for ^{238}Pu, $^{239/240}$Pu, and ^{241}Am. Appendix G, Table G.15, presents the CY soil sample analysis data for the gamma radionuclides and ^{90}Sr. Table G.15 shows that ^{137}Cs was detected in WFF at 2-5cm, MLR at 0-2 and 2-5, MLR Dup at 0-2, SEC at 0-2 and 2-5, and WEE at all three depths. Cobalt-60 and ^{90}Sr were not detected in any of the samples.

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 the 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 4.6 (a, b, and c), 4.7 (a, b, and c), and 4.8 (a, b, and c) show historical concentrations of $^{239/240}$Pu, ^{241}Am, and ^{137}Cs in WIPP soils. The values all fell within the range of concentrations previously observed in WIPP soils.

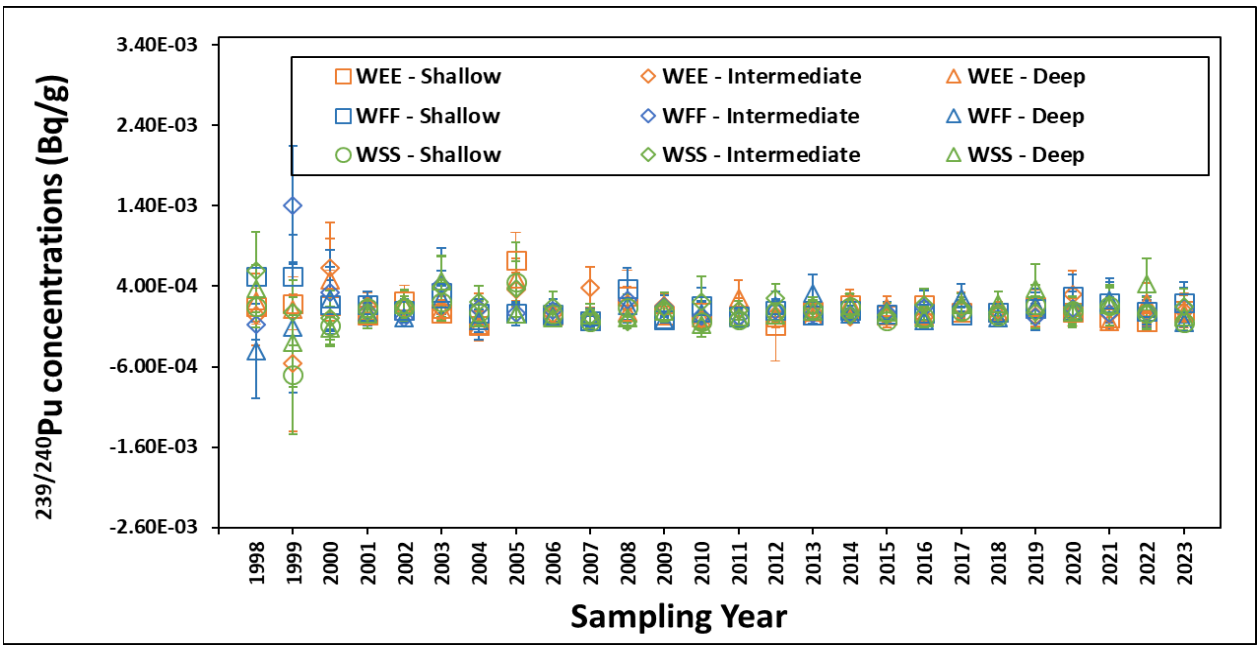

Figure 4.6a – $^{239/240}$Pu Concentrations in Soil Samples Collected from WIPP Site

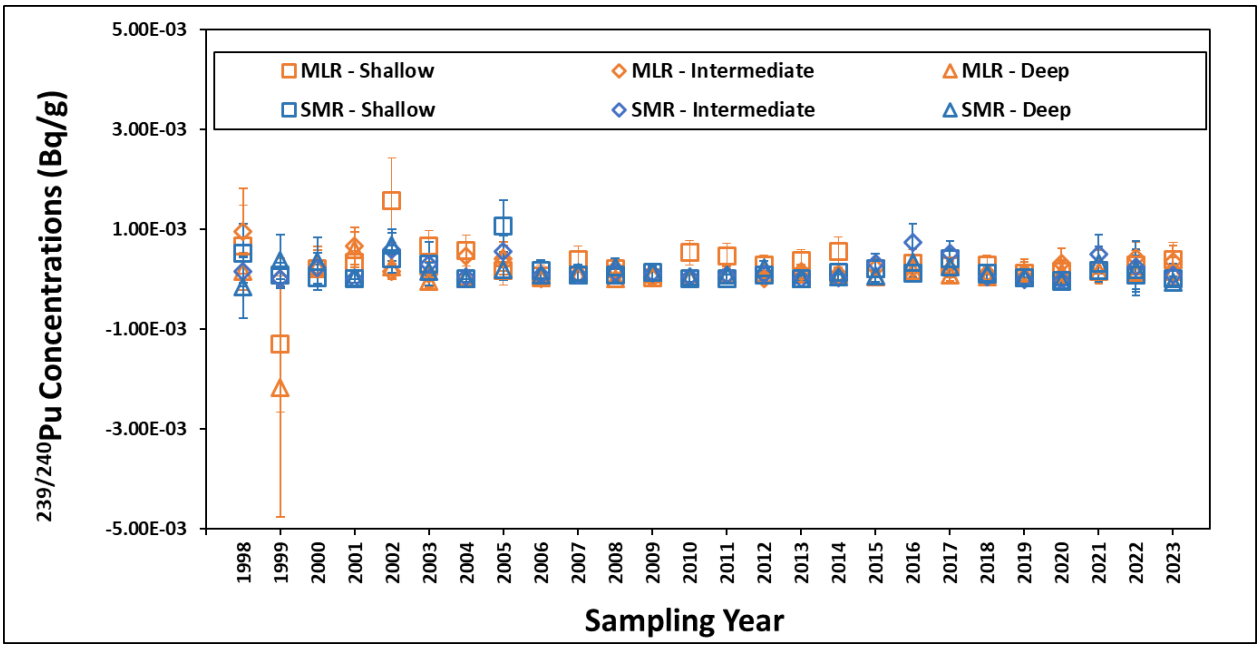

Figure 4.6b – $^{239/240}$Pu Concentrations in Soil Samples Collected from 5-mi Ring

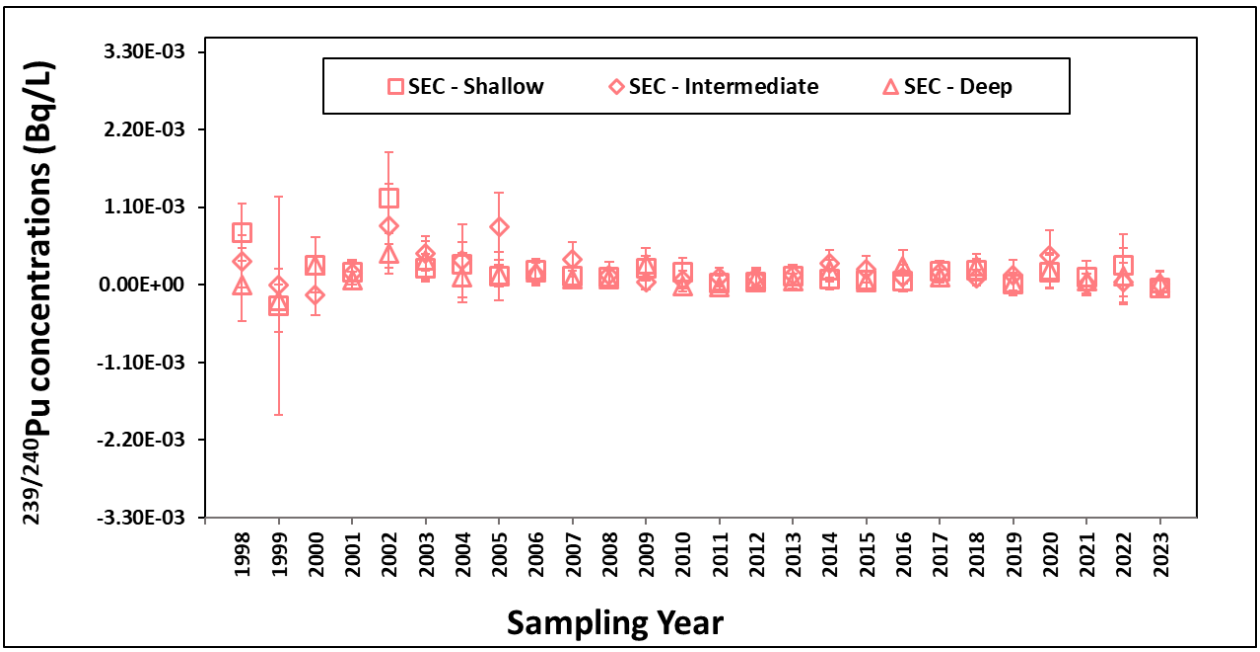

Figure 4.6c – $^{239/240}$Pu Concentrations in Soil Samples Collected from Outer Sites

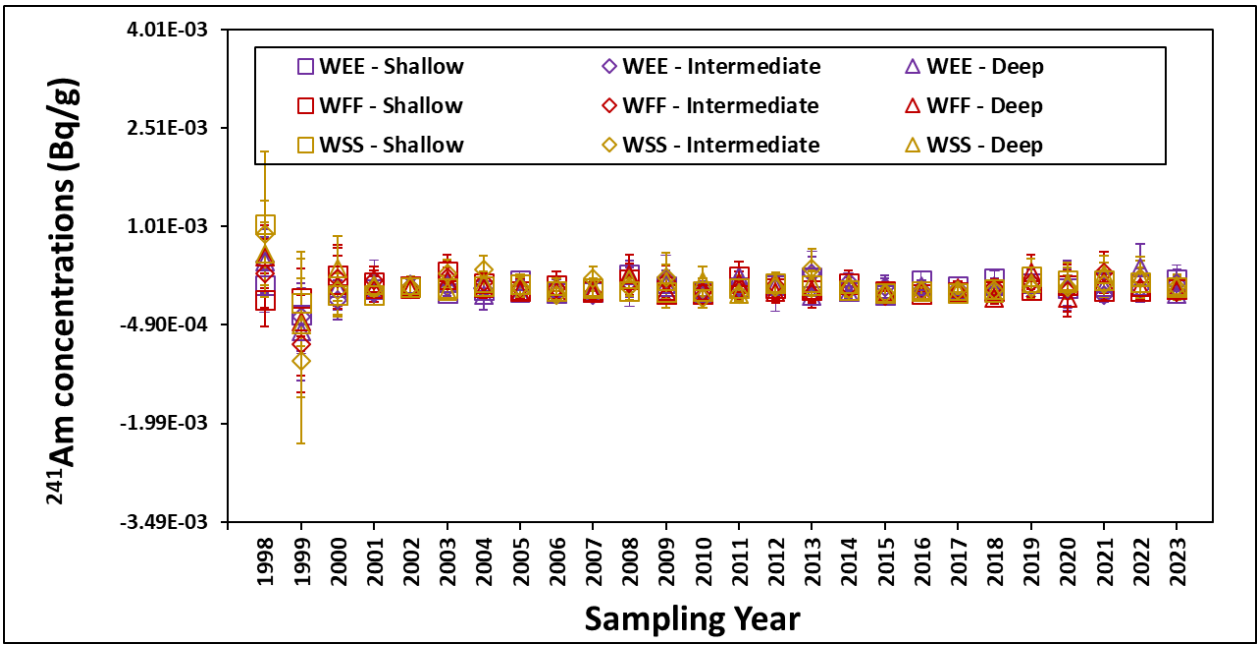

Figure 4.7a – ^{241}Am Concentrations in Soil Samples Collected from WIPP Site

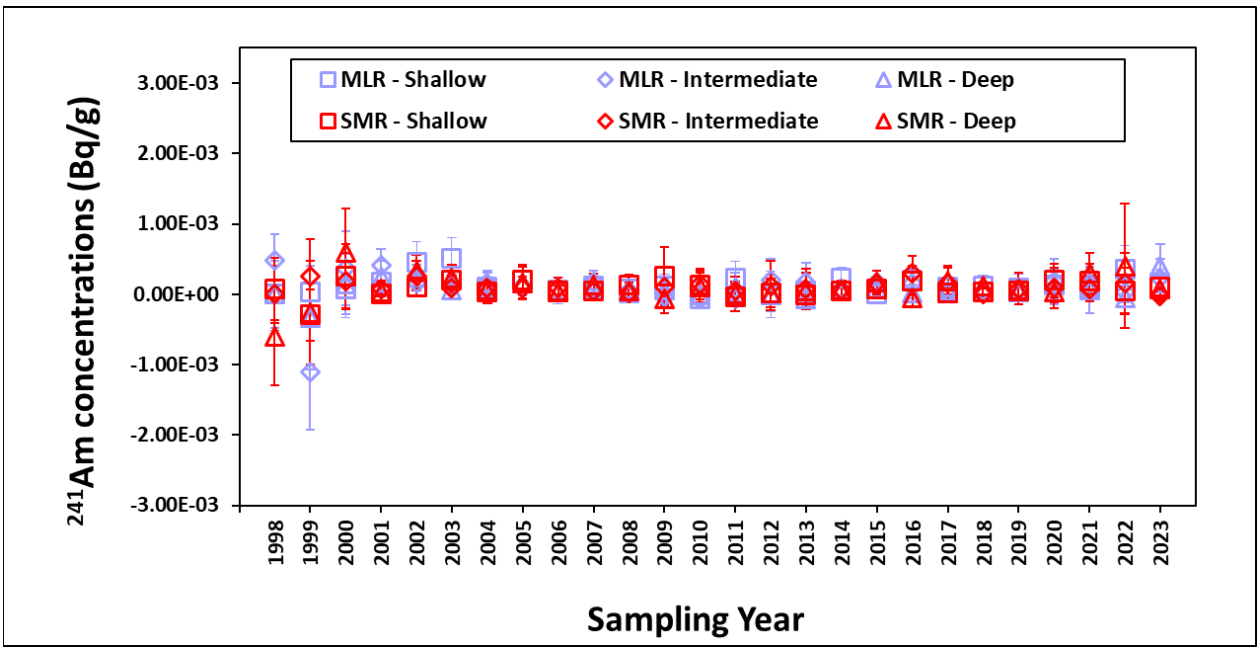

Figure 4.7b – ^{241}Am Concentrations in Soil Samples Collected from 5-mi Ring

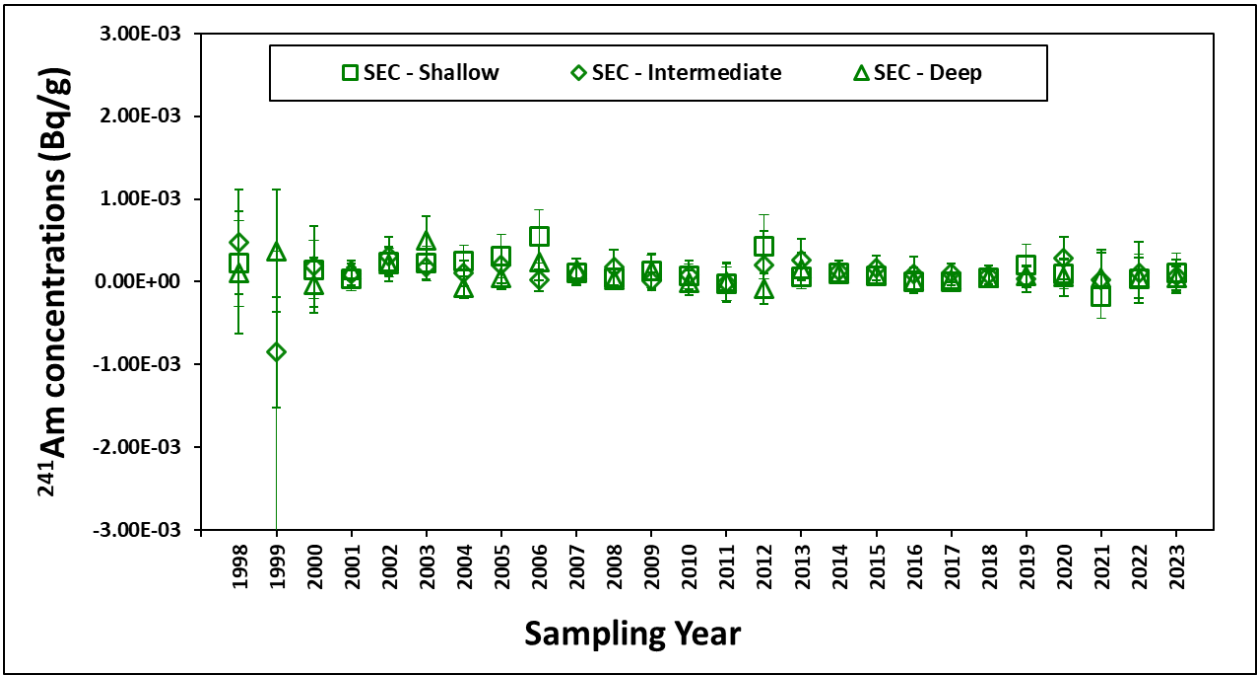

Figure 4.7c – ^{241}Am Concentrations in Soil Samples Collected from Outer Sites

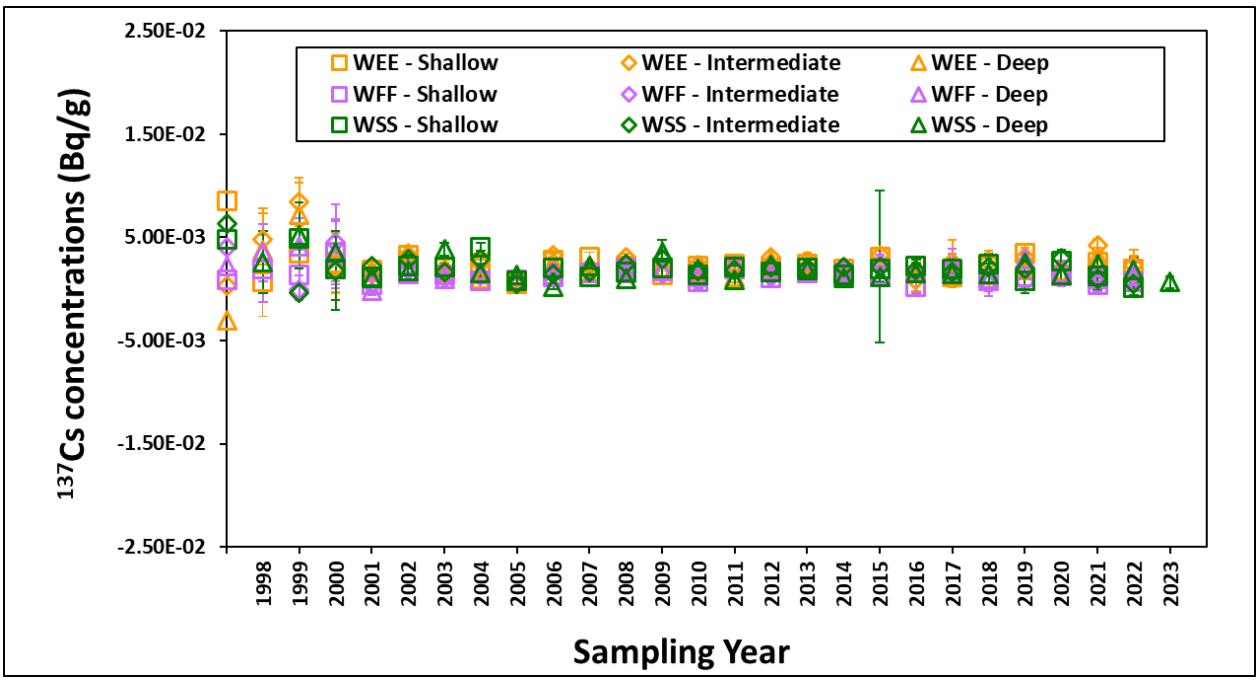

Figure 4.8a – ^{137}Cs Concentrations in Soil Samples Collected from WIPP Site

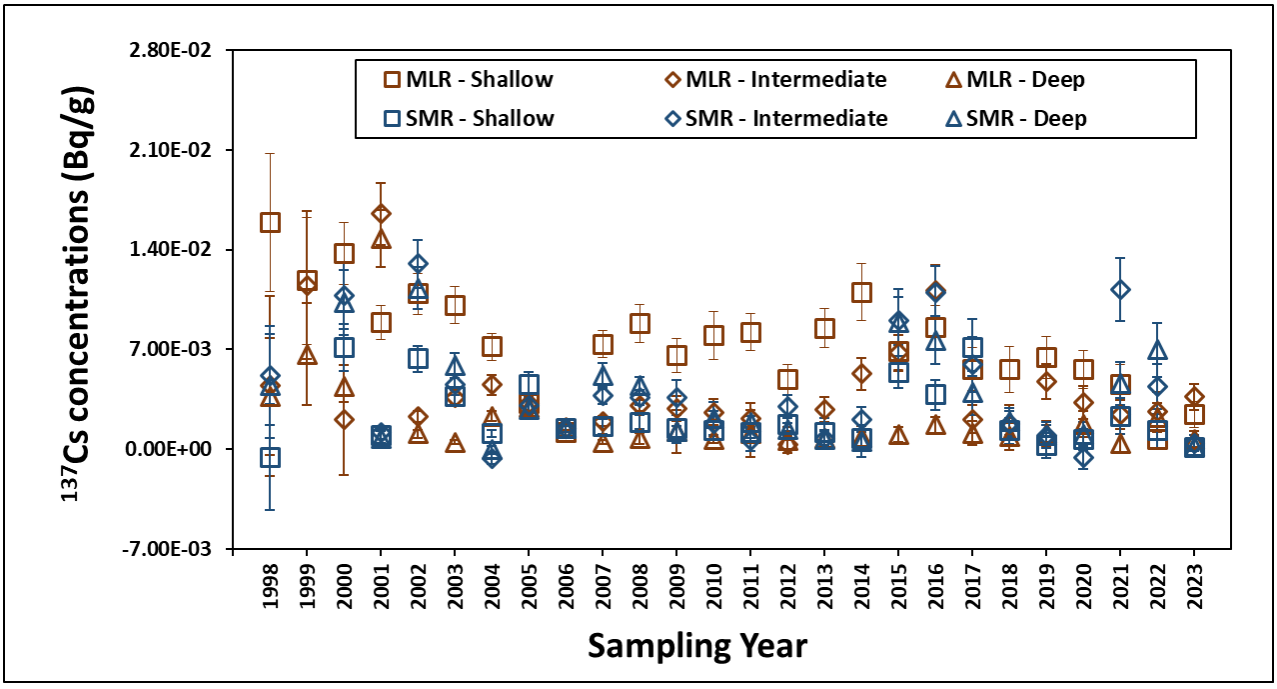

Figure 4.8b – ^{137}Cs Concentrations in Soil Samples Collected from 5-mi Ring

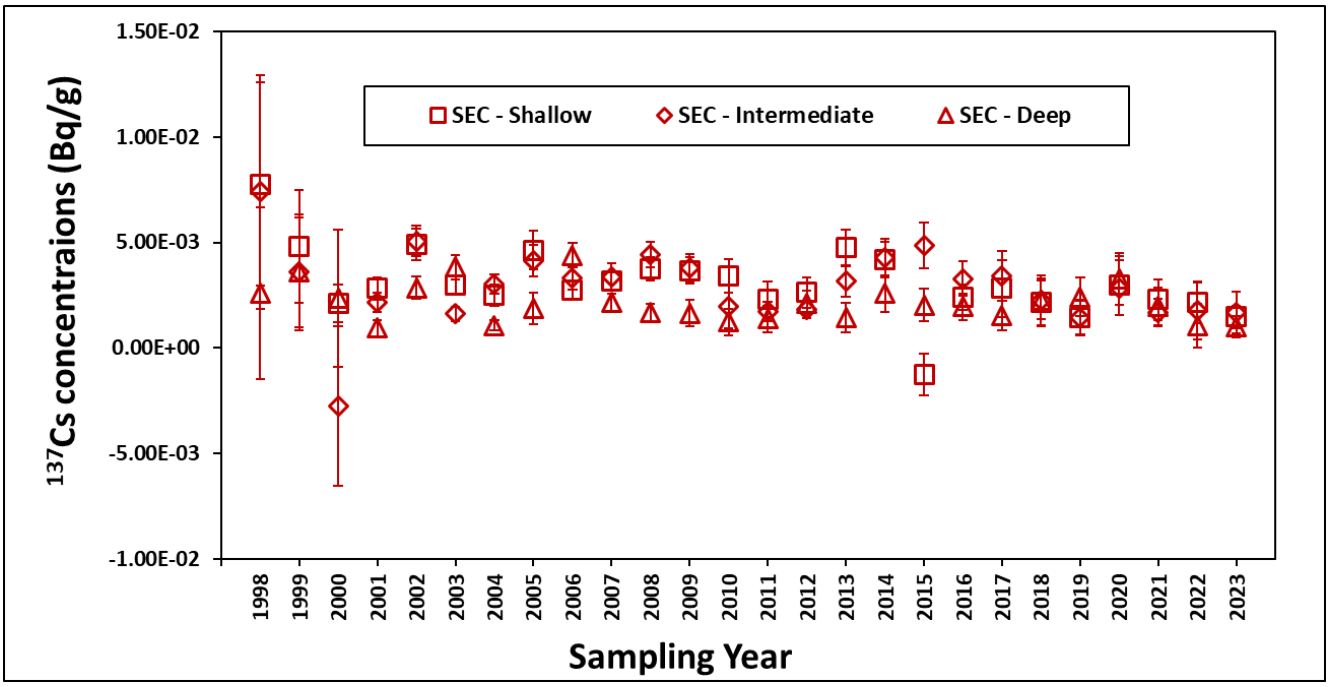

Figure 4.8c – ^{137}Cs Concentrations in Soil Samples Collected from Outer Sites

4.6 BIOTA

4.6.1 Sample Collection

Rangeland vegetation samples were collected from the same six locations as the soil samples (Figure 4.1). Fauna (animal) samples were also collected when available. Biota samples were analyzed for the 10 target radionuclides.

4.6.2 Results and Discussion

4.6.2.1 Vegetation Samples

There were no detections of plutonium isotopes and americium isotopes in any of the vegetation samples. Figures 4.9, 4.10, and 4.11 show historical concentrations of $^{239/240}$Pu, ^{241}Am, and ^{137}Cs in 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 WEE during the vegetation sampling period in 2023. Appendix G, Table G.17, presents the analysis results for the gamma radionuclides and ^{90}Sr during the regular vegetation sampling in the CY.

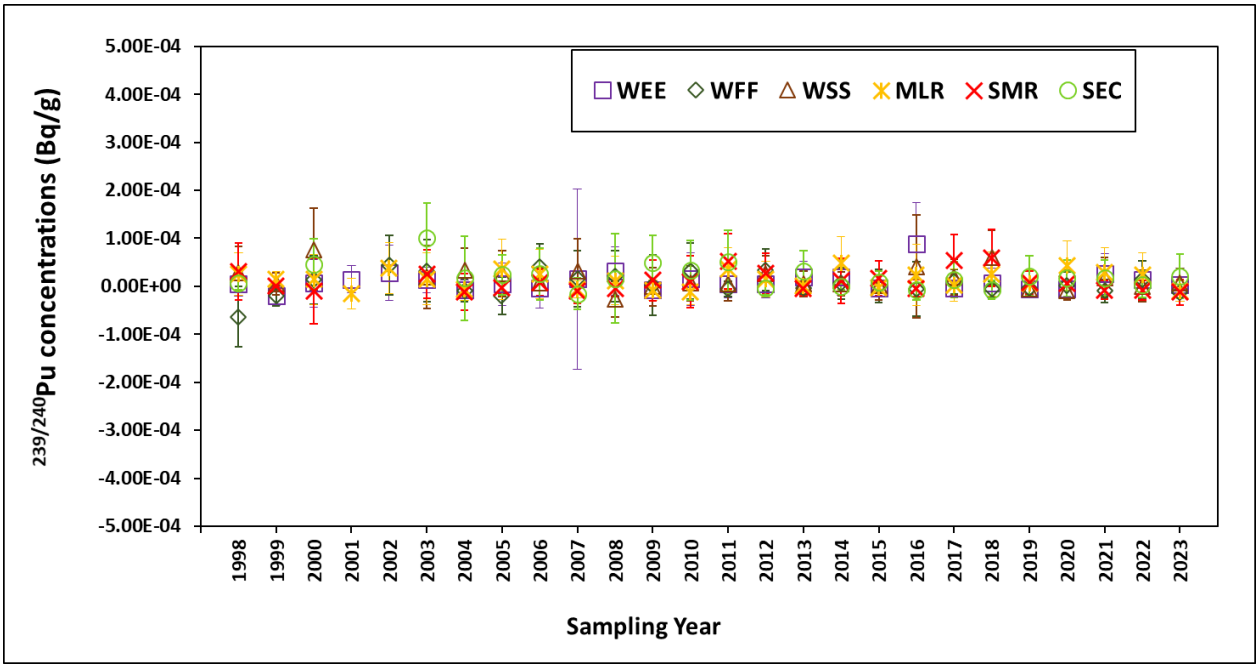

Figure 4.9 – Historical Concentrations of $^{239/240}$Pu in Vegetation Samples Collected from Six Sampling Locations

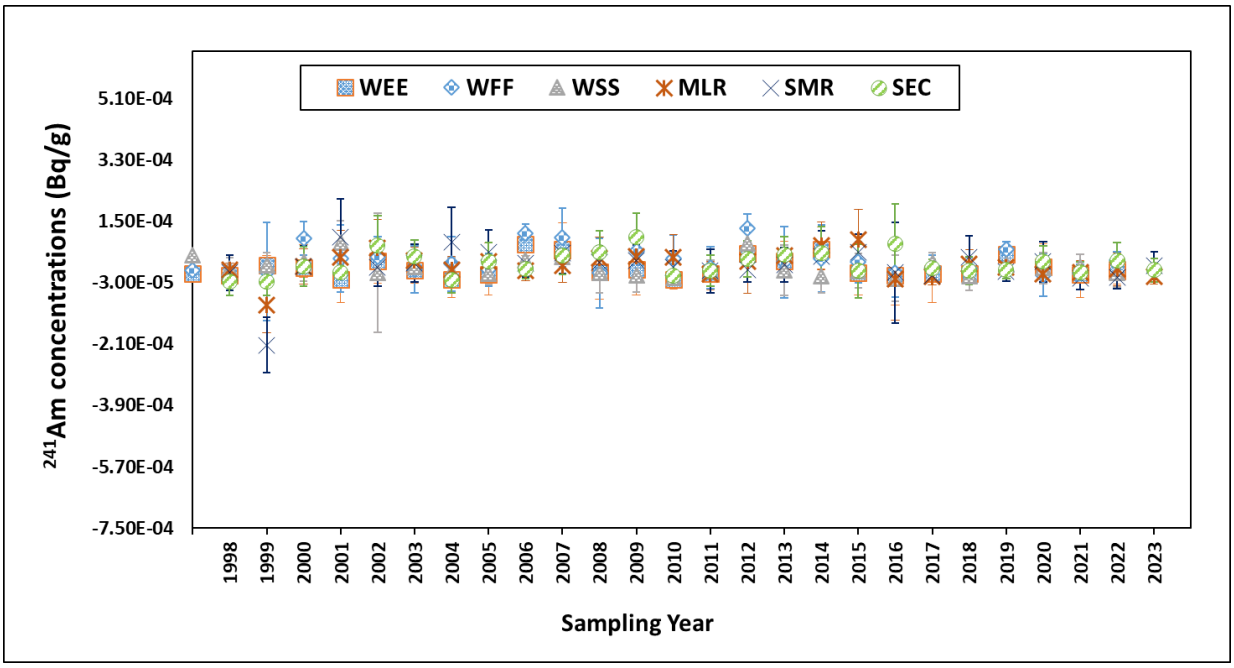

Figure 4.10 – Historical Concentrations of ^{241}Am in Vegetation Samples Collected from Six Sampling Locations

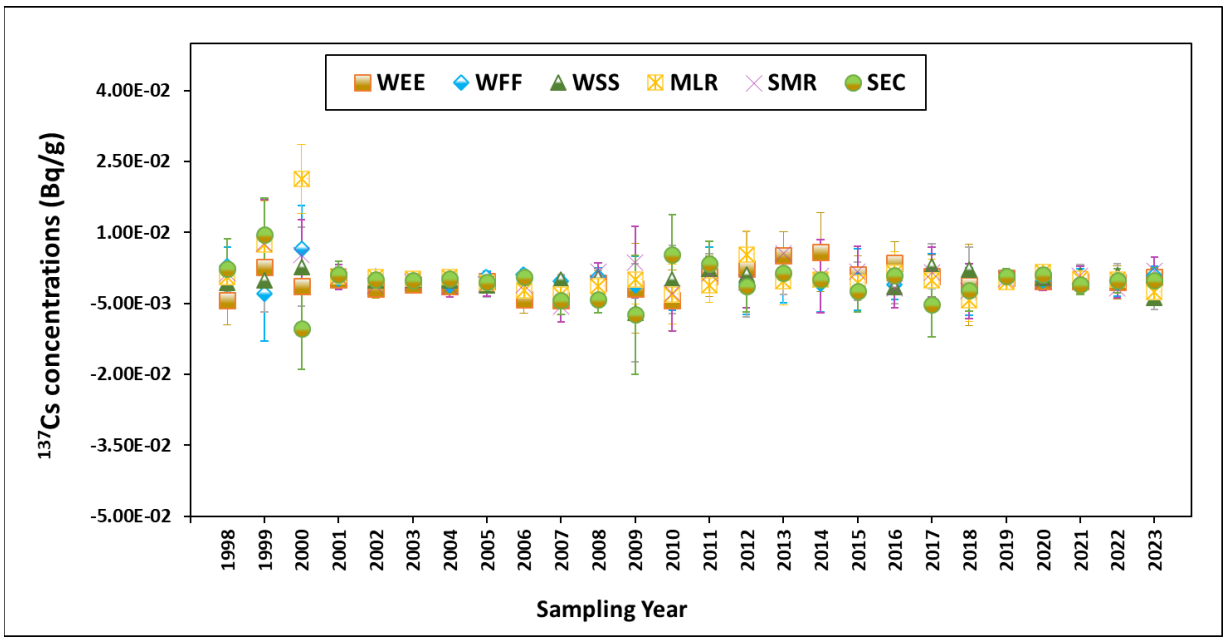

Figure 4.11 – Historical Concentrations of ^{137}Cs in Vegetation Samples Collected from Six Sampling Locations

4.6.2.2 Fauna (Animals)

The fauna samples analyzed included two composite fish samples from CBD and BRA. Five sample of opportunity (SOO) were collected, three deer samples, one rabbit sample, and one beef sample. All radionuclides detected in fish samples are within the trends of previous fish composite samples. 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. Two deer SOO samples received a "UJ" qualifier used (nuclide was not detected above the reported MDC and 2 sigma counting uncertainty and a quality deficiency affected the data making the reported data more uncertain) for ^{137}Cs and ^{60}Co.

4.7 GROUNDWATER

4.7.1 Sample Collection

Groundwater samples were collected once in the CY (Round 45) from each of six detection monitoring wells on the WIPP Site (Figure 4.12). The wells are completed in the Culebra Dolomite Member (Culebra), 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).

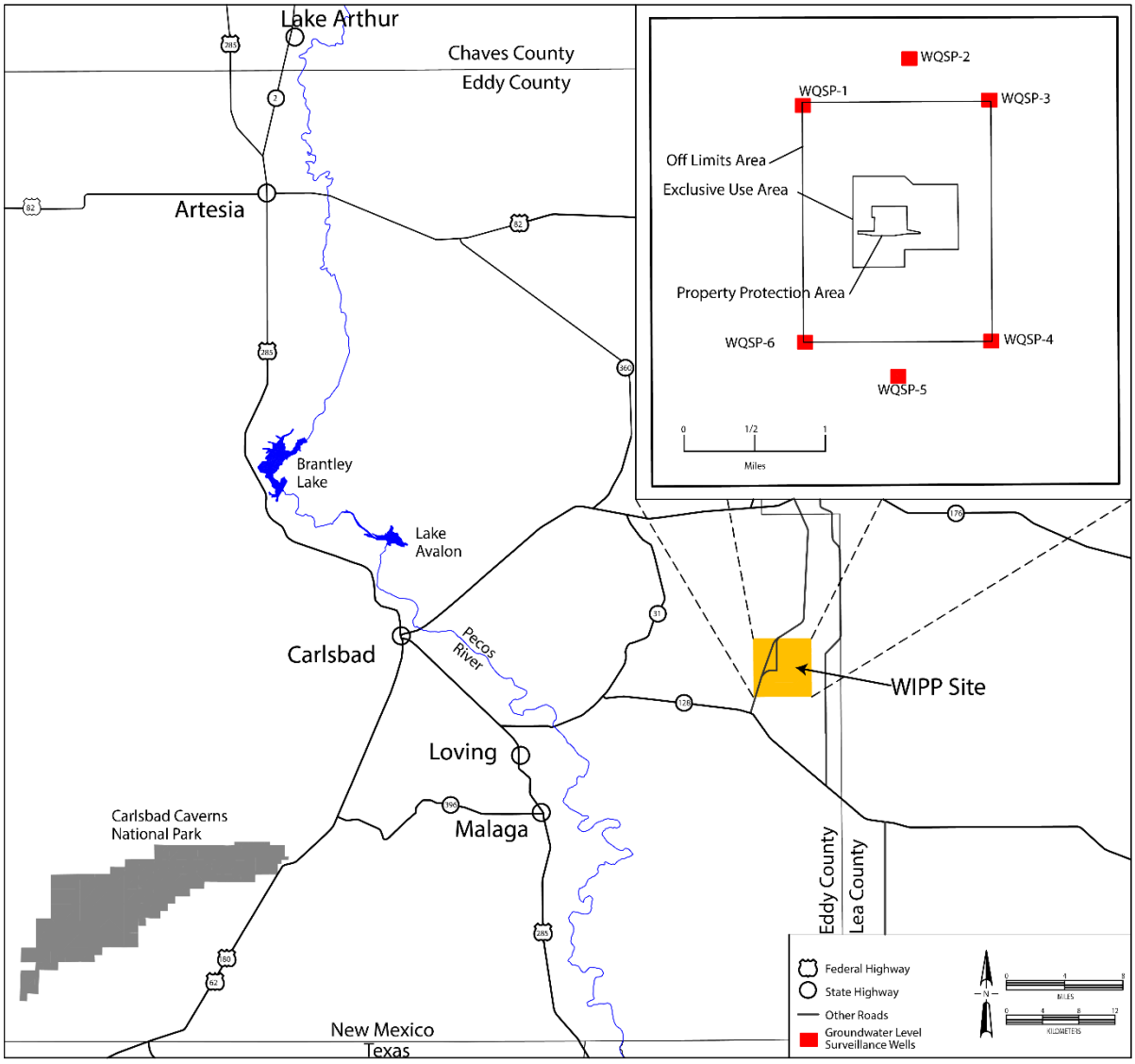

Figure 4.12 – DMP Well Locations

4.7.2 Results and Discussion

The data in Appendix G, Table G.6 show that isotopes of naturally occurring uranium (^{234}U, ^{235}U, and ^{238}U) were detected in the groundwater well samples in the CY. 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 Bq/L, ^{235}U = 3.10E-02 Bq/L, and ^{238}U = 3.20E-01 Bq/L). The highest Round 45 concentration of $^{233/234}$U was 1.72E+00 Bq/L in WQSP-1, slightly higher than the 99 percent confidence interval range

of the baseline concentration of 1.30E+00 Bq/L. The concentration of $^{233/234}$U in WQSP-2 was 1.59E+00, which was also slightly higher than the 99 percent confidence interval range of the baseline concentration of 1.30E+00 Bq/L. The baseline concentrations were based on samples collected from 37 wells, including 23 wells in the Culebra.

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. For ^{241}Am for WQSP-1 and WQSP-2, qualifier "UJ" was used (nuclide was not detected above the reported MDC and 2 sigma counting uncertainty and a quality deficiency affected the data making the reported data more uncertain). Historical concentrations of selected radionuclides are shown in Figures 4.13a and 4.13b. The concentrations measured were consistent with those from previous years. The groundwater wells were sampled twice yearly until 2012 when modifications were made to the Permit that required them to be sampled only once a year. Table G.6 also shows the concentration of the other gamma radionuclides and ^{90}Sr, which was not detected in the CY.

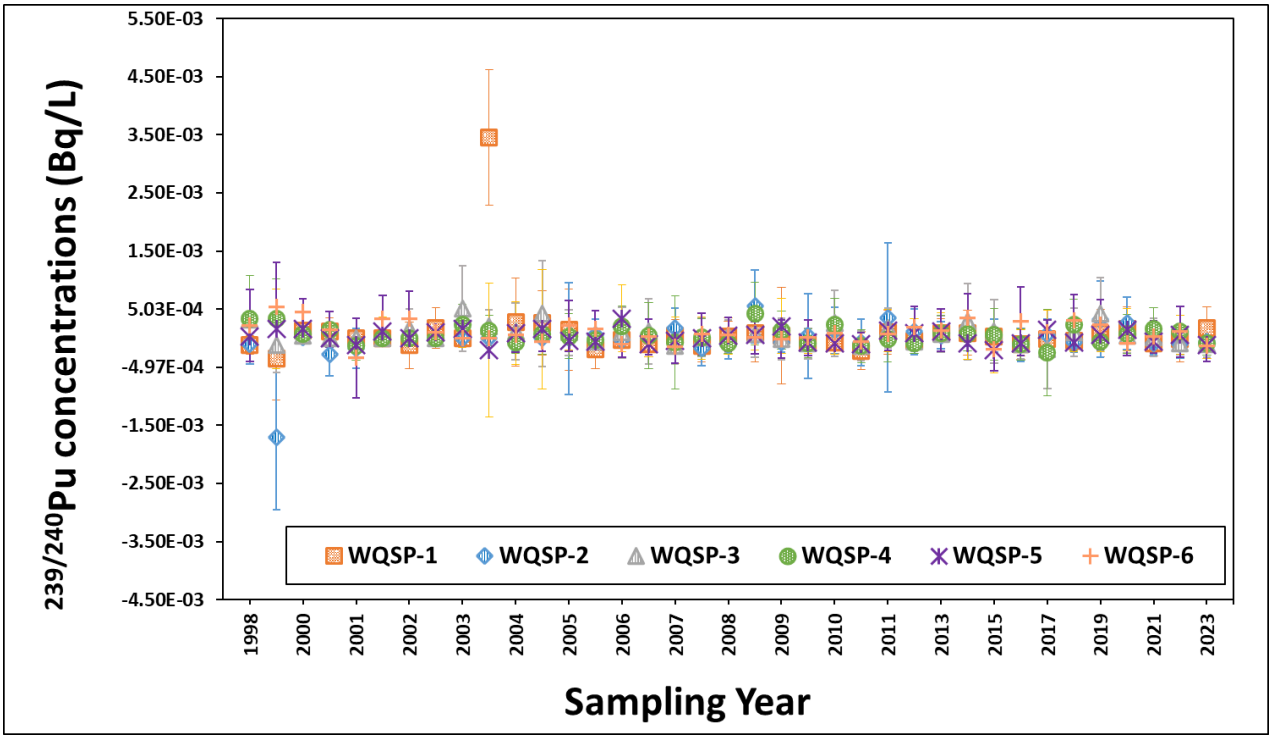

Figure 4.13a – Historical Concentrations of $^{239/240}$Pu at Six DMP Wells

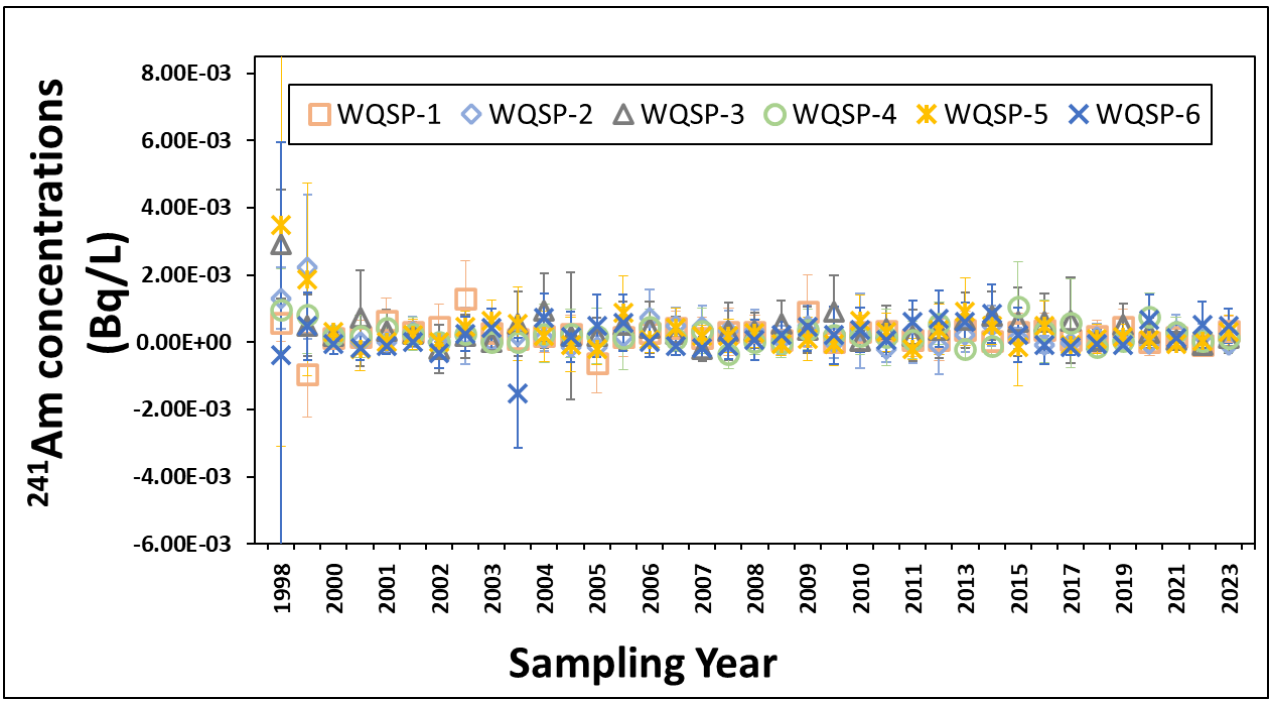

Figure 4.13b – Historical Concentrations of ^{241}Am at Six DMP Wells

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 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 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).

Compliance with Subpart A, "Standards" (40 CFR §191.03[b]) and the NESHAP limit (40 CFR §61.92) is determined by comparing annual radiation doses calculated for the maximally exposed individual (MEI) to the regulatory limits. As recommended by the EPA, computer modeling is used to calculate radiation doses to comply 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 assume that exposed persons remain at the same point of exposure during the entire year and that the 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

The radiation limits specified 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, deer and rabbit. Potassium-40 was detected in all but two deer composite samples. Uranium-233/234 and Uranium-238 were detected in only one fish composite sample. Therefore, no measurable 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 calculating a potential dose. Table 4.1 summarizes the total atmospheric release and potential radiological

dose at the WIPP facility in the CY 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
2.241E-07 Ci	9.578E-08 Ci	5.610E-07 Ci	9.523E-07 Ci	7.131E-08 Ci	4.147E-08 Ci	2.737E-06 Ci
8.293E+03 Bq	3.544E+03 Bq	2.076E+04 Bq	3.523E+04 Bq	2.639E+03 Bq	1.535E+03 Bq	1.013E+05 Bq

WIPP Radiological Dose Reporting Table – MEI				
	EDE to the Safety Significant Confinement Ventilation System Office Worker MEI at 0.2 miles (330 m) ESE[(e)]		Percent of EPA 10 mrem/yr limit to member of the public	
Pathway	(mrem/year)	(mSv/year)		
Air	6.30E-05	6.30E-07	6.30E-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	1.98E-06	1.98E-08	1.98E-05	1.22E-05	1.22E-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						
	Dose equivalent to the whole body of the receptor who resides year-round at WIPP fence line 822 m NW		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 822 m NW		Percent of EPA 75-mrem/year critical organ limit
Pathway	(mrem/year)	(mSv/year)		(mrem/year)	(mSv/year)	
Air	9.44E-05	9.44E-07	3.78E-06	2.61E-03	2.61E-05	3.48E-05
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) The previous MEI at the Utility Shaft construction office was included in dose assessments and based on primary wind direction, the SSCVS construction office resulted in a higher dose than the Utility Shaft 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 northwest sector. For the CY, the dose to this hypothetical receptor was calculated to be 9.44E-07 mSv/yr (9.44E-05 mrem/yr) for the whole body and 2.61E-05 mSv/yr (2.61E-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 1.98E-08 mSv/yr (1.98E-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 SSCVS construction office trailer MEI in the CY, assumed to be located 330 meters (0.2 mi) east-southeast of the WIPP facility, is calculated to be 6.30E-07 mSv/yr (6.30E-05 mrem/yr) for the whole body. This value is less than the 40 CFR §61.92 limit. The non-WIPP worker at the Utility Shaft was included in the dose assessment evaluations for the CY; however, the resulting dose at this location was lower than the dose at the SSCVS 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 1.22E-07 person-Sv/yr (1.22E-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 radiation doses to nonhuman biota are reported 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 various 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 about 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	2.72E-02	PKT	2.00E+02	1.36E-04
	^{235}U	2.33E-03	BRA	1.00E+02	2.33E-05
	^{238}U	2.93E-02	BRA	9.00E+01	3.25E-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	9.23E-03	PKT	1.00E+02	9.23E-05
	^{90}Sr	ND[c]	N/A[d]	2.00E+01	N/A[d]
Surface Water[b] (Bq/L)	$^{233/234}$U	2.43E-01	PCN	7.00E+00	3.47E-02
	^{235}U	1.60E-02	PCN	8.00E+00	2.00E-03
	^{238}U	1.49E-01	UPR	8.00E+00	1.87E-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					5.60E-02
Terrestrial System Evaluation					
Soil (Bq/g)	$^{233/234}$U	1.88E-02	SMR 0-2 cm	2.00E+02	9.38E-05
	^{235}U	2.50E-03	SMR 2-5 cm	1.00E+02	2.50E-05
	^{238}U	1.98E-02	SMR 5-10 cm	6.00E+01	3.31E-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	3.68E-03	MLR 2-5 cm	8.00E-01	4.60E-03
	^{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	2.43E-01	PCN	7.00E+00	3.47E-02
	^{235}U	1.60E-02	PCN	8.00E+00	2.00E-03
	^{238}U	1.49E-01	UPR	8.00E+00	1.87E-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					6.05E-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 samples 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

WIPP uses procedures to govern unconditionally releasing items. WIPP can release the item after it has a radiological survey if it meets specific documented limits. For items meeting unconditional release criteria, WIPP generates a form and performs multiple verifications to ensure compliance. These measures ensure that radiological material releases from WIPP are consistent with DOE Order 458.1 requirements. Compliance with these limits which are dose-based and are such that if any member of the public received any exposure, it would be less than 1 mrem/yr. There was no release of TRU radiologically contaminated materials or property from the WIPP facility in the CY

In 2022 WIPP released one item (TRU-Pact 148) containing residual radioactive material. The radioactive material was contained within a chemical matrix and upon notification the item was returned to WIPP. No exposure from radiation was incurred by members of the public. Due to the issue in 2022, there was a corrective action implemented. In 2023 the TP sampling plan was updated and states that: The sampling must be sufficient so that the evaluation of the results may be utilized to ensure that no part of the TRUPACT-II container is contaminated and Honeycomb spacers from a TRUPACT-II container that is being decontaminated cannot be released because the internal surfaces cannot be sufficiently sampled or monitored for contamination.

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 9.44E-07 mSv/yr (9.44E-05 mrem/yr) for the whole body and 2.61E-05 mSv/yr (2.61E-03 mrem/yr) for the critical organs. For the WIPP Effluent Monitoring Program, Figure 4.14 and Table 4.3 show the dose to the whole body for the hypothetical MEI from CY 2002 to this CY. Figure 4.15 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 0.25 mSv (25 mrem) to the whole body and 0.75 mSv (75 mrem) to any critical organ, in accordance with the limits in 40 CFR § 191.03(b).

Calculated dose estimates were within the limit of 0.1 mSv (10 mrem) EDE to the off-site resident MEI.

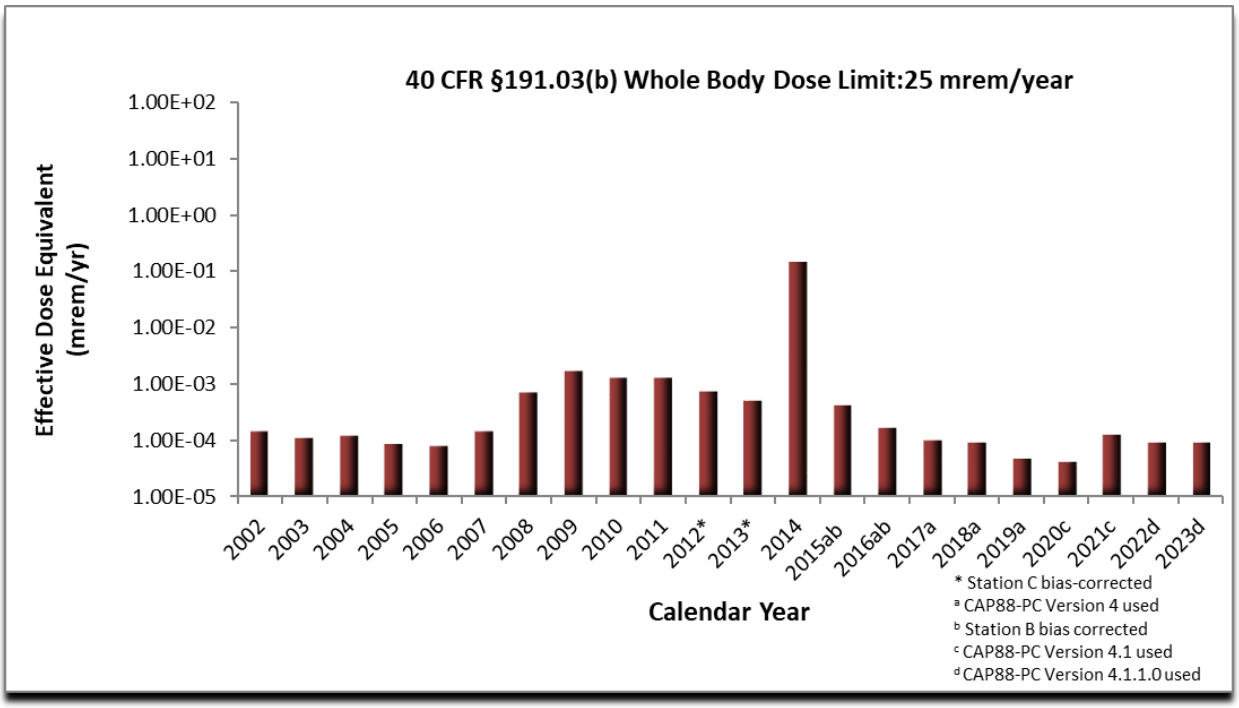

Figure 4.14 – Dose to the Whole Body for the Hypothetical Maximally Exposed Individual at the WIPP Fence Line

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%
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%
2022[(d)]	9.35E-05	0.00037%
2023[(d)]	9.44E-05	0.00038%
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.
(d) CAP88-PC Version 4.1.1.0 used.

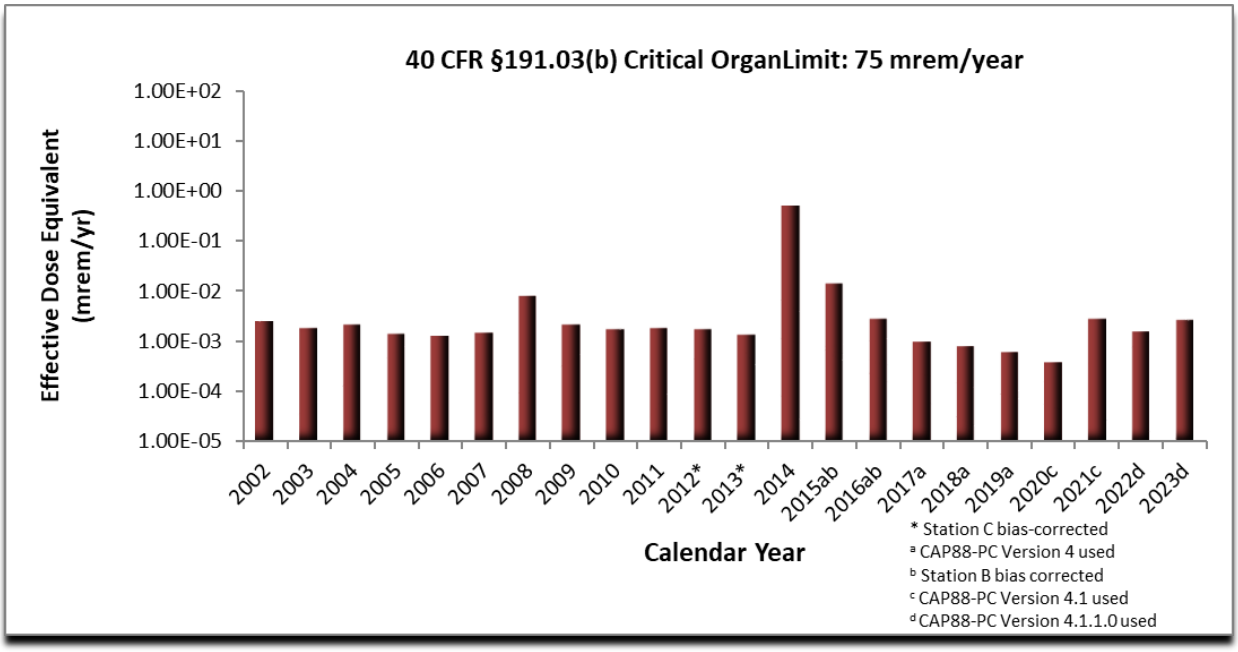

Figure 4.15 – Dose to the Critical Organ for Hypothetical Maximally Exposed Individual at the WIPP Fence Line

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%
2022[d]	1.56E-03	0.0021%
2023 [d]	2.61E-03	0.0035%
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.
(d) CAP88-PC Version 4.1.1.0 used.

The calculated annual EDE to the non-WIPP worker at the SSCVS construction office trailer for this CY is 6.30E-07 mSv (6.30E-05 mrem). The SSCVS construction office trailer is located 0.2 mi (330 m) east-southeast. For the WIPP Effluent Monitoring Program, Figure 4.16 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 0.1 mSv (10 mrem) per year, as specified in 40 CFR §61.92.

The non-WIPP business workspace identified as a construction office trailer at the nearest occupied point of the Utility Shaft 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 SSCVS construction office was selected as the receptor location. The dose for the Utility Shaft workspace is included in Addendum A to the Periodic Confirmatory Measurement Compliance Report for Calendar Year 2023. The calculated dose for the Utility Shaft workspace was less than that for the SSCVS workspace, and thus, is not the maximum receptor. Figure 4.16 and Table 4.5 include the historical dose to the MEI (either the SSCVS or the Utility Shaft workspace) for the respective calendar year.

For the CY, the calculated annual EDE to the off-site resident MEI from normal operations conducted at the WIPP facility is 1.98E-08 mSv (1.98E-06 mrem). For the WIPP Effluent Monitoring Program, Figure 4.17 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 0.1 mSv/yr (10 mrem/yr), as specified in 40 CFR § 61.92.

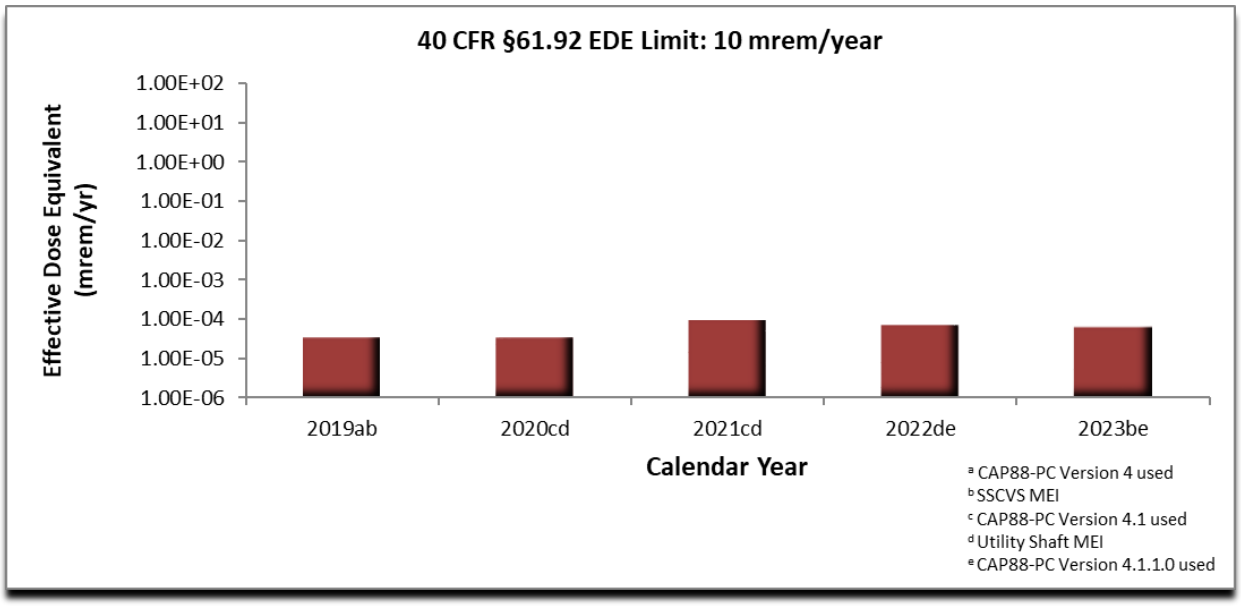

Figure 4.16 – WIPP Effective Dose Equivalent to the Maximally Exposed Individual

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
2019[(a)(b)]	3.48E-05	0.000348%
2020[(a)]	3.43E-05	0.000342%
2021[(a)]	9.70E-05	0.000970%
2022[(b)]	7.20E-05	0.000720%
2023[(b)(e)]	6.30E-05	0.000630%

(a) CAP88-PC Version 4 used.
(b) SSCVS MEI.
(c) CAP88-PC Version 4.1 used.
(d) Utility Shaft MEI.
(e) CAP88-PC Version 4.1.1.0 used.

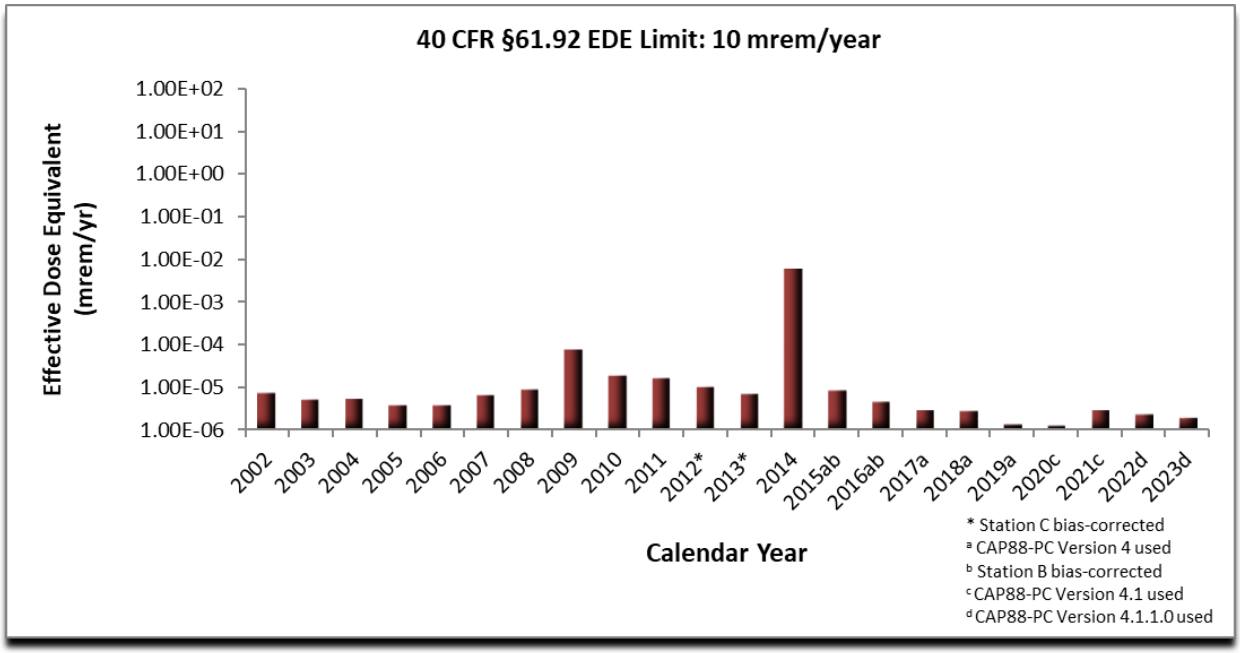

Figure 4.17 – WIPP Effective Dose Equivalent to the Off-Site Maximally Exposed Individual (i.e., individual resident member of the public)

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%
2022[(d)]	2.49E-06	0.000025%
2023[(d)]	1.98E-06	0.000020%
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.
(d) CAPP88-PC Version 4.1.1.0 used.

4.9.2 Environmental Monitoring

The radionuclide concentrations observed in environmental monitoring samples were extremely low and comparable to radiological baseline levels and to previous years' levels.

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

Ground Water: For $^{233/234}$U, WQSP-1 at 1.72E+00 and WQSP-2 at 1.59E+00 were above the $^{233/234}$U baseline of 1.30E+00 Bq/L

Surface Water: The tanks and tank-like structures ^{238}U baseline concentration of 3.20E-02 Bq/L was exceeded by LST with 3.26E-02 Bq/L and LST Dup with

3.55E-02 Bq/L. For Pecos River and associated bodies of water, UPR ^{238}U concentration of 1.49E-01 Bq/L was higher than the ^{238}U baseline value of 1.10E-01 Bq/L, and PCN ^{235}U concentration of 1.60E-02 Bq/L was higher than the baseline concentration for ^{235}U of 1.40E-02 Bq/L.

Soil: For ^{235}U above the baseline concentration of 1.70E-03 Bq/g were SMR 0-2 cm with 1.76E-03 Bq/L and SMR 2-5 cm with 2.50E-03 Bq/L. For ^{238}U above the baseline concentration of 1.30E-02 Bq/g were SMR 0-2 cm with 1.92E-02 Bq/g, SMR 2-5 cm with 1.98E-02 Bq/g, SMR 5-10 cm with1.94E-02 Bq/g, MLR 2-5 cm with 1.51E-02 Bq/g and MLR Dup 2-5 cm with 1.34E-02 Bq/g. For ^{234}U WSS 0-2 cm with 1.07E-02 was higher that the baseline of 8.60E-03. For the ^{40}K concentrations at the 5-mi ring group, all depths of SMR were above the baseline concentration of 3.40 E-01 Bq/g with 7.30E-01 Bq/g for 0-2 cm, 6.78E-01 Bq/g for 2-5 cm and 7.01E-01 Bq/g for 5-10 cm.

Vegetation: ^{234}U was above the baseline concentration of 6.00E-05 Bq/g for MLR at 1.03E-03 Bq/g

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, and 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 has not been or will not be acquired by other programs but is 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 LMP, available to the public on the WIPP Home Page, was developed as required by the WIPP LWA to identify resource values, promote multiple-use management, and establish long-term goals for the management of WIPP lands. It was developed in consultation with the BLM and the State of NM.

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. The LMP was updated in the CY.

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 an LUR. An LUR consists of a narrative description of the project, a completed environmental compliance review, and a map depicting the location of the proposed activity. In the 2023 update to the LMP, the LUR abstract was revised to include an abbreviated environmental compliance review for non-WIPP related projects. WIPP-related projects will continue to provide separate environmental compliance review documentation with land use requests. Documentation is used to determine if applicable regulatory requirements have been met prior to approval of a proposed project. An LUR 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, two LURs were reviewed and approved.

5.2.2 Wildlife Population Monitoring

An updated list of threatened and endangered species for Eddy and Lea Counties, NM, was compiled from multiple sources in April 2023 and included in the updated LMP (see section 2.11 Endangered Species Act). 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 wildlife or their habitat. The LMP details wildlife management objectives and provisions for hunting and trapping. Implementation of these objectives ensures that operations at the WIPP facility have little to no impact on wildlife.

Implementation of specific best management practices are also utilized to monitor and protect wildlife. For example, best management practices for mowing access road rights-of-way have been developed. They are utilized to support compliance with the DOE's Pollinator Protection Plan, which is part of a national strategy to protect pollinators and enhance their habitats. As previously mentioned in Chapter 2, Section 2.12, best management practices are utilized to protect migratory birds found nesting on an artificial nesting platform near a groundwater monitoring well.

In the May 23, 2023 edition of the WIPP Morning Summary distributed by WIPP Communications, a wildlife reminder was provided to WIPP employees. An excerpt of that distribution, as follows, is an example of wildlife information outreach during the CY.

5.2.3 Reclamation of Disturbed Lands

Reclamation mitigates the effects of WIPP-related activities on affected plant and animal communities and ensure that affects are not permanent. 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 by achieving short-term stability that sets a course for eventual ecosystem restoration through natural processes. Reclamation is intended to reduce soil erosion, increase the rate of natural plant colonization and succession, provide habitat for wildlife in disturbed areas, and comply with land use reclamation commitments.

Reclamation includes controlling invasive non-native plants and noxious weeds. Executive Order 13751, *Safeguarding the Nation from the Impacts of Invasive Species,* calls on federal agencies to prevent the introduction, establishment, and spread of invasive species, and eradicate and control populations of established invasive species. In addition, right-of-way grants typically require control of noxious weeds. The primary invasive plant at the WIPP Site and on DOE rights-of-way is *Peganum harmala*, commonly known as African rue. Noxious weed management objectives have been

established in the LMP to address control of this noxious weed at the WIPP Site and on rights-of-ways.

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.

During the CY, one reclamation project was completed. All structures, improvements, and debris associated with the Angel Ranch aerosol sampling station (right-of-way RW-22789) were removed from the location and the site was reseeded with approved native vegetation. Noxious weed control was not needed at this location. The State Land Office inspected the site on April 14, 2023, and found that reclamation was completed, and the land was left in an appropriate condition. The right-of-way was allowed to remain expired on its own terms, effective April 25, 2023.

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 surveillance and field inspections. Oil and gas industry traffic remained high near the WLWA and rights-of-way. Consequently, land management measures were utilized to ensure objectives were met for minimal environmental impact on 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. The oil and gas industry traffic resulted in many abandoned tires and debris on WIPP access roads. This material was removed by WIPP personnel and properly discarded or recycled if possible.

The New Mexico Department of Agriculture selects noxious weeds and targets them 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 sufficiently far from the LWB to protect the WLWA from potential surface and subsurface trespass. Data from a public database maintained by the State of NM indicated that no new oil wells were spudded during the CY within 1.6 km (1 mi) of the LWB. This was determined from data available on January 2, 2024, and is subject to change. The Delaware Basin Drilling Surveillance Program tracks new wells and updates in status of existing wells.

5.3 METEOROLOGICAL MONITORING

Precipitation recorded from the meteorological tower from January through December 2023 was 219.19 mm (8.63 in) compared to 360.17 mm (14.18 in) for 2022. The average yearly rainfall recorded at the meteorological tower since 1991 is 358 mm (14.13 in). Figure 5.1 and Table 5.1 display the monthly precipitation at the WIPP Site for 2022.

The maximum recorded temperature (10-m level) at the WIPP Site in the CY was 41.24 °C (106.23 °F) in June, whereas the lowest temperature recorded was -6.21 °C (20.82 °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 2023 was 18.96 °C (66.13 °F), which is 0.53 °C cooler than the 2022 average of 19.49 °C (°F). The average monthly temperatures for the WIPP area ranged from 30.29 °C (86.52 °F) during July to 8.55 °C (47.39 °F) in January (Figure 5.3).

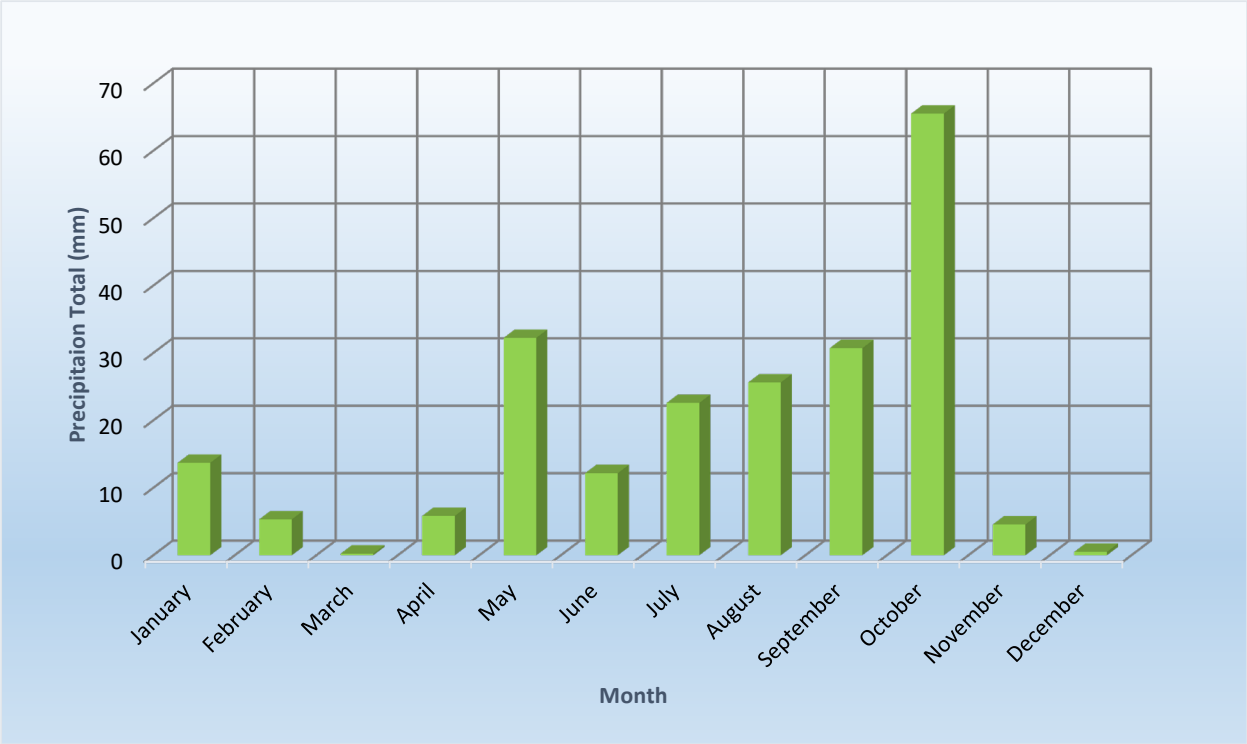

Figure 5.1 – WIPP Site Precipitation Monthly Totals for 2023

Table 5.1 – WIPP Site Precipitation Monthly Totals for 2023

Month	Total (mm)
January	13.72
February	5.33
March	0.25
April	5.84
May	32.26
June	12.19
July	22.61
August	25.65
September	30.73
October	65.53
November	4.57
December	0.51

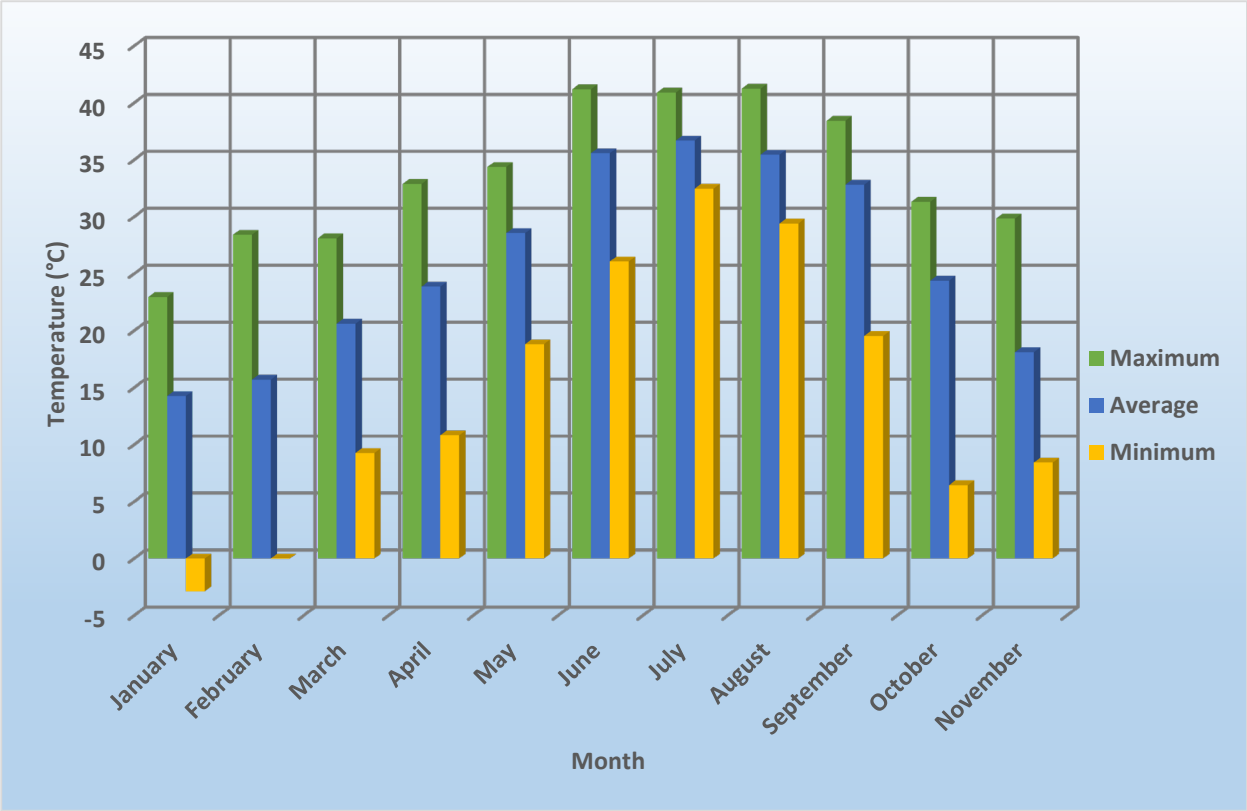

Figure 5.2 – WIPP Site High Temperatures (°C) for 2023

Table 5.2 – WIPP Site High Temperatures (ºC) for 2023

Month	Maximum High	Average High	Minimum High
January	22.96	14.26	-2.88
February	28.42	15.71	-0.03
March	28.1	20.62	9.26
April	32.88	23.87	10.82
May	34.37	28.57	18.81
June	41.19	35.58	26.08
July	40.91	36.69	32.47
August	41.24	35.45	29.4
September	38.43	32.81	19.54
October	31.32	24.39	6.44
November	29.85	18.12	8.43
December	24.32	15.9	6.09

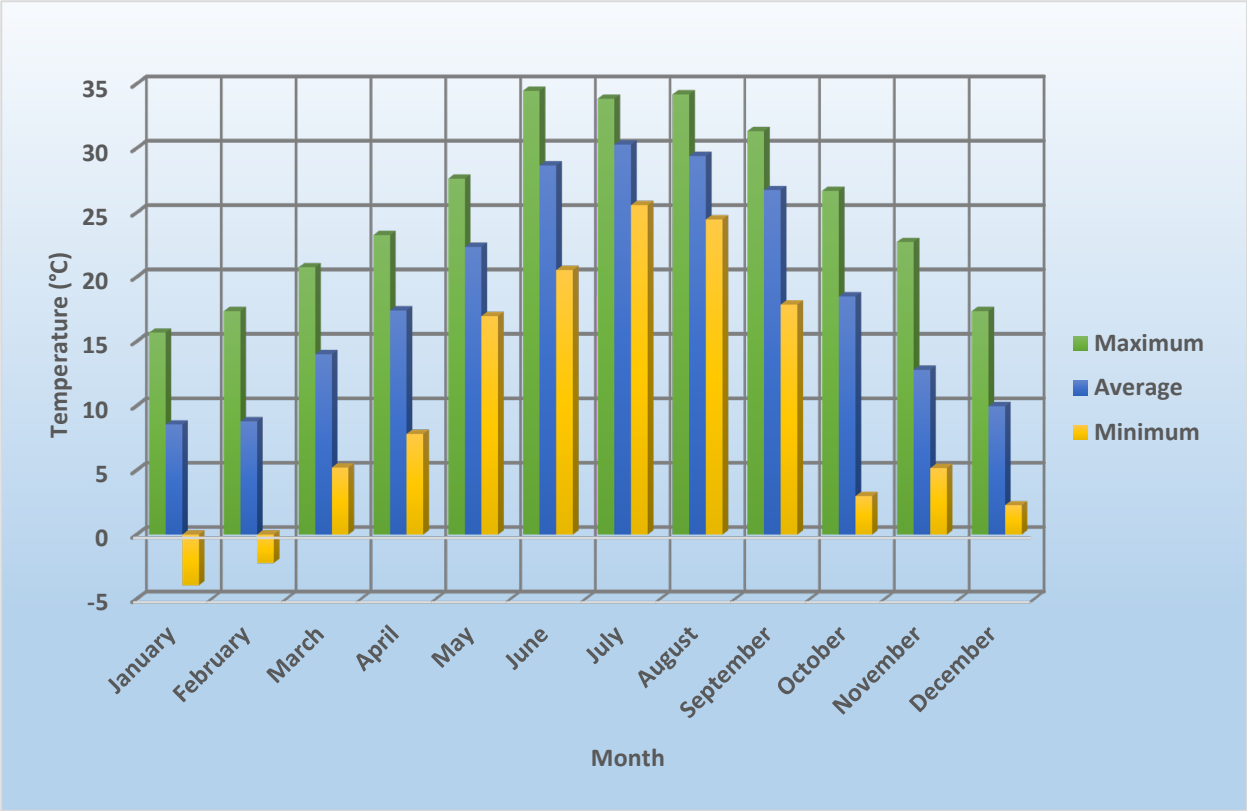

Figure 5.3 – WIPP Site Average Temperatures (°C) for 2023

Table 5.3 – WIPP Site Average Temperatures (°C) for 2023

Month	Maximum Average	Average	Minimum Average
January	15.68	8.55	-3.95
February	17.35	8.8	-2.21
March	20.76	14.01	5.2
April	23.26	17.4	7.82
May	27.63	22.34	16.97
June	34.46	28.66	20.54
July	33.84	30.29	25.58
August	34.19	29.4	24.47
September	31.33	26.75	17.87
October	26.69	18.49	2.99
November	22.72	12.8	5.16
December	17.35	9.97	2.28

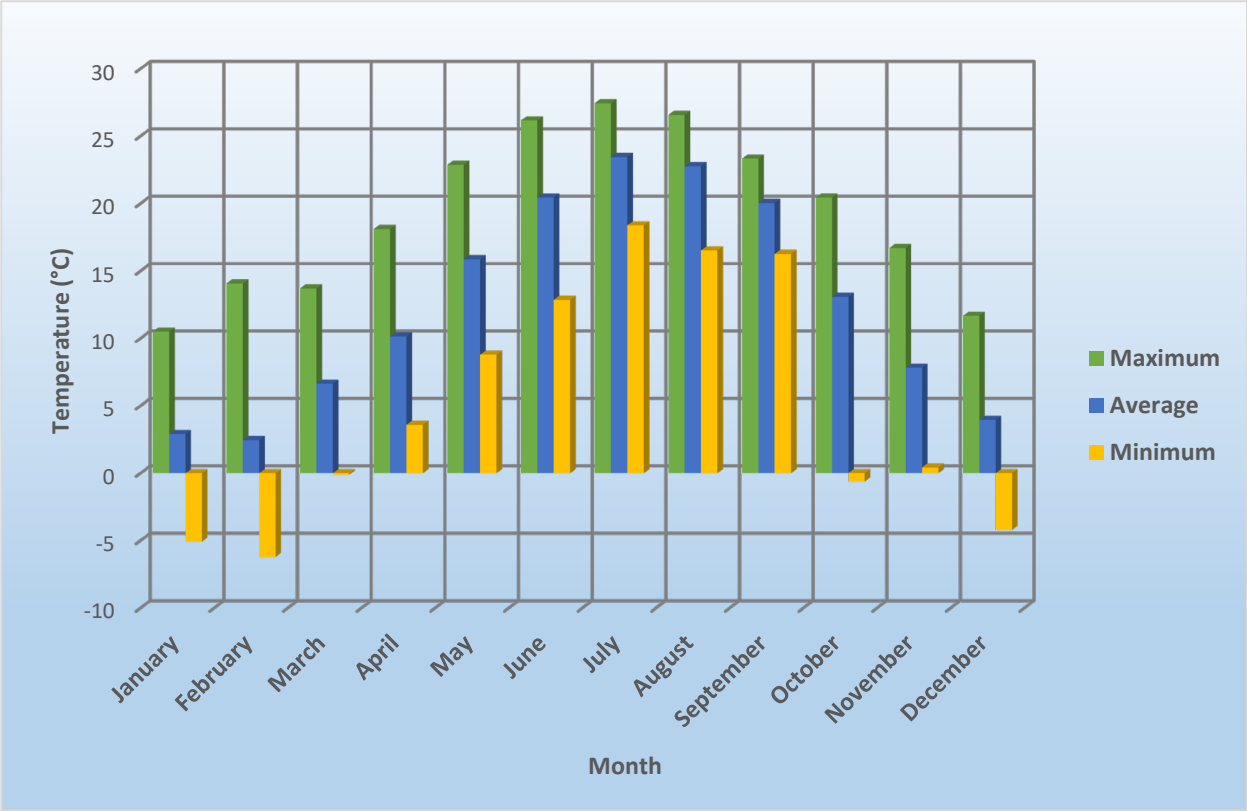

Figure 5.4 – WIPP Site Low Temperatures (°C) for 2023

Table 5.4 – WIPP Site Low Temperatures (ºC) for 2023

Month	Maximum Low	Average Low	Minimum Low
January	10.5	2.9	-5.08
February	14.07	2.45	-6.21
March	13.71	6.64	-0.12
April	18.1	10.14	3.58
May	22.87	15.87	8.79
June	26.16	20.44	12.86
July	27.44	23.46	18.38
August	26.57	22.77	16.52
September	23.33	20.04	16.25
October	20.44	13.08	-0.62
November	16.7	7.82	0.42
December	11.67	3.95	-4.22

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 39.35 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.

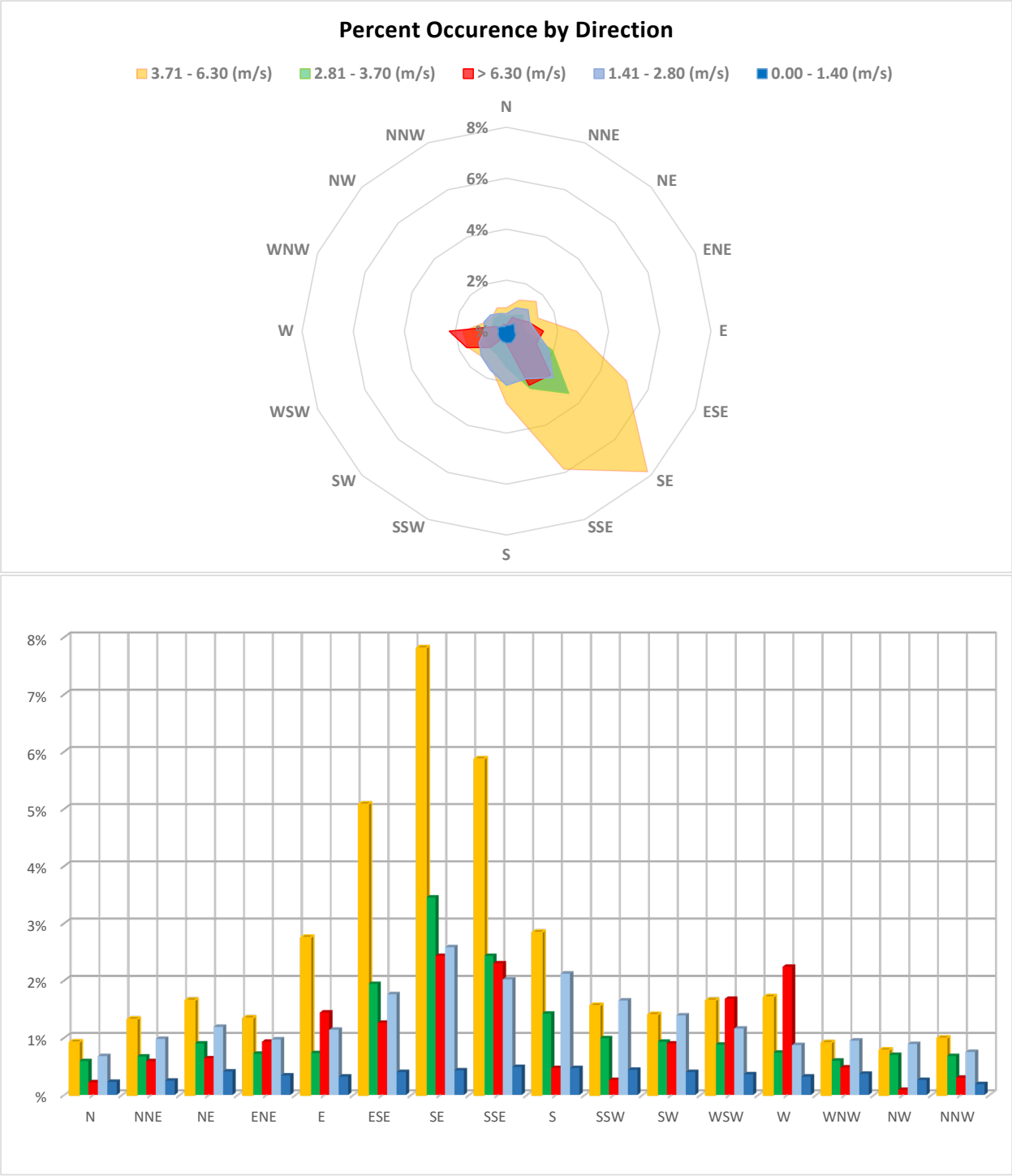

Figure 5.5 – WIPP Site Wind Speed and Direction (at 10-meter Level) Report

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 shows wind speeds from the SE at 3.71 - 6.30 (m/s), 7.81 percent of the time (Table 5.5).

Table 5.5 – WIPP Site Wind Speed and Direction (at 10-meter Level) Report

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	0.23	0.68	0.59	0.92	0.22	2.63
NNE	0.25	0.98	0.67	1.32	0.59	3.8
NE	0.41	1.19	0.9	1.65	0.64	4.78
ENE	0.34	0.97	0.72	1.34	0.93	4.3
E	0.32	1.14	0.73	2.75	1.44	6.39
ESE	0.4	1.76	1.94	5.08	1.26	10.44
SE	0.43	2.58	3.45	7.81	2.43	16.7
SSE	0.49	2.02	2.43	5.87	2.3	13.11
S	0.47	2.12	1.42	2.84	0.47	7.31
SSW	0.44	1.65	0.99	1.56	0.26	4.9
SW	0.4	1.39	0.93	1.4	0.9	5.03
WSW	0.36	1.16	0.88	1.65	1.68	5.73
W	0.32	0.87	0.74	1.71	2.24	5.87
WNW	0.37	0.95	0.6	0.91	0.48	3.32
NW	0.26	0.89	0.7	0.78	0.09	2.73
NNW	0.19	0.75	0.68	0.99	0.3	2.92
Totals:	**5.70%**	**21.10%**	**18.39%**	**38.58%**	**16.23%**	**100.00%**

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, 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. The 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 (1).

For this reporting period, 208 samples were collected from Stations VOC-C and VOC-D, along with 22 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 January 1, 2023, through December 31, 2023, are included in Tables 5.6a and 5.6b. None of the cancer risks or hazard indexes shown in Table 5.6b exceeded the action levels as prescribed in Permit Part 4. Cancer risk was below the prescribed action level of 10^{-5} for non-waste surface workers and the hazard index was below the action level of 1.

Table 5.6a – Target Analyte Maximum Emission Value

Target Compound	Maximum Value (pptv)	Sample Date
Carbon Tetrachloride	1,102.28	6/7/2023
Chlorobenzene	26.0	12/5/2023
Chloroform	27.0	12/5/2023
1,1-Dichloroethylene	0	N/A
1,2-Dichloroethane	36.0	12/5/2023
Methylene Chloride	1,590.00	12/13/2023
1,1,2,2-Tetrachloroethane	0	N/A
Toluene	3,640	12/5/2023
1,1,1-Trichloroethane	558.52	6/7/2023
Trichloroethylene	350.96	6/7/2023

pptv – parts per trillion by volume

Table 5.6b – Annual Average and Maximum Result for Cancer Risk and Hazard Index

Calculation	Cancer Risk	Hazard Index
Action Levels	1E-05	1.0
Maximum Running Annual Average	2.12E-07 (67/2023)	1.52E-02 (6/7/2023)
Maximum Individual Sample Result	1.55 E -06 (6/7/2023)	2.22E-01 (6/7/2023)

Sampling frequency for disposal room VOC monitoring occurs once every two weeks in accordance with Permit Attachment N, Section N-3d (2). For this reporting period, 74 samples were collected from disposal rooms along with 9 field duplicate samples. Disposal room VOC monitoring was performed in Panel 7, Rooms 6, 5, 3 (exhaust only), 2, and 1 and Panel 8, Rooms 7 through 6 during this reporting period. Panel 7 Rooms 3 and 4 intakes were determined to be usable in early December 2021 and Panel 7 Room 4 exhaust was determined to be unusable in October 2022. Sample

results are summarized in Table 5.6c. Sample location data are identified by the source panel number, room number, and intake (I) or exhaust (E) function.

Table 5.6c – Disposal Room VOC Monitoring Results

Target Compound	Maximum Detected Value (ppmv)	Location of Maximum Detected Value	Collection Date of Maximum Detected Value	50% Action Level (ppmv)	95% Action Level (ppmv)	Room-based Limits (ppmv)	Total Exceedances
Panel 7							
Carbon Tetrachloride	814.74	Room 5E	1/23/2023	4,813	9,145	9,625	0
Chlorobenzene	ND	N/A	N/A	6,500	12,350	13,000	0
Chloroform	38.58	Room 5E	1/23/2023	4,965	9,433	9,930	0
1,1-Dichloroethylene	0.79 J	Room 6I and Room 5E	1/10/2023	2,745	5,215	5,490	0
1,2-Dichloroethane	0.00051 J	Room 2I	1/23/2023	1,200	2,280	2,400	0
Methylene Chloride	3.28 J	Room 6E, Room 6I, Room 5E	01/23/23 01/10/23 01/23/23	50,000	95,000	100,000	0
1,1,2,2-Tetrachloroethane	ND	N/A	N/A	1,480	2,812	2,960	0
Toluene	3.15 J, Q	Room 6E, Room 5E	2/6/2023	5,500	10,450	11,000	0
1,1,1-Trichloroethane	294.33	Room 5E	1/23/2023	16,850	32,015	33,700	0
Trichloroethylene	290.00	Room 5E	1/23/2023	24,000	45,600	48,000	0
Panel 8							
Carbon Tetrachloride	0.01605	Room 7E	8/21/2023	1,604	3,047	3,208	0
Chlorobenzene	0.00021 J	Room 7E	8/21/2023	6,500	12,350	13,000	0
Chloroform	0.01074	Room 7E	8/21/2023	1,655	3,144	3,310	0
1,1-Dichloroethylene	0.00039 J	Room 7E	8/21/2023	915	1,738	1,830	0
1,2-Dichloroethane	0.00063 J	Room 7E	8/21/2023	400	760	800	0
Methylene Chloride	0.01161	Room 7E	8/21/2023	16,665	31,665	33,333	0
1,1,2,2-Tetrachloroethane	0.00015 J	Room 7E	2/6/2023	493	936	986	0
Toluene	0.00711	Room 7E	8/21/2023	4,011	7,621	8,023	0
1,1,1-Trichloroethane	0.00951	Room 7E	8/21/2023	5,616	10,671	11,233	0
Trichloroethylene	0.31905	Room 7E	8/21/2023	8,000	15,200	16,000	0

N/A = Not applicable
ND = Non-detect
ppmv = parts per million by volume
J = Estimated value
Q = Results are useable, but were not associated with analyses that met the QA/QC requirements for precision, accuracy, or completeness.

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 (NM Tech) using data from a network of seismic monitoring stations approximately centered on the Site (Figure 5.6). Station signals are transmitted to the NM Tech Seismological Observatory (NMTSO) in Socorro, NM. Readings from the WIPP network stations are combined with readings from an additional NM Tech network in the central Rio Grande Rift, readings collected by the Texas seismic monitoring network (TexNet) in west Texas and stations operated by the United States Geological Survey. The NMTSO calculated locations of earthquakes inside NM using SeisComP, combined with Texas earthquake locations calculated by TexNet to form the complete catalog of events.

The mean operational efficiency of the WIPP seismic monitoring stations during the CY was approximately 93.2 percent. No additional stations were installed this year. From January 1, through December 31, 2023, locations for 3,657 total seismic events were recorded within 300 km (186 mi) of the WIPP Site. For this same period, 554 seismic events larger than magnitude 2.5 recorded within 300 km (186 mi) of the WIPP Site. Recorded data included origin times, epicenter coordinates, and magnitudes. This number of events cannot be directly compared to ASERs prior to 2022 because a new methodology was used that located events more accurately but excluded extremely small indeterminate events. Comparing similar datasets, this region’s detected events remained approximately constant from 2022. The strongest recorded event (magnitude 5.2) occurred on November 08, 2023; this event was approximately 85.2 km (52.9 mi) southwest of the Site. The seismic event closest to the Site occurred approximately 7.2 km (4.5 mi) southwest and had a magnitude of 1.9. A total of 235 events were recorded within 50 km (31 mi) of the Site during the CY, with nine of those events being magnitude 2.5 or greater.

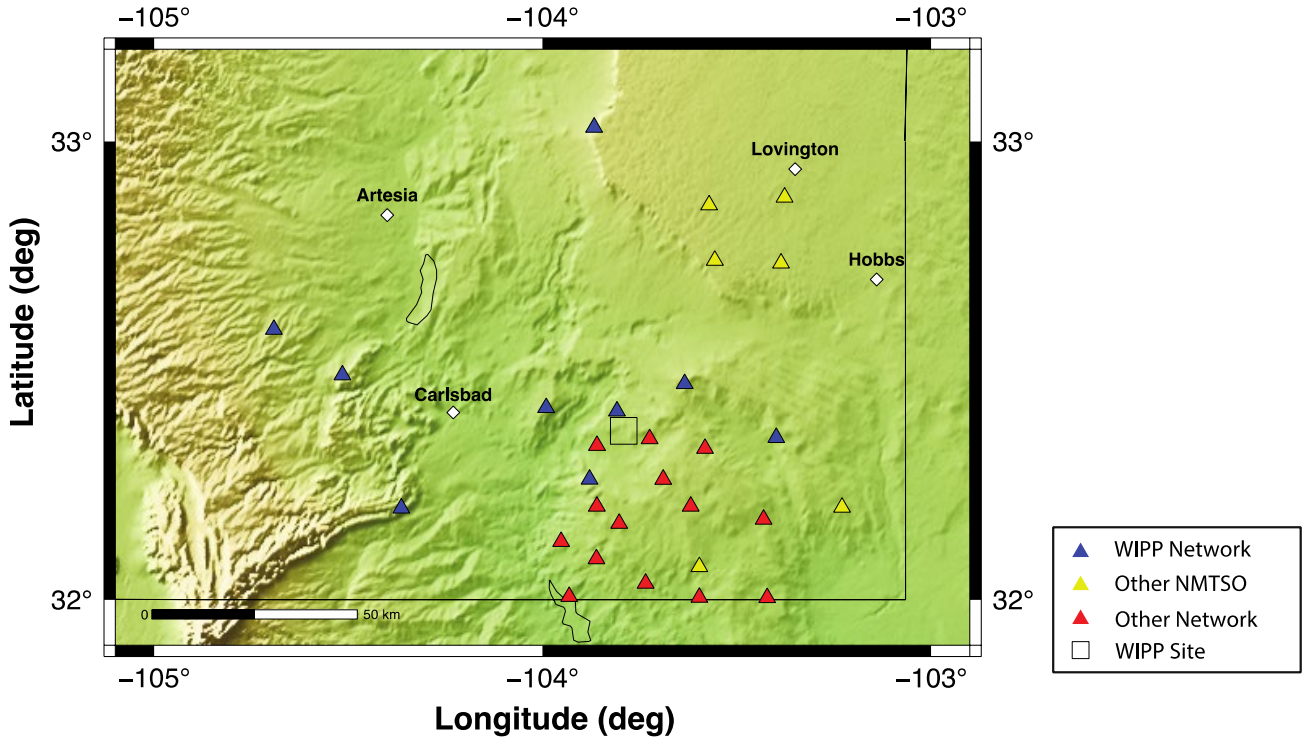

Figure 5.6 – Seismograph Station Locations in the Vicinity of the WIPP Site

5.6 LIQUID EFFLUENT MONITORING

The NMED Ground and Surface Water Protection regulations outlined 20.6.2 NMAC regulate discharges that could impact surface water or groundwater. Department of Energy's compliance with these regulations is discussed in Chapter 2. The DP was modified and renewed on January 28, 2022. This DP renewal/modification was discussed in the last ASER. All of the ponds and lagoons were sampled at least one time during the year except for Evaporation Lagoons B and C due to their lack of water. Brine Water Storage Pond 4 and Brine Retention Ponds East and West were not sampled because they were not completed during this reporting period. Analytical data from the discharge monitoring reports are summarized in Table 5.7.

Table 5.7 – Sewage Lagoon, H19, and Infiltration Control Pond Analytical Results for Spring and Fall 2023

Spring 2023					
Location	**Nitrate (mg/L)**	**TKN (mg/L)**	**TDS (mg/L)**	**Sulfate (mg/L)**	**Chloride (mg/L)**
Effluent Lagoon A	ND	77	4,170	280	1,400
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	NS	NS	NS
Salt Storage Pond 1	N/A	N/A	NS	NS	NS
Salt Storage Pond 2	N/A	N/A	NS	NS	NS
Salt Storage Pond 3	N/A	N/A	NS	NS	NS
Storm Water Pond 1	NS	NS	NS	NS	NS
Storm Water Pond 2	NS	NS	NS	NS	NS
Storm Water Pond 3	NS	NS	NS	NS	NS
Fall 2023					
Location	**Nitrate (mg/L)**	**TKN (mg/L)**	**TDS (mg/L)**	**Sulfate (mg/L)**	**Chloride (mg/L)**
Effluent Lagoon A	ND	0.5	2,070	120	600
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	455,000	89	220,000
Salt Storage Pond 1	N/A	N/A	18,200	250	11,000
Salt Storage Pond 2	N/A	N/A	300,000	11,000	200,000
Salt Storage Pond 3	N/A	N/A	336,000	15,000	190,000
Salt Storage Pond 5	N/A	N/A	159,000	14,000	84,000
Storm Water Pond 1	NS	NS	190	46	41
Storm Water Pond 2	NS	NS	216	14	71
Storm Water Pond 3	NS	NS	510	24	220

Notes:

mg/L: Milligrams per liter.

N/A: Not applicable; analysis not required by DP-831.

ND: Non-detect.

NS: Not sampled (due to pond/lagoon being dry or no rainfall event over 2 inches in 24 hours).

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

Current groundwater monitoring activities near 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. The following sections summarize the hydrology in this area. Figure 6.1 shows a generalized schematic of the site's stratigraphy. Details for hydrology and stratigraphy can be found in Mercer (1983), Beauheim (1986, 1987), and Beauheim and Ruskauff (1998).

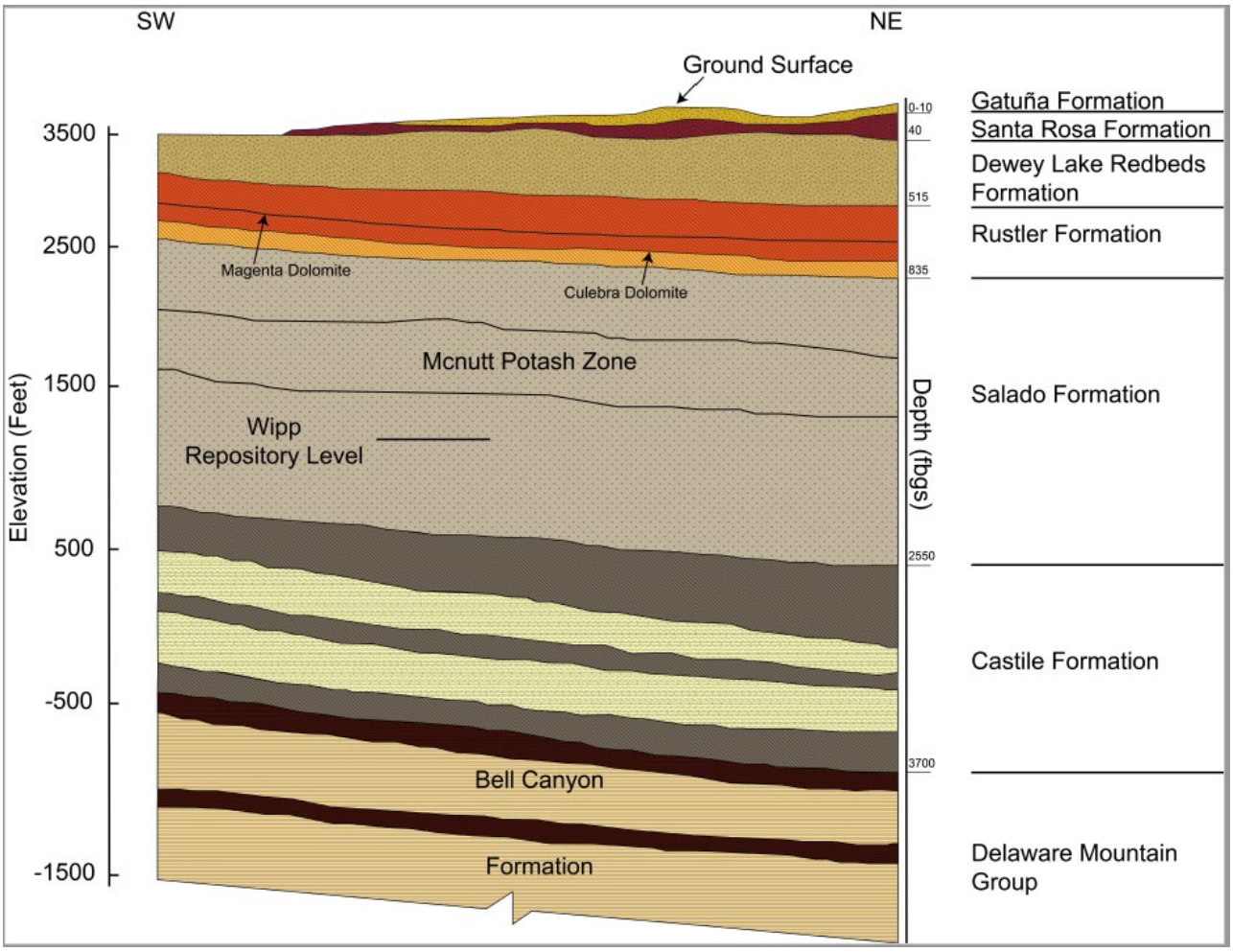

Figure 6.1 – WIPP Stratigraphy

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 near 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). Culebra transmissivities in the Nash Draw range up to 1,250 square ft (ft^2) per day (ft^2/d) (1.3 x 10^{-3} meters squared per second [m^2/s]); closer to the WIPP facility, they are as low as 0.007 to 74 ft^2/d (7.5 x 10^{-9} to 8.0 x 10^{-5} m^2/s) (see WIPP Hazardous Waste Facility Permit Amended Renewal Application Addendum L1, Section L-1a(2)(iii)), the document is available here: wipp.energy.gov. 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 wells WQSP-6A and PZ-17b (Figure 6.8, later in this chapter) intersect natural water in the Dewey Lake. At these locations, the saturated horizon is within the middle portion of the formation. The saturated zone is 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) 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 to map 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 the 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. For further investigation wells PZ-16, PZ-17a, PZ-18, and PZ-19 were completed in the Santa Rosa in 2020.

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.

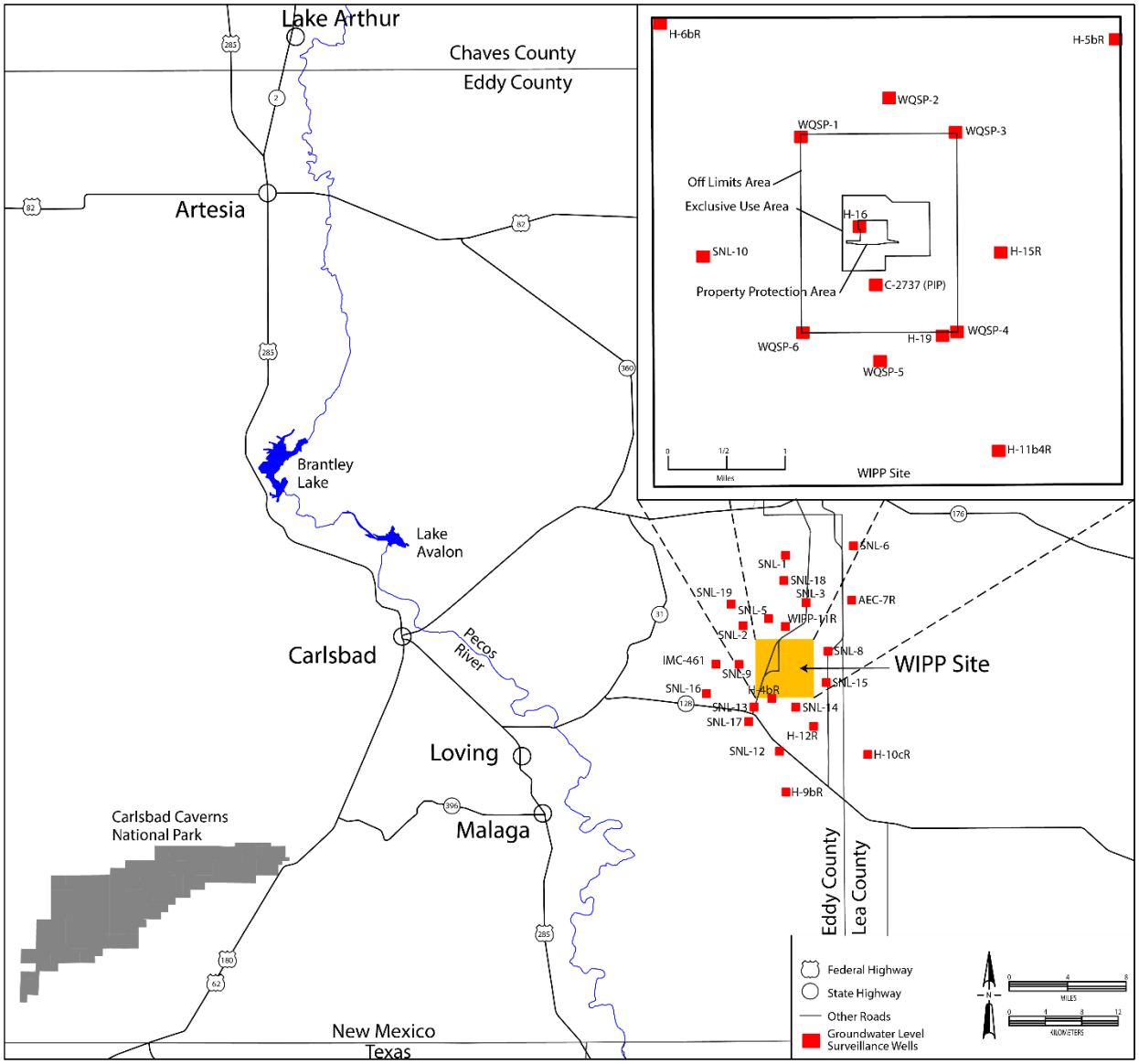

Figure 6.2 – Culebra Groundwater Level Surveillance Wells *(Inset Represents the Groundwater Surveillance Wells in the WIPP Land Withdrawal Area)*

The Gatuña is water-bearing in some areas, with saturation occurring in discontinuous perched zones. However, the Gatuña has no known continuous saturation zone because of its erratic distribution. 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 95th upper tolerance limit value (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 has 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's groundwater monitoring activities include groundwater quality sampling, groundwater level monitoring, and the fluid density survey, as described in this section. The Permit requires these programs. 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 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 WIPP Groundwater Monitoring Program

Number of Active Wells during CY	81
Number of Samples	230[(a)]
Number of Water Level Measurements	719
Total Number of Analyte Measurements	1,292[(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 52 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. The six redundant wells on the H-19 pad, the 21 shallow water wells for Santa Rosa/Dewey Lake contact, the one Gatuña well, and the 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 October (Round 45 for this CY). Sampling for groundwater quality was performed at six well locations completed in the Culebra (WQSP-1 through WQSP-6), (Figure 6.2). 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 six wells, for 230 analyses completed per sampling round. Groundwater quality sampling results for the six WQSP wells are included in Appendix F, Table F.2.

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.

The difference between the depth of the WIPP repository and the depth of the detection monitoring wells completed in the Culebra varies from 1,270 ft to 1,926 ft (387 m to 587 m). WIPP-related contamination in the groundwater is not anticipated because a release from the repository to the Culebra is highly unlikely. 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 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 14,700 mg/L (WQSP-6 primary) to a high of 217,000 mg/L (WQSP-3 primary). The groundwater of the Culebra is 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 3,105 mg/L. This water is suitable for livestock consumption and is classified as Class II water by EPA guidelines. The saturation of 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 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 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 45) can be found in the *Annual Culebra Groundwater Report* (U.S. Department of Energy, November 2023).

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 42 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 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 every quarter. 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.

Water elevation trend analysis was performed for 42 Culebra wells, which showed 26 naturally changing wells. The subset of wells analyzed 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 H-19 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 31.55 in (801.39 mm) in 2016, while the lowest was 4.65 in (118.13 mm) in 2020. The CY rainfall was below average at 8.63 in (219.19 mm). Water level fell in 13 of the 19 naturally occurring water level changes, which averaged -138.20 mm (-0.45 ft).

For the Culebra wells in the vicinity of the WIPP Site, equivalent freshwater heads for December 2023 were used to calibrate a groundwater flow model, which was used by Sandia National Laboratories (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. The 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	Measurement Date	Freshwater Head (ft. AMSL)	Specific Gravity (Freshwater at 70˚F [21˚C])	Notes
AEC-7R	12/5/2023	3061.08	1.072	
C-2737	12/6/2023	2976.12	1.027	
H-4bR	12/4/2023	2993.41	1.021	
H-5bR	12/5/2023	3063.68	1.091	
H-6bR	12/6/2023	3060.69	1.040	
H-9bR	12/4/2023	2971.92	1.004	
H-10cR	12/4/2023	3039.37	1.092	
H-11b4R	12/4/2023	2989.16	1.080	
H-12R	12/4/2023	3004.20	1.105	
H-15R	12/6/2023	2999.50	1.127	
H-16	12/6/2023	2944.20	1.033	
H-19b0	12/4/2023	2988.04	1.067	
IMC-461	12/6/2023	3033.24	1.004	
SNL-1	12/5/2023	3073.29	1.034	
SNL-2	12/5/2023	3060.99	1.009	
SNL-3	12/5/2023	3069.12	1.027	
SNL-5	12/5/2023	3061.63	1.008	
SNL-6	12/5/2023	3485.85	1.263	Excluded from mapping, long-term recovery
SNL-8	12/5/2023	3054.93	1.092	
SNL-9	12/6/2023	3044.29	1.017	
SNL-10	12/6/2023	3037.82	1.005	
SNL-12	12/4/2023	2986.89	1.014	
SNL-13	12/4/2023	2999.01	1.027	
SNL-14	12/4/2023	2986.24	1.048	
SNL-15	12/4/2023	3120.85	1.230	Excluded from mapping, long-term recovery
SNL-16	12/4/2023	3006.89	1.020	

Well	Measurement Date	Freshwater Head (ft. AMSL)	Specific Gravity (Freshwater at 70˚F [21˚C])	Notes
SNL-17	12/4/2023	3001.82	1.001	
SNL-18	12/5/2023	3061.92	1.002	
SNL-19	12/5/2023	3061.56	1.006	
WIPP-11R	12/6/2023	3064.93	1.025	
WQSP-1	12/6/2023	3066.20	1.056	
WQSP-2	12/5/2023	3064.35	1.033	
WQSP-3	12/5/2023	3056.31	1.141	
WQSP-4	12/6/2023	2987.11	1.070	
WQSP-5	12/6/2023	2985.16	1.024	
WQSP-6	12/6/2023	2994.70	1.010	

Modeled freshwater head contours for December 2023 for the model domain are shown in Figure 6.3 (Akara, 2024). For this model, an ensemble of 100 calibrated parameters (transmissivity [T], horizontal anisotropy [A], and recharge [R]) fields were used. The calibrated parameter fields were taken from the data used in the CRA-2009 Performance Assessment Baseline Calculation (PABC), and subsequently used in CRA-2014 & 2019 Performance Assessments (PAs). For each parameter, the average of the 100 realizations was computed. These averaged parameter fields were then used with MODFLOW-2000 to simulate hydraulic head distribution within and near the WIPP Land Withdrawal Boundary (LWB). The parameter estimation software (PEST) was used to adjust the model boundary conditions to obtain a good fit between observed and simulated hydraulic heads. Hydraulic heads measured in December 2023 were used as optimization targets during PEST calibration. Based on the optimal boundary conditions, the simulated hydraulic heads 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 CRA-2009 PABC, and subsequently used in CRA-2014 & 2019 PAs. These averaged parameter fields (T, A, R) were used as inputs for the MODFLOW-2000 groundwater model. The version of MODFLOW-2000 and boundary conditions of the groundwater model are identical to those used in CRA-2019 PA. 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 parameter estimation software PEST is used during this calibration phase. This calibration process differs from that used in the CRA-2019 PA. Here, only a subset of boundary conditions (Figure 6.3) 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-2000 domain, as shown in Figure 6.3. The direction of groundwater flow in the WIPP LWB is also presented. The last step of this analysis uses the flow field/budget file from MODFLOW-2000 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 is used for particle tracking.

Figure 6.4 shows the hydraulic head contours within and around the WIPP LWB. Hydraulic head contours in the central portion of the map are east-west trending and closely spaced, which suggests a low transmissivity zone. The general east-west trending head contours suggest a north-south groundwater flow direction, as shown with the black arrows in Figures 6.3 and 6.4. Hydraulic head contours are not drawn for the eastern region of the model domain. This region corresponds to the portion of the Culebra bounded by the Anhydrite of the Tamarisk Member and the Mudstone/Halite of the Los Medaños Member. The eastern region is considered a no-flow boundary because of its low transmissivity. Figure 6.4 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 dashed line with the arrow in Figure 6.4 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 3,952 m [12,966 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 6,583 years, corresponding to an average velocity of 0.60 m/yr. The 2023 velocity is 18 percent lower than 2022, likely due to a combination of the new parameter fields and the 2023 measured water levels.

Figure 6.5 shows the triangulated contours of measured-modeled heads. The contour labels represent the difference between measured and modeled heads. The scatter plot in Figure 6.6 presents the measured vs. simulated hydraulic heads for all wells used in the calibration process. These wells are divided into three groups, based on their proximity to the WIPP LWB. Wells inside the WIPP LWB are represented by circles, wells outside but within 3 km of the LWB are shown with the squares, and all other wells are indicated by the stars. Figure 6.6 also shows the 1:1 line and the ± 1 m misfit lines. Note that only wells with a misfit greater than 1.5 m are labeled in Figure 6.6.

The simulated hydraulic heads are in good agreement with the observed heads; 62 percent of simulated heads are within ±1.5 m of observations. Of all wells inside the WIPP LWB, H-5bR has the highest residual, likely due to its low transmissivity. The r^2 values indicate a strong correlation between observed and simulated hydraulic heads. Similarly, the root mean square error (RMSE) and the normalized RMSE are 7.7 ft and 3.6 percent, respectively. The strongest correlation between simulated and observed heads corresponds to wells inside the WIPP LWB. This is particularly important, given that the WIPP LWB is the primary region of interest in this analysis.

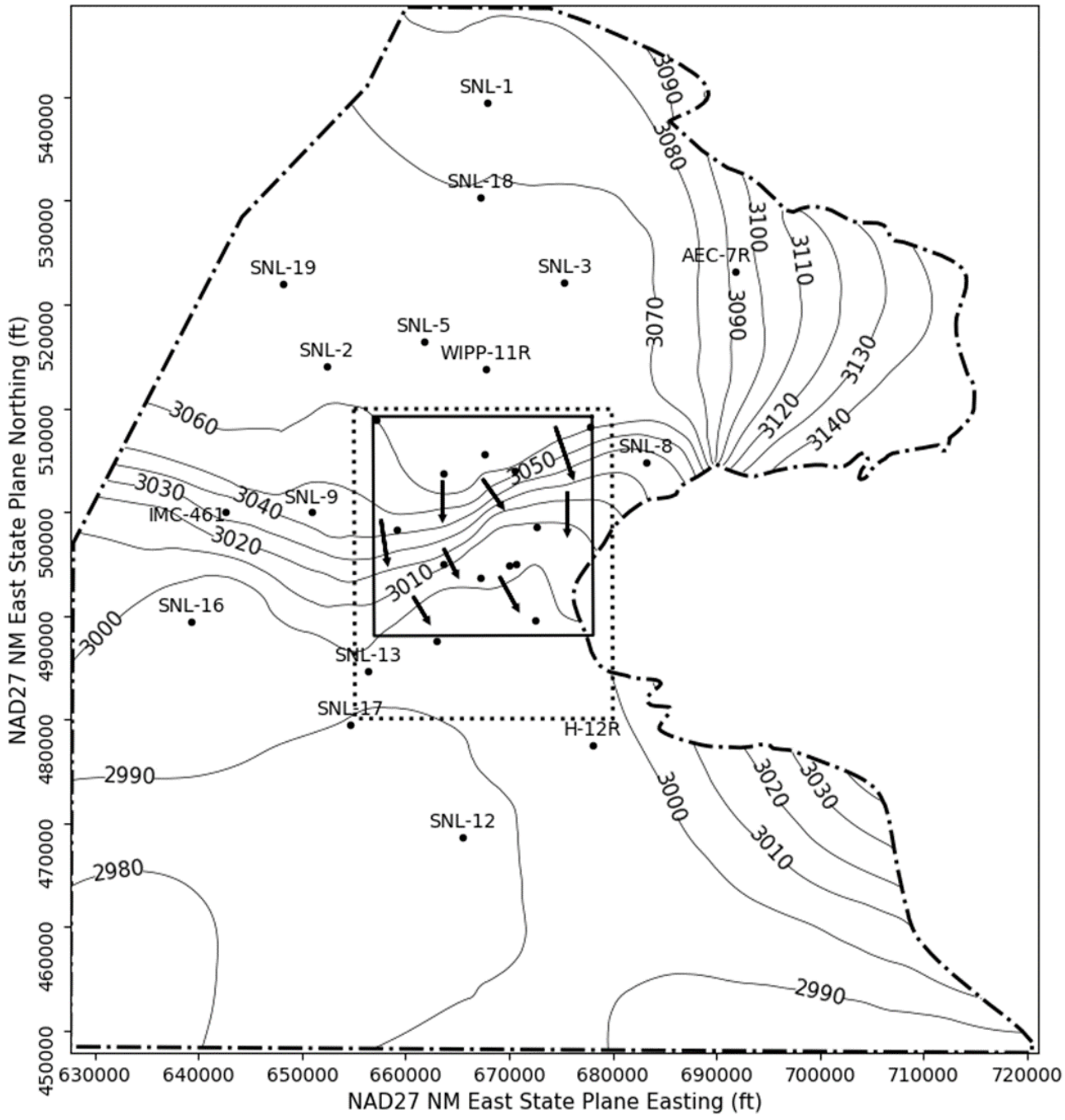

Figure 6.3 – Model-Generated 2023 Culebra Freshwater Head Contours in the Model Domain *(Contour interval 10 feet, contour in feet above mean sea level). The dotted rectangle corresponds to the region contoured in Figure 6.4. The black square corresponds to the WIPP LWB. Wells inside the WIPP LWB are not labeled; refer to Figure 6.5 for identification of these wells. The black arrows indicate the groundwater flow direction inside the WIPP LWB.*

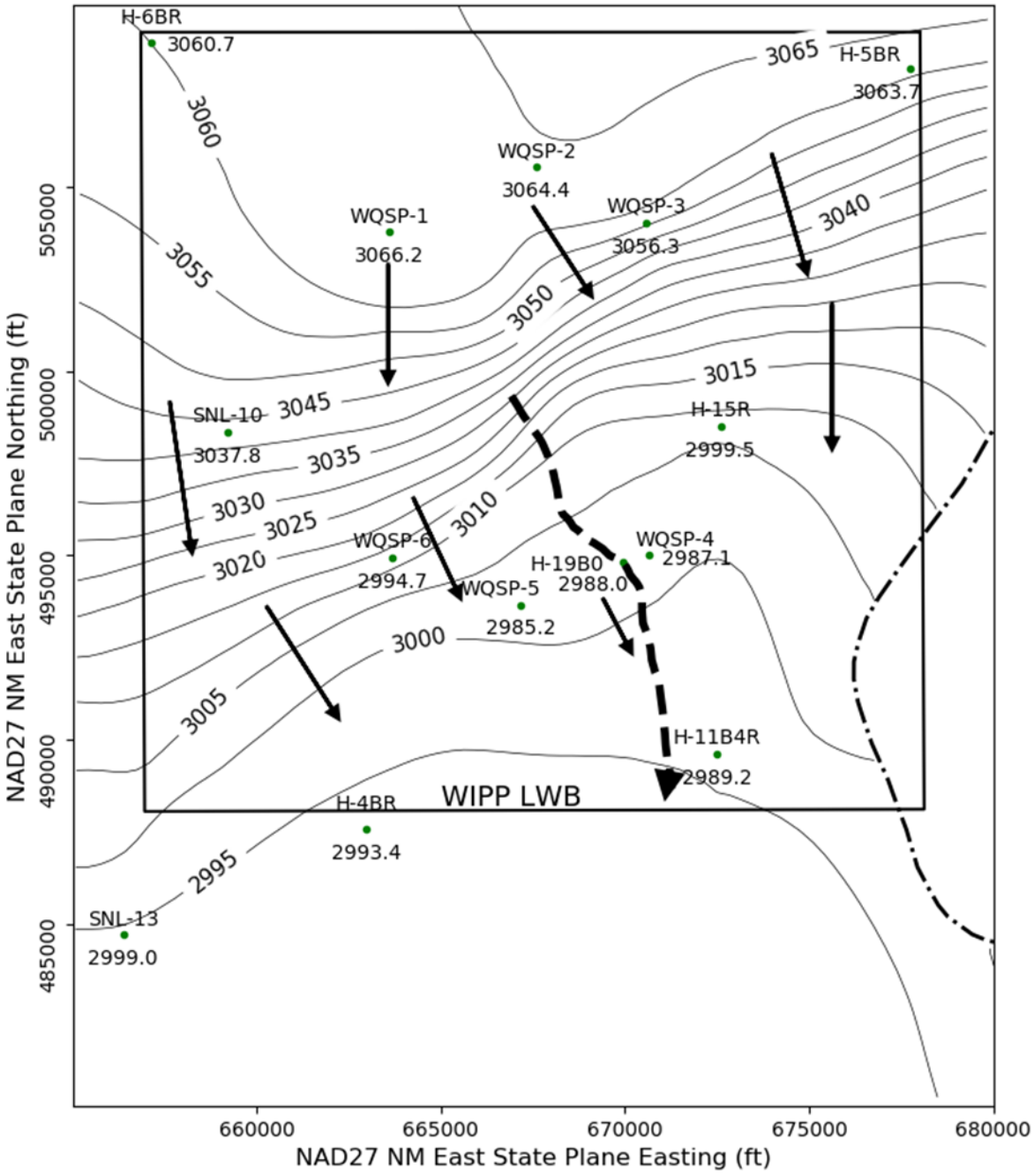

Figure 6.4 – Model-Generated 2023 Culebra Freshwater Head Contours (5-ft Contour Interval) in the WIPP Vicinity with Water Particle Track (Dashed Line with Arrow) from Waste Handling Shaft to WIPP Land Withdrawal Boundary *(Contour in feet above mean sea level, black arrows indicate flow direction within LWB).*

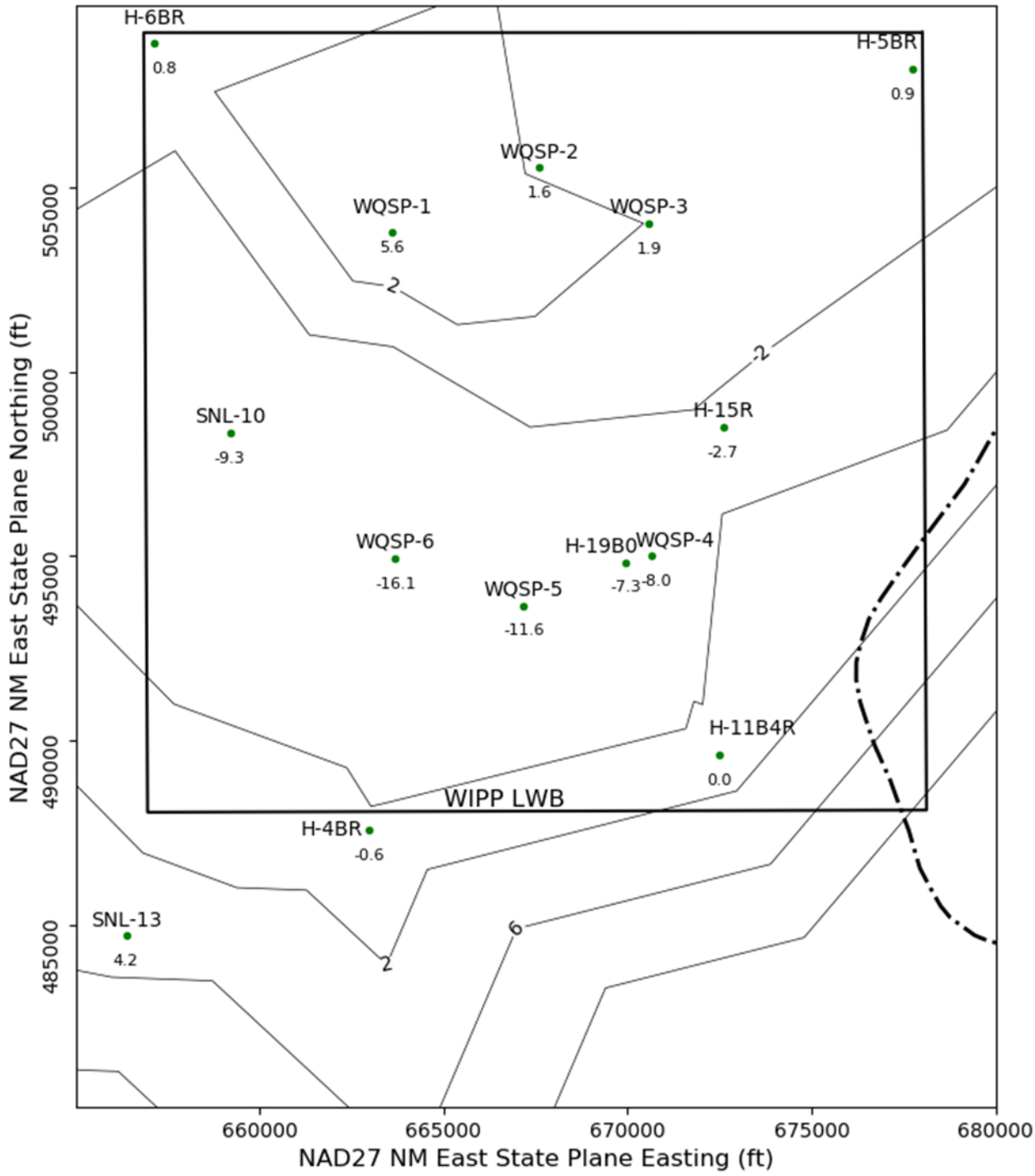

Figure 6.5 – Triangulated Contours (in 5-ft intervals) for Measured Minus Modeled Culebra Freshwater Head

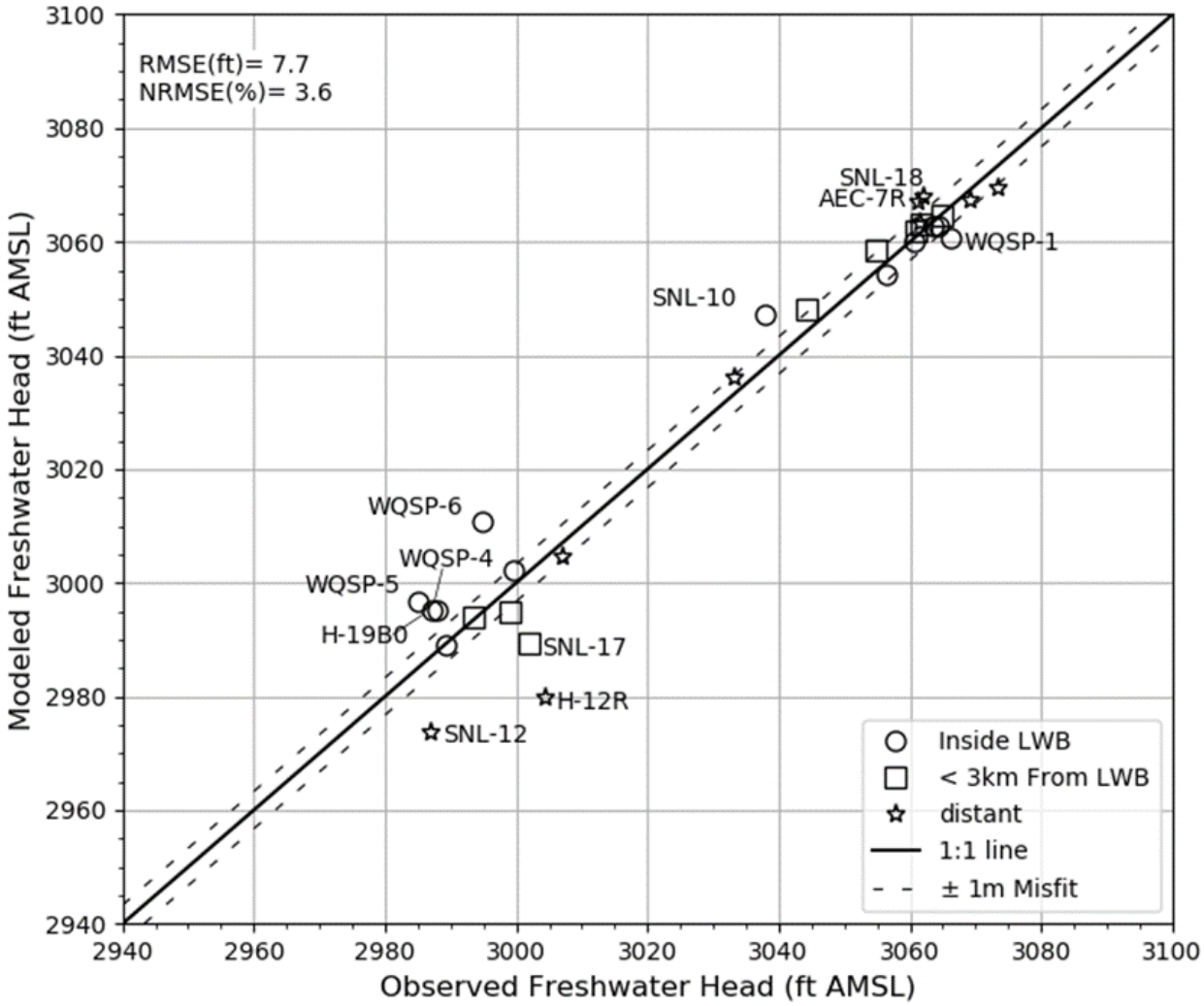

Figure 6.6 – Modeled Versus Measured Scatter Plot for Parameter Estimation Tool-Calibrated MODFLOW 2000 Generated Heads and December 2023 Culebra Freshwater Heads

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 a more accurate determination of relative heads between wells. In the CY, densities were derived from 36 wells containing pressure transducers installed by SNL (Table 6.3). For comparison, 2021 and 2022 density data are shown. Year-to-year density differences are within the error described in WP 02-1.

Table 6.3 – Fluid Density Survey

Well	2021 Fluid Density Survey Result (g/cm^3)	2021 Conversion to Specific Gravity at 70°F	2022 Fluid Density Survey Result (g/cm^3)	2022 Conversion to Specific Gravity at 70°F	2023 Fluid Density Survey Result (g/cm^3)	2023 Conversion to Specific Gravity at 70°F	Notes for 2021–2023 Fluid Density Survey
AEC-7R	1.067	1.069	1.070	1.072	1.070	1.072	
C-2737	1.026	1.028	1.025	1.027	1.027	1.029	
H-4bR	1.021	1.023	1.019	1.021	1.021	1.023	
H-5bR	N/A	N/A	1.089	1.091	1.090	1.092	No 2021 densities available due to well testing.
H-6bR	1.038	1.040	1.038	1.040	1.037	1.039	
H-9bR	1.002	1.004	1.002	1.004	1.002	1.004	
H-10cR	1.089	1.091	1.090	1.092	1.092	1.094	
H-11b4R	1.079	1.081	1.078	1.080	1.074	1.076	
H-12R	1.103	1.105	1.103	1.105	1.094	1.096	
H-15R	1.124	1.126	1.125	1.127	1.125	1.127	
H-16	1.030	1.032	1.031	1.033	1.033	1.035	
H-19b0	1.065	1.067	1.065	1.067	1.062	1.064	Fluid density used for all other H-19 wells
IMC-461	1.000	1.000	1.002	1.004	1.010	1.012	
SNL-1	1.029	1.031	1.032	1.034	1.033	1.035	
SNL-2	1.009	1.011	1.007	1.009	1.011	1.013	
SNL-3	1.027	1.029	1.025	1.027	1.026	1.028	
SNL-5	1.005	1.007	1.006	1.008	1.005	1.007	
SNL-6	1.259	1.262	1.260	1.263	1.260	1.263	
SNL-8	1.090	1.092	1.090	1.092	1.096	1.098	
SNL-9	1.015	1.017	1.015	1.017	1.016	1.018	
SNL-10	1.011	1.013	1.003	1.005	1.006	1.008	
SNL-12	1.010	1.012	1.012	1.014	1.011	1.013	
SNL-13	1.024	1.026	1.025	1.027	1.025	1.027	
SNL-14	1.043	1.045	1.046	1.048	1.046	1.048	
SNL-15	1.230	1.232	1.228	1.230	1.232	1.234	
SNL-16	1.015	1.017	1.018	1.020	1.009	1.011	
SNL-17	1.013	1.015	1.000	1.001	1.002	1.004	
SNL-18	1.011	1.013	1.000	1.002	1.000	1.001	

Well	2021 Fluid Density Survey Result (g/cm^3)	2021 Conversion to Specific Gravity at 70°F	2022 Fluid Density Survey Result (g/cm^3)	2022 Conversion to Specific Gravity at 70°F	2023 Fluid Density Survey Result (g/cm^3)	2023 Conversion to Specific Gravity at 70°F	Notes for 2021–2023 Fluid Density Survey
SNL-19	1.004	1.006	1.004	1.006	1.004	1.006	
WIPP-11R	1.030	1.032	1.023	1.025	1.026	1.028	
WQSP-1	1.042	1.044	1.054	1.056	1.040	1.042	SNL data used for 2021-2023
WQSP-2	1.031	1.033	1.031	1.033	1.032	1.034	SNL data used for 2021-2023
WQSP-3	1.139	1.141	1.139	1.141	1.140	1.142	SNL data used for 2021-2023
WQSP-4	1.075	1.077	1.068	1.070	1.067	1.069	Field hydrometer sampling average used for 2021; SNL data used for 2022 & 2023
WQSP-5	1.026	1.028	1.022	1.024	1.026	1.028	Field hydrometer sampling average used for 2021; SNL data used for 2022 & 2023
WQSP-6	1.014	1.016	1.008	1.010	1.003	1.005	Field hydrometer sampling average used for 2021; SNL data used for 2022 & 2023

6.3 DRILLING AND PLUGGING ACTIVITIES

No wells were drilled or plugged in the CY.

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 historical concentrations of TDS (874 mg/L to 274,000 mg/L) and chloride (146 mg/L to 197,000 mg/L). To the south, yields are greater, and TDS and chloride concentrations are 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. The PAW primarily resulting from surficial runoff and infiltration

existed before the liners were installed. Infiltration controls in the form of liners were installed beginning in 2003 and completed in 2005 for the salt cells and ponds.

In order to investigate the PAW, 21 piezometers completed in the Santa Rosa/Dewey Lake contact (PZ-1 to PZ-7 and PZ-9 to PZ-14, PZ-16, PZ-17a, PZ-18 and PZ-19, C-2505, C-2506, C-2507, and C-2811) and one in the Gatuña (PZ-15) 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 22 locations (Figure 6.7).

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 and PZ-17b; Figure 6.8) and to the south of the WIPP Site (Mills Ranch). To date, based on water chemistry, there is no indication that the PAW has affected the naturally occurring groundwater in the Dewey Lake.

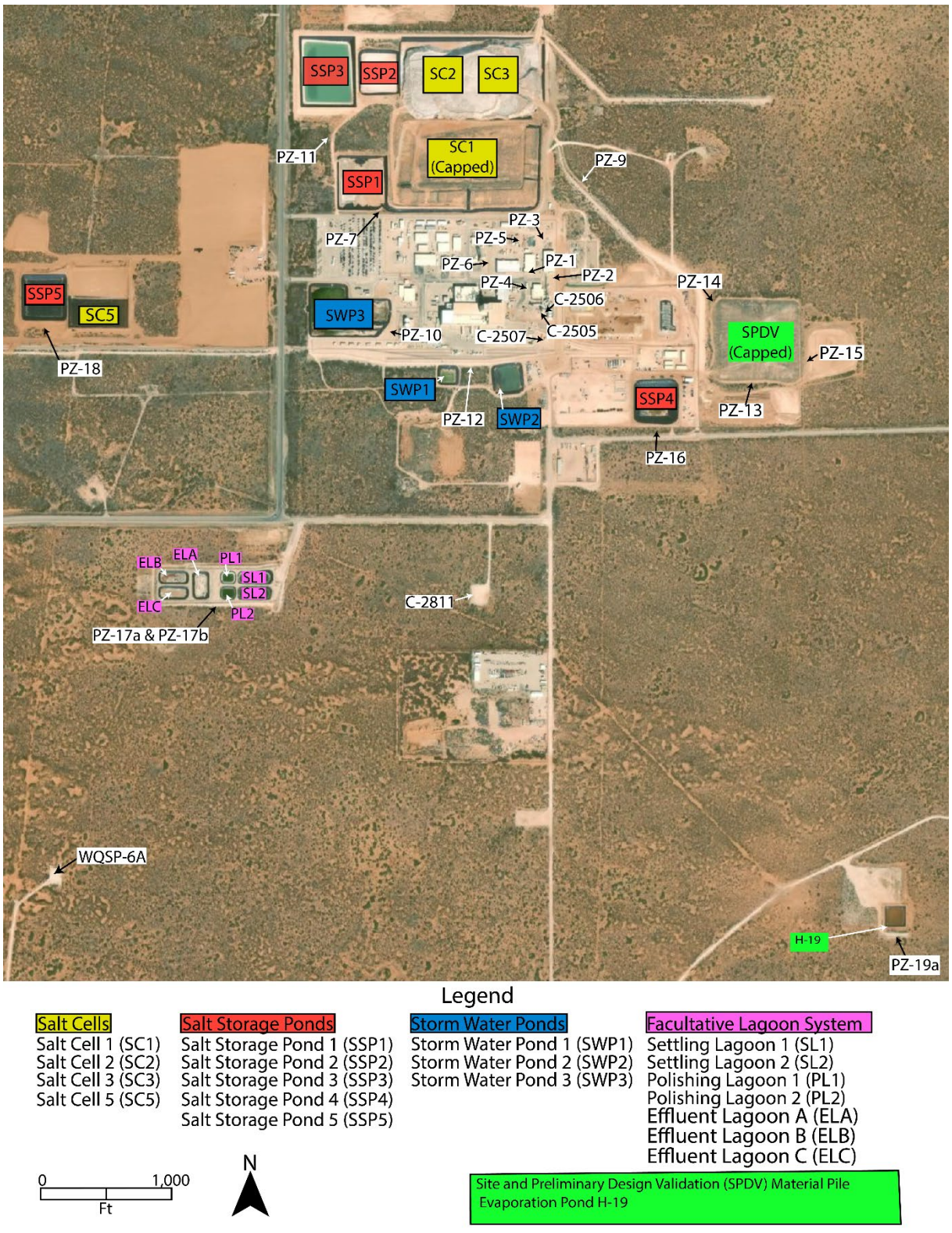

Figure 6.7 – Location of Perched Anthropogenic Water Wells

6.4.1 Perched Anthropogenic Water Quality Sampling

The DP-831, as issued in January 2022, requires 17 PAW wells (C-2507, C-2811, PZ-1, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, PZ-13, PZ-14, PZ-15, PZ-16, PZ-17a, PZ-18, PZ-19) and two middle DL wells (WQSP-6A, PZ-17b) to be sampled on a semi-annual basis. These wells were sampled in April-May (Round 39) and October-December 2023 (Round 40) and reported in the semi-annual DP-831 reports (U.S. Department of Energy, July 2023 and January 2024, respectively). Field parameters were measured for pH, temperature and, Specific Conductivity in the 19 wells listed above except for PZ-9, PZ-13, PZ-14, and PZ-15, which were bailed, and PZ-16, PZ-17a, PZ-18 and, PZ-19, which were dry and not sampled. Laboratory analysis was performed for Sulfate, Chloride, and TDS in all wells sampled except for PZ-17b, which was also tested for TKN and Nitrate.

6.4.1.1 Results and Discussion

In general, the concentrations of Sulfate, Chloride, and TDS have been decreasing since 2008 except for PZ-7, PZ-9, and C-2507. The PAW quality sampling during the CY (rounds 39 and 40) did not identify any new exceedances with respect groundwater quality standards listed in 20.6.2.3103 NMAC for Human Health and Domestic Water Supply.

6.4.2 Perched Anthropogenic Water Level Surveillance

Twenty-one 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 decreased. However, water levels experienced an increase from 2014 to March 2017 due to higher-than-average precipitation levels from 2014 to 2016. During this reporting period, wells inside the PPA (C-2505, C-2506, C-2507, PZ-1-PZ-6) all had water level increases of less than a foot, except for PZ-3 and PZ-5 which decreased. All wells located outside of the PPA showed a decrease.

The potentiometric surface for the PAW using December 2023 data is presented in Figure 6.9. The contours were generated using *SURFER*, Version 19, a surface mapping software by Golden Software. Fifteen 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 geochemically 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, and 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 rainwater has accumulated from a localized recharge source.

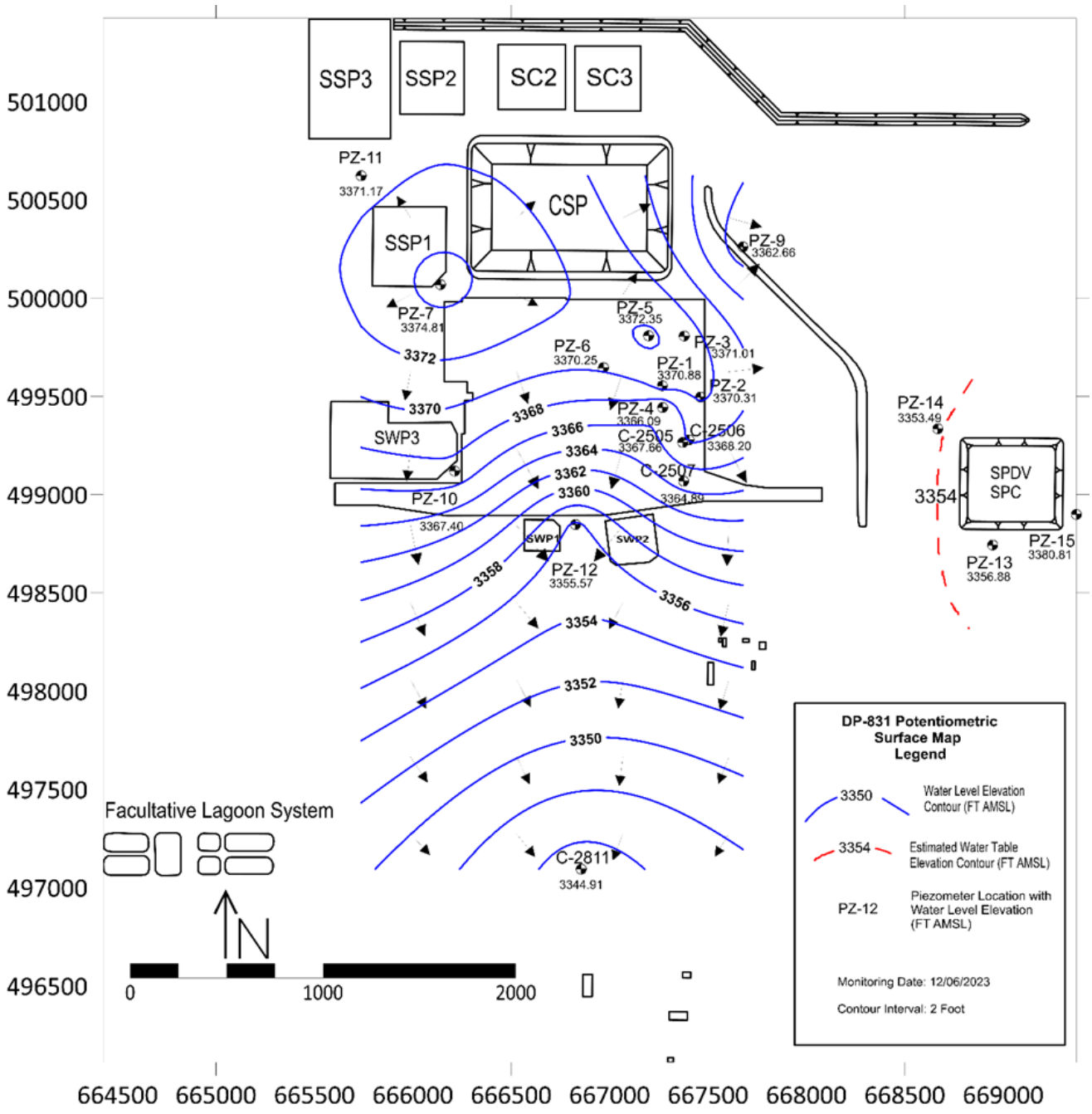

Figure 6.8 – December 2023 Perched Anthropogenic Water Potentiometric Surface

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).

6.6 EMERGING CONTAMINANTS

In recent years, there has been increasing regulatory interest in emerging contaminants of concern that may be present in the environment and in drinking water supplies. A category of man-made chemicals known as per- and polyfluoroalkyl substances (PFAS) have been detected in surface waters and groundwater across the country, and their toxicity and persistence in the environment has led to designation of these substances as emerging contaminants of concern.

WIPP has no records of ordering or using chemicals with PFAS but does have products that may have been manufactured using fluoropolymers (e.g., fire protective gear, UV-resistant materials). Given the lack of chemical use records and regulatory limits, monitoring of the WIPP facility drinking water supply for PFAS has not occurred. Water is supplied to the Site by the City of Carlsbad from the Double Eagle Water System. The city plans to obtain and analyze PFAS samples from the water supply wells in the 2024-2025 time frame when drinking water limits have been established.

To assure PFAS does not exist in the environment, WIPP is planning on sampling groundwater monitoring wells and the Facultative Lagoon System. All domestic wastewater derived from the WIPP facility is discharged into the Facultative Lagoon System. With respect to groundwater, sampling will occur for nine monitoring wells completed in three water bearing zones. The well sampling is planned for the spring and summer months of 2024.

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 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, NM and SGS North America Inc. (SGS) in Dayton, New Jersey, performed the non-radiological VOC analyses, and Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, NM, 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 subcontracted laboratory used to measure trace concentrations of metals by EPA Method 6020 (Inductively Coupled Plasma –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 Mixed Analyte Performance Evaluation Program (MAPEP), the National Environmental Laboratory Accreditation Conference, and the National Air Toxics Trends Station (NATTS) proficiency test studies. Laboratories used the applicable requirements of the CBFO *Quality Assurance Program Document* (DOE/CBFO-94-1012), as flowed down through the *Quality Assurance Program Description* (WP 13-1).

The 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 *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, four 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.

Any significant findings discovered during assessments and audits of the contract laboratories will be discussed in the sections below specific to each laboratory.

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, 7.3, and 7.4 discuss the QC results for the WIPP Laboratories, CEMRC, HEAL/Anatek and, SGS respectively, regarding 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. The WIPP Laboratories organization is 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. There were instances where data were qualified due to QC deficiencies, but the results were comparable to the previous year's data. 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 the 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. The precision of field duplicates was calculated and reported by the data validator based on the analysis results of the individual samples. The precision objective is a requirement of the laboratory. In some cases, batches of samples were recounted or reprocessed to achieve the laboratory duplicate precision objective before the data were reported.

The relative error ratios (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. Regarding vegetation samples, separate plants were collected to generate a duplicate sample.

For 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. The WIPP field duplicate analyses yielded 17 RER values greater than 1.96, indicating whether the radionuclide was detected or not in the CY. A total of 160 field duplicate RERs were calculated resulting in 89.4% of field duplicates yielding RERs less than 1.96.

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 for 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 using 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 2023 were MAPEP 48 and MAPEP 49. WIPP laboratories participated in the two studies. For MAPEP 48 they are receiving mostly acceptable results with two Warnings (W) for Uranium-234 and Uranium-238 and two Result “Not Acceptable” (N) for Plutonium-239/240 and Potassium-40 in Mixed Analyte Water Standard. For MAPEP 49 they are receiving mostly acceptable results with one “W” for Americium-241 and one Result “N” for Plutonium-239/240 in Radiological Air Filter Standard.

7.1.5 Representativeness

Representativeness is the extent to which measurements represent the actual environmental condition or population at the time a sample was collected. The primary objective of the Environmental Monitoring Program is to generate environmental data to determine that the health and safety of the population surrounding the WIPP facility is being protected. Analytical representativeness is ensured through 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 analyses of air VOC samples collected at the WIPP facility during the CY. The laboratory QA/QC analyses indicate instances where data quality objectives were not within specifications but still capable of quantifying detectable target analytes. In late November 2023, the Permittees entered a new contract with SGS. Therefore, data sets at the end of 2023, beginning with samples collected on 11/7/2023, were analyzed by SGS.

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 (i.e., those which meet data 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, 265 VOC compliance samples and field duplicate samples were submitted to CEMRC for analysis. The program was deficient in 131 samples for the following reasons:

- 10 repository samples were voided. Of the 10 voided samples, two were voided due to the sample technician using a canister designated for disposal room sampling. Canisters are segregated with respect to the sampling program due to differences in reporting limits and cleaning certification criteria. The technician was retrained on the reasons for canister segregation. The other eight samples were voided due to various issues with QC during sample analysis that deemed them unusable.
- 118 were assigned a "Q" qualifier, indicating they did not meet one or more of the quality objectives of the VOC Monitoring program.
- Two were assigned an "R" qualifier, indicating sample results are unusable due to the quality of the data generated because certain criteria were not met, and the analyte may or may not be present in the sample.
- One disposal room sample was voided due to failing a canister vacuum verification requirement (vacuum in canister lost more than the allowable 2.5 inHg from the field to the lab).

To determine the completeness percentage for repository VOC monitoring, 93 is divided by 194, and therefore, the program analytical completion percentage was 47.9 percent. The analytical completeness percentage for disposal room VOC monitoring was determined by dividing 41 by 71, resulting in 57.7 percent. The overall analytical completeness percentage was determined by dividing 134 by 265, which results in 50.6 percent. Results are summarized in Table 7.1.

Table 7.1– Summary of Total VOC Samples for the CY Analyzed by CEMRC

	Surface VOC	Disposal room VOC	Surface and Disposal room Combined
[1]Number of samples collected and analyzed	184	70	254
[2]Number of samples with valid results received	93	41	134
[3]Number of samples required to be collected	194	71	265
Percent Complete	47.4	57.7	49.8

Note: [1]Collected and analyzed samples include field duplicates, those samples that received a Q qualifier, and rejected samples (if any). Voided samples not included in this total. [2]Samples with valid results exclude samples which received a Q qualifier, were voided, and which were rejected. [3]Number of samples required to be collected includes all samples (original samples, field duplicates, samples qualified Q, voided, and rejected samples).

7.2.2 Precision

Precision is demonstrated in the VOC Monitoring Program by evaluating results from 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 analytical 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.01. 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
Note: vertical lines in the formula above indicate absolute value of A minus B

An LCS and an LCSD report were generated and evaluated for data submitted in the CY. The LCS/LCSD data generated from laboratory duplicate samples during the CY yielded RPDs less than or equal to the acceptance limit of 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 the acceptance limit of 35. For each target VOC value reported over the MRL, the acceptance criterion was met.

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. All prescribed checks were performed and met all limits.

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.

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

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

During the CY, 78.5 percent of instrument calibrations met criteria of less than or equal to 30 percent. Fifty-seven of the 265 samples were found to be outside the limits.

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, 96.6 percent of the LCS recoveries met the ±40 percent criterion. Nine of the 265 samples were found to be outside the limits.

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, 86.4 percent of internal standards met the ±40 percent criterion. Thirty-six of the 265 samples were found to be outside the limits.

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 quarter of the CY.

For the NATTS first quarter 2023 PT, 1,2-dichloroethane, chloroform, and trichloroethylene met the acceptance criterion of ± 30 percent of the nominal spike value established in the WIPP Laboratory PT Program. 1,1,2,2- tetrachloroethane and carbon tetrachloride returned a result above the acceptance criterion of ±30 percent, at 37.0 and 67.3 percent difference relatively. The CEMRC laboratory mistakenly failed to report a value for methylene chloride. However, using the value obtained from the sample run (as seen on the instrument results), methylene chloride would have met the acceptance criterion of ± 30 percent of the nominal spike value at -20.4 percent difference (Table 7.2). Corrective action requests were issued to CEMRC.

Table 7.2 – CEMRC Proficiency Testing Results

Target Compounds	The CEMRC Reported Value (ppbv)	NATTS Spike Value (ppbv)	Percent Difference
1st Quarter 2023 Results			
1,1,2,2-Tetrachloroethane	0.100	0.073	37.0
1,2-Dichloroethane	0.386	0.45	-14.2
Carbon Tetrachloride	0.184	0.110	67.3
Chloroform	0.550	0.53	3.8
Methylene Chloride*	0.374*	0.47	-20.4*
Trichloroethylene	0.277	0.29	-4.5

ppbv – parts per billion by volume

*Indicates value was not reported by CEMRC, so result was not included in the NATTS summary.

7.2.5 Representativeness

Representativeness is ensured using 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 45 groundwater sampling in the CY. Hall Environmental Analysis Laboratory followed laboratory SOPs based on standard analytical methods from the EPA and *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 to achieve the requisite MRLs. After the conclusion of Round 45 sampling HEAL was acquired by Eurofins and will be referred to as Eurofins in future reports.

7.3.1 Completeness

Six DMP wells were sampled once in the CY from March through October. 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 quality assurance objective (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 45, 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 laboratory's QC summary reports located in Appendices 3 through 8 of the *Annual Culebra Groundwater Report* (U.S. Department of Energy, November 2023).

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 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. Where applicable, the LCS and LCSD samples 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 surrogate 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. The accuracies of the QC data are detailed in the laboratory's QC summary reports located in Appendices 3 through 8 of the *Annual Culebra Groundwater Report* (U.S. Department of Energy, November 2023).

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 a consistent methodology. These comparability requirements were met through 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 the National Environmental Laboratory Accreditation Program through Oregon for HEAL and Anatek. Hall Environmental Analysis Laboratory is certified in Oregon, Utah, Texas, NM, and Arizona. The labs participate in inter-laboratory evaluation programs, including onsite 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, Phenomenex Company. The results from the 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 2023).

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.

7.4 SGS NORTH AMERICA INC.

The analytical laboratory at SGS performed analyses beginning with air VOC samples collected on November 7, 2023, at the WIPP Facility.

7.4.1 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 (i.e., those which meet data 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, 48 VOC compliance samples and field duplicate samples were submitted to SGS Dayton for analysis. The VOC program was deficient in 2 samples as they were voided after analysis showed sampling issues had occurred in the field at the time of collection. These samples did not count against completeness.

The repository analytical completion percentage was 100 percent. The analytical completeness percentage for disposal room VOC monitoring was 100 percent. The overall analytical completeness percentage was 100 percent.

7.4.2 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 LCS and LCSD, and laboratory sample duplicates (duplicate analytical 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 RPD, as defined in WP 12-VC.01.

An LCS and an LCSD report was generated and evaluated for data submitted in the CY. The LCS/LCSD data generated during the CY yielded RPDs less than or equal to the acceptance limit of 25. Laboratory duplicate samples yielded RPDs less than or equal to the acceptance limit of 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 the acceptance limit of 35. For each target VOC value reported over the MRL, the acceptance criterion was met.

7.4.3 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. All prescribed checks were performed and met all limits.

7.4.3.1 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. During the CY, 100 percent of instrument calibrations met the ±30 percent criterion.

Laboratory Control Sample Recoveries

Laboratory control sample recoveries are required to have an acceptance criterion of ±40 percent (60 to 140 percent recoveries). 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, 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 SGS met the MDL requirements for the CY data.

7.4.3.2 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.

7.4.4 Comparability

SGS participated in the Phenova PT for VOC analysis in the third quarter of the CY. For the Phenova third quarter 2023 PT, 9 of 10 analytes of interest met the acceptance criterion of +/- 30%. The Permittees also observed that 1,1,2,2-Tetrachloroethane exceeded the acceptance criterion of ± 30 percent, at 40.6 percent difference, with a study mean of 14.4 and a standard deviation of 2.94. Corrective action was not taken since these PT results were obtained prior to entering a contract agreement.

Furthermore, all 10 target analytes passed according to the PT laboratory acceptance criteria. Results are summarized in table 7.4

Table 7.3 – SGS Proficiency Testing Results

Target Compound	Result (ppbv)	Assigned Value (ppbv)	Percent Difference
1,2-Dichloroethane	14.2	16	-11.9
1,1-Dichloroethylene	<0.20	<5	N/A
Methylene Chloride	32.6	37.0	-12.6
1,1,1-Trichloroethane	32.1	35.0	-8.6
Carbon Tetrachloride	<0.20	<5	N/A
Chlorobenzene	<0.20	<5	N/A
Chloroform	<0.20	<5	N/A
1,1,2,2-Tetrachloroethane	10.6	16.0	-40.6
Trichloroethylene	15.8	17.0	-7.3
Toluene	13.0	16.0	-20.7

7.4.5 Representativeness

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

APPENDIX A – REFERENCES

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WP 12-VC.02, *Quality Assurance Project Plan for Volatile Organic Compound Monitoring.* Waste Isolation Pilot Plant, Carlsbad, NM.

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APPENDIX B – ENVIRONMENTAL PERMITS

Major Environmental Permits for the Waste Isolation Pilot Plant as of January 2024

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	Obsolete on 11/03/2023
New Mexico Environment Department	Hazardous Waste Facility Permit	NM4890139088-TSDF	10/04/2023 effective 11/03/2023	12/30/2030	Active
New Mexico Environment Department Groundwater Quality Bureau	Discharge Permit	DP-831	01/28/2022	01/27/2027	Active
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	310-M-3	07/12/2019	None	Active
New Mexico Environment Department Petroleum Storage Tank Bureau	Petroleum Storage Tank Registration Certificate	Registration Number 1728 Facility Number 31539	07/01/2022	06/30/2023	Expired
New Mexico Environment Department Petroleum Storage Tank Bureau	Petroleum Storage Tank Registration Certificate	Registration Number 2008 Facility Number 31539	07/02/2023	06/30/2024	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, NM	N/A	03/19/2018	09/30/2023	Active Renewal in Process
U.S. Fish and Wildlife Service	Special Purpose – Relocate	MB155189-1	05/21/2020	03/31/2023	Expired
U.S. Fish and Wildlife Service	Special Purpose – Relocate	MB155189-2	04/01/2023	03/31/2026	Active
New Mexico Department of Game and Fish	Biotic Collection Permit	Authorization № 3293	12/16/2022	12/31/2025	Active

N/A = Not applicable

APPENDIX C – LOCATION CODES

BHT	Bottom of the Hill Tank	PCN	Pierce Canyon
BLK	Blank	PEC	Pecos River
BRA	Brantley Lake	PKT	Poker Trap
CBD	Carlsbad	RED	Red Tank
COW	Coyote Well (deionized water blank)	RLK	Red Lake
COY	Coyote (surface water duplicate)	SEC	Southeast Control
FWT	Fresh Water Tank	SMR	Smith Ranch
H19	Evaporation Pond H-19 (DP-831)	SOO	Sample of Opportunity*
HIL	Hill Tank	SWL	Sewage Lagoon
IDN	Indian Tank	UPR	Upper Pecos River
LST	Lost Tank	WEE	WIPP East
MLR	Mills Ranch	WFF	WIPP Far Field
NOY	Noya Tank	WSS	WIPP South

* A SOO 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 large or small numbers. For example, 1 million can be written as 1,000,000 or, using E notation, written as 1.0E+06. Converting from scientific notation to a general 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 the general number is 0.004. If the value given is 1.0E+03, the decimal point should be moved three places to the right, so the result would be 1,000.

Minimum Detectable Concentration

The MDC is the smallest amount (activity or mass) of a radionuclide in a sample that will be detected with a maximum of a 5 percent probability of false positive, a maximum of a 5 percent probability of a false negative and a 95 percent probability for detection. It is possible to achieve a very low detection level by analyzing a large sample size and counting for an extended time.

The WIPP Laboratories use the following general 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 estimates 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, to compare duplicate sample analysis results (see Chapters 4 and 7, and WP 02-EM3004, *Radiological Data Verification and Validation*). RER for laboratory duplicates has an objective of ≤ 2.

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

Where:

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

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

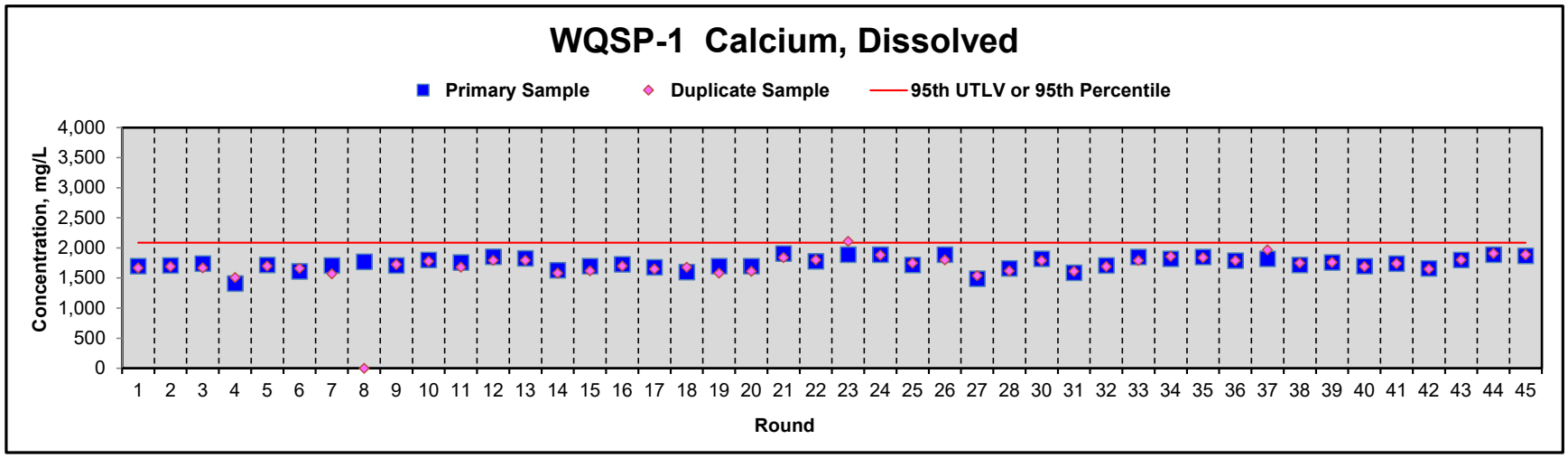
1σTPU = total propagated uncertainty at the 1 σ level

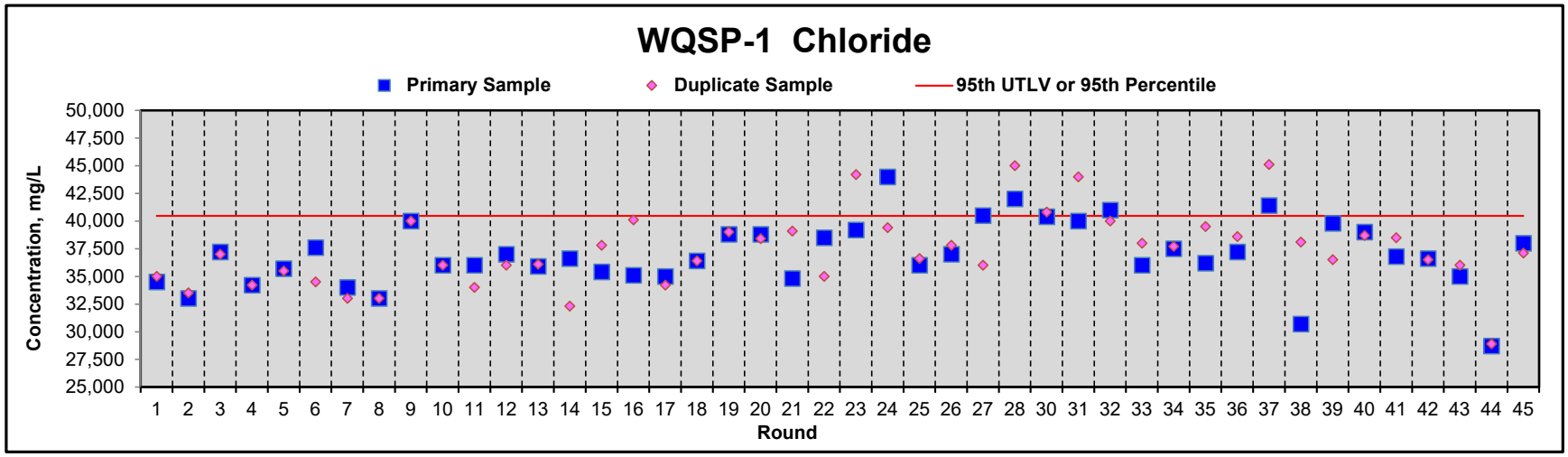
ABS = *absolute value*

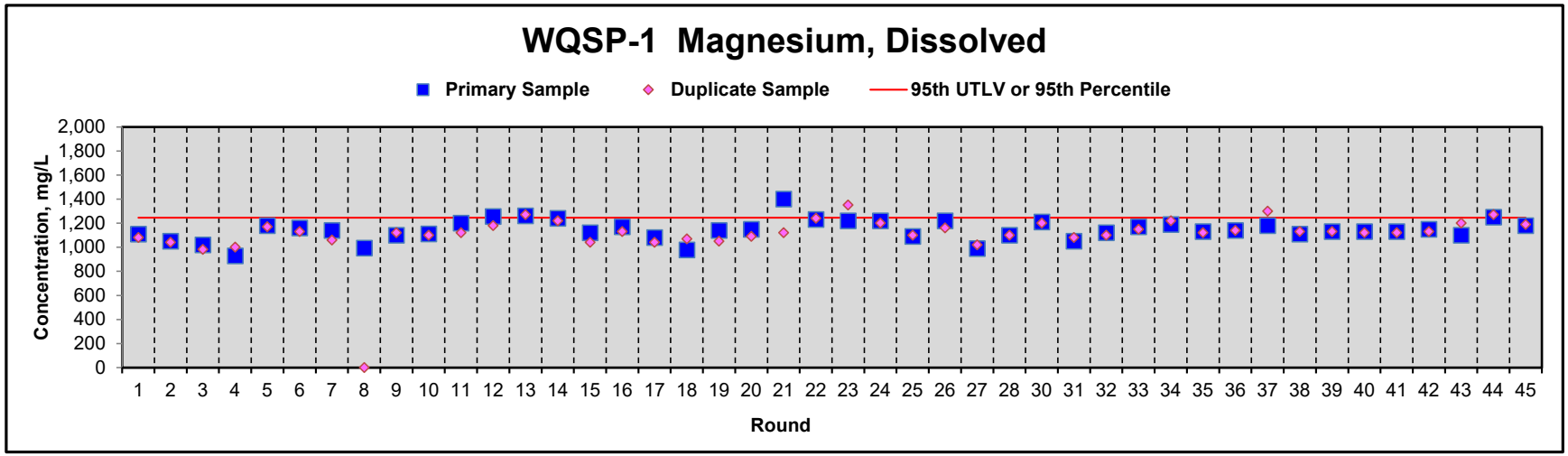
APPENDIX E – TIME SERIES PLOTS FOR MAIN PARAMETERS IN GROUNDWATER

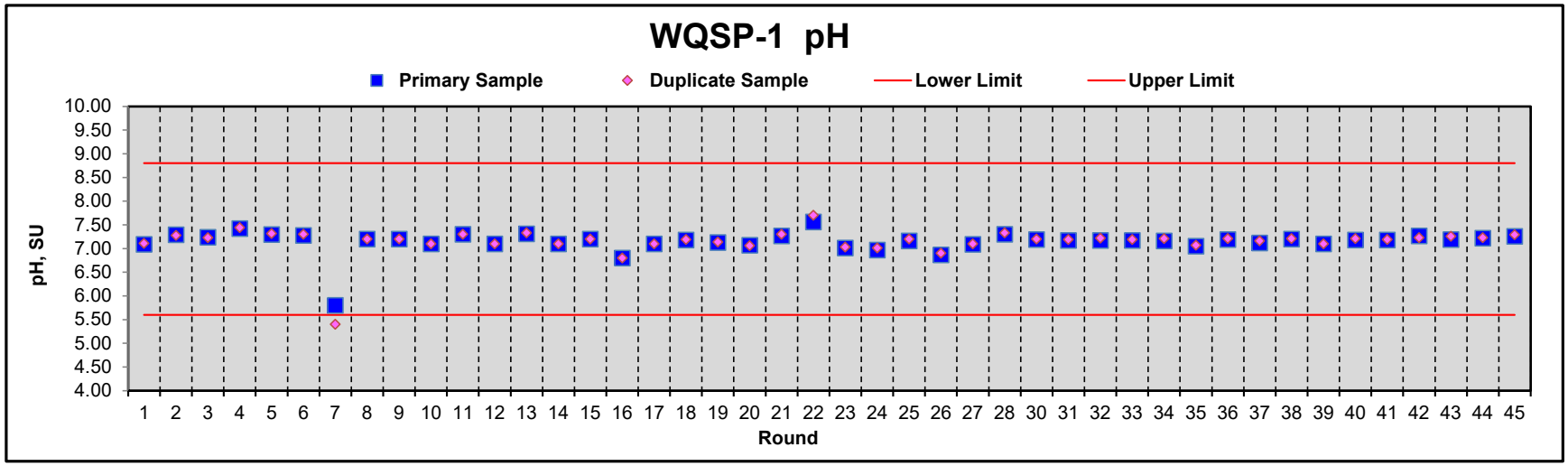
The first 10 sampling rounds were conducted from 1995 through 2000 (prior to receiving mixed waste at the WIPP) and were used to establish the original baseline for groundwater chemistry at each sampling location. The baseline sample sets are used to determine whether statistically significant changes 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.

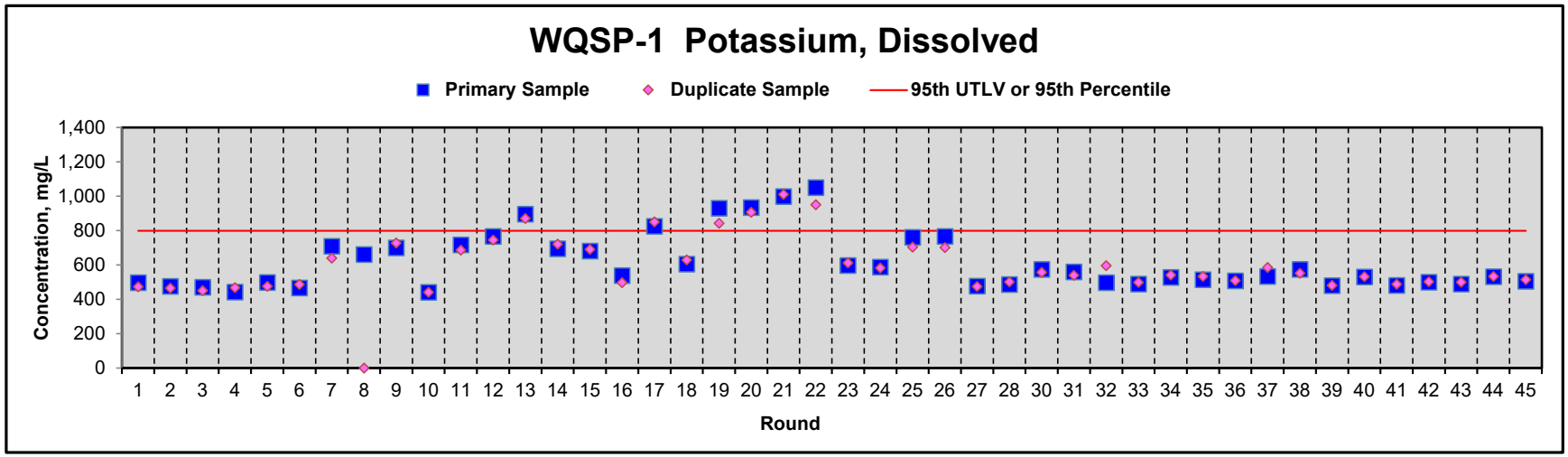
The CY laboratory analytical results were verified and validated in accordance with WIPP procedures and EPA technical guidance. Sampling Round 45 samples were collected from March through October 2023. See Appendix F for method reporting limits in Table F.1 and the results of the target analytes in the DMP wells in Table F.2.

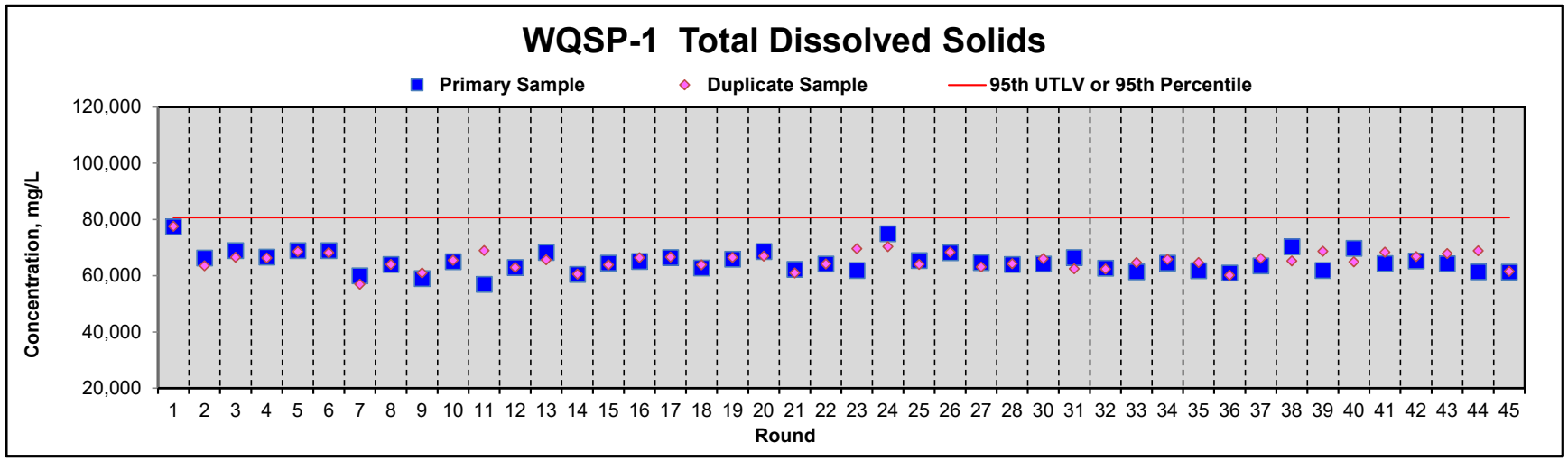

WQSP-1 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

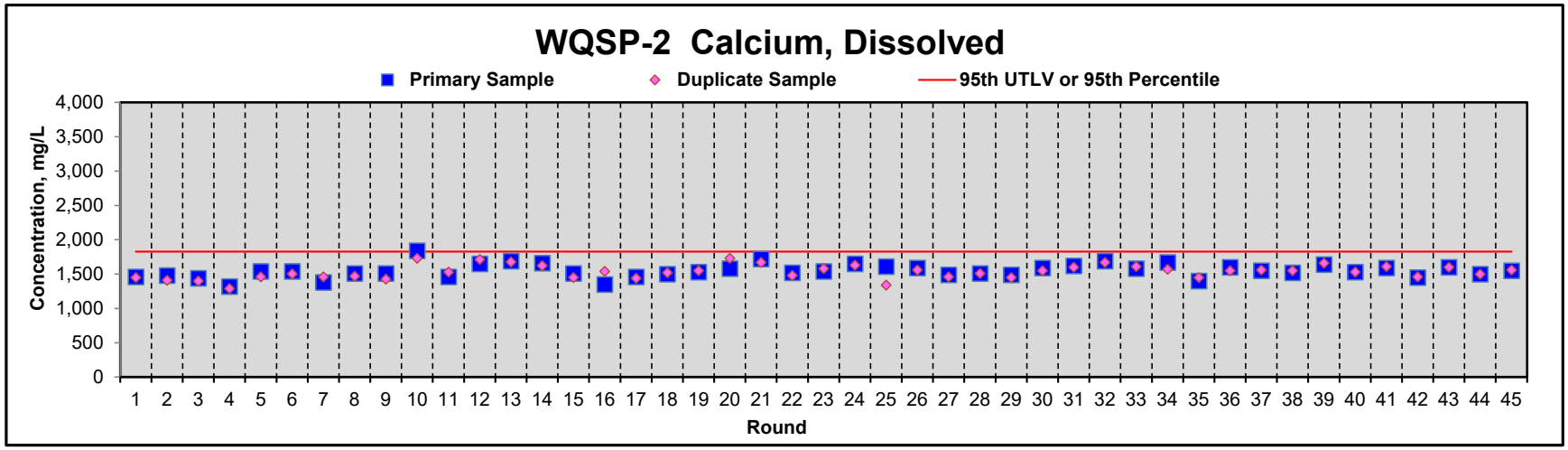

WQSP-1 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
50,000
47,500
45,000
42,500
40,000
37,500
35,000
32,500
30,000
27,500
25,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

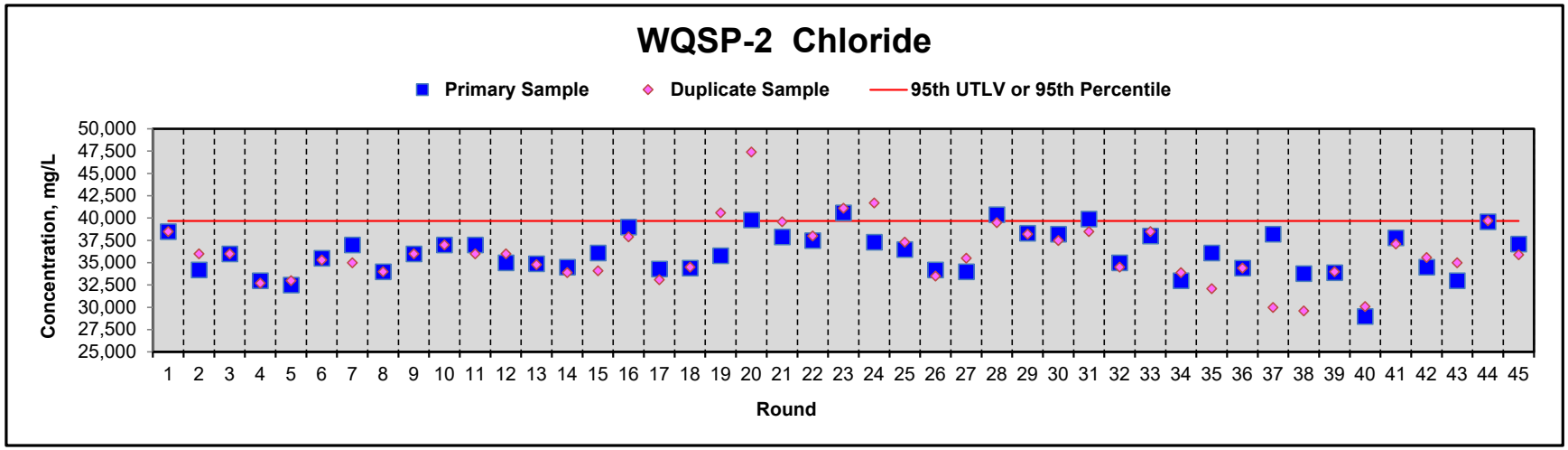

WQSP-1 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

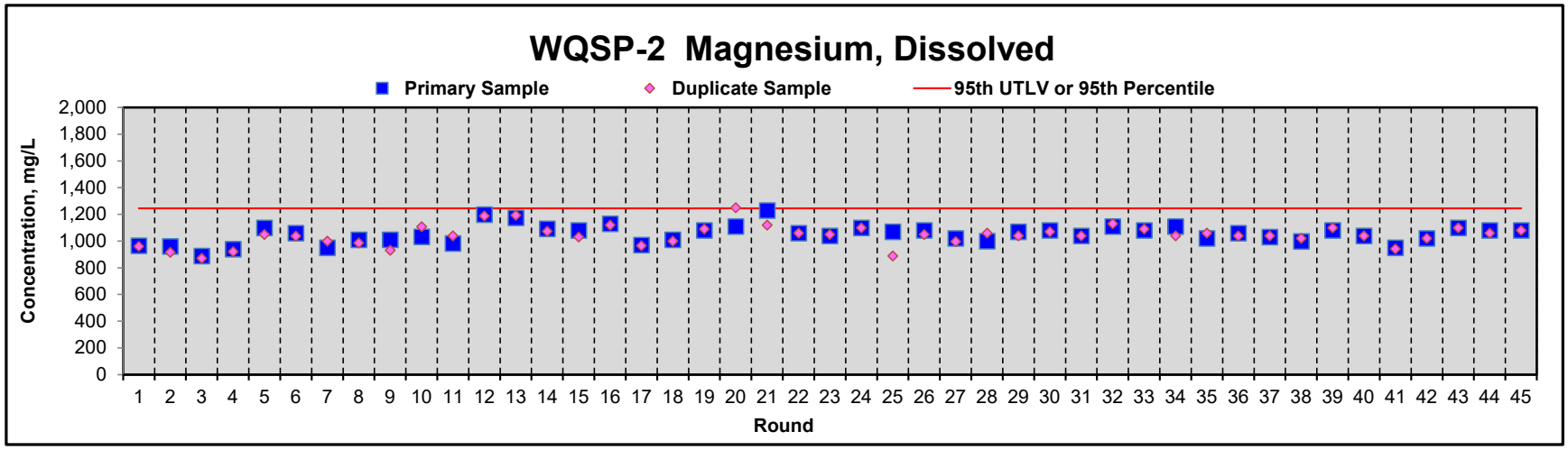

WQSP-1 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

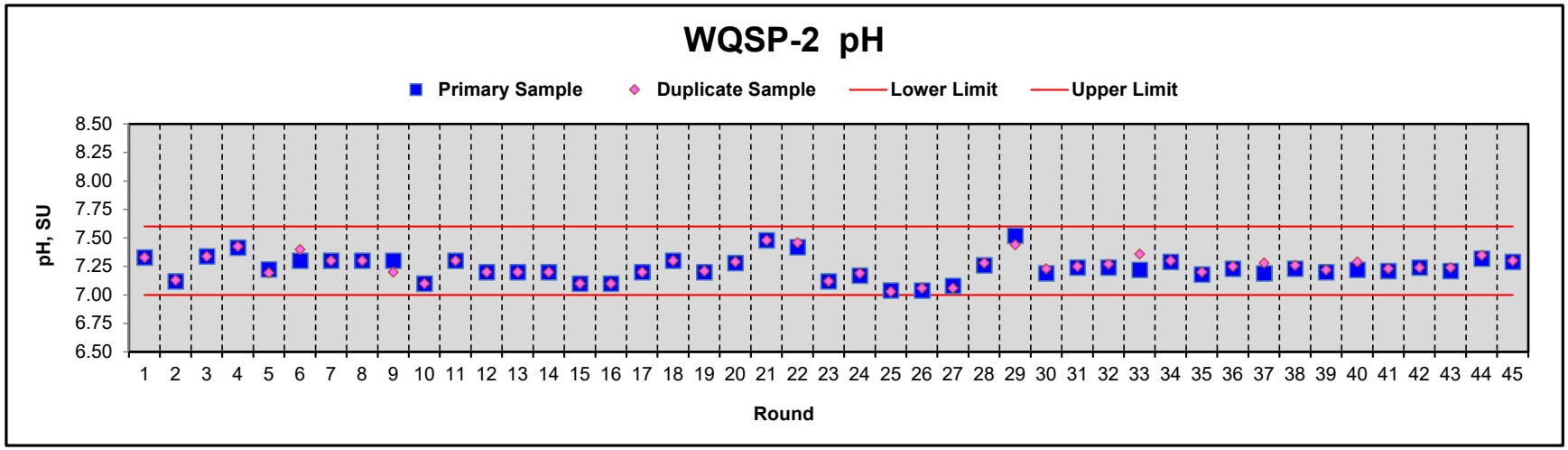

WQSP-1 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

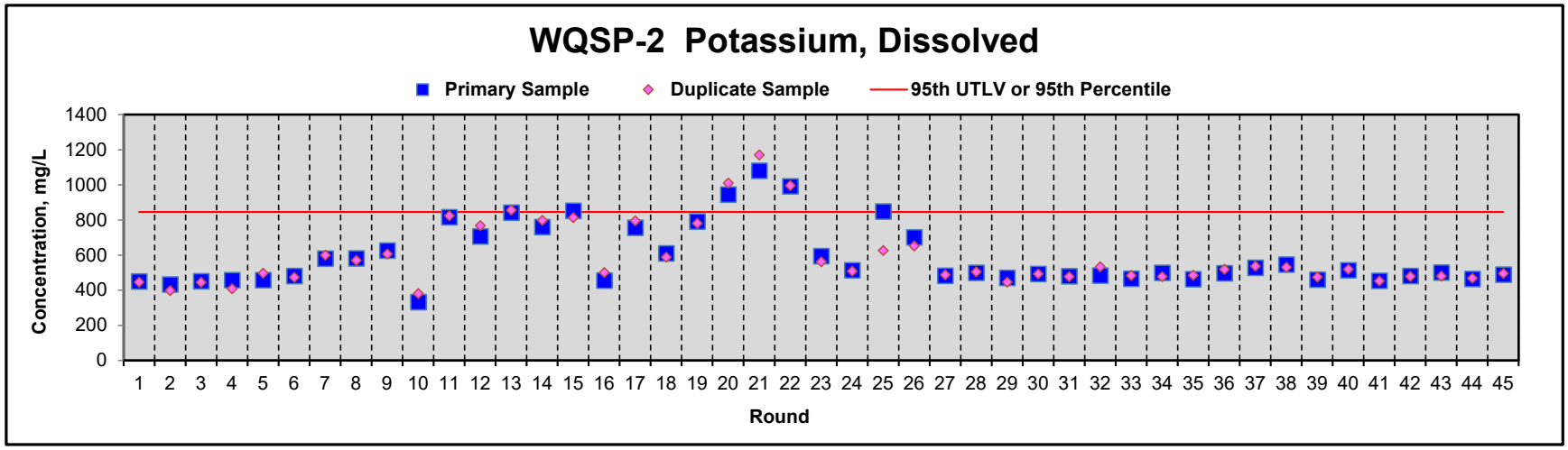

WQSP-1 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
120,000
100,000
80,000
60,000
40,000
20,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

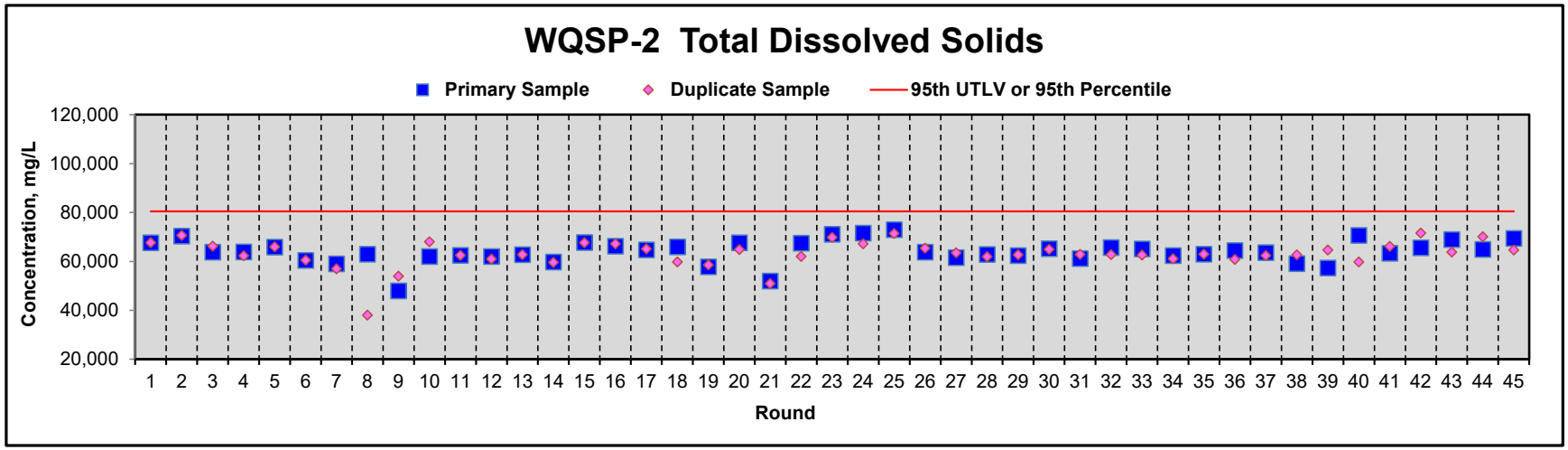

WQSP-2 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

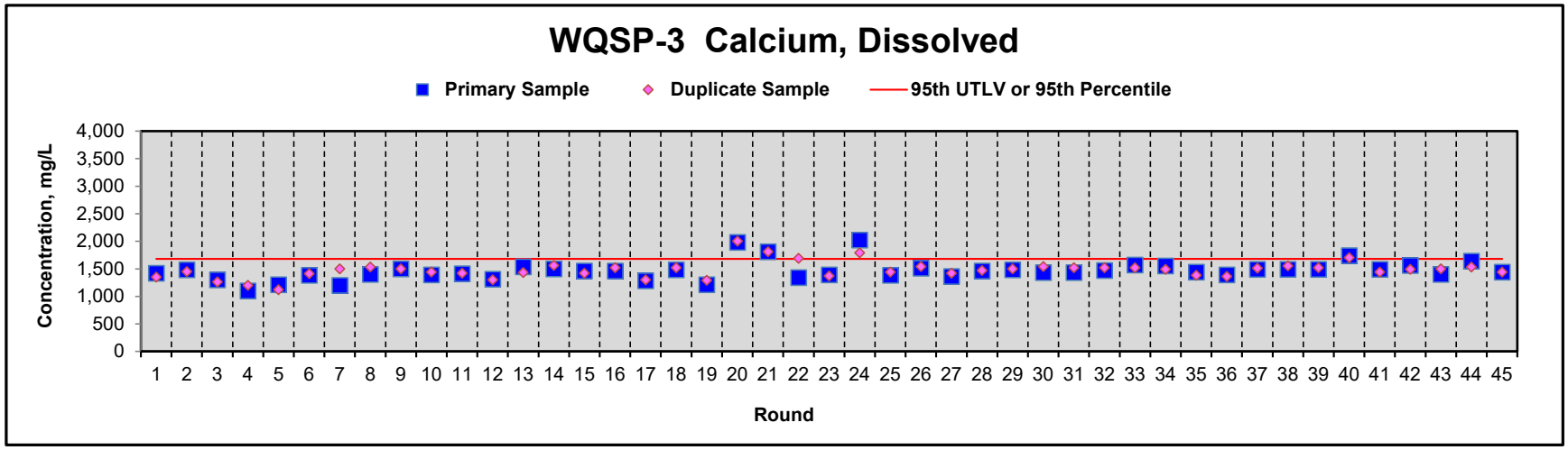

WQSP-2 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
50,000
47,500
45,000
42,500
40,000
37,500
35,000
32,500
30,000
27,500
25,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

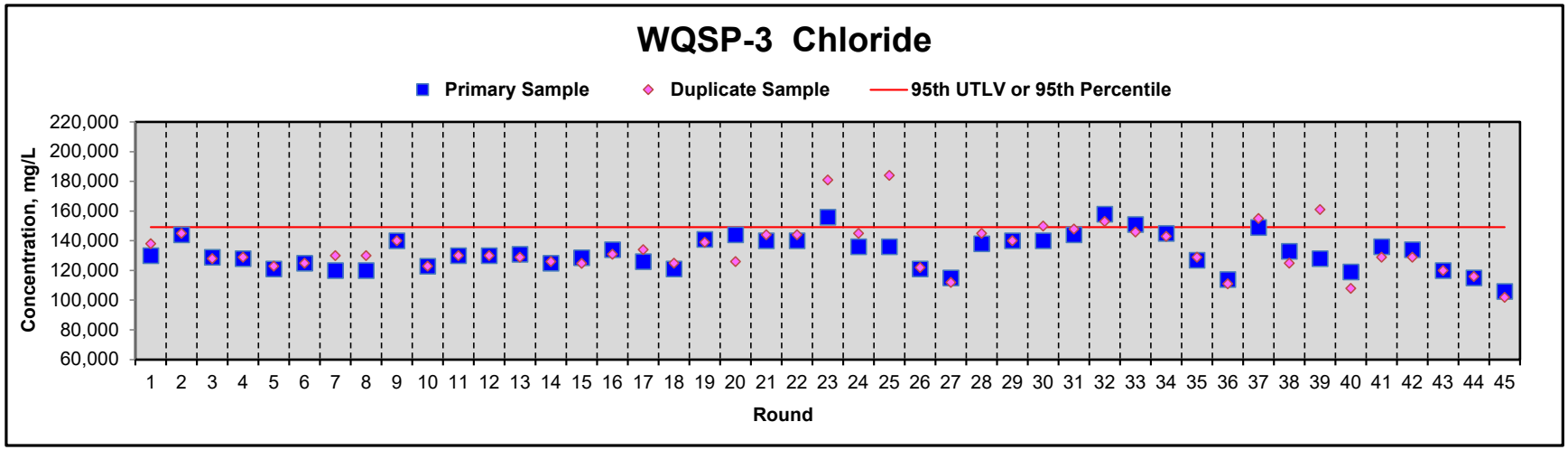

WQSP-2 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

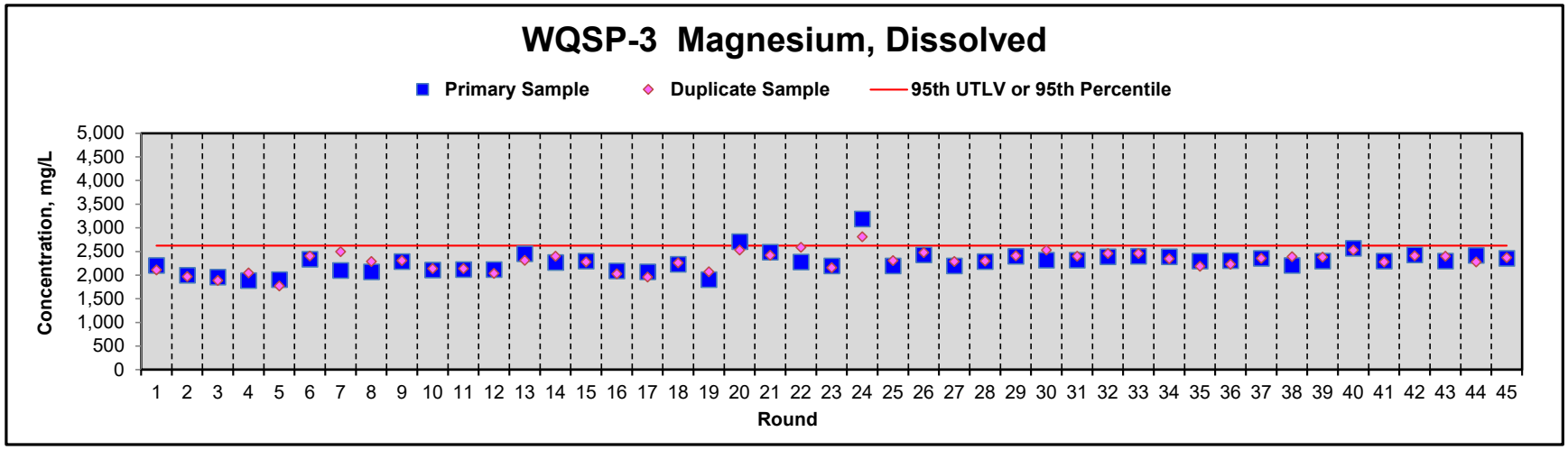

WQSP-2 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

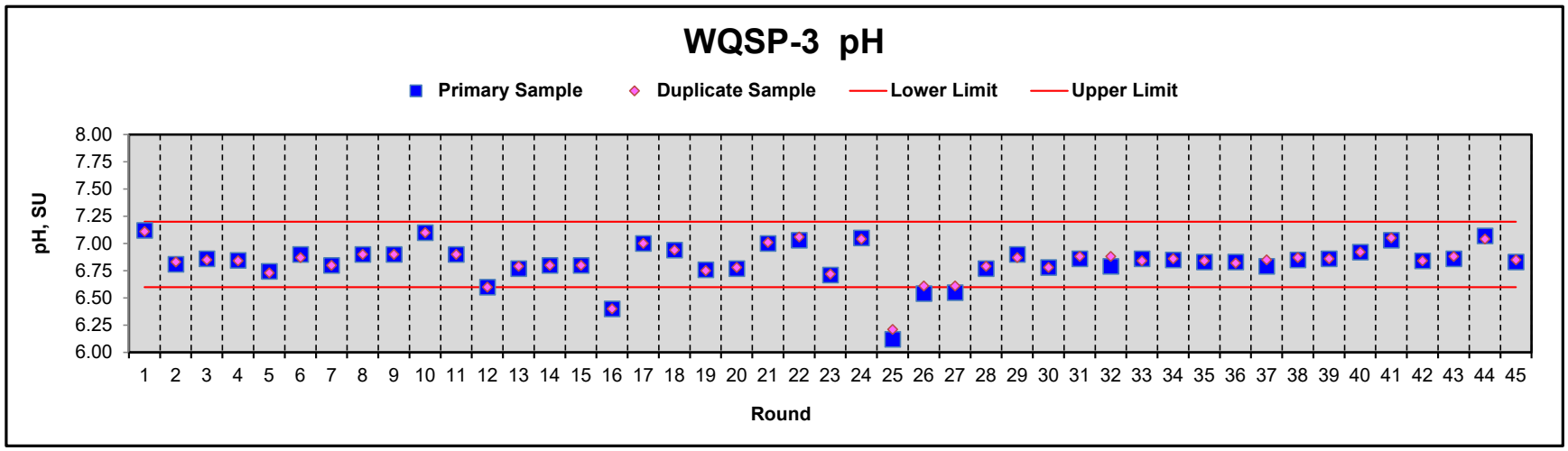

WQSP-2 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
0
200
400
600
800
1000
1200
1400
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

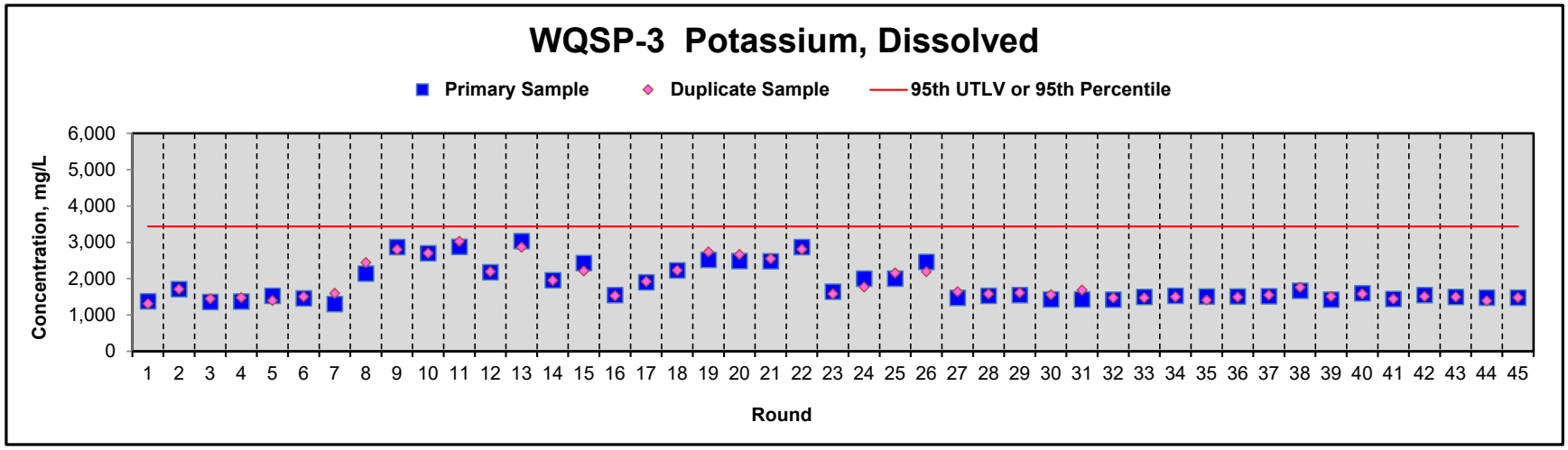

WQSP-2 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
20,000
40,000
60,000
80,000
100,000
120,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

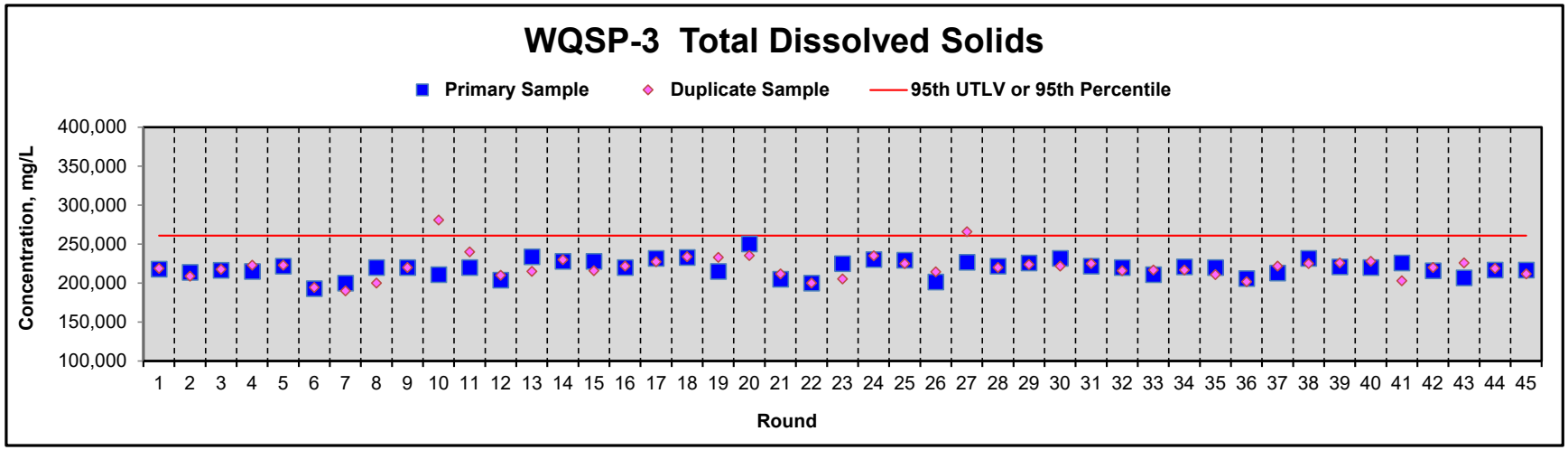

WQSP-3 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

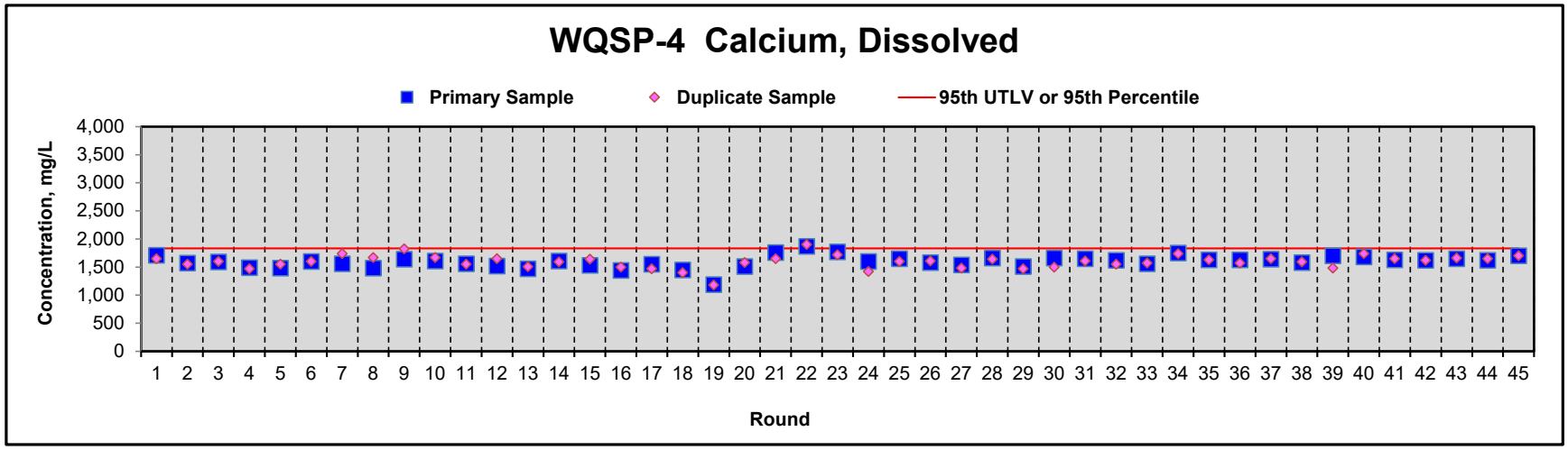

WQSP-3 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

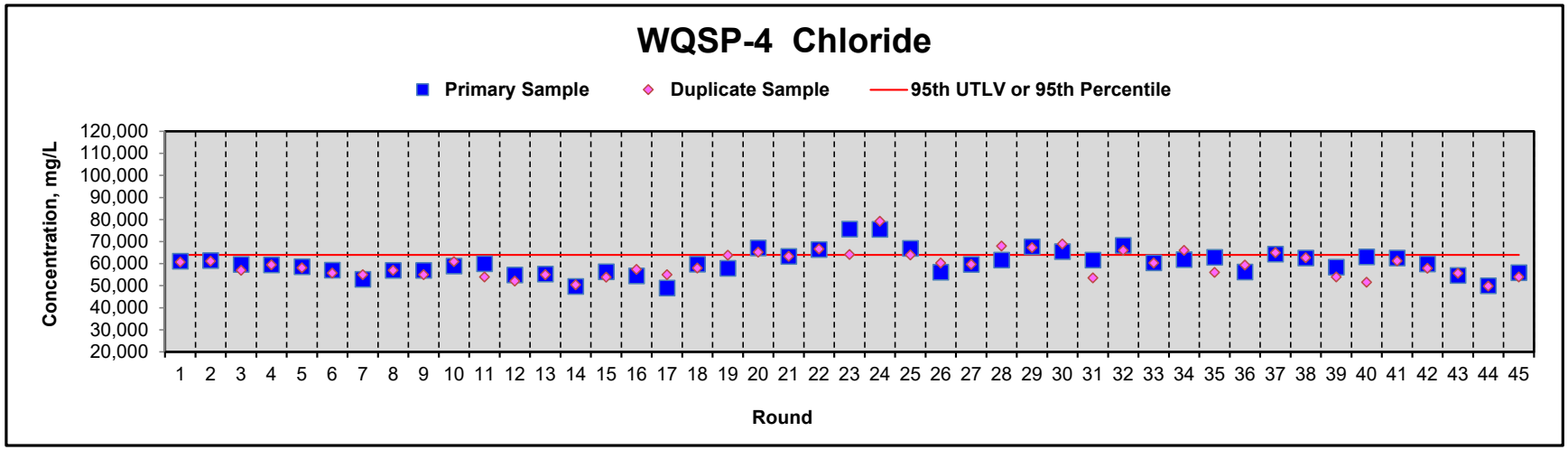

WQSP-3 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

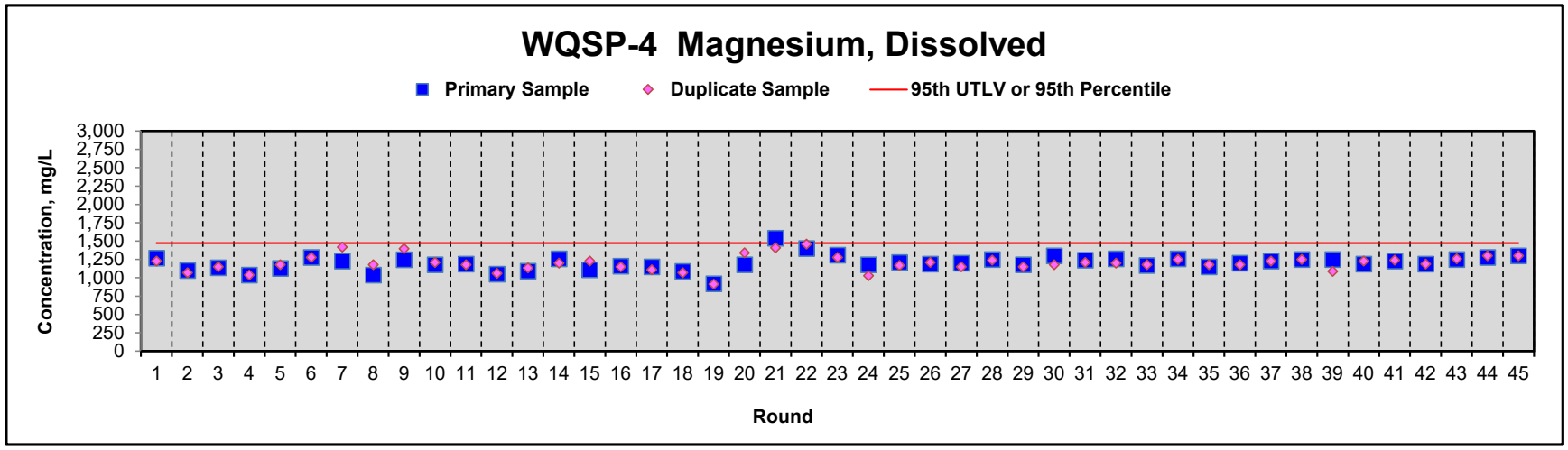

WQSP-3 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

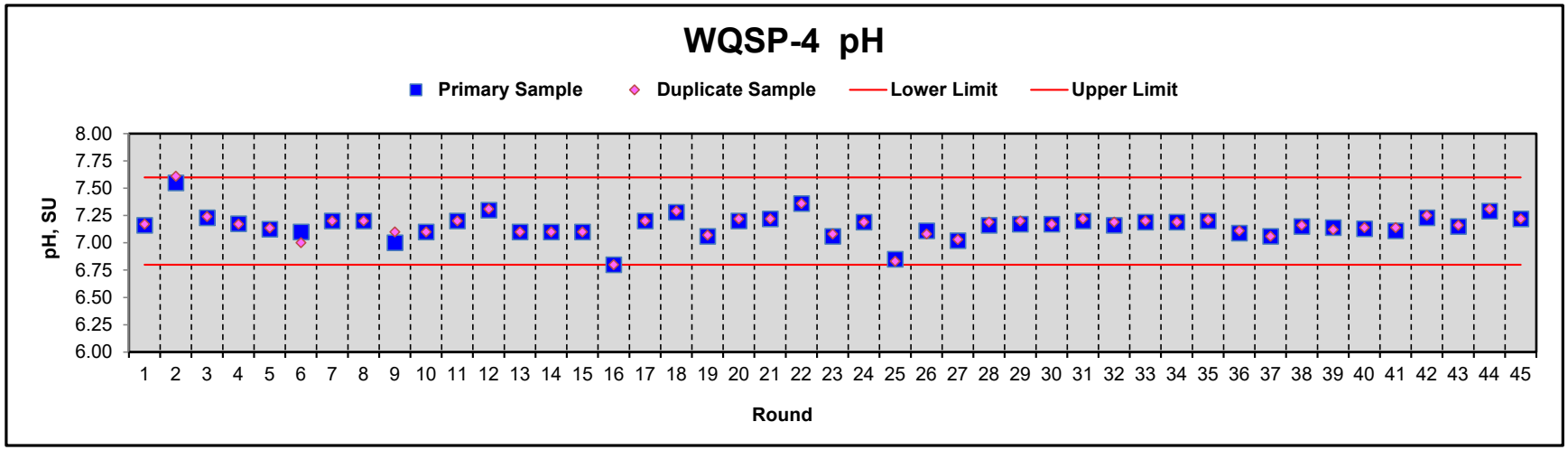

WQSP-3 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
6,000
5,000
4,000
3,000
2,000
1,000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

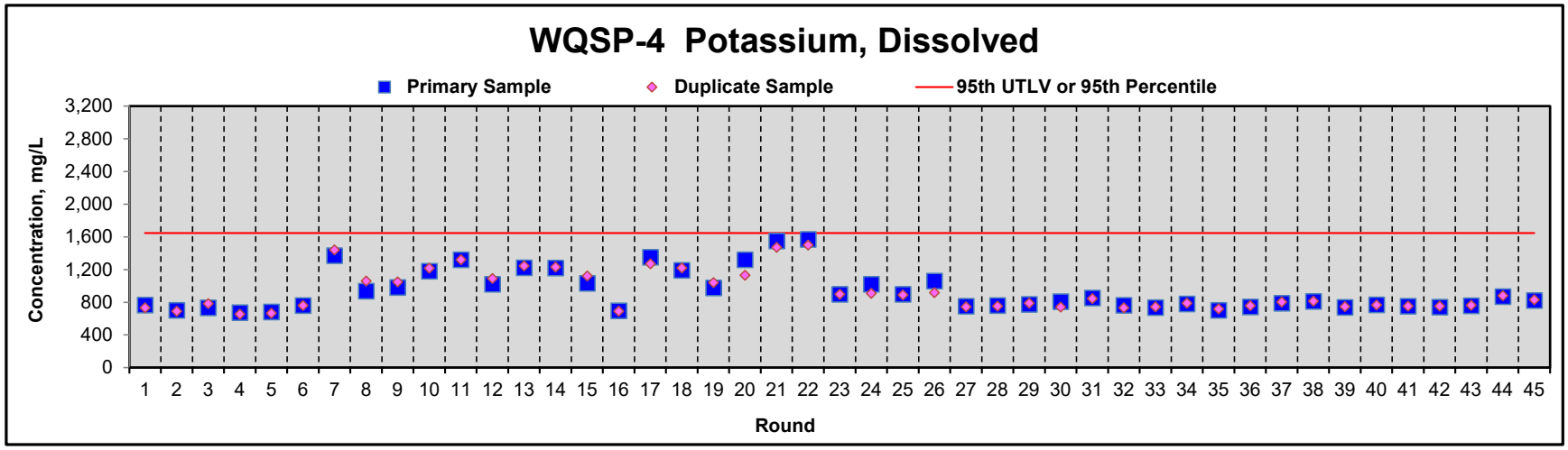

WQSP-3 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
400,000
350,000
300,000
250,000
200,000
150,000
100,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

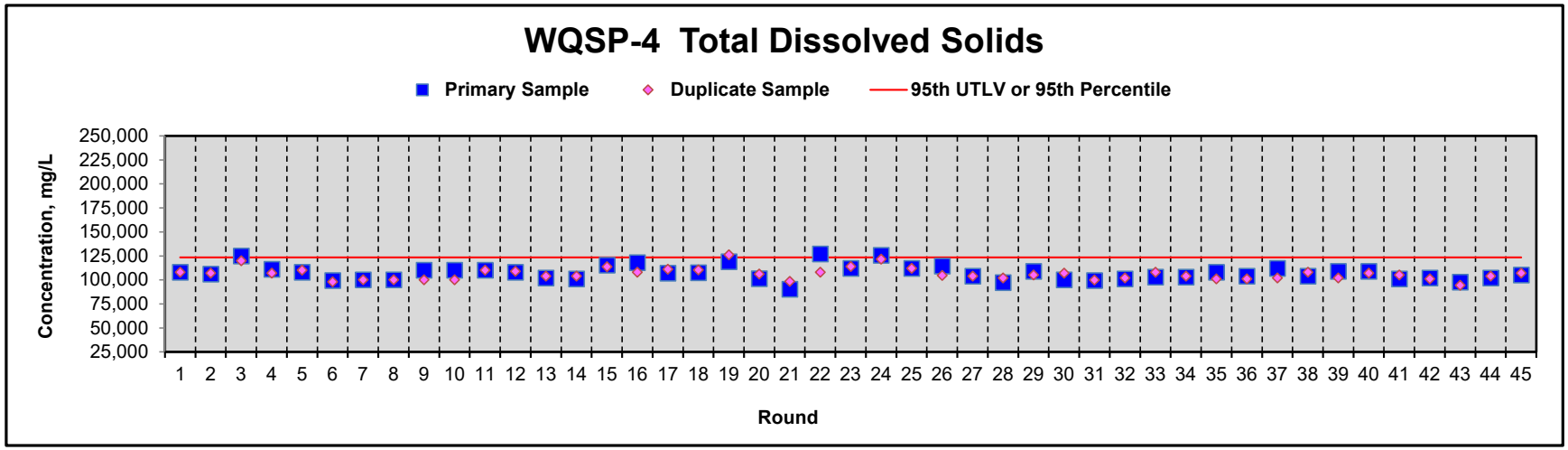

WQSP-4 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

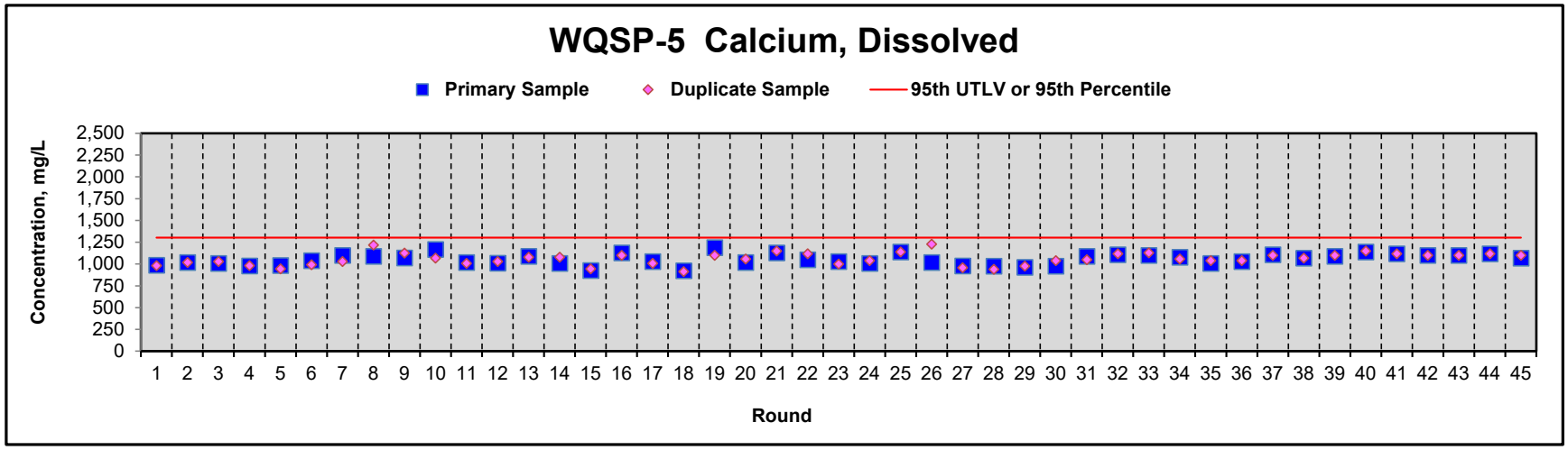

WQSP-4 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

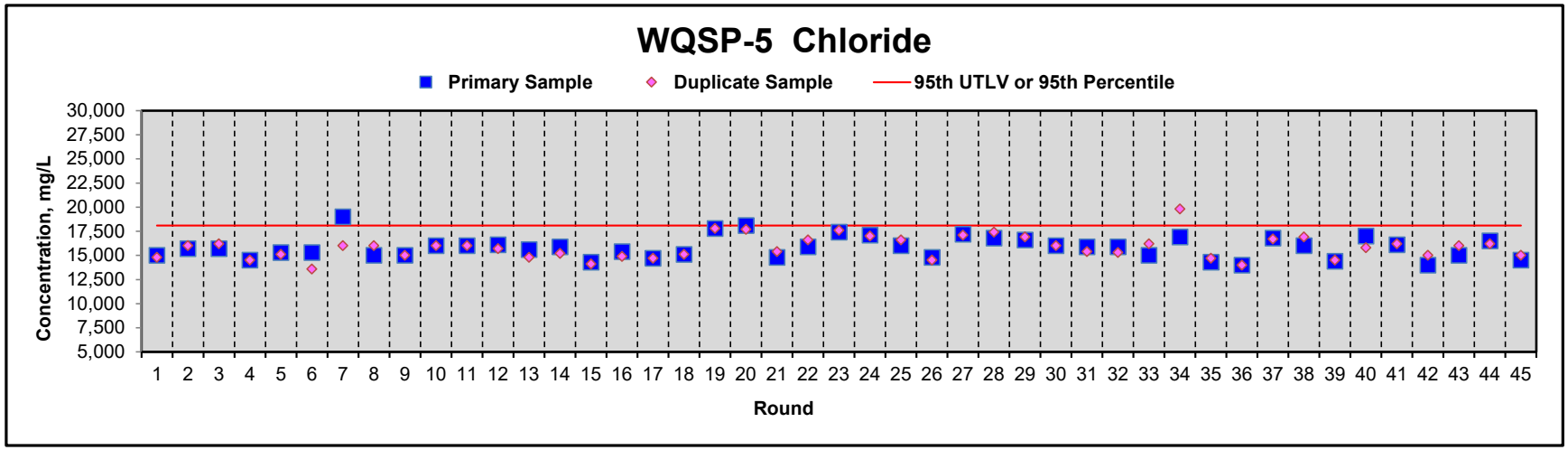

WQSP-4 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
3,000
2,750
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

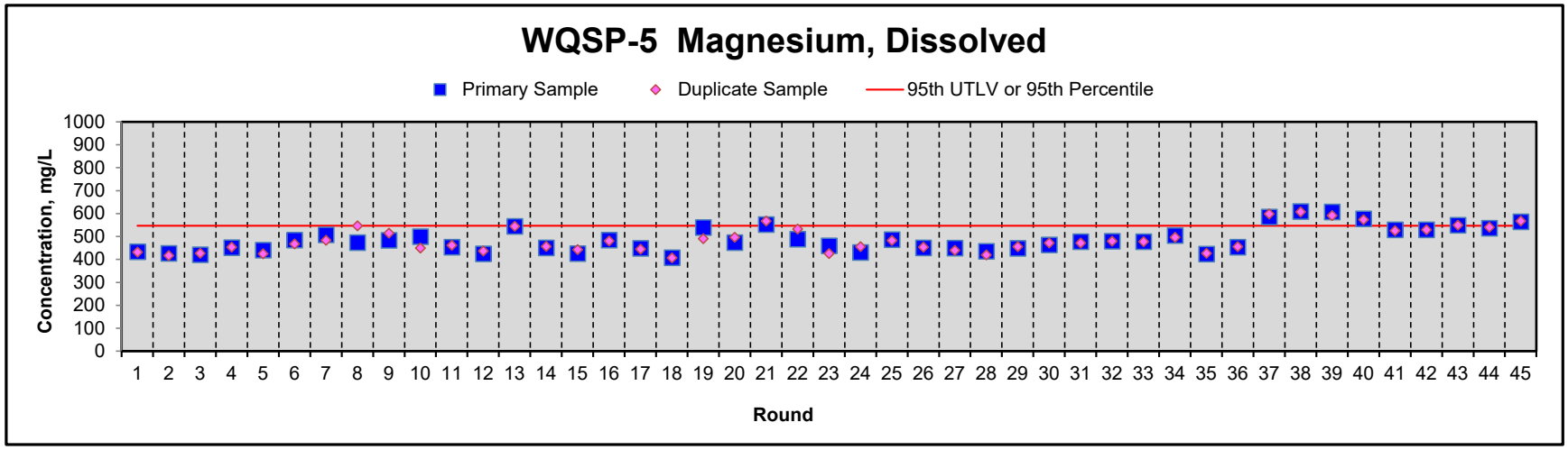

WQSP-4 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

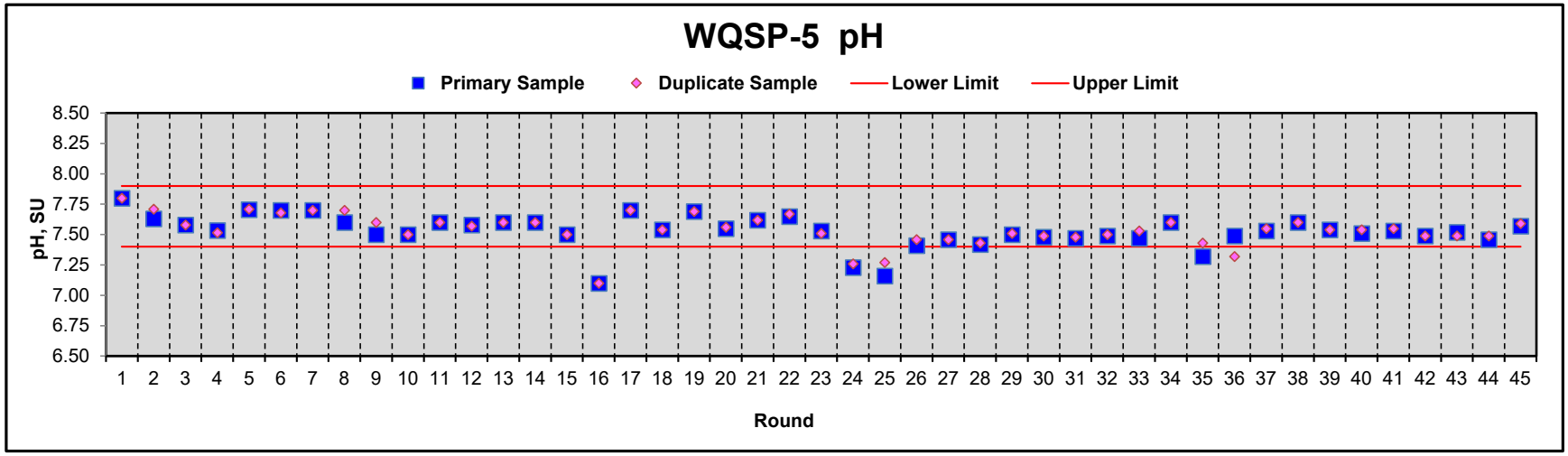

WQSP-4 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

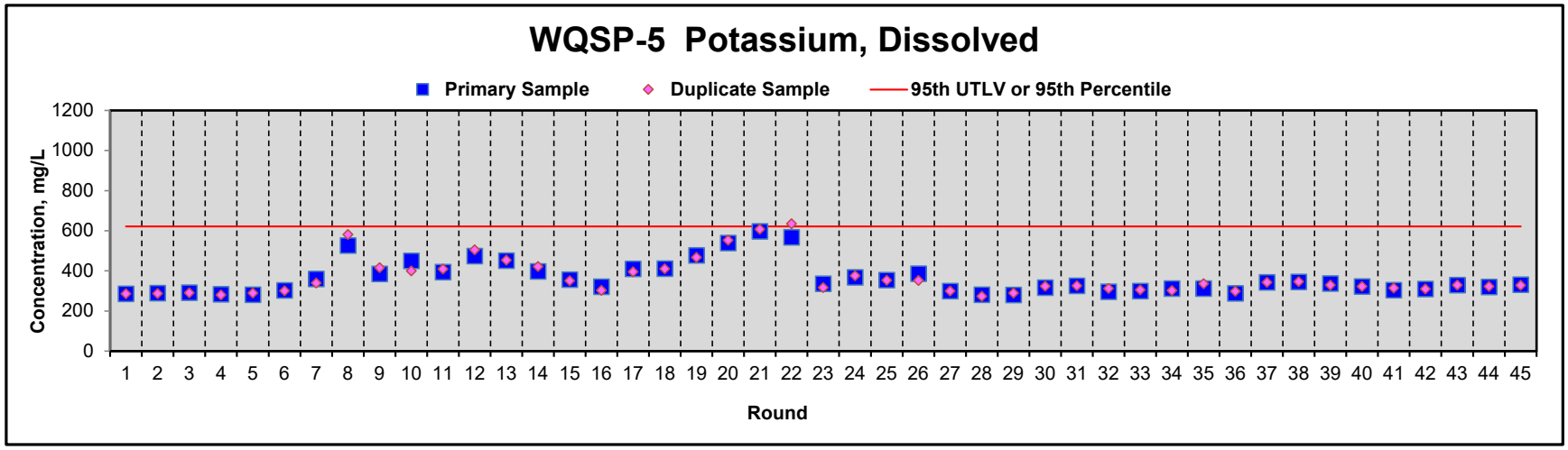

WQSP-4 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

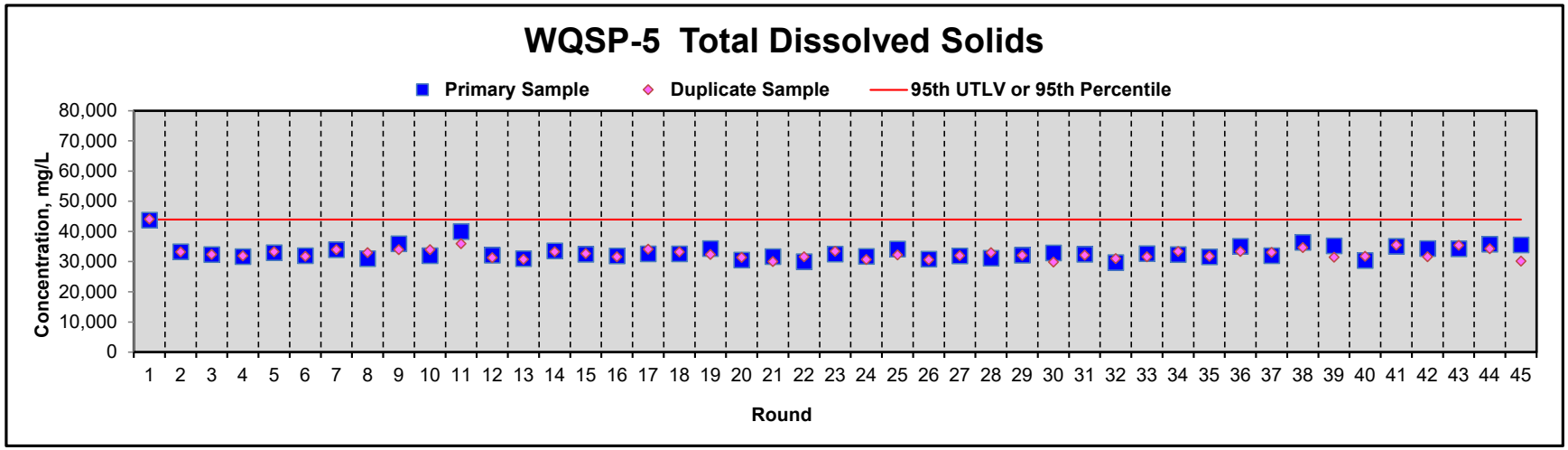

WQSP-5 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

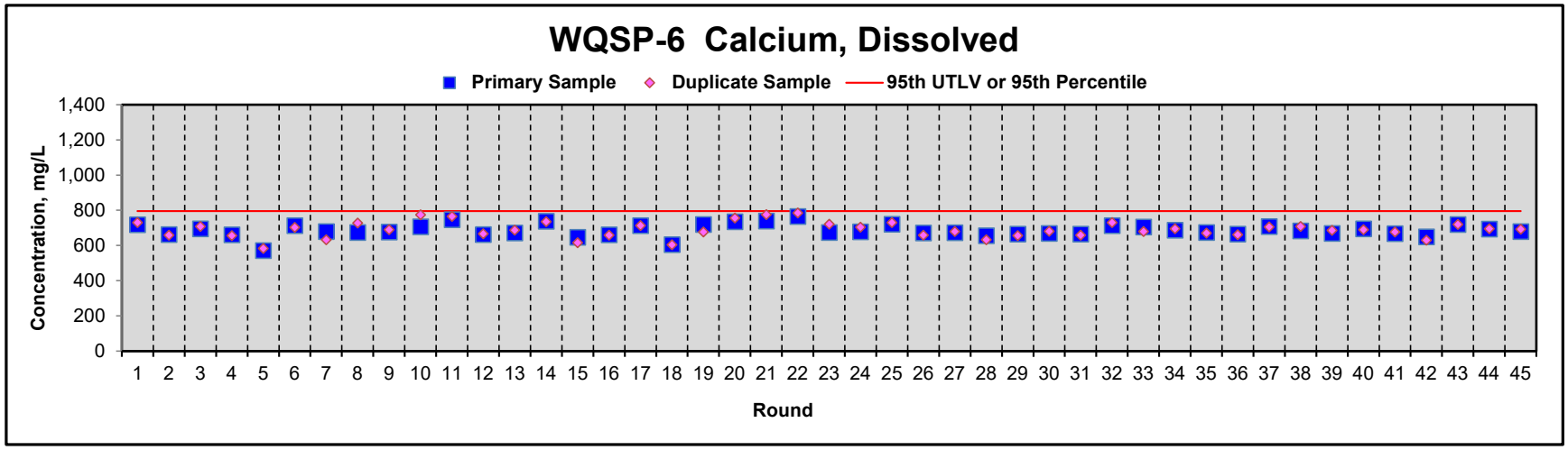

WQSP-5 Chloride
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
30,000
27,500
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

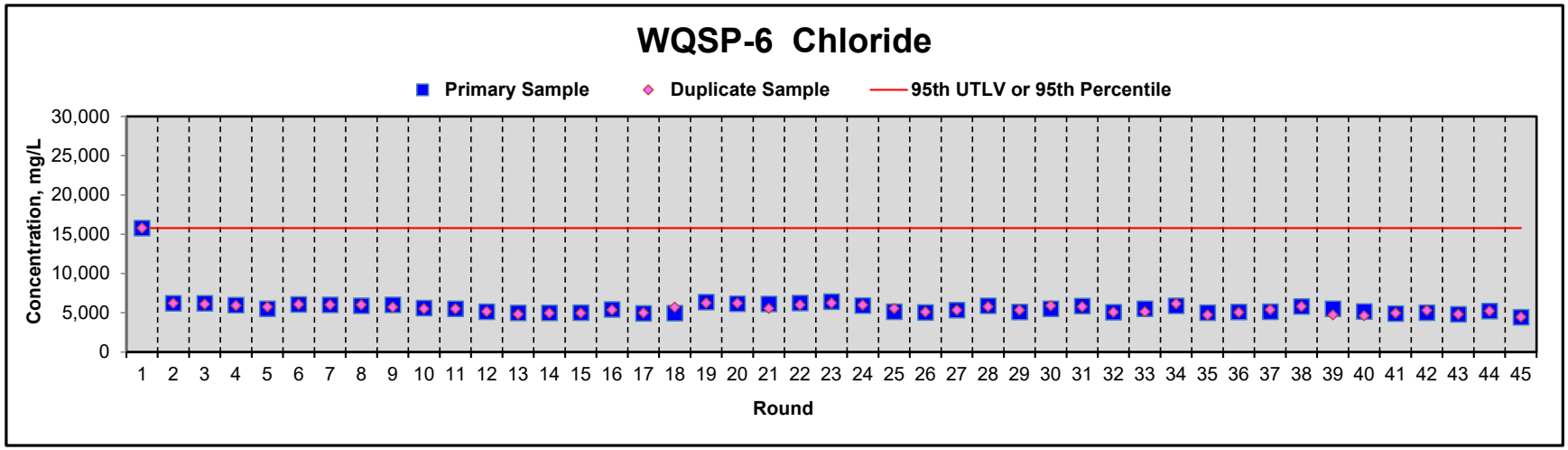

WQSP-5 Magnesium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1000
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

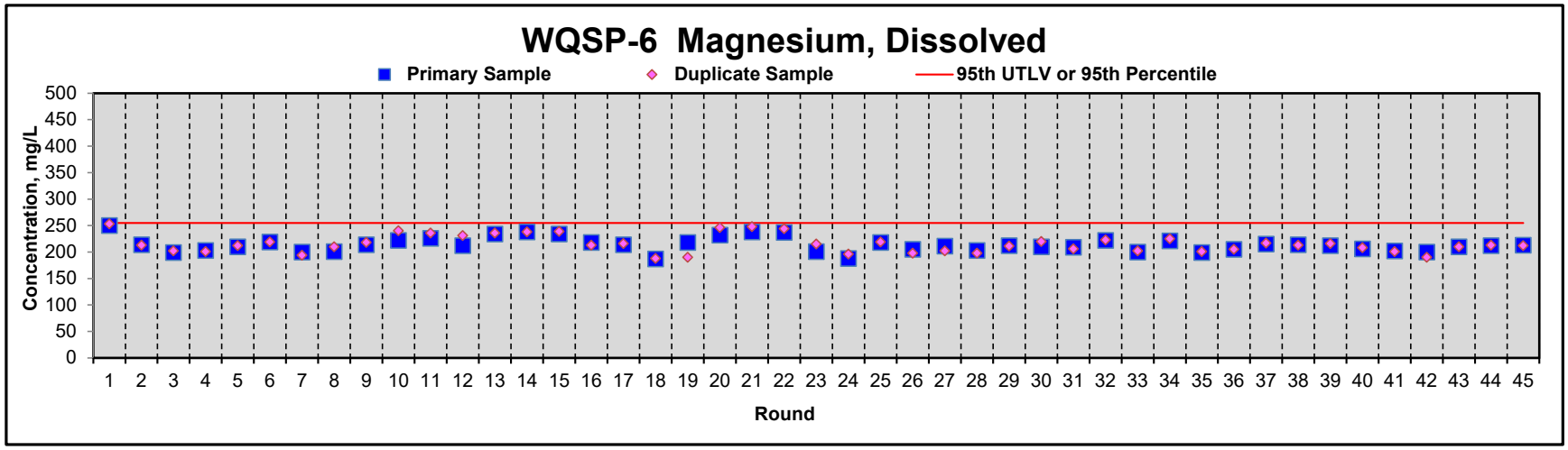

WQSP-5 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

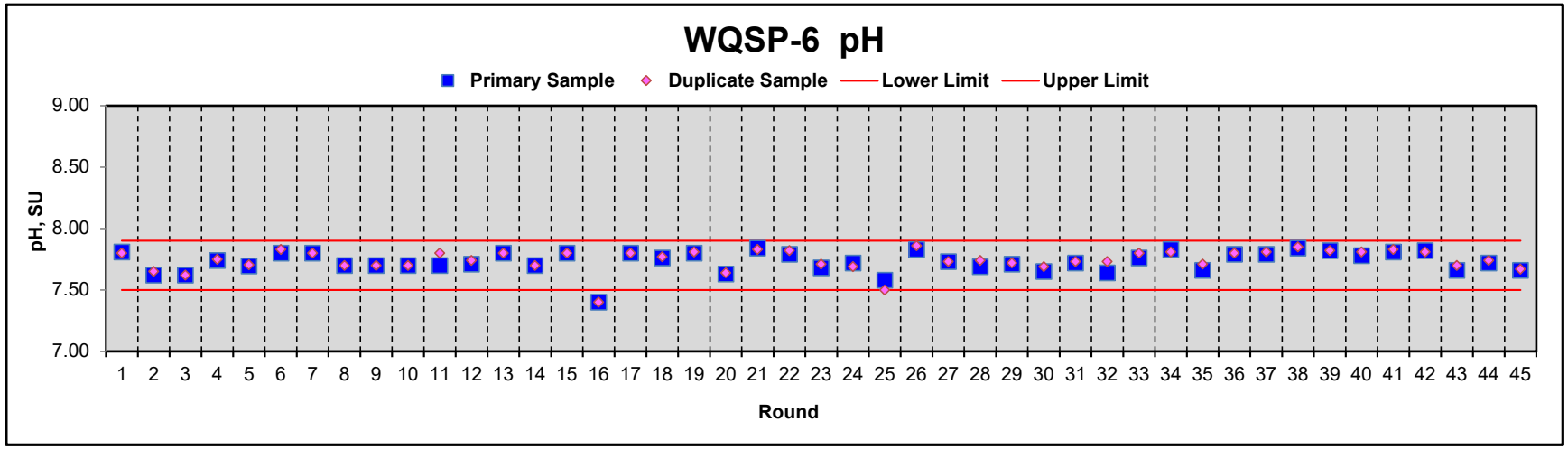

WQSP-5 Potassium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
0
200
400
600
800
1000
1200
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

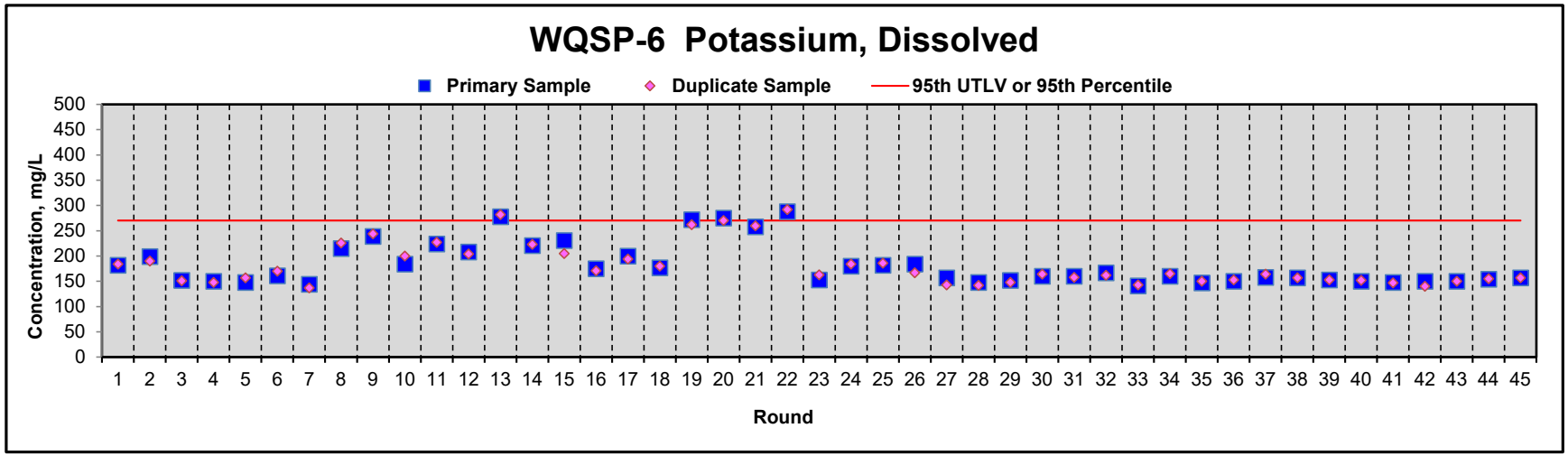

WQSP-5 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round

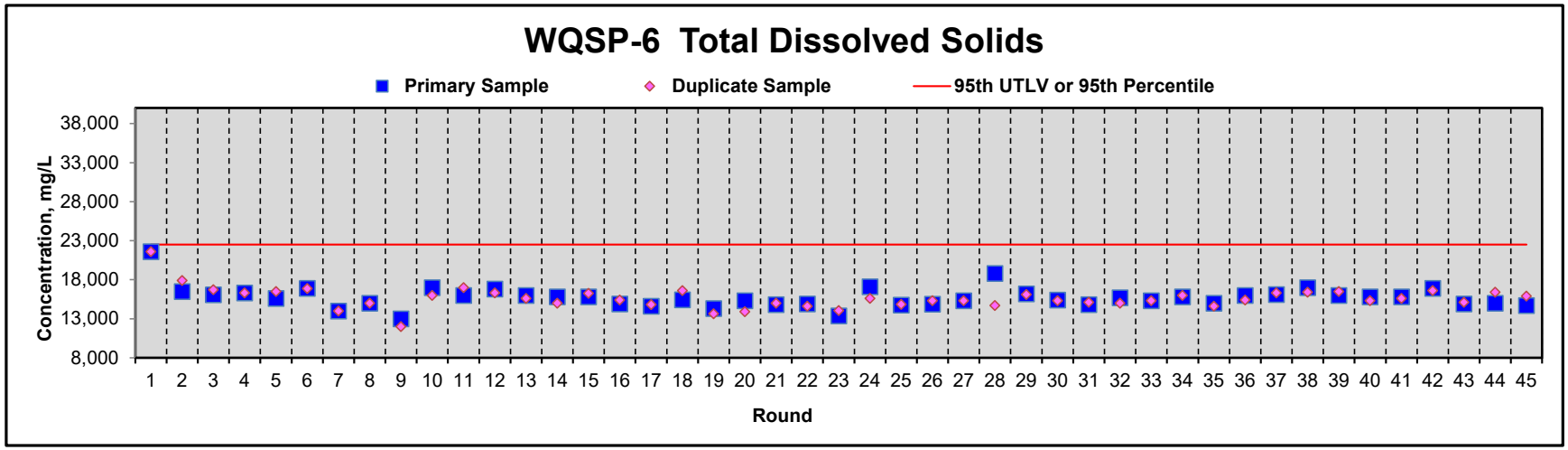

WQSP-6 Calcium, Dissolved
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
1,400
1,200
1,000
800
600
400
200
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Round


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 44 45
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 44 45
Round


WQSP-6 pH
Primary Sample
Duplicate Sample
Lower Limit
Upper Limit
pH, SU
9.00
8.50
8.00
7.50
7.00
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 44 45
Round


WQSP-6 Potassium, 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 44 45
Round


WQSP-6 Total Dissolved Solids
Primary Sample
Duplicate Sample
95th UTLV or 95th Percentile
Concentration, mg/L
38,000
33,000
28,000
23,000
18,000
13,000
8,000
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 44 45
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		

Compound [a]	MRL, µg/L	Trace Metal	MRL, mg/L
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)

WQSP-1 Round 45, SDG 2303961											
General Chemistry Parameter	**Units**	**SOW MRL[a]**	**Lab MDL[b]**	**Lab MRL[a]**	**Primary Sample**	**Flag**	**Duplicate Sample**	**Flag**	**Avg**	**RPD**	**Applicable 95th UTLV or 95th %**
Chloride	mg/L	0.5	500	1,000	38,000		37,100		37,550	2.40	40,472
TOC	mg/L	1.0	0.46	1.0	0.91	J	0.91	J	0.9	0.7	<5.0
Alkalinity (Bicarbonate)	mg/L	4.0	20	20	51.4		51.4		51.4	0.08	55.8
Specific Conductance	umhos/cm	NA	1,000	1000	132,000		131,000		131,500	0.76	175,000
pH	pH units	NA	NA	NA	7.26		7.29		7.28	0.41	5.6 - 8.8
Specific Gravity	NA	NA	0.0	0.0	1.044		1.042		1.043	0.19	1.07
TDS	mg/L	10	5,000	5,000	61,300		61,600		61,450	0.49	80,700
TSS	mg/L	1.0	4.0	4.0	24.0		**39.0**		32	**47.6**	33.3
Dissolved Metals (ICP)											
Ca (Diss)	mg/L	0.5	8.90	100	1,870		1,890		1,880	1.06	2,087
Mg (Diss)	mg/L	0.5	9.81	100	1,180		1,190		1,185	0.84	1,247
K (Diss)	mg/L	0.5	13.40	10.0	506		515		511	1.76	799
Na (Diss)	mg/L	0.5	297	1,000	19,500		19,800		19,650	1.53	22,090
Total Metals (ICP)											
Hg (CVAAS)	mg/L	0.00020	0.00008	0.0002	ND		ND		NA	NA	<0.002
Ba	mg/L	0.020	0.0022	0.010	0.0146		0.0148		0.0147	1.4	<1.0
Be	mg/L	0.010	0.0025	0.015	0.0029	J	0.0026	J	ND	NA	<0.02
Cd	mg/L	0.010	0.0061	0.010	ND		ND		NA	NA	<0.2
Ca	mg/L	0.500	4.61	100	1,870		1,870		1,870	0.0	NA
Cr	mg/L	0.025	0.0058	0.030	ND		ND		NA	NA	<0.5
Pb	mg/L	0.020	0.069	0.100	ND		ND		NA	NA	0.105
Mg	mg/L	0.50	3.1	100	1,220		1,200		1,210	1.65	NA
Ni	mg/L	0.025	0.018	0.050	ND		ND		NA	NA	0.490
K	mg/L	0.50	9.66	100.0	527		521		524	1.15	NA
Ag	mg/L	0.013	0.0065	0.025	0.027		0.027		0.027	0.75	<0.5
Na	mg/L	0.50	229	1,000	20,600		20,400		20,500	0.98	NA

Total Metals (ICP)	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
V	mg/L	0.025	0.0118	0.25	0.0173	J	0.018	J	NA	NA	<0.1
ICP/MS Metals											
Sb	mg/L	0.025	0.01000	0.0200	ND		ND		NA	NA	0.33
As	mg/L	0.050	0.01000	0.0200	ND		ND		NA	NA	<0.1
Se	mg/L	0.025	0.01000	0.0200	0.0205		ND		NA	NA	0.15
Tl	mg/L	0.025	0.01000	0.0200	ND		ND		NA	NA	0.98
WQSP-2 Round 45, SDG 2303B73											
General Chemistry Parameter	**Units**	**SOW MRL[a]**	**Lab MDL[b]**	**Lab MRL[a]**	**Primary Sample**	**Flag**	**Duplicate Sample**	**Flag**	**Avg**	**RPD**	**Applicable 95th UTLV or 95th %**
Chloride	mg/L	0.5	500	1,000	37,100		35,900		36,500	3.29	39,670
TOC	mg/L	1.0	0.459	1.00	0.484	J	ND		NA	NA	7.97
Alkalinity (Bicarbonate)	mg/L	4.0	20.0	20.0	47.88		47.92		47.9	0.08	70.3
Specific Conductance	umhos/cm	NA	1,000	1,000	**130,000**		**127,000**		128,500	2.33	124,000
pH	pH units	NA	NA	NA	7.29		7.30		7.30	0.14	7.0 - 7.6
Specific Gravity	NA	NA	0.00	0.00	1.041		1.042		1.042	0.10	1.06
TDS	mg/L	10	500	500	69,400		64,600		67,000	7.16	80,500
TSS	mg/L	1.0	4.00	4.00	ND		6.0		NA	NA	43.0
Dissolved Metals (ICP)											
Ca (Diss)	mg/L	0.50	8.90	100.0	1,550		1,560		1,555	0.64	1,827
Mg (Diss)	mg/L	0.50	9.81	100.0	1,080		1,080		1,080	0.00	1,244
K (Diss)	mg/L	0.50	13.40	100.0	489		495		492	1.22	845
Na (Diss)	mg/L	0.50	297	1,000	21,200		21,800		21,500	2.79	21,900
Total Metals (ICP)											
Hg (CVAAS)	mg/L	0.00020	0.000081	0.0002	ND		ND		NA	NA	<0.002
Ba	mg/L	0.020	0.00220	0.010	0.008		0.010		0.0092	16.33	<1.0
Be	mg/L	0.010	0.00248	0.015	ND		ND		NA	NA	<1.0
Cd	mg/L	0.010	0.00606	0.010	ND		ND		NA	NA	<0.50
Ca	mg/L	0.500	4.61	100.0	1,380		1,290		1,335	6.74	NA
Cr	mg/L	0.025	0.00575	0.030	ND		ND		NA	NA	<0.50
Pb	mg/L	0.020	0.0680	0.100	ND		ND		NA	NA	0.163
Mg	mg/L	0.50	3.06	100.0	944		879		912	7.13	NA

Total Metals (ICP)	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Ni	mg/L	0.025	0.0182	0.05	ND		ND		NA	NA	0.37
K	mg/L	0.50	0.48	5.00	443		490		467	10.08	NA
Ag	mg/L	0.013	0.00652	0.025	0.018	J	0.022	J	0.020	18.36	<0.5
Na	mg/L	0.50	229.0	1,000	19,100		17,300		18,200	9.89	NA
V	mg/L	0.025	0.0118	0.250	ND		0.013	J	NA	NA	<0.1
ICP/MS Metals											
Sb	mg/L	0.025	0.0100	0.0200	ND		ND		NA	NA	<0.5
As	mg/L	0.050	0.0100	0.0200	ND		ND		NA	NA	0.062
Se	mg/L	0.025	0.0100	0.0200	ND		ND		NA	NA	0.150
Tl	mg/L	0.025	0.0100	0.0200	ND		ND		NA	NA	0.980

WQSP-3 Round 45, SDG 2304638

General Chemistry Parameter	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Chloride	mg/L	0.5	5,000	10,000	106,000		102,000		104,000	3.85	149,100
TOC	mg/L	1.0	0.459	1.00	1.100		1.00		1.05	9.52	<5.0
Alkalinity (Bicarbonate)	mg/L	4.0	20.0	20.0	37.48		37.08		37.3	1.07	54.5
Specific Conductance	umhos/cm	NA	1,000	1000	409,000		419,000		414,000	2.42	517,000
pH	pH units	NA	NA	NA	6.83		6.85		6.84	0.29	6.6 - 7.2
Specific Gravity	NA	NA	0.00	0.00	1.136		1.134		1.135	0.18	1.17
TDS	mg/L	10	5,000	5,000	217,000		212,000		214,500	2.3	261,000
TSS	mg/L	1.0	4.00	4.00	**170.0**		**146.0**		158.0	**15.2**	**107**
Dissolved Metals (ICP)											
Ca (Diss)	mg/L	0.5	4.45	50.0	1,440		1,440		1,440	0.00	1,680
Mg (Diss)	mg/L	0.5	4.91	50.0	2,360		2,370		2,365	0.42	2,625
K (Diss)	mg/L	0.5	6.7	50.0	1,480		1,480		1,480	0.00	3,438
Na (Diss)	mg/L	0.5	297	1,000	79,900		82,000		80,950	2.59	140,400
Total Metals (ICP)											
Hg (CVAAS)	mg/L	0.00020	0.0004070	0.00100	ND		ND		NA	NA	<0.002
Ba	mg/L	0.020	0.02200	0.100	0.0271	J	0.038	J	0.032	32.5	<1.0
Be	mg/L	0.010	0.024800	0.015	ND		ND		NA	NA	<0.1
Cd	mg/L	0.010	0.06060	0.100	ND		ND		NA	NA	<0.5

Total Metals (ICP)	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Ca	mg/L	0.500	2.31	50.0	1,530		1,510		1,520	1.3	NA
Cr	mg/L	0.025	0.05750	0.300	ND		ND		NA	NA	<2.0
Pb	mg/L	0.020	0.0300	0.050	ND		ND		NA	NA	0.8
Mg	mg/L	0.50	1.53	50.0	2,470		2,450		2,460	0.81	NA
Ni	mg/L	0.025	0.1820	0.500	ND		ND		NA	NA	<5.0
K	mg/L	0.50	4.83	50.0	1,530		1,510		1,520	1.32	NA
Ag	mg/L	0.013	0.06520	0.250	0.0943	J	ND		NA	NA	0.31
Na	mg/L	0.50	229	1,000	72,900		71,200		72,050	2.36	NA
V	mg/L	0.025	0.1180	2.500	ND		ND		NA	NA	<5.0
ICP/MS Metals											
Sb	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	<1.0
As	mg/L	0.050	0.010	0.020	ND		ND		NA	NA	<1.0
Se	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	<2.0
Tl	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	5.8
VOC											
Toluene	ug/L	1.00	0.199	1.00	0.66		0.80	J	0.73	19.97	<1.0

WQSP-4 Round 45, SDG 2310694

General Chemistry Parameter	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Chloride	mg/L	0.5	1,200	2,500	56,000		54,000		55,000	3.64	63,960
TOC	mg/L	1.0	0.46	1.00	1.00	J	0.65	J	NA	NA	<5.0
Alkalinity (Bicarbonate)	mg/L	4.0	20.0	20.0	41.28		39.76		40.5	3.75	47.1
Specific Conductance	umhos/cm	NA	1,000	1,000	210,000		210,000		210,000	0.00	319,800
pH	pH units	NA	NA	NA	7.22		7.22		7.22	0.00	6.8 - 7.6
Specific Gravity	NA	NA	0.000	0.000	1.070		1.072		1.071	0.19	1.09
TDS	mg/L	10	5,000	5,000	105,000		107,000		106,000	1.89	123,500
TSS	mg/L	1.0	4.00	4.00	52.0		34.0		43.0	41.9	57.0
Dissolved Metals											
Ca (Diss)	mg/L	0.5	8.90	100.0	1,700		1,700		1,700	0.00	1,834
Mg (Diss)	mg/L	0.5	9.80	100.0	1,300		1,300		1,300	0.00	1,472
K (Diss)	mg/L	0.5	1.3	10.0	820		830		825	1.21	1,648

Dissolved Metals	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Na (Diss)	mg/L	0.5	150	500	38,000		**39,000**		38,500	2.60	**38,790**
Total Metals (ICP)											
Hg (CVAAS)	mg/L	0.0002	0.00041	0.0010	ND		ND		NA	NA	<0.002
Ba	mg/L	0.020	0.0022	0.010	0.028		0.029		0.029	3.51	1.000
Be	mg/L	0.010	0.0025	0.015	ND		ND		NA	NA	0.250
Cd	mg/L	0.010	0.0061	0.010	ND		ND		NA	NA	<0.5
Ca	mg/L	0.500	23.00	500.0	1,700		1,700		1,700	0.00	NA
Cr	mg/L	0.025	0.0058	0.030	ND		ND		NA	NA	<2.0
Pb	mg/L	0.020	0.068	0.100	ND		ND		NA	NA	0.525
Mg	mg/L	0.50	15.00	500.0	1,400		1,400		1,400	0.00	NA
Ni	mg/L	0.025	0.018	0.050	ND		ND		NA	NA	<5.0
K	mg/L	0.50	48.00	500.0	790		760		775	3.87	NA
Ag	mg/L	0.013	0.0065	0.025	0.060		0.061		0.061	1.7	0.519
Na	mg/L	0.50	110	500	37,000		35,000		36,000	5.56	NA
V	mg/L	0.025	0.0120	0.25	0.022	J	0.023	J	NA	NA	<5.0
ICP/MS Metals											
Sb	mg/L	0.025	0.0100	0.0200	ND		ND		NA	NA	<10.0
As	mg/L	0.050	0.0100	0.0200	ND		ND		NA	NA	<0.5
Se	mg/L	0.025	0.0100	0.0200	ND		ND		NA	NA	2.009
Tl	mg/L	0.025	0.0100	0.0200	ND		ND		NA	NA	1.000

WQSP-5 Round 45, SDG 2304B51

General Chemistry Parameter	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Chloride	mg/L	0.5	500	1,000	14,500		15,000		14,750	3.39	18,100
TOC	mg/L	1.0	0.46	1.00	ND		0.61	J	NA	NA	<5.0
Alkalinity (Bicarbonate)	mg/L	4.0	20.0	20.0	49.1		49.0		49.0	0.16	56
Specific Conductance	umhos/cm	NA	1,000	1000	66,800		67,100		66,950	0.45	67,700
pH	pH units	NA	NA	NA	7.57		7.59		7.58	0.26	7.4 - 7.9
Specific Gravity	NA	NA	0.00	0.00	1.017		1.018		1.018	0.10	1.04
TDS	mg/L	10	5,000	5,000	35,600		30,200		32,900	16.41	43,950
TSS	mg/L	1.0	4.00	4.00	**20.00**		**12.00**		16.0	**50.0**	<10.0

Dissolved Metals	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Ca (Diss)	mg/L	0.5	8.90	100.0	1,070		1,100		1,085	2.76	1,303
Mg (Diss)	mg/L	0.5	9.87	100.0	**565**		**568**		567	0.53	547
K (Diss)	mg/L	0.5	13.40	100.0	332		329		331	0.91	622
Na (Diss)	mg/L	0.5	297	1000	11,200		11,300		11,250	0.89	11,190
Total Metals (ICP)											
Hg (CVAAS)	mg/L	0.0002	0.0000814	0.0020	0.000444		0.000131	J	0	**108.9**	<0.002
Ba	mg/L	0.020	0.0044	0.0200	0.0128	J	0.0125	J	0	2.4	<1.0
Be	mg/L	0.010	0.00496	0.030	ND		ND		NA	NA	<0.02
Cd	mg/L	0.010	0.0121	0.020	ND		ND		NA	NA	<0.05
Ca	mg/L	0.500	4.61	100.0	1,070		1,090		1,080	1.9	NA
Cr	mg/L	0.025	0.0115	0.060	ND		ND		NA	NA	<0.5
Pb	mg/L	0.020	0.0300	0.1	ND		ND		NA	NA	<0.05
Mg	mg/L	0.50	0.31	10.0	556		547		552	1.6	NA
Ni	mg/L	0.025	0.0364	0.100	ND		ND		NA	NA	<0.1
K	mg/L	0.50	0.97	10.00	327		322		325	1.54	NA
Ag	mg/L	0.013	0.0130	0.050	0.029	J	0.032	J	0.031	**10.08**	<0.5
Na	mg/L	0.50	229	1,000	10,500		11,000		10,750	4.65	NA
V	mg/L	0.025	0.0237	0.500	ND		0.0264	J	NA	NA	2.7
ICP/MS Metals											
Sb	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	0.073
As	mg/L	0.050	0.010	0.020	ND		ND		NA	NA	<0.5
Se	mg/L	0.025	0.010	0.020	0.014	J	0.014	J	0.014	0.73	<0.1
Tl	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	0.209

WQSP-6 Round 45, SDG 2308304

General Chemistry Parameter	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Chloride	mg/L	0.5	500	1,000	4,420		4,470		4,445	1.12	15,800
TOC	mg/L	1.0	0.46	1.0	3.33		2.80		3.07	17.29	10.14
Alkalinity (Bicarbonate)	mg/L	4.0	20.0	20.0	50.8		50.8		50.8	0.08	55.8
Specific Conductance	umhos/cm	NA	100	100	26,400		26,500		26,450	0.38	27,660
pH	pH units	NA	NA	NA	7.66		7.67		7.67	0.13	7.5 - 7.9

General Chemistry Parameter	Units	SOW MRL[a]	Lab MDL[b]	Lab MRL[a]	Primary Sample	Flag	Duplicate Sample	Flag	Avg	RPD	Applicable 95th UTLV or 95th %
Specific Gravity	NA	NA	0.0	0.0	1.013		1.006		1.010	0.69	1.02
TDS	mg/L	10	500	500	14,700		15,900		15,300	7.84	22,500
TSS	mg/L	1.0	4.00	4.00	ND		ND		NA	NA	14.8
Dissolved Metals											
Ca (Diss)	mg/L	0.5	0.89	10.0	680		693		687	1.89	796
Mg (Diss)	mg/L	0.5	0.491	5.0	213		212		213	0.47	255
K (Diss)	mg/L	0.5	0.67	5.0	157		157		157	0.00	270
Na (Diss)	mg/L	0.5	14.9	50	4,250		4,350		4,300	2.33	6,290
Total Metals (ICP)											
Hg (CVAAS)	mg/L	0.0002	0.0000814	0.0002	ND		ND		NA	NA	<0.002
Ba	mg/L	0.020	0.00439	0.002	0.0097		0.0097		0	**0.6**	<1.0
Be	mg/L	0.010	0.00496	0.003	ND		ND		NA	NA	<0.02
Cd	mg/L	0.010	0.0012	0.002	ND		ND		NA	NA	<0.05
Ca	mg/L	0.500	0.46	10.0	700		680		690	2.90	NA
Cr	mg/L	0.025	0.00115	0.006	ND		ND		NA	NA	<0.5
Pb	mg/L	0.020	0.030	0.05	ND		ND		NA	NA	0.150
Mg	mg/L	0.50	0.15	5.00	214		215		215	0.47	NA
Ni	mg/L	0.025	0.0036	0.01	0.0075	J	0.0074	J	NA	NA	<0.5
K	mg/L	0.50	0.483	5.00	158		158		158	0.00	NA
Ag	mg/L	0.013	0.0013	0.005	0.0138		0.014		0.014	2.20	<0.5
Na	mg/L	0.50	11.0	50.0	4,300		4,200		4,250	2.35	NA
V	mg/L	0.025	0.0024	0.05	0.004	J	0.004	J	0.004	NA	0.070
ICP/MS Metals											
Sb	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	0.140
As	mg/L	0.050	0.010	0.020	ND		ND		NA	NA	<0.5
Se	mg/L	0.025	0.010	0.020	ND		0.0109	J	NA	NA	0.10
Tl	mg/L	0.025	0.010	0.020	ND		ND		NA	NA	0.560

Method Reporting Limit (MRL) and lab's Practical Quantitation Level (PQL) generally equivalent for a given sample.

Lab's PQL corresponds to low calibration standard adjusted for the dilution factor as necessary for high-brine samples.

J Flag indicates concentration was below the lab's PQL but above the Method Detection Limit (MDL) for the analyte.

NA - Not Applicable
ND - Not Detected
CVAAS - cold vapor atomic absorption spectroscopy.
ICP - inductively coupled plasma emission spectroscopy.
ICP/MS - ICP combined with mass spectrometry.
(a) MRL - method reporting limit
(b) MDL - method detection limit

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	C-2737	CUL	
5	C-2737	CUL		5	H-4bR	CUL	
6	C-2737	MAG		6	H-5bR	CUL	
7	C-2811	SR/DL		7	H-6bR	CUL	
8	CB-1	B/C		8	H-9bR	CUL	
9	DOE-2	B/C		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	

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
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	
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	
39	SNL-2	CUL		39	WQSP-1	CUL	
40	SNL-3	CUL		40	WQSP-2	CUL	
41	SNL-5	CUL		41	WQSP-3	CUL	
42	SNL-6	CUL		42	WQSP-4	CUL	
43	SNL-8	CUL		43	WQSP-5	CUL	
44	SNL-9	CUL		44	WQSP-6	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
45	SNL-10	CUL		45	WQSP-6A	DL	
46	SNL-12	CUL		46	PZ-17b	DL	
47	SNL-13	CUL		47	PZ-15	GAT	
48	SNL-14	CUL		48	H-2b1	MAG	
49	SNL-15	CUL		49	H-3b1	MAG	
50	SNL-16	CUL		50	H-4c	MAG	
51	SNL-17	CUL		51	H-6c	MAG	
52	SNL-18	CUL		52	H-8a	MAG	
53	SNL-19	CUL		53	H-9c	MAG	
54	PZ-1	SR/DL		54	H-10a	MAG	
55	PZ-2	SR/DL		55	H-11b2	MAG	
56	PZ-3	SR/DL		56	H-14	MAG	
57	PZ-4	SR/DL		57	H-18	MAG	
58	PZ-5	SR/DL		58	WIPP-18	MAG	
59	PZ-6	SR/DL		59	H-15	MAG	
60	PZ-7	SR/DL		60	C-2737	MAG	
61	PZ-9	SR/DL		61	C-2505	SR/DL	
62	PZ-10	SR/DL		62	C-2506	SR/DL	
63	PZ-11	SR/DL		63	C-2507	SR/DL	
64	PZ-12	SR/DL		64	C-2811	SR/DL	
65	PZ-13	SR/DL		65	PZ-1	SR/DL	
66	PZ-14	SR/DL		66	PZ-2	SR/DL	
67	PZ-15	GAT		67	PZ-3	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
68	PZ-16	SR/DL	Drilled June 2020	68	PZ-4	SR/DL	
69	PZ-17a	SR/DL	Drilled July 2020	69	PZ-5	SR/DL	
70	PZ-17b	DL	Drilled July 2020	70	PZ-6	SR/DL	
71	PZ-18	SR/DL	Drilled June 2020	71	PZ-7	SR/DL	
72	PZ-19a	SR/DL	Drilled July 2020	72	PZ-9	SR/DL	
73	WIPP-11R	CUL	Drilled in Sept 2019	73	PZ-10	SR/DL	
74	WIPP-18	MAG		74	PZ-11	SR/DL	
75	WQSP-1	CUL		75	PZ-12	SR/DL	
76	WQSP-2	CUL		76	PZ-13	SR/DL	
77	WQSP-3	CUL		77	PZ-14	SR/DL	
78	WQSP-4	CUL		78	PZ-16	SR/DL	
79	WQSP-5	CUL		79	PZ-17a	SR/DL	
80	WQSP-6	CUL		80	PZ-18	SR/DL	
81	WQSP-6A	DL		81	PZ-19a	SR/DL	

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	01/10/23	615.50	3,042.85	3,061.44
AEC-7R	CUL	02/07/23	615.46	3,042.89	3,061.49
AEC-7R	CUL	03/07/23	615.48	3,042.87	3,061.47
AEC-7R	CUL	04/04/23	615.20	3,043.15	3,061.77
AEC-7R	CUL	05/02/23	615.54	3,042.81	3,061.40
AEC-7R	CUL	06/06/23	615.77	3,042.58	3,061.16
AEC-7R	CUL	07/11/23	615.68	3,042.67	3,061.25
AEC-7R	CUL	08/08/23	615.72	3,042.63	3,061.21
AEC-7R	CUL	09/11/23	615.75	3,042.60	3,061.18
AEC-7R	CUL	10/03/23	616.12	3,042.23	3,060.78
AEC-7R	CUL	11/07/23	615.85	3,042.50	3,061.07
AEC-7R	CUL	12/05/23	615.84	3,042.51	3,061.08
C-2737 (PIP)	CUL	01/11/23	414.57	2,986.19	2,993.66
C-2737 (PIP)	CUL	02/08/23	418.74	2,982.02	2,989.37
C-2737 (PIP)	CUL	03/08/23	421.12	2,979.64	2,986.93
C-2737 (PIP)	CUL	04/05/23	423.05	2,977.71	2,984.95
C-2737 (PIP)	CUL	05/03/23	424.94	2,975.82	2,983.01
C-2737 (PIP)	CUL	06/06/23	426.28	2,974.48	2,981.63
C-2737 (PIP)	CUL	07/10/23	427.74	2,973.02	2,980.13
C-2737 (PIP)	CUL	08/09/23	428.42	2,972.34	2,979.43
C-2737 (PIP)	CUL	09/12/23	429.56	2,971.20	2,978.26
C-2737 (PIP)	CUL	10/04/23	429.88	2,970.88	2,977.93
C-2737 (PIP)	CUL	11/08/23	430.95	2,969.81	2,976.83

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
C-2737 (PIP)	CUL	12/06/23	431.64	2,969.12	2,976.12
H-4bR	CUL	01/09/23	347.04	2,987.60	2,990.98
H-4bR	CUL	02/06/23	346.82	2,987.82	2,991.20
H-4bR	CUL	03/06/23	347.09	2,987.55	2,990.93
H-4bR	CUL	04/03/23	346.91	2,987.73	2,991.11
H-4bR	CUL	05/01/23	347.21	2,987.43	2,990.80
H-4bR	CUL	06/05/23	347.78	2,986.86	2,990.22
H-4bR	CUL	07/10/23	348.65	2,985.99	2,989.33
H-4bR	CUL	08/07/23	348.78	2,985.86	2,989.20
H-4bR	CUL	09/11/23	347.94	2,986.70	2,990.06
H-4bR	CUL	10/02/23	346.95	2,987.69	2,991.07
H-4bR	CUL	11/06/23	345.42	2,989.22	2,992.63
H-4bR	CUL	12/04/23	344.66	2,989.98	2,993.41
H-5bR	CUL	01/10/23	483.70	3,025.25	3,064.27
H-5bR	CUL	02/08/23	483.77	3,025.18	3,064.19
H-5bR	CUL	03/07/23	483.82	3,025.13	3,064.14
H-5bR	CUL	04/04/23	483.84	3,025.11	3,064.11
H-5bR	CUL	05/02/23	484.49	3,024.46	3,063.40
H-5bR	CUL	06/06/23	485.04	3,023.91	3,062.80
H-5bR	CUL	07/11/23	484.71	3,024.24	3,063.16
H-5bR	CUL	08/08/23	484.38	3,024.57	3,063.52
H-5bR	CUL	09/12/23	484.30	3,024.65	3,063.61
H-5bR	CUL	10/03/23	484.16	3,024.79	3,063.76
H-5bR	CUL	11/07/23	484.19	3,024.76	3,063.73
H-5bR	CUL	12/05/23	484.24	3,024.71	3,063.68
H-6bR	CUL	01/10/23	300.66	3,048.56	3,061.23

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-6bR	CUL	02/08/23	300.88	3,048.34	3,061.00
H-6bR	CUL	03/07/23	300.76	3,048.46	3,061.12
H-6bR	CUL	04/05/23	300.98	3,048.24	3,060.89
H-6bR	CUL	05/03/23	301.01	3,048.21	3,060.86
H-6bR	CUL	06/06/23	300.95	3,048.27	3,060.92
H-6bR	CUL	07/11/23	300.85	3,048.37	3,061.03
H-6bR	CUL	08/09/23	300.95	3,048.27	3,060.92
H-6bR	CUL	09/12/23	301.33	3,047.89	3,060.53
H-6bR	CUL	10/04/23	301.00	3,048.22	3,060.87
H-6bR	CUL	11/07/23	300.75	3,048.47	3,061.13
H-6bR	CUL	12/06/23	301.18	3,048.04	3,060.69
H-9bR	CUL	01/09/23	450.39	2,957.95	2,958.81
H-9bR	CUL	02/06/23	450.56	2,957.78	2,958.64
H-9bR	CUL	03/06/23	450.02	2,958.32	2,959.18
H-9bR	CUL	04/03/23	451.03	2,957.31	2,958.17
H-9bR	CUL	05/01/23	452.07	2,956.27	2,957.12
H-9bR	CUL	06/05/23	455.02	2,953.32	2,954.16
H-9bR	CUL	07/10/23	456.12	2,952.22	2,953.05
H-9bR	CUL	08/07/23	450.94	2,957.40	2,958.26
H-9bR	CUL	09/11/23	444.12	2,964.22	2,965.10
H-9bR	CUL	10/02/23	439.37	2,968.97	2,969.87
H-9bR	CUL	11/06/23	441.16	2,967.18	2,968.07
H-9bR	CUL	12/04/23	437.33	2,971.01	2,971.92
H-10cR	CUL	01/09/23	718.50	2,971.57	3,031.85
H-10cR	CUL	02/06/23	715.31	2,974.76	3,035.34
H-10cR	CUL	03/06/23	715.36	2,974.71	3,035.28

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-10cR	CUL	04/03/23	714.26	2,975.81	3,036.48
H-10cR	CUL	05/01/23	714.32	2,975.75	3,036.42
H-10cR	CUL	06/05/23	714.27	2,975.80	3,036.47
H-10cR	CUL	07/10/23	713.97	2,976.10	3,036.80
H-10cR	CUL	08/07/23	713.88	2,976.19	3,036.90
H-10cR	CUL	09/11/23	713.36	2,976.71	3,037.47
H-10cR	CUL	10/02/23	713.53	2,976.54	3,037.28
H-10cR	CUL	11/06/23	710.14	2,979.93	3,040.98
H-10cR	CUL	12/04/23	711.62	2,978.45	3,039.37
H-11b4R	CUL	01/09/23	446.33	2,965.54	2,988.70
H-11b4R	CUL	02/07/23	446.32	2,965.55	2,988.71
H-11b4R	CUL	03/06/23	446.49	2,965.38	2,988.53
H-11b4R	CUL	04/03/23	446.55	2,965.32	2,988.46
H-11b4R	CUL	05/01/23	446.95	2,964.92	2,988.03
H-11b4R	CUL	06/05/23	447.81	2,964.06	2,987.10
H-11b4R	CUL	07/10/23	448.77	2,963.10	2,986.07
H-11b4R	CUL	08/07/23	449.02	2,962.85	2,985.80
H-11b4R	CUL	09/12/23	448.62	2,963.25	2,986.23
H-11b4R	CUL	10/02/23	447.31	2,964.56	2,987.64
H-11b4R	CUL	11/06/23	445.89	2,965.98	2,989.18
H-11b4R	CUL	12/04/23	445.91	2,965.96	2,989.16
H-12R	CUL	01/09/23	463.95	2,964.93	3,004.41
H-12R	CUL	02/06/23	463.31	2,965.57	3,005.12
H-12R	CUL	03/06/23	463.41	2,965.47	3,005.01
H-12R	CUL	04/03/23	463.34	2,965.54	3,005.09
H-12R	CUL	05/01/23	463.30	2,965.58	3,005.13

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-12R	CUL	06/05/23	463.65	2,965.23	3,004.75
H-12R	CUL	07/10/23	464.51	2,964.37	3,003.79
H-12R	CUL	08/07/23	465.06	2,963.82	3,003.19
H-12R	CUL	09/11/23	464.92	2,963.96	3,003.34
H-12R	CUL	10/02/23	464.70	2,964.18	3,003.58
H-12R	CUL	11/06/23	464.35	2,964.53	3,003.97
H-12R	CUL	12/04/23	464.14	2,964.74	3,004.20
H-15R	CUL	01/11/23	523.54	2,958.48	3,002.83
H-15R	CUL	02/08/23	523.64	2,958.38	3,002.71
H-15R	CUL	03/08/23	523.86	2,958.16	3,002.47
H-15R	CUL	04/05/23	524.20	2,957.82	3,002.08
H-15R	CUL	05/03/23	525.09	2,956.93	3,001.08
H-15R	CUL	06/07/23	525.40	2,956.62	3,000.73
H-15R	CUL	07/10/23	526.04	2,955.98	3,000.01
H-15R	CUL	08/09/23	526.55	2,955.47	2,999.43
H-15R	CUL	09/12/23	528.11	2,953.91	2,997.68
H-15R	CUL	10/04/23	526.96	2,955.06	2,998.97
H-15R	CUL	11/08/23	526.60	2,955.42	2,999.38
H-15R	CUL	12/06/23	526.49	2,955.53	2,999.50
H-16	CUL	01/11/23	447.25	2,962.81	2,971.63
H-16	CUL	02/08/23	453.49	2,956.57	2,965.18
H-16	CUL	03/08/23	457.33	2,952.73	2,961.21
H-16	CUL	04/06/23	458.68	2,951.38	2,959.82
H-16	CUL	05/03/23	463.41	2,946.65	2,954.93
H-16	CUL	06/07/23	463.24	2,946.82	2,955.11
H-16	CUL	07/11/23	463.21	2,946.85	2,955.14

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-16	CUL	08/09/23	465.10	2,944.96	2,953.19
H-16	CUL	09/12/23	465.12	2,944.94	2,953.17
H-16	CUL	10/04/23	467.77	2,942.29	2,950.43
H-16	CUL	11/08/23	468.30	2,941.76	2,949.88
H-16	CUL	12/06/23	473.80	2,936.26	2,944.20
H-19b0	CUL	01/09/23	444.53	2,973.80	2,994.53
H-19b0	CUL	02/07/23	445.43	2,972.90	2,993.57
H-19b0	CUL	03/06/23	446.16	2,972.17	2,992.79
H-19b0	CUL	04/03/23	446.77	2,971.56	2,992.14
H-19b0	CUL	05/01/23	447.84	2,970.49	2,991.00
H-19b0	CUL	06/07/23	448.84	2,969.49	2,989.93
H-19b0	CUL	07/10/23	449.70	2,968.63	2,989.01
H-19b0	CUL	08/09/23	450.32	2,968.01	2,988.35
H-19b0	CUL	09/13/23	450.88	2,967.45	2,987.75
H-19b0	CUL	10/04/23	450.76	2,967.57	2,987.88
H-19b0	CUL	11/06/23	450.66	2,967.67	2,987.99
H-19b0	CUL	12/04/23	450.61	2,967.72	2,988.04
H-19b2	CUL	03/06/23	447.77	2,971.16	2,991.81
H-19b2	CUL	06/07/23	450.19	2,968.74	2,989.23
H-19b2	CUL	09/13/23	452.26	2,966.67	2,987.02
H-19b2	CUL	12/04/23	451.96	2,966.97	2,987.34
H-19b3	CUL	03/06/23	447.75	2,971.27	2,991.83
H-19b3	CUL	06/07/23	450.37	2,968.65	2,989.03
H-19b3	CUL	09/13/23	452.62	2,966.40	2,986.63
H-19b3	CUL	12/04/23	452.18	2,966.84	2,987.10
H-19b4	CUL	03/06/23	447.05	2,971.93	2,992.53

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-19b4	CUL	06/07/23	449.74	2,969.24	2,989.66
H-19b4	CUL	09/13/23	451.34	2,967.64	2,987.96
H-19b4	CUL	12/04/23	451.56	2,967.42	2,987.72
H-19b5	CUL	03/06/23	446.99	2,971.59	2,992.17
H-19b5	CUL	06/07/23	449.67	2,968.91	2,989.31
H-19b5	CUL	09/13/23	451.70	2,966.88	2,987.15
H-19b5	CUL	12/04/23	451.45	2,967.13	2,987.41
H-19b6	CUL	03/06/23	447.68	2,971.34	2,991.90
H-19b6	CUL	06/07/23	450.30	2,968.72	2,989.11
H-19b6	CUL	09/13/23	452.48	2,966.54	2,986.78
H-19b6	CUL	12/04/23	452.15	2,966.87	2,987.14
H-19b7	CUL	03/06/23	447.51	2,971.43	2,992.00
H-19b7	CUL	06/07/23	450.14	2,968.80	2,989.19
H-19b7	CUL	09/13/23	452.19	2,966.75	2,987.01
H-19b7	CUL	12/04/23	452.09	2,966.85	2,987.11
I-461	CUL	01/10/23	251.07	3,032.81	3,033.31
I-461	CUL	02/08/23	251.18	3,032.70	3,033.20
I-461	CUL	03/07/23	251.10	3,032.78	3,033.29
I-461	CUL	04/05/23	251.29	3,032.59	3,033.09
I-461	CUL	05/03/23	251.33	3,032.55	3,033.05
I-461	CUL	06/06/23	250.67	3,033.21	3,033.72
I-461	CUL	07/11/23	250.87	3,033.01	3,033.51
I-461	CUL	08/09/23	251.45	3,032.43	3,032.93
I-461	CUL	09/12/23	251.83	3,032.05	3,032.55
I-461	CUL	10/04/23	251.37	3,032.51	3,033.01
I-461	CUL	11/07/23	251.76	3,032.12	3,032.62

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
I-461	CUL	12/06/23	251.15	3,032.73	3,033.24
SNL-1	CUL	01/10/23	444.98	3,067.86	3,073.57
SNL-1	CUL	02/07/23	445.02	3,067.82	3,073.53
SNL-1	CUL	03/07/23	444.93	3,067.91	3,073.62
SNL-1	CUL	04/04/23	444.33	3,068.51	3,074.24
SNL-1	CUL	05/02/23	444.82	3,068.02	3,073.73
SNL-1	CUL	06/06/23	445.07	3,067.77	3,073.47
SNL-1	CUL	07/10/23	445.02	3,067.82	3,073.53
SNL-1	CUL	08/08/23	445.14	3,067.70	3,073.40
SNL-1	CUL	09/11/23	445.11	3,067.73	3,073.43
SNL-1	CUL	10/03/23	445.03	3,067.81	3,073.52
SNL-1	CUL	11/07/23	445.08	3,067.76	3,073.46
SNL-1	CUL	12/05/23	445.25	3,067.59	3,073.29
SNL-2	CUL	01/10/23	264.84	3,058.22	3,060.07
SNL-2	CUL	02/07/23	264.75	3,058.31	3,060.16
SNL-2	CUL	03/07/23	264.44	3,058.62	3,060.48
SNL-2	CUL	04/05/23	264.37	3,058.69	3,060.55
SNL-2	CUL	05/02/23	264.31	3,058.75	3,060.61
SNL-2	CUL	06/06/23	264.21	3,058.85	3,060.71
SNL-2	CUL	07/11/23	264.04	3,059.02	3,060.88
SNL-2	CUL	08/08/23	264.05	3,059.01	3,060.87
SNL-2	CUL	09/12/23	264.23	3,058.83	3,060.69
SNL-2	CUL	10/03/23	263.95	3,059.11	3,060.97
SNL-2	CUL	11/07/23	263.65	3,059.41	3,061.27
SNL-2	CUL	12/05/23	263.93	3,059.13	3,060.99
SNL-3	CUL	01/10/23	429.70	3,060.65	3,069.74

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-3	CUL	02/07/23	429.72	3,060.63	3,069.72
SNL-3	CUL	03/07/23	429.70	3,060.65	3,069.74
SNL-3	CUL	04/05/23	429.72	3,060.63	3,069.72
SNL-3	CUL	05/02/23	429.74	3,060.61	3,069.70
SNL-3	CUL	06/06/23	429.96	3,060.39	3,069.48
SNL-3	CUL	07/10/23	429.91	3,060.44	3,069.53
SNL-3	CUL	08/08/23	430.08	3,060.27	3,069.35
SNL-3	CUL	09/11/23	430.10	3,060.25	3,069.33
SNL-3	CUL	10/03/23	430.02	3,060.33	3,069.42
SNL-3	CUL	11/07/23	430.12	3,060.23	3,069.31
SNL-3	CUL	12/05/23	430.31	3,060.04	3,069.12
SNL-5	CUL	01/10/23	320.63	3,059.35	3,061.98
SNL-5	CUL	02/07/23	320.26	3,059.72	3,062.35
SNL-5	CUL	03/07/23	320.28	3,059.70	3,062.33
SNL-5	CUL	04/05/23	320.19	3,059.79	3,062.42
SNL-5	CUL	05/02/23	320.28	3,059.70	3,062.33
SNL-5	CUL	06/06/23	320.49	3,059.49	3,062.12
SNL-5	CUL	07/11/23	320.56	3,059.42	3,062.05
SNL-5	CUL	08/08/23	320.68	3,059.30	3,061.93
SNL-5	CUL	09/12/23	320.96	3,059.02	3,061.64
SNL-5	CUL	10/03/23	320.74	3,059.24	3,061.87
SNL-5	CUL	11/07/23	320.70	3,059.28	3,061.91
SNL-5	CUL	12/05/23	320.97	3,059.01	3,061.63
SNL-6	CUL	01/10/23	412.04	3,234.07	3,477.65
SNL-6	CUL	02/07/23	411.45	3,234.66	3,478.40
SNL-6	CUL	03/07/23	410.77	3,235.34	3,479.26

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-6	CUL	04/04/23	410.18	3,235.93	3,480.00
SNL-6	CUL	05/02/23	409.80	3,236.31	3,480.48
SNL-6	CUL	06/06/23	408.96	3,237.15	3,481.54
SNL-6	CUL	07/11/23	408.28	3,237.83	3,482.40
SNL-6	CUL	08/08/23	407.78	3,238.33	3,483.03
SNL-6	CUL	09/11/23	407.02	3,239.09	3,483.99
SNL-6	CUL	10/03/23	406.82	3,239.29	3,484.25
SNL-6	CUL	11/07/23	406.05	3,240.06	3,485.22
SNL-6	CUL	12/05/23	405.55	3,240.56	3,485.85
SNL-8	CUL	01/10/23	543.77	3,011.96	3,051.15
SNL-8	CUL	02/07/23	542.86	3,012.87	3,052.14
SNL-8	CUL	03/07/23	538.35	3,017.38	3,057.07
SNL-8	CUL	04/04/23	537.70	3,018.03	3,057.78
SNL-8	CUL	05/02/23	538.92	3,016.81	3,056.44
SNL-8	CUL	06/06/23	540.09	3,015.64	3,055.17
SNL-8	CUL	07/11/23	539.71	3,016.02	3,055.58
SNL-8	CUL	08/08/23	539.47	3,016.26	3,055.84
SNL-8	CUL	09/11/23	539.51	3,016.22	3,055.80
SNL-8	CUL	10/03/23	539.64	3,016.09	3,055.66
SNL-8	CUL	11/07/23	540.38	3,015.35	3,054.85
SNL-8	CUL	12/05/23	540.31	3,015.42	3,054.93
SNL-9	CUL	01/10/23	320.54	3,040.42	3,044.61
SNL-9	CUL	02/08/23	320.66	3,040.30	3,044.49
SNL-9	CUL	03/07/23	320.63	3,040.33	3,044.52
SNL-9	CUL	04/05/23	320.64	3,040.32	3,044.51
SNL-9	CUL	05/03/23	320.74	3,040.22	3,044.41

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-9	CUL	06/06/23	320.60	3,040.36	3,044.55
SNL-9	CUL	07/11/23	320.48	3,040.48	3,044.67
SNL-9	CUL	08/09/23	320.68	3,040.28	3,044.47
SNL-9	CUL	09/12/23	321.06	3,039.90	3,044.08
SNL-9	CUL	10/04/23	320.79	3,040.17	3,044.36
SNL-9	CUL	11/07/23	320.48	3,040.48	3,044.67
SNL-9	CUL	12/06/23	320.86	3,040.10	3,044.29
SNL-10	CUL	01/10/23	337.42	3,040.17	3,041.55
SNL-10	CUL	02/08/23	338.16	3,039.43	3,040.81
SNL-10	CUL	03/07/23	338.49	3,039.10	3,040.48
SNL-10	CUL	04/05/23	338.93	3,038.66	3,040.03
SNL-10	CUL	05/03/23	339.56	3,038.03	3,039.40
SNL-10	CUL	06/06/23	339.84	3,037.75	3,039.12
SNL-10	CUL	07/11/23	340.05	3,037.54	3,038.91
SNL-10	CUL	08/09/23	340.25	3,037.34	3,038.71
SNL-10	CUL	09/12/23	340.75	3,036.84	3,038.20
SNL-10	CUL	10/04/23	340.75	3,036.84	3,038.20
SNL-10	CUL	11/07/23	340.83	3,036.76	3,038.12
SNL-10	CUL	12/06/23	341.13	3,036.46	3,037.82
SNL-12	CUL	01/09/23	358.78	2,980.68	2,983.65
SNL-12	CUL	02/06/23	358.49	2,980.97	2,983.94
SNL-12	CUL	03/06/23	359.00	2,980.46	2,983.43
SNL-12	CUL	04/03/23	358.71	2,980.75	2,983.72
SNL-12	CUL	05/01/23	359.00	2,980.46	2,983.43
SNL-12	CUL	06/05/23	360.14	2,979.32	2,982.27
SNL-12	CUL	07/10/23	361.41	2,978.05	2,980.98

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-12	CUL	08/07/23	360.75	2,978.71	2,981.65
SNL-12	CUL	09/11/23	358.82	2,980.64	2,983.61
SNL-12	CUL	10/02/23	356.55	2,982.91	2,985.91
SNL-12	CUL	11/06/23	355.21	2,984.25	2,987.27
SNL-12	CUL	12/04/23	355.38	2,984.08	2,987.10
SNL-13	CUL	01/09/23	297.90	2,996.21	2,998.99
SNL-13	CUL	02/06/23	297.74	2,996.37	2,999.16
SNL-13	CUL	03/06/23	297.80	2,996.31	2,999.10
SNL-13	CUL	04/03/23	297.63	2,996.48	2,999.27
SNL-13	CUL	05/01/23	297.74	2,996.37	2,999.16
SNL-13	CUL	06/05/23	297.93	2,996.18	2,998.96
SNL-13	CUL	07/10/23	298.01	2,996.10	2,998.88
SNL-13	CUL	08/07/23	298.08	2,996.03	2,998.81
SNL-13	CUL	09/11/23	298.28	2,995.83	2,998.60
SNL-13	CUL	10/02/23	298.39	2,995.72	2,998.49
SNL-13	CUL	11/06/23	298.30	2,995.81	2,998.58
SNL-13	CUL	12/04/23	297.88	2,996.23	2,999.01
SNL-14	CUL	01/09/23	396.37	2,972.04	2,985.15
SNL-14	CUL	02/07/23	396.34	2,972.07	2,985.18
SNL-14	CUL	03/06/23	396.43	2,971.98	2,985.09
SNL-14	CUL	04/03/23	396.31	2,972.10	2,985.21
SNL-14	CUL	05/01/23	396.65	2,971.76	2,984.86
SNL-14	CUL	06/05/23	397.58	2,970.83	2,983.88
SNL-14	CUL	07/10/23	398.40	2,970.01	2,983.02
SNL-14	CUL	08/07/23	398.54	2,969.87	2,982.88
SNL-14	CUL	09/12/23	397.38	2,971.03	2,984.09

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-14	CUL	10/02/23	395.66	2,972.75	2,985.89
SNL-14	CUL	11/06/23	394.18	2,974.23	2,987.45
SNL-14	CUL	12/04/23	395.33	2,973.08	2,986.24
SNL-15	CUL	01/09/23	467.54	3,012.39	3,117.11
SNL-15	CUL	02/06/23	467.22	3,012.71	3,117.50
SNL-15	CUL	03/06/23	467.01	3,012.92	3,117.76
SNL-15	CUL	04/03/23	466.73	3,013.20	3,118.10
SNL-15	CUL	05/01/23	466.48	3,013.45	3,118.41
SNL-15	CUL	06/05/23	466.25	3,013.68	3,118.69
SNL-15	CUL	07/10/23	466.67	3,013.26	3,118.18
SNL-15	CUL	08/07/23	466.10	3,013.83	3,118.88
SNL-15	CUL	09/11/23	465.37	3,014.56	3,119.78
SNL-15	CUL	10/02/23	465.08	3,014.85	3,120.13
SNL-15	CUL	11/06/23	464.77	3,015.16	3,120.51
SNL-15	CUL	12/04/23	464.50	3,015.43	3,120.85
SNL-16	CUL	01/09/23	127.14	3,005.86	3,007.44
SNL-16	CUL	02/06/23	127.07	3,005.93	3,007.51
SNL-16	CUL	03/06/23	127.45	3,005.55	3,007.13
SNL-16	CUL	04/03/23	127.42	3,005.58	3,007.16
SNL-16	CUL	05/01/23	127.65	3,005.35	3,006.92
SNL-16	CUL	06/05/23	127.64	3,005.36	3,006.93
SNL-16	CUL	07/10/23	127.88	3,005.12	3,006.69
SNL-16	CUL	08/07/23	128.21	3,004.79	3,006.35
SNL-16	CUL	09/11/23	128.55	3,004.45	3,006.01
SNL-16	CUL	10/02/23	128.41	3,004.59	3,006.15
SNL-16	CUL	11/06/23	127.42	3,005.58	3,007.16

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-16	CUL	12/04/23	127.68	3,005.32	3,006.89
SNL-17	CUL	01/09/23	237.70	3,000.36	3,000.47
SNL-17	CUL	02/06/23	237.61	3,000.45	3,000.56
SNL-17	CUL	03/06/23	238.02	3,000.04	3,000.15
SNL-17	CUL	04/03/23	238.01	3,000.05	3,000.16
SNL-17	CUL	05/01/23	238.14	2,999.92	3,000.03
SNL-17	CUL	06/05/23	238.50	2,999.56	2,999.67
SNL-17	CUL	07/10/23	238.80	2,999.26	2,999.37
SNL-17	CUL	08/07/23	238.87	2,999.19	2,999.30
SNL-17	CUL	09/11/23	238.86	2,999.20	2,999.31
SNL-17	CUL	10/02/23	238.54	2,999.52	2,999.63
SNL-17	CUL	11/06/23	237.94	3,000.12	3,000.23
SNL-17	CUL	12/04/23	236.35	3,001.71	3,001.82
SNL-18	CUL	01/10/23	313.88	3,061.56	3,062.03
SNL-18	CUL	02/07/23	313.30	3,062.14	3,062.62
SNL-18	CUL	03/07/23	313.26	3,062.18	3,062.66
SNL-18	CUL	04/05/23	313.24	3,062.20	3,062.68
SNL-18	CUL	05/02/23	313.18	3,062.26	3,062.74
SNL-18	CUL	06/06/23	313.55	3,061.89	3,062.37
SNL-18	CUL	07/11/23	313.63	3,061.81	3,062.29
SNL-18	CUL	08/08/23	313.75	3,061.69	3,062.16
SNL-18	CUL	09/11/23	313.77	3,061.67	3,062.14
SNL-18	CUL	10/03/23	313.86	3,061.58	3,062.05
SNL-18	CUL	11/07/23	313.71	3,061.73	3,062.21
SNL-18	CUL	12/05/23	313.99	3,061.45	3,061.92
SNL-19	CUL	01/10/23	163.28	3,059.37	3,060.52

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
SNL-19	CUL	02/07/23	163.07	3,059.58	3,060.73
SNL-19	CUL	03/07/23	162.77	3,059.88	3,061.03
SNL-19	CUL	04/05/23	162.79	3,059.86	3,061.01
SNL-19	CUL	05/02/23	162.54	3,060.11	3,061.27
SNL-19	CUL	06/06/23	162.60	3,060.05	3,061.20
SNL-19	CUL	07/11/23	162.50	3,060.15	3,061.31
SNL-19	CUL	08/08/23	162.50	3,060.15	3,061.31
SNL-19	CUL	09/12/23	162.68	3,059.97	3,061.12
SNL-19	CUL	10/03/23	162.35	3,060.30	3,061.46
SNL-19	CUL	11/07/23	162.03	3,060.62	3,061.78
SNL-19	CUL	12/05/23	162.25	3,060.40	3,061.56
WIPP-11R	CUL	01/10/23	373.51	3,053.75	3,065.84
WIPP-11R	CUL	02/08/23	373.58	3,053.68	3,065.77
WIPP-11R	CUL	03/07/23	373.54	3,053.72	3,065.81
WIPP-11R	CUL	04/05/23	373.67	3,053.59	3,065.68
WIPP-11R	CUL	05/02/23	373.88	3,053.38	3,065.46
WIPP-11R	CUL	06/06/23	373.90	3,053.36	3,065.44
WIPP-11R	CUL	07/11/23	373.95	3,053.31	3,065.39
WIPP-11R	CUL	08/09/23	374.00	3,053.26	3,065.34
WIPP-11R	CUL	09/12/23	374.27	3,052.99	3,065.06
WIPP-11R	CUL	10/03/23	373.98	3,053.28	3,065.36
WIPP-11R	CUL	11/07/23	374.00	3,053.26	3,065.34
WIPP-11R	CUL	12/06/23	374.40	3,052.86	3,064.93
WQSP-1	CUL	01/10/23	371.17	3,048.08	3,067.26
WQSP-1	CUL	02/08/23	371.38	3,047.87	3,067.04
WQSP-1	CUL	03/07/23	371.38	3,047.87	3,067.04

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-1	CUL	04/05/23	372.67	3,046.58	3,065.67
WQSP-1	CUL	05/03/23	371.82	3,047.43	3,066.57
WQSP-1	CUL	06/06/23	371.76	3,047.49	3,066.64
WQSP-1	CUL	07/11/23	371.67	3,047.58	3,066.73
WQSP-1	CUL	08/09/23	371.79	3,047.46	3,066.60
WQSP-1	CUL	09/12/23	372.12	3,047.13	3,066.26
WQSP-1	CUL	10/04/23	371.86	3,047.39	3,066.53
WQSP-1	CUL	11/07/23	371.76	3,047.49	3,066.64
WQSP-1	CUL	12/06/23	372.17	3,047.08	3,066.20
WQSP-2	CUL	01/10/23	412.01	3,051.86	3,065.49
WQSP-2	CUL	02/08/23	412.19	3,051.68	3,065.31
WQSP-2	CUL	03/07/23	412.15	3,051.72	3,065.35
WQSP-2	CUL	04/04/23	411.88	3,051.99	3,065.63
WQSP-2	CUL	05/02/23	412.36	3,051.51	3,065.13
WQSP-2	CUL	06/06/23	412.57	3,051.30	3,064.91
WQSP-2	CUL	07/11/23	412.67	3,051.20	3,064.81
WQSP-2	CUL	08/08/23	412.77	3,051.10	3,064.71
WQSP-2	CUL	09/12/23	412.94	3,050.93	3,064.53
WQSP-2	CUL	10/03/23	412.78	3,051.09	3,064.70
WQSP-2	CUL	11/07/23	412.91	3,050.96	3,064.56
WQSP-2	CUL	12/05/23	413.11	3,050.76	3,064.35
WQSP-3	CUL	01/10/23	474.57	3,005.57	3,059.89
WQSP-3	CUL	02/08/23	474.93	3,005.21	3,059.48
WQSP-3	CUL	03/07/23	475.06	3,005.08	3,059.33
WQSP-3	CUL	04/04/23	475.08	3,005.06	3,059.31
WQSP-3	CUL	05/02/23	476.72	3,003.42	3,057.44

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-3	CUL	06/06/23	476.79	3,003.35	3,057.36
WQSP-3	CUL	07/11/23	476.91	3,003.23	3,057.22
WQSP-3	CUL	08/08/23	477.06	3,003.08	3,057.05
WQSP-3	CUL	09/12/23	477.36	3,002.78	3,056.71
WQSP-3	CUL	10/03/23	477.31	3,002.83	3,056.77
WQSP-3	CUL	11/07/23	477.46	3,002.68	3,056.60
WQSP-3	CUL	12/05/23	477.71	3,002.43	3,056.31
WQSP-4	CUL	01/09/23	461.84	2,971.25	2,993.58
WQSP-4	CUL	02/07/23	462.72	2,970.37	2,992.64
WQSP-4	CUL	03/08/23	463.50	2,969.59	2,991.81
WQSP-4	CUL	04/03/23	463.89	2,969.20	2,991.39
WQSP-4	CUL	05/01/23	464.93	2,968.16	2,990.28
WQSP-4	CUL	N/A	N/A	N/A	N/A
WQSP-4	CUL	N/A	N/A	N/A	N/A
WQSP-4	CUL	N/A	N/A	N/A	N/A
WQSP-4	CUL	N/A	N/A	N/A	N/A
WQSP-4	CUL	N/A	N/A	N/A	N/A
WQSP-4	CUL	11/06/23	467.80	2,965.29	2,987.21
WQSP-4	CUL	12/06/23	467.89	2,965.20	2,987.11
WQSP-5	CUL	01/09/23	397.53	2,986.85	2,993.12
WQSP-5	CUL	02/07/23	398.37	2,986.01	2,992.26
WQSP-5	CUL	03/08/23	399.24	2,985.14	2,991.37
WQSP-5	CUL	04/05/23	400.22	2,984.16	2,990.36
WQSP-5	CUL	05/01/23	401.33	2,983.05	2,989.23
WQSP-5	CUL	06/07/23	402.15	2,982.23	2,988.39
WQSP-5	CUL	07/10/23	403.01	2,981.37	2,987.51

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-5	CUL	08/09/23	403.68	2,980.70	2,986.82
WQSP-5	CUL	09/13/23	404.54	2,979.84	2,985.94
WQSP-5	CUL	10/04/23	404.73	2,979.65	2,985.74
WQSP-5	CUL	11/06/23	405.00	2,979.38	2,985.47
WQSP-5	CUL	12/06/23	405.30	2,979.08	2,985.16
WQSP-6	CUL	01/09/23	360.25	3,004.47	3,006.84
WQSP-6	CUL	02/06/23	361.50	3,003.22	3,005.58
WQSP-6	CUL	03/08/23	363.16	3,001.56	3,003.90
WQSP-6	CUL	04/05/23	364.56	3,000.16	3,002.49
WQSP-6	CUL	05/01/23	365.54	2,999.18	3,001.50
WQSP-6	CUL	06/05/23	367.37	2,997.35	2,999.65
WQSP-6	CUL	07/10/23	368.44	2,996.28	2,998.57
WQSP-6	CUL	08/02/23	366.99	2,997.73	3,000.03
WQSP-6	CUL	09/13/23	370.65	2,994.07	2,996.33
WQSP-6	CUL	10/04/23	370.90	2,993.82	2,996.08
WQSP-6	CUL	11/06/23	371.55	2,993.17	2,995.43
WQSP-6	CUL	12/06/23	372.27	2,992.45	2,994.70
C-2737 (ANNULUS)	MAG	01/11/23	250.50	3,150.26	N/A
C-2737 (ANNULUS)	MAG	02/08/23	251.63	3,149.13	N/A
C-2737 (ANNULUS)	MAG	03/08/23	252.66	3,148.10	N/A
C-2737 (ANNULUS)	MAG	04/05/23	253.84	3,146.92	N/A
C-2737 (ANNULUS)	MAG	05/03/23	255.30	3,145.46	N/A
C-2737 (ANNULUS)	MAG	06/06/23	256.74	3,144.02	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
C-2737 (ANNULUS)	MAG	07/10/23	258.56	3,142.20	N/A
C-2737 (ANNULUS)	MAG	08/09/23	259.05	3,141.71	N/A
C-2737 (ANNULUS)	MAG	09/12/23	260.48	3,140.28	N/A
C-2737 (ANNULUS)	MAG	10/04/23	261.12	3,139.64	N/A
C-2737 (ANNULUS)	MAG	11/08/23	262.44	3,138.32	N/A
C-2737 (ANNULUS)	MAG	12/06/23	263.64	3,137.12	N/A
H-2b1	MAG	01/09/23	229.85	3,148.64	N/A
H-2b1	MAG	02/06/23	230.07	3,148.42	N/A
H-2b1	MAG	03/06/23	230.27	3,148.22	N/A
H-2b1	MAG	04/03/23	230.51	3,147.98	N/A
H-2b1	MAG	05/01/23	230.83	3,147.66	N/A
H-2b1	MAG	06/05/23	231.45	3,147.04	N/A
H-2b1	MAG	07/10/23	231.08	3,147.41	N/A
H-2b1	MAG	08/07/23	232.76	3,145.73	N/A
H-2b1	MAG	09/11/23	233.57	3,144.92	N/A
H-2b1	MAG	10/02/23	234.05	3,144.44	N/A
H-2b1	MAG	11/06/23	234.98	3,143.51	N/A
H-2b1	MAG	12/04/23	235.83	3,142.66	N/A
H-3b1	MAG	01/09/23	237.78	3,152.94	N/A
H-3b1	MAG	02/08/23	237.91	3,152.81	N/A
H-3b1	MAG	03/08/23	238.05	3,152.67	N/A
H-3b1	MAG	04/03/23	238.44	3,152.28	N/A
H-3b1	MAG	05/03/23	238.99	3,151.73	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-3b1	MAG	06/06/23	239.52	3,151.20	N/A
H-3b1	MAG	07/10/23	240.02	3,150.70	N/A
H-3b1	MAG	08/09/23	240.42	3,150.30	N/A
H-3b1	MAG	09/12/23	241.15	3,149.57	N/A
H-3b1	MAG	10/04/23	241.40	3,149.32	N/A
H-3b1	MAG	11/08/23	242.22	3,148.50	N/A
H-3b1	MAG	12/06/23	242.84	3,147.88	N/A
H-4c	MAG	01/09/23	190.32	3,143.96	N/A
H-4c	MAG	02/06/23	190.18	3,144.10	N/A
H-4c	MAG	03/06/23	189.86	3,144.42	N/A
H-4c	MAG	04/03/23	189.79	3,144.49	N/A
H-4c	MAG	05/01/23	189.73	3,144.55	N/A
H-4c	MAG	06/05/23	189.76	3,144.52	N/A
H-4c	MAG	07/10/23	189.31	3,144.97	N/A
H-4c	MAG	08/07/23	189.70	3,144.58	N/A
H-4c	MAG	09/11/23	189.74	3,144.54	N/A
H-4c	MAG	10/02/23	189.81	3,144.47	N/A
H-4c	MAG	11/06/23	189.98	3,144.30	N/A
H-4c	MAG	12/04/23	190.02	3,144.26	N/A
H-6c	MAG	01/10/23	282.91	3,065.78	N/A
H-6c	MAG	02/08/23	283.74	3,064.95	N/A
H-6c	MAG	03/07/23	284.11	3,064.58	N/A
H-6c	MAG	04/05/23	284.54	3,064.15	N/A
H-6c	MAG	05/03/23	285.02	3,063.67	N/A
H-6c	MAG	06/06/23	285.49	3,063.20	N/A
H-6c	MAG	07/11/23	285.98	3,062.71	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-6c	MAG	08/09/23	286.15	3,062.54	N/A
H-6c	MAG	09/12/23	287.10	3,061.59	N/A
H-6c	MAG	10/04/23	287.15	3,061.54	N/A
H-6c	MAG	11/07/23	287.59	3,061.10	N/A
H-6c	MAG	12/06/23	288.24	3,060.45	N/A
H-8a	MAG	01/09/23	400.84	3,032.44	N/A
H-8a	MAG	02/06/23	400.88	3,032.40	N/A
H-8a	MAG	03/06/23	400.88	3,032.40	N/A
H-8a	MAG	04/03/23	400.91	3,032.37	N/A
H-8a	MAG	05/01/23	400.97	3,032.31	N/A
H-8a	MAG	06/05/23	401.16	3,032.12	N/A
H-8a	MAG	07/10/23	401.96	3,031.32	N/A
H-8a	MAG	08/07/23	402.88	3,030.40	N/A
H-8a	MAG	09/11/23	403.67	3,029.61	N/A
H-8a	MAG	10/02/23	403.70	3,029.58	N/A
H-8a	MAG	11/06/23	403.64	3,029.64	N/A
H-8a	MAG	12/04/23	403.19	3,030.09	N/A
H-9c	MAG	01/09/23	259.16	3,147.89	N/A
H-9c	MAG	02/06/23	258.87	3,148.18	N/A
H-9c	MAG	03/06/23	258.70	3,148.35	N/A
H-9c	MAG	04/03/23	258.70	3,148.35	N/A
H-9c	MAG	05/01/23	258.70	3,148.35	N/A
H-9c	MAG	06/05/23	258.74	3,148.31	N/A
H-9c	MAG	07/10/23	258.78	3,148.27	N/A
H-9c	MAG	08/07/23	259.45	3,147.60	N/A
H-9c	MAG	09/11/23	259.27	3,147.78	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-9c	MAG	10/02/23	258.92	3,148.13	N/A
H-9c	MAG	11/06/23	259.21	3,147.84	N/A
H-9c	MAG	12/04/23	259.57	3,147.48	N/A
H-10a	MAG	01/10/23	578.82	3,109.63	N/A
H-10a	MAG	02/06/23	579.64	3,108.81	N/A
H-10a	MAG	03/06/23	579.61	3,108.84	N/A
H-10a	MAG	04/03/23	579.79	3,108.66	N/A
H-10a	MAG	05/01/23	579.81	3,108.64	N/A
H-10a	MAG	06/05/23	579.81	3,108.64	N/A
H-10a	MAG	07/10/23	579.64	3,108.81	N/A
H-10a	MAG	08/07/23	579.66	3,108.79	N/A
H-10a	MAG	09/11/23	579.28	3,109.17	N/A
H-10a	MAG	10/02/23	579.33	3,109.12	N/A
H-10a	MAG	11/06/23	578.01	3,110.44	N/A
H-10a	MAG	12/04/23	578.77	3,109.68	N/A
H-11b2	MAG	01/09/23	267.49	3,144.37	N/A
H-11b2	MAG	02/07/23	267.55	3,144.31	N/A
H-11b2	MAG	03/06/23	267.43	3,144.43	N/A
H-11b2	MAG	04/03/23	267.26	3,144.60	N/A
H-11b2	MAG	05/01/23	267.01	3,144.85	N/A
H-11b2	MAG	06/05/23	266.72	3,145.14	N/A
H-11b2	MAG	07/10/23	266.57	3,145.29	N/A
H-11b2	MAG	08/07/23	266.56	3,145.30	N/A
H-11b2	MAG	09/12/23	266.49	3,145.37	N/A
H-11b2	MAG	10/02/23	266.63	3,145.23	N/A
H-11b2	MAG	11/06/23	266.75	3,145.11	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-11b2	MAG	12/04/23	266.87	3,144.99	N/A
H-14	MAG	01/09/23	206.79	3,140.29	N/A
H-14	MAG	02/06/23	206.80	3,140.28	N/A
H-14	MAG	03/06/23	206.88	3,140.20	N/A
H-14	MAG	04/03/23	206.77	3,140.31	N/A
H-14	MAG	05/01/23	206.78	3,140.30	N/A
H-14	MAG	06/05/23	206.88	3,140.20	N/A
H-14	MAG	07/10/23	206.96	3,140.12	N/A
H-14	MAG	08/07/23	207.02	3,140.06	N/A
H-14	MAG	09/11/23	207.08	3,140.00	N/A
H-14	MAG	10/02/23	207.13	3,139.95	N/A
H-14	MAG	11/06/23	207.25	3,139.83	N/A
H-14	MAG	12/04/23	207.39	3,139.69	N/A
H-15	MAG	01/11/23	324.28	3,159.50	N/A
H-15	MAG	02/08/23	324.54	3,159.24	N/A
H-15	MAG	03/08/23	324.62	3,159.16	N/A
H-15	MAG	04/05/23	324.85	3,158.93	N/A
H-15	MAG	05/03/23	325.35	3,158.43	N/A
H-15	MAG	06/07/23	325.38	3,158.40	N/A
H-15	MAG	07/10/23	325.70	3,158.08	N/A
H-15	MAG	08/09/23	325.82	3,157.96	N/A
H-15	MAG	09/12/23	326.37	3,157.41	N/A
H-15	MAG	10/04/23	326.04	3,157.74	N/A
H-15	MAG	11/08/23	326.67	3,157.11	N/A
H-15	MAG	12/06/23	327.01	3,156.77	N/A
H-18	MAG	01/10/23	254.35	3,159.86	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
H-18	MAG	02/08/23	254.59	3,159.62	N/A
H-18	MAG	03/07/23	254.63	3,159.58	N/A
H-18	MAG	04/05/23	254.88	3,159.33	N/A
H-18	MAG	05/03/23	254.82	3,159.39	N/A
H-18	MAG	06/06/23	255.83	3,158.38	N/A
H-18	MAG	07/11/23	256.23	3,157.98	N/A
H-18	MAG	08/09/23	256.61	3,157.60	N/A
H-18	MAG	09/12/23	257.33	3,156.88	N/A
H-18	MAG	10/04/23	257.52	3,156.69	N/A
H-18	MAG	11/07/23	258.10	3,156.11	N/A
H-18	MAG	12/06/23	258.84	3,155.37	N/A
WIPP-18	MAG	01/10/23	298.88	3,158.69	N/A
WIPP-18	MAG	02/08/23	299.07	3,158.50	N/A
WIPP-18	MAG	03/07/23	299.14	3,158.43	N/A
WIPP-18	MAG	04/04/23	299.32	3,158.25	N/A
WIPP-18	MAG	05/02/23	299.66	3,157.91	N/A
WIPP-18	MAG	06/06/23	300.07	3,157.50	N/A
WIPP-18	MAG	07/11/23	300.36	3,157.21	N/A
WIPP-18	MAG	08/08/23	300.60	3,156.97	N/A
WIPP-18	MAG	09/12/23	301.02	3,156.55	N/A
WIPP-18	MAG	10/03/23	301.28	3,156.29	N/A
WIPP-18	MAG	11/07/23	301.59	3,155.98	N/A
WIPP-18	MAG	12/05/23	301.87	3,155.70	N/A
WQSP-6a	DL	01/09/23	168.43	3,195.37	N/A
WQSP-6a	DL	02/06/23	168.06	3,195.74	N/A
WQSP-6a	DL	03/08/23	168.51	3,195.29	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
WQSP-6a	DL	04/05/23	168.55	3,195.25	N/A
WQSP-6a	DL	05/01/23	168.37	3,195.43	N/A
WQSP-6a	DL	06/05/23	168.58	3,195.22	N/A
WQSP-6a	DL	07/10/23	168.57	3,195.23	N/A
WQSP-6a	DL	08/09/23	168.47	3,195.33	N/A
WQSP-6a	DL	09/13/23	168.61	3,195.19	N/A
WQSP-6a	DL	10/04/23	168.49	3,195.31	N/A
WQSP-6a	DL	11/06/23	168.41	3,195.39	N/A
WQSP-6a	DL	12/06/23	168.80	3,195.00	N/A
CB-1	B/C	01/09/23	269.10	3,060.02	N/A
CB-1	B/C	02/07/23	268.94	3,060.18	N/A
CB-1	B/C	03/06/23	268.60	3,060.52	N/A
CB-1	B/C	04/03/23	268.27	3,060.85	N/A
CB-1	B/C	05/01/23	267.94	3,061.18	N/A
CB-1	B/C	06/05/23	267.59	3,061.53	N/A
CB-1	B/C	07/10/23	267.12	3,062.00	N/A
CB-1	B/C	08/07/23	266.84	3,062.28	N/A
CB-1	B/C	09/12/23	266.44	3,062.68	N/A
CB-1	B/C	10/02/23	266.18	3,062.94	N/A
CB-1	B/C	11/06/23	265.75	3,063.37	N/A
CB-1	B/C	12/04/23	265.44	3,063.68	N/A
DOE-2	B/C	01/10/23	347.14	3,072.04	N/A
DOE-2	B/C	02/08/23	347.05	3,072.13	N/A
DOE-2	B/C	03/07/23	346.95	3,072.23	N/A
DOE-2	B/C	04/05/23	346.98	3,072.20	N/A
DOE-2	B/C	05/02/23	347.28	3,071.90	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
DOE-2	B/C	06/06/23	347.35	3,071.83	N/A
DOE-2	B/C	07/11/23	347.24	3,071.94	N/A
DOE-2	B/C	08/09/23	347.20	3,071.98	N/A
DOE-2	B/C	09/12/23	347.13	3,072.05	N/A
DOE-2	B/C	10/04/23	347.19	3,071.99	N/A
DOE-2	B/C	11/07/23	347.23	3,071.95	N/A
DOE-2	B/C	12/06/23	347.39	3,071.79	N/A
C-2505	SR/DL	03/08/23	45.46	3,367.47	N/A
C-2505	SR/DL	06/07/23	45.27	3,367.66	N/A
C-2505	SR/DL	09/12/23	45.44	3,367.49	N/A
C-2505	SR/DL	12/06/23	45.27	3,367.66	N/A
C-2506	SR/DL	03/08/23	44.77	3,368.07	N/A
C-2506	SR/DL	06/07/23	44.58	3,368.26	N/A
C-2506	SR/DL	09/12/23	44.71	3,368.13	N/A
C-2506	SR/DL	12/06/23	44.64	3,368.20	N/A
C-2507	SR/DL	03/08/23	45.02	3,364.89	N/A
C-2507	SR/DL	06/07/23	44.94	3,364.97	N/A
C-2507	SR/DL	09/12/23	45.08	3,364.83	N/A
C-2507	SR/DL	12/06/23	45.01	3,364.90	N/A
C-2811	SR/DL	03/08/23	53.56	3,345.28	N/A
C-2811	SR/DL	06/06/23	53.21	3,345.63	N/A
C-2811	SR/DL	09/12/23	53.72	3,345.12	N/A
C-2811	SR/DL	12/06/23	53.92	3,344.92	N/A
PZ-1	SR/DL	03/08/23	42.77	3,370.51	N/A
PZ-1	SR/DL	06/07/23	42.41	3,370.87	N/A
PZ-1	SR/DL	09/12/23	42.55	3,370.73	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
PZ-1	SR/DL	12/06/23	42.40	3,370.88	N/A
PZ-2	SR/DL	03/08/23	43.44	3,369.92	N/A
PZ-2	SR/DL	06/07/23	43.08	3,370.28	N/A
PZ-2	SR/DL	09/12/23	43.28	3,370.08	N/A
PZ-2	SR/DL	12/06/23	43.05	3,370.31	N/A
PZ-3	SR/DL	03/08/23	44.97	3,371.15	N/A
PZ-3	SR/DL	06/07/23	44.88	3,371.24	N/A
PZ-3	SR/DL	09/13/23	45.01	3,371.11	N/A
PZ-3	SR/DL	12/06/23	45.11	3,371.01	N/A
PZ-4	SR/DL	03/08/23	46.04	3,365.97	N/A
PZ-4	SR/DL	06/07/23	45.77	3,366.24	N/A
PZ-4	SR/DL	09/12/23	46.03	3,365.98	N/A
PZ-4	SR/DL	12/06/23	45.92	3,366.09	N/A
PZ-5	SR/DL	03/08/23	42.58	3,372.66	N/A
PZ-5	SR/DL	06/07/23	42.69	3,372.55	N/A
PZ-5	SR/DL	09/12/23	43.14	3,372.10	N/A
PZ-5	SR/DL	12/06/23	42.89	3,372.35	N/A
PZ-6	SR/DL	03/08/23	43.18	3,370.15	N/A
PZ-6	SR/DL	06/07/23	43.13	3,370.20	N/A
PZ-6	SR/DL	09/12/23	43.55	3,369.78	N/A
PZ-6	SR/DL	12/06/23	43.08	3,370.25	N/A
PZ-7	SR/DL	03/08/23	38.49	3,375.35	N/A
PZ-7	SR/DL	06/07/23	38.61	3,375.23	N/A
PZ-7	SR/DL	09/13/23	38.81	3,375.03	N/A
PZ-7	SR/DL	12/06/23	39.03	3,374.81	N/A
PZ-9	SR/DL	03/08/23	58.43	3,362.66	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	06/07/23	58.32	3,362.77	N/A
PZ-9	SR/DL	09/13/23	58.19	3,362.90	N/A
PZ-9	SR/DL	12/06/23	58.43	3,362.66	N/A
PZ-10	SR/DL	03/08/23	38.19	3,367.54	N/A
PZ-10	SR/DL	06/07/23	38.27	3,367.46	N/A
PZ-10	SR/DL	09/13/23	38.52	3,367.21	N/A
PZ-10	SR/DL	12/06/23	38.33	3,367.40	N/A
PZ-11	SR/DL	03/08/23	46.95	3,371.83	N/A
PZ-11	SR/DL	06/07/23	46.97	3,371.81	N/A
PZ-11	SR/DL	09/13/23	47.27	3,371.51	N/A
PZ-11	SR/DL	12/06/23	47.61	3,371.17	N/A
PZ-12	SR/DL	03/08/23	53.26	3,355.66	N/A
PZ-12	SR/DL	06/07/23	53.15	3,355.77	N/A
PZ-12	SR/DL	09/13/23	53.48	3,355.44	N/A
PZ-12	SR/DL	12/06/23	53.35	3,355.57	N/A
PZ-13	SR/DL	03/08/23	65.06	3,357.18	N/A
PZ-13	SR/DL	06/07/23	65.18	3,357.06	N/A
PZ-13	SR/DL	09/13/23	65.10	3,357.14	N/A
PZ-13	SR/DL	12/06/23	65.36	3,356.88	N/A
PZ-14	SR/DL	03/08/23	66.87	3,353.71	N/A
PZ-14	SR/DL	06/07/23	66.88	3,353.70	N/A
PZ-14	SR/DL	09/13/23	66.90	3,353.68	N/A
PZ-14	SR/DL	12/06/23	67.09	3,353.49	N/A
PZ-15	GAT	03/08/23	49.82	3,381.04	N/A
PZ-15	GAT	06/07/23	49.83	3,381.03	N/A
PZ-15	GAT	09/13/23	50.00	3,380.86	N/A

Well	Zone	Date	Adjusted Depth Top of Casing (ft)	Water Level Elevation (ft AMSL)	Adjusted Freshwater Head (ft AMSL)
PZ-15	GAT	12/06/23	50.05	3,380.81	N/A
PZ-16	SR/DL	03/08/23	N/A	N/A	N/A
PZ-16	SR/DL	06/07/23	N/A	N/A	N/A
PZ-16	SR/DL	09/12/23	N/A	N/A	N/A
PZ-16	SR/DL	12/06/23	N/A	N/A	N/A
PZ-17a	SR/DL	03/08/23	N/A	N/A	N/A
PZ-17a	SR/DL	06/07/23	N/A	N/A	N/A
PZ-17a	SR/DL	09/13/23	N/A	N/A	N/A
PZ-17a	SR/DL	12/06/23	N/A	N/A	N/A
PZ-17b	DL	03/08/23	191.19	3,116.47	N/A
PZ-17b	DL	06/07/23	191.21	3,116.45	N/A
PZ-17b	DL	09/13/23	191.20	3,116.46	N/A
PZ-17b	DL	12/06/23	191.44	3,116.22	N/A
PZ-18	SR/DL	03/08/23	N/A	N/A	N/A
PZ-18	SR/DL	06/07/23	N/A	N/A	N/A
PZ-18	SR/DL	09/13/23	N/A	N/A	N/A
PZ-18	SR/DL	12/06/23	N/A	N/A	N/A
PZ-19	SR/DL	03/06/23	N/A	N/A	N/A
PZ-19	SR/DL	06/07/23	N/A	N/A	N/A
PZ-19	SR/DL	09/13/23	N/A	N/A	N/A
PZ-19	SR/DL	12/04/23	N/A	N/A	N/A

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	7.88E-03	2.16E-03	7.07E-04
Feb	^{241}Am	3.37E-03	1.39E-03	8.29E-04
Mar	^{241}Am	2.15E-03	1.04E-03	7.84E-04
Apr	^{241}Am	4.03E-03	1.43E-03	6.18E-04
May	^{241}Am	1.47E-02	3.28E-03	6.73E-04
Jun	^{241}Am	7.59E-03	2.58E-03	8.84E-04
Jul	^{241}Am	9.55E-03	2.49E-03	8.51E-04
Aug	^{241}Am	2.66E-02	4.77E-03	7.07E-04
Sep	^{241}Am	9.66E-03	2.33E-03	8.44E-04
Oct	^{241}Am	7.51E-03	2.00E-03	7.73E-04
Nov	^{241}Am	1.41E-02	3.32E-03	9.21E-04
Dec	^{241}Am	2.46E-03	1.09E-03	8.07E-04

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{238} Pu	-9.62E-05	2.16E-04	7.55E-04
Feb	^{238} Pu	1.19E-04	4.22E-04	8.03E-04
Mar	^{238} Pu	1.61E-05	4.33E-04	9.73E-04
Apr	^{238} Pu	-8.18E-05	1.92E-04	6.22E-04
May	^{238} Pu	1.59E-04	5.62E-04	9.47E-04
Jun	^{238} Pu	3.20E-04	4.55E-04	6.55E-04
Jul	^{238} Pu	2.79E-04	4.96E-04	8.07E-04
Aug	^{238} Pu	-7.70E-05	1.85E-04	6.51E-04
Sep	^{238} Pu	2.06E-04	3.61E-04	6.07E-04
Oct	^{238} Pu	-6.18E-05	1.75E-04	7.84E-04
Nov	^{238} Pu	-1.99E-05	9.58E-05	5.25E-04
Dec	^{238} Pu	-7.40E-05	1.78E-04	5.74E-04

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	$^{239/240}$Pu	2.68E-04	4.85E-04	8.58E-04
Feb	$^{239/240}$Pu	6.40E-04	6.36E-04	8.21E-04
Mar	$^{239/240}$Pu	6.55E-04	7.73E-04	1.01E-03
Apr	$^{239/240}$Pu	2.60E-04	4.44E-04	6.85E-04
May	$^{239/240}$Pu	2.20E-03	1.30E-03	9.25E-04
Jun	$^{239/240}$Pu	1.25E-03	8.58E-04	8.03E-04
Jul	$^{239/240}$Pu	1.42E-03	9.29E-04	8.33E-04
Aug	$^{239/240}$Pu	3.96E-03	1.47E-03	7.18E-04
Sep	$^{239/240}$Pu	9.10E-03	2.46E-03	6.88E-04
Oct	$^{239/240}$Pu	3.52E-04	4.59E-04	6.62E-04
Nov	$^{239/240}$Pu	1.46E-03	8.95E-04	7.84E-04
Dec	$^{239/240}$Pu	3.32E-04	4.88E-04	7.99E-04

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	^{90}Sr	4.40E-03	1.76E-02	1.44E-02
Feb	^{90}Sr	-1.44E-03	1.96E-02	1.48E-02
Mar	^{90}Sr	-5.40E-05	1.94E-02	1.63E-02
Apr	^{90}Sr	1.31E-03	1.60E-02	1.68E-02
May	^{90}Sr	-5.18E-03	1.63E-02	1.68E-02
Jun	^{90}Sr	-1.76E-02	2.49E-02	1.71E-02
Jul	^{90}Sr	6.77E-03	2.93E-02	1.77E-02
Aug	^{90}Sr	4.29E-03	2.59E-02	2.06E-02
Sep	^{90}Sr	1.79E-03	1.75E-02	1.94E-02
Oct	^{90}Sr	-8.44E-03	1.72E-02	1.93E-02
Nov	^{90}Sr	1.81E-02	3.10E-02	1.81E-02
Dec	^{90}Sr	1.87E-04	2.69E-02	1.75E-02

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	**$^{233/234}$U**	7.70E-04	6.77E-04	1.22E-03
Feb	**$^{233/234}$U**	1.40E-03	9.73E-04	1.17E-02
Mar	**$^{233/234}$U**	1.40E-03	1.06E-03	1.27E-03
Apr	**$^{233/234}$U**	9.29E-04	7.22E-04	1.20E-03
May	**$^{233/234}$U**	1.22E-03	9.81E-04	1.36E-03
Jun	**$^{233/234}$U**	2.28E-03	1.42E-03	1.47E-03
Jul	**$^{233/234}$U**	7.18E-04	7.66E-04	1.39E-03
Aug	**$^{233/234}$U**	6.33E-04	5.99E-04	1.27E-03
Sep	**$^{233/234}$U**	7.73E-04	6.40E-04	1.28E-03
Oct	**$^{233/234}$U**	1.01E-03	7.25E-04	1.30E-03
Nov	**$^{233/234}$U**	5.18E-04	5.59E-04	1.27E-03
Dec	**$^{233/234}$U**	7.14E-04	6.18E-04	1.23E-03

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	**^{137}Cs**	-4.11E-02	4.77E-02	8.18E-02
Feb	**^{137}Cs**	5.22E-02	6.92E-02	1.30E-01
Mar	**^{137}Cs**	-4.00E-02	5.74E-02	9.92E-02
Apr	**^{137}Cs**	2.19E-02	6.77E-02	1.27E-01
May	**^{137}Cs**	-5.25E-02	6.25E-02	1.08E-01
Jun	**^{137}Cs**	-5.55E-02	6.59E-02	1.12E-01
Jul	**^{137}Cs**	2.53E-02	6.70E-02	1.21E-01
Aug	**^{137}Cs**	-2.04E-02	6.73E-02	1.21E-01
Sep	**^{137}Cs**	-1.12E-01	6.73E-02	1.03E-01
Oct	**^{137}Cs**	-2.26E-02	7.96E-02	1.32E-01
Nov	**^{137}Cs**	4.70E-03	5.92E-02	1.01E-01
Dec	**^{137}Cs**	-3.29E-02	6.07E-02	1.00E-01

Month	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
Jan	**^{238}U**	8.73E-04	7.36E-04	1.01E-03
Feb	**^{238}U**	9.55E-04	8.10E-04	1.16E-03
Mar	**^{238}U**	8.70E-04	8.25E-04	1.22E-03
Apr	**^{238}U**	7.88E-04	6.77E-04	1.15E-03
May	**^{238}U**	2.88E-04	5.48E-04	1.30E-03
Jun	**^{238}U**	6.92E-04	8.14E-04	1.45E-03
Jul	**^{238}U**	7.66E-04	7.40E-04	1.31E-03
Aug	**^{238}U**	3.96E-04	5.00E-04	1.16E-03
Sep	**^{238}U**	7.70E-04	6.36E-04	1.33E-03
Oct	**^{238}U**	8.99E-04	6.77E-04	1.33E-03
Nov	**^{238}U**	6.33E-04	6.29E-04	1.32E-03
Dec	**^{238}U**	2.69E-04	4.18E-04	1.25E-03

(a) Total propagated uncertainty.

(b) Minimum detectable concentration.

Table G.2 – Station C Sample Results

Qtr.	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{241}Am	3.70E-05	3.16E-04	7.77E-04
2nd	^{241}Am	2.32E-04	4.07E-04	7.25E-04
3rd	^{241}Am	4.74E-04	4.92E-04	7.14E-04
4th	^{241}Am	1.11E-04	3.92E-04	8.03E-04

Qtr.	Nuclide	Activity (Bq/Sample)	2 σ TPU[a]	MDC[b]
1st	^{238} Pu	9.32E-05	3.38E-04	7.22E-04
2nd	^{238} Pu	8.36E-05	2.68E-04	5.81E-04
3rd	^{238} Pu	-1.41E-04	2.56E-04	7.03E-04
4th	^{238} Pu	-3.45E-05	1.24E-04	6.62E-04

Qtr.	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st	$^{239/240}$Pu	-5.40E-05	1.75E-04	7.62E-04
2nd	$^{239/240}$Pu	4.37E-05	2.99E-04	7.29E-04
3rd	$^{239/240}$Pu	4.40E-05	3.01E-04	6.96E-04
4th	$^{239/240}$Pu	-9.55E-05	2.05E-04	6.48E-04

Qtr.	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st	^{90}Sr	8.07E-03	1.86E-02	1.63E-02
2nd	^{90}Sr	8.03E-03	2.87E-02	1.75E-02
3rd	^{90}Sr	-8.07E-03	1.62E-02	1.92E-02
4th	^{90}Sr	6.59E-03	2.84E-02	1.76E-02

Qtr.	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st	$^{233/234}$U	1.21E-03	1.15E-03	1.54E-03
2nd	$^{233/234}$U	4.92E-04	7.03E-04	1.49E-03
3rd	$^{233/234}$U	6.73E-04	6.07E-04	1.29E-03
4th	$^{233/234}$U	9.32E-04	7.18E-04	1.29E-03

Qtr.	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st	^{238}U	2.96E-04	7.14E-04	1.46E-03
2nd	^{238}U	6.96E-04	7.92E-04	1.42E-03
3rd	^{238}U	9.95E-04	7.47E-04	1.38E-03
4th	^{238}U	1.08E-03	7.51E-04	1.25E-03

Qtr.	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st	^{137}Cs	6.62E-03	4.92E-02	8.99E-02
2nd	^{137}Cs	1.76E-02	7.22E-02	1.24E-01
3rd	^{137}Cs	1.69E-02	7.22E-02	1.32E-01
4th	^{137}Cs	-6.66E-02	6.51E-02	1.10E-01

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

Table G.3 – Station H Sample Results

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	^{241}Am	7.01E-02	1.27E-02	1.40E-03
2nd 6 Mon	^{241}Am	3.04E-02	5.47E-03	1.06E-03

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	^{238} Pu	4.78E-02	8.64E-03	1.06E-03
2nd 6 Mon	^{239} Pu	9.05E-03	2.85E-03	1.04E-03

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	$^{239/240}$Pu	1.06E-02	2.99E-03	1.01E-03
2nd 6 Mon	$^{239/240}$Pu	4.25E-03	1.82E-03	8.74E-04

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	^{90}Sr	-8.18E-03	2.55E-02	2.65E-02
2nd 6 Mon	^{90}Sr	-1.64E-02	3.89E-02	2.61E-02

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	$^{233/234}$U	7.01E-03	2.34E-03	1.84E-03
2nd 6 Mon	$^{233/234}$U	3.64E-03	2.11E-03	2.09E-03

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	^{238}U	2.53E-03	1.36E-03	1.64E-03
2nd 6 Mon	^{238}U	1.71E-03	1.47E-03	2.16E-03

Period	Nuclide	Activity (Bq/Sample)	2σTPU[a]	MDC[b]
1st 6 Mon	^{137}Cs	-4.05E-02	8.13E-02	1.43E-01
2nd 6 Mon	^{137}Cs	-1.09E-02	1.00E-01	1.79E-01

(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)

		$^{233/234}U$				^{235}U				^{238}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]
WFF	1	5.15E-03	3.53E-03	5.54E-03	U	5.26E-04	1.09E-03	1.63E-03	U	1.24E-03	3.92E-03	5.77E-03	U
	2	4.09E-03	4.46E-03	5.54E-03	U	8.83E-04	1.18E-03	1.69E-03	U	2.92E-03	4.74E-03	6.03E-03	U
	3 [f]	3.80E-03	4.80E-03	5.51E-03	U	3.80E-03	4.80E-03	5.51E-03	U	3.61E-03	5.19E-03	6.22E-03	U
	4	5.36E-03	3.99E-03	5.39E-03	U	1.20E-03	1.14E-03	1.71E-03	U	4.25E-03	3.86E-03	5.97E-03	U
WEE	1	5.17E-03	3.61E-03	5.56E-03	U	1.40E-03	1.36E-03	1.69E-03	U	3.77E-03	4.18E-03	5.80E-03	U
	2	1.46E-03	3.99E-03	5.46E-03	U	1.17E-03	1.16E-03	1.59E-03	U	-2.30E-03	4.16E-03	5.94E-03	U
	3	2.04E-03	4.51E-03	5.46E-03	U	-1.02E-03	1.30E-03	1.72E-03	U	7.25E-04	4.84E-03	6.17E-03	U
	4	3.37E-03	3.82E-03	5.39E-03	U	4.50E-04	9.24E-04	1.72E-03	U	3.82E-03	3.81E-03	5.97E-03	U
WSS	1	9.88E-03	4.26E-03	5.59E-03	=	3.87E-04	1.12E-03	1.72E-03	U	7.33E-03	4.65E-03	5.84E-03	=
	2	4.17E-03	4.14E-03	5.46E-03	U	9.83E-04	1.11E-03	1.58E-03	U	2.86E-03	4.40E-03	5.94E-03	U
	3	9.80E-03	5.14E-03	5.48E-03	=	-5.30E-04	1.45E-03	1.77E-03	U	7.48E-03	5.33E-03	6.20E-03	=
	4 [f]	5.79E-03	4.15E-03	5.43E-03	=	7.43E+03	8.97E-08	1.43E-07	U	6.19E-03	4.15E-03	6.01E-03	=
MLR	1	8.67E-03	3.82E-03	5.53E-03	=	-9.11E-05	9.20E-04	1.63E-03	U	1.79E-03	3.94E-03	5.78E-03	U
	2 [f]	5.74E-04	3.94E-03	5.46E-03	U	1.86E-04	8.88E-04	1.57E-03	U	-7.71E-04	4.23E-03	5.95E-03	U
	3	5.18E-03	4.81E-03	5.50E-03	U	-3.10E-04	1.49E-03	1.79E-03	U	9.32E-04	4.93E-03	6.21E-03	U
	4	8.31E-03	4.34E-03	5.40E-03	=	-1.27E-04	7.17E-04	1.73E-03	U	8.22E-03	4.30E-03	5.99E-03	=
SEC	1 [f]	8.20E-03	3.87E-03	5.55E-03	=	7.26E-04	1.17E-03	1.68E-03	U	4.52E-03	4.22E-03	5.79E-03	U
	2	7.28E-03	4.60E-03	5.51E-03	=	5.85E-04	1.06E-03	1.64E-03	U	3.11E-03	4.63E-03	5.99E-03	U
	3	3.12E-03	4.82E-03	5.53E-03	U	-7.70E-04	1.42E-03	1.83E-03	U	4.14E-03	5.31E-03	6.25E-03	U
	4	1.03E-02	4.58E-03	5.41E-03	=	-1.40E-04	7.37E-04	1.75E-03	U	4.63E-03	4.01E-03	6.00E-03	U
CBD	1	7.66E-03	3.83E-03	5.55E-03	=	5.52E-04	1.12E-03	1.67E-03	U	4.94E-03	4.25E-03	5.79E-03	U

		$^{233/234}$U				^{235}U				^{238}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]
	2	9.27E-03	4.91E-03	5.53E-03	=	4.96E-04	1.06E-03	1.68E-03	U	4.94E-03	4.25E-03	5.79E-03	U
	3	1.30E-02	8.29E-03	5.97E-03	=	-1.34E-05	1.95E-03	2.41E-03	U	6.94E-03	7.63E-03	6.70E-03	U
	4	2.94E-03	3.91E-03	5.41E-03	U	8.37E-04	1.08E-03	1.75E-03	U	1.07E-03	3.73E-03	6.00E-03	U
SMR	1	1.21E-02	4.92E-03	5.68E-03	=	3.37E-04	1.17E-03	1.84E-03	U	1.09E-02	5.40E-03	5.91E-03	=
	2	3.17E-03	4.11E-03	5.46E-03	U	9.22E-04	1.09E-03	1.57E-03	U	-1.68E-03	4.20E-03	5.95E-03	U
	3	8.68E-03	5.56E-03	5.60E-03	=	-9.10E-05	1.68E-03	2.01E-03	U	3.97E-03	5.53E-03	6.31E-03	U
	4	2.74E-03	4.00E-03	5.45E-03	U	8.01E-04	1.09E-03	1.78E-03	U	1.24E-03	3.84E-03	6.04E-03	U
Mean		6.12E-03	4.45E-03	5.51E-03	NA	2.65E+02	1.26E-03	1.81E-03	NA	3.60E-03	4.56E-03	6.01E-03	NA
Minimum[e]		5.74E-04	3.94E-03	5.46E-03	MLR (3)	-1.02E-03	1.30E-03	1.72E-03	WEE (3)	-2.30E-03	4.84E-03	6.17E-03	WEE (3)
Maximum[e]		1.30E-02	8.29E-03	5.97E-03	CBD (3)	7.43E+03	8.97E-08	1.43E-07	WSS (4)	1.09E-02	5.40E-03	5.91E-03	SMR (1)
WAB	1	7.47E-03	2.28E-03	5.58E-03	=	6.37E-04	6.72E-04	1.66E-03	U	1.06E-02	2.84E-03	5.82E-03	=
(Filter	2	1.11E-02	2.95E-03	5.54E-03	=	4.81E-04	6.27E-04	1.69E-03	U	1.27E-02	3.23E-03	6.02E-03	=
Blank)	3	1.12E-02	3.38E-03	5.59E-03	=	1.46E-03	1.15E-03	1.91E-03	U	1.29E-02	3.71E-03	6.30E-03	=
	4	1.00E-02	2.57E-03	5.40E-03	=	4.20E-04	5.56E-04	1.73E-03	U	9.87E-03	2.54E-03	5.98E-03	=

		^{238}Pu				$^{239/240}$PU				^{241}Am			
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]
WFF	1	-3.17E-04	3.71E-04	7.54E-04	U	-4.01E-04	6.23E-04	8.87E-04	U	-5.70E-04	6.23E-04	1.09E-03	U
	2	-1.05E-04	1.98E-04	7.36E-04	U	9.64E-05	4.61E-04	8.36E-04	U	3.42E-04	6.03E-04	1.10E-03	U
	3 [f]	1.11E-04	3.75E-04	7.74E-04	U	1.00E-04	4.10E-04	8.50E-04	U	8.39E-05	5.56E-04	1.20E-03	U
	4	-1.95E-04	2.93E-04	8.11E-04	U	-2.46E-05	3.62E-04	8.73E-04	U	1.42E-04	6.25E-04	1.00E-03	U
WEE	1	-3.79E-04	6.14E-04	8.74E-04	U	1.75E-05	6.66E-04	9.15E-04	U	-4.54E-04	6.67E-04	1.04E-03	U
	2	7.00E-05	4.33E-04	7.81E-04	U	1.99E-05	3.72E-04	8.04E-04	U	4.14E-04	6.77E-04	1.13E-03	U
	3	2.43E-04	4.54E-04	7.55E-04	U	3.56E-05	4.29E-04	8.64E-04	U	-3.73E-07	4.14E-04	1.04E-03	U
	4	-1.49E-04	2.13E-04	7.30E-04	U	-3.41E-07	3.36E-04	8.70E-04	U	-2.44E-04	5.38E-04	1.05E-03	U
WSS	1	-4.01E-04	6.54E-04	9.38E-04	U	-4.22E-04	6.51E-04	1.08E-03	U	-3.09E-04	7.33E-04	1.11E-03	U

		^{238}Pu				$^{239/240}$PU				^{241}Am			
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]
	2	-1.22E-04	2.33E-04	8.10E-04	U	-1.45E-04	3.64E-04	8.90E-04	U	2.16E-04	4.30E-04	1.06E-03	U
	3	1.04E-04	4.10E-04	7.63E-04	U	1.50E-04	4.84E-04	9.13E-04	U	1.82E-04	5.53E-04	1.07E-03	U
	4 [f]	-1.01E-04	3.72E-04	7.70E-04	U	1.61E-07	3.06E-04	8.13E-04	U	-8.88E-05	5.41E-04	9.98E-04	U
MLR	1	-3.45E-04	5.42E-04	7.25E-04	U	-2.10E-04	7.71E-04	8.49E-04	U	-5.94E-04	6.41E-04	1.13E-03	U
	2 [f]	-1.16E-04	3.64E-04	8.80E-04	U	-1.07E-05	4.49E-04	9.13E-04	U	-7.86E-05	3.90E-04	1.08E-03	U
	3	-1.36E-04	2.67E-04	8.11E-04	U	-8.41E-05	3.78E-04	8.92E-04	U	1.23E-04	4.77E-04	1.05E-03	U
	4	-2.08E-04	3.10E-04	8.10E-04	U	-1.44E-04	2.81E-04	8.48E-04	U	-2.01E-04	5.06E-04	1.01E-03	U
SEC	1 [f]	-3.13E-04	6.26E-04	8.23E-04	U	-3.27E-04	6.10E-04	9.47E-04	U	-4.51E-04	7.65E-04	1.13E-03	U
	2	-1.01E-04	1.89E-04	7.62E-04	U	1.34E-04	4.65E-04	8.43E-04	U	5.42E-05	4.34E-04	1.04E-03	U
	3	2.38E-04	5.56E-04	8.81E-04	U	6.20E-05	4.73E-04	1.00E-03	U	4.25E-06	4.59E-04	1.15E-03	U
	4	-1.37E-04	1.87E-04	7.52E-04	U	7.77E-06	3.26E-04	8.42E-04	U	2.74E-04	6.89E-04	1.02E-03	U
CBD	1	-2.03E-04	4.73E-04	7.54E-04	U	-3.77E-04	5.49E-04	8.86E-04	U	-4.38E-04	6.54E-04	1.03E-03	U
	2	2.45E-04	6.66E-04	1.12E-03	U	1.35E-04	5.99E-04	1.12E-03	U	-7.09E-05	4.07E-04	1.15E-03	U
	3	-1.98E-04	3.74E-04	1.11E-03	U	-2.16E-04	3.22E-04	1.13E-03	U	2.01E-04	5.83E-04	1.07E-03	U
	4	-1.56E-04	2.26E-04	7.52E-04	U	1.91E-04	4.65E-04	9.03E-04	U	-3.49E-04	4.86E-04	1.08E-03	U
SMR	1	-2.36E-04	5.96E-04	8.29E-04	U	8.22E-05	7.61E-04	8.76E-04	U	-3.89E-04	7.27E-04	1.05E-03	U
	2	2.61E-04	5.08E-04	8.11E-04	U	1.41E-04	4.88E-04	8.83E-04	U	3.98E-05	4.68E-04	1.12E-03	U
	3	-1.43E-04	2.80E-04	8.45E-04	U	-8.28E-05	3.89E-04	9.45E-04	U	-1.17E-04	3.57E-04	1.13E-03	U
	4	-1.60E-04	2.34E-04	7.77E-04	U	1.31E-04	4.21E-04	8.72E-04	U	-2.06E-04	5.07E-04	1.00E-03	U
Mean		-1.05E-04	3.94E-04	8.19E-04	NA	-4.07E-05	4.72E-04	9.05E-04	NA	-8.88E-05	5.54E-04	1.08E-03	NA
Minimum[e]		-4.01E-04	6.54E-04	9.38E-04	WSS (1)	-4.22E-04	6.51E-04	1.08E-03	WSS (1)	-5.94E-04	6.41E-04	1.13E-03	MLR (1)
Maximum[e]		2.61E-04	5.08E-04	8.11E-04	SMR (2)	1.91E-04	4.65E-04	9.03E-04	CBD (4)	4.14E-04	6.77E-04	1.13E-03	WEE (2)
WAB	1	-2.84E-04	6.19E-04	2.15E-03	U	-3.05E-04	6.41E-04	2.15E-03	U	5.18E-04	6.19E-04	1.15E-03	U
(Filter	2	-6.02E-05	1.62E-04	7.29E-04	U	4.86E-05	2.75E-04	8.25E-04	U	-9.18E-05	2.15E-04	1.12E-03	U
Blank)	3	-6.28E-05	1.74E-04	7.89E-04	U	-1.17E-04	2.37E-04	9.36E-04	U	4.53E-05	3.09E-04	1.08E-03	U
	4	-9.70E-05	2.05E-04	7.88E-04	U	-5.21E-05	1.50E-04	8.21E-04	U	2.71E-04	4.45E-04	1.08E-03	U

		^{40}K				^{60}Co				^{137}Cs			
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]
WFF	1	2.79E+00	2.29E+00	5.01E+00	U	-1.80E-02	2.34E-01	4.11E-01	U	4.83E-02	1.30E-01	2.66E-01	U
	2	-1.13E+00	2.08E+00	3.51E+00	U	-1.22E-01	1.67E-01	2.89E-01	U	-1.30E-01	1.27E-01	2.12E-01	U
	3 [f]	2.28E+00	1.78E+00	3.89E+00	U	-2.89E-02	1.52E-01	2.71E-01	U	-5.42E-02	1.32E-01	2.38E-01	U
	4	1.12E+00	1.98E+00	4.14E+00	U	1.19E-01	1.71E-01	3.16E-01	U	8.74E-02	1.39E-01	2.81E-01	U
WEE	1	1.96E+00	1.45E+00	3.12E+00	U	-8.13E-02	1.55E-01	2.21E-01	U	3.95E-02	1.36E-01	2.57E-01	U
	2	4.00E+00	1.70E+00	3.82E+00	=	-1.13E-01	1.60E-01	2.51E-01	U	-4.02E-02	1.20E-01	2.15E-01	U
	3	2.12E+00	1.86E+00	3.01E+00	U	-3.34E-02	8.72E-02	1.64E-01	U	-1.07E-01	1.34E-01	2.10E-01	U
	4	3.35E+00	1.57E+00	3.49E+00	U	-4.05E-02	1.21E-01	2.26E-01	U	-4.60E-02	1.45E-01	2.49E-01	U
WSS	1	3.53E+00	1.84E+00	3.92E+00	U	-7.05E-02	1.33E-01	2.33E-01	U	-2.68E-02	1.25E-01	2.14E-01	U
	2	2.03E+00	1.47E+00	2.23E+00	U	7.75E-02	1.38E-01	2.53E-01	U	-4.94E-02	1.45E-01	2.47E-01	U
	3	3.60E+00	1.54E+00	3.46E+00	=	-9.09E-02	1.14E-01	1.90E-01	U	-3.72E-02	1.28E-01	2.16E-01	U
	4 [f]	2.02E+00	1.45E+00	3.03E+00	U	5.05E-02	1.30E-01	2.41E-01	U	-6.35E-03	1.42E-01	2.44E-01	U
MLR	1	3.20E+00	1.72E+00	3.72E+00	U	-3.63E-02	1.17E-01	2.21E-01	U	-4.85E-02	9.99E-02	1.80E-01	U
	2 [f]	2.35E+00	1.66E+00	2.98E+00	U	-4.15E-02	1.33E-01	2.26E-01	U	-2.41E-02	1.29E-01	2.31E-01	U
	3	1.92E+00	1.33E+00	2.94E+00	U	-1.22E-02	1.29E-01	2.15E-01	U	5.03E-02	1.12E-01	2.22E-01	U
	4	-1.06E+00	1.83E+00	2.82E+00	U	-1.19E-01	1.30E-01	2.20E-01	U	3.80E-02	1.18E-01	2.25E-01	U
SEC	1[f]	2.60E+00	1.68E+00	3.55E+00	U	-4.81E-02	1.55E-01	2.53E-01	U	2.79E-02	1.37E-01	2.46E-01	U
	2	4.09E+00	1.62E+00	3.72E+00	=	-1.23E-01	1.33E-01	2.17E-01	U	2.95E-02	1.43E-02	2.63E-01	U
	3	3.19E+00	1.71E+00	3.69E+00	U	2.98E-02	1.32E-01	2.56E-01	U	-4.49E-02	1.40E-01	2.52E-01	U
	4	3.19E+00	1.71E+00	3.71E+00	U	-1.42E-01	1.48E-01	2.22E-01	U	9.45E-02	1.45E-01	2.72E-01	U
CBD	1	2.18E+00	2.18E+00	3.50E+00	U	-8.62E-02	1.84E-01	3.26E-01	U	9.94E-03	1.45E-01	2.77E-01	U
	2	1.00E+00	1.62E+00	3.21E+00	U	2.34E-01	1.37E-01	2.65E-01	U	-7.77E-02	1.04E-01	1.80E-01	U
	3	3.13E+00	1.71E+00	3.67E+00	U	-4.64E-02	1.55E-01	2.37E-01	U	1.53E-02	1.57E-01	2.75E-01	U
	4	8.65E-01	2.16E+00	4.33E+00	U	0.00E+00	1.55E-01	2.68E-01	U	-1.96E-02	1.38E-01	2.58E-01	U
SMR	1	2.55E+00	1.38E+00	3.08E+00	U	-7.97E-02	1.33E-01	2.33E-01	U	6.07E-02	1.09E-01	2.14E-01	U
	2	1.42E+00	2.07E+00	4.33E+00	U	-5.25E-02	2.08E-01	3.82E-01	U	5.79E-02	1.47E-01	2.93E-01	U
	3	2.06E+00	1.47E+00	3.06E+00	U	8.98E-02	1.19E-01	2.28E-01	U	3.78E-02	1.22E-01	2.23E-01	U
	4	2.87E+00	1.39E+00	3.13E+00	U	5.39E-02	9.96E-02	2.17E-01	U	-1.74E-02	1.30E-01	2.22E-01	U

		^{40}K				^{60}Co				^{137}Cs			
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]**
Mean		2.26E+00	1.72E+00	3.50E+00	NA	-2.61E-02	1.44E-01	2.52E-01	NA	-4.73E-03	1.27E-01	2.39E-01	NA
Minimum[e]		-1.13E+00	2.08E+00	3.51E+00	WFF (2)	-1.42E-01	1.48E-01	2.22E-01	SEC (4)	-1.30E-01	1.27E-01	2.12E-01	WFF (2)
Maximum[e]		4.09E+00	1.62E+00	3.72E+00	SEC (2)	2.34E-01	1.37E-01	2.65E-01	CBD (2)	9.45E-02	1.45E-01	2.72E-01	SEC (4)
WAB	1	4.09E+00	1.66E+00	3.75E+00	=	-1.28E-02	1.23E-01	2.36E-01	U	-1.78E-02	1.10E-01	2.05E-01	U
(Filter	2	2.69E+00	1.60E+02	3.47E+00	U	1.09E-01	1.69E-01	1.89E-01	U	2.07E-02	1.56E-01	2.69E-01	U
Blank)	3	2.15E+00	1.70E+00	3.54E+00	U	9.87E-02	1.43E-01	2.44E-01	U	-4.38E-02	1.49E-01	2.57E-01	U
	4	1.26E+00	1.38E+00	2.90E+00	U	-4.63E-02	1.59E-01	2.41E-01	U	1.33E-01	1.36E-01	2.66E-01	U

		^{90}Sr			
Location	**Quarter**	**[RN][a]**	**2 σ TPU[b]**	**MDC[c]**	**Q[d]**
WFF	1	2.40E-02	1.96E-02	3.01E-02	U
	2	9.15E-03	2.43E-02	2.99E-02	U
	3 [f]	-1.19E-02	2.11E-02	3.13E-02	U
	4	-8.00E-05	1.67E-02	3.10E-02	U
WEE	1	-3.37E-03	1.85E-02	3.00E-02	U
	2	1.70E-02	2.10E-02	2.94E-02	U
	3	-1.97E-02	2.02E-02	3.13E-02	U
	4	-7.59E-03	1.59E-02	3.10E-02	U
WSS	1	3.01E-03	1.91E-02	3.01E-02	U
	2	-6.12E-03	1.96E-02	2.94E-02	U
	3	7.63E-03	2.27E-02	3.14E-02	U
	4 [f]	3.61E-03	1.69E-02	3.10E-02	U
MLR	1	-6.70E-03	1.84E-02	3.00E-02	U
	2[f]	9.28E-03	2.11E-02	2.96E-02	U
	3	-9.36E-03	2.06E-02	3.12E-02	U
	4	2.48E-03	1.67E-02	3.10E-02	U
SEC	1[f]	-8.48E-03	1.83E-02	3.00E-02	U
	2	3.93E-03	2.29E-02	2.89E-02	U

		^{90}Sr			
Location	Quarter	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
	3	8.21E-03	2.19E-02	3.14E-02	U
	4	-6.91E-03	1.69E-02	3.11E-02	U
CBD	1	-1.48E-02	1.81E-02	3.00E-02	U
	2	2.09E-02	2.23E-02	2.97E-02	U
	3	-6.65E-03	2.03E-02	3.14E-02	U
	4	3.52E-03	1.71E-02	3.11E-02	U
SMR	1	-4.86E-03	1.90E-02	3.01E-02	U
	2	5.12E-03	2.12E-02	2.96E-02	U
	3	-1.60E-04	2.07E-02	3.14E-02	U
	4	4.32E-03	1.72E-02	3.11E-02	U
Mean		5.55E-04	1.96E-02	3.05E-02	NA
Minimum[e]		-1.97E-02	2.02E-02	3.13E-02	WEE (3)
Maximum[e]		2.40E-02	1.96E-02	3.01E-02	WFF (1)
WAB	1	1.08E-02	1.34E-02	3.01E-02	U
(Filter	2	3.45E-03	1.46E-02	2.95E-02	U
Blank)	3	-1.30E-02	1.53E-02	3.15E-02	U
	4	4.99E-03	1.23E-02	3.12E-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. Samples 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. Equal sign (=) denotes detected. U denotes undetected.
(e) Minimum and maximum reported concentrations for each radionuclide are based on the sample's activity, [RN]
(f) Average of primary and duplicate samples

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	7370.58	5.15E-03	6.98E-07	5.26E-04	7.14E-08	1.24E-03	1.68E-07	-3.17E-04	-4.30E-08	-4.01E-04	-5.44E-08	-5.70E-04	-7.74E-08
	2	7231.36	4.09E-03	5.66E-07	8.83E-04	1.22E-07	2.92E-03	4.03E-07	-1.05E-04	-1.45E-08	9.64E-05	1.33E-08	3.42E-04	4.73E-08
	3[(a)]	7495.50	3.80E-03	5.07E-07	3.80E-03	5.07E-07	3.61E-03	4.81E-07	1.11E-04	1.49E-08	1.00E-04	1.33E-08	8.39E-05	1.12E-08
	4	7421.60	5.36E-03	7.22E-07	1.20E-03	1.61E-07	4.25E-03	5.72E-07	-1.95E-04	-2.63E-08	-2.46E-05	-3.31E-09	1.42E-04	1.91E-08
WEE	1	5051.59	5.17E-03	1.02E-06	1.40E-03	2.78E-07	3.77E-03	7.47E-07	-3.79E-04	-7.50E-08	1.75E-05	3.47E-09	-4.54E-04	-8.98E-08
	2	5055.02	1.46E-03	2.89E-07	1.17E-03	2.31E-07	-2.30E-03	-4.54E-07	7.00E-05	1.39E-08	1.99E-05	3.94E-09	4.14E-04	8.20E-08
	3	5188.88	2.04E-03	3.94E-07	-1.02E-03	-1.97E-07	7.25E-04	1.40E-07	2.43E-04	4.68E-08	3.56E-05	6.86E-09	-3.73E-07	-7.18E-11
	4	5684.01	3.37E-03	5.92E-07	4.50E-04	7.91E-08	3.82E-03	6.72E-07	-1.49E-04	-2.62E-08	-3.41E-07	-6.00E-11	-2.44E-04	-4.30E-08
WSS	1	7333.10	9.88E-03	1.35E-06	3.87E-04	5.27E-08	7.33E-03	1.00E-06	-4.01E-04	-5.47E-08	-4.22E-04	-5.75E-08	-3.09E-04	-4.22E-08
	2	7064.08	4.17E-03	5.90E-07	9.83E-04	1.39E-07	2.86E-03	4.05E-07	-1.22E-04	-1.73E-08	-1.45E-04	-2.06E-08	2.16E-04	3.06E-08
	3	7446.74	9.80E-03	1.32E-06	-5.30E-04	-7.12E-08	7.48E-03	1.00E-06	1.04E-04	1.40E-08	1.50E-04	2.02E-08	1.82E-04	2.44E-08
	4[(a)]	7378.24	5.79E-03	7.85E-07	7.43E+03	1.01E+00	6.19E-03	8.39E-07	-1.01E-04	-1.38E-08	1.61E-07	2.18E-11	-8.88E-05	-1.20E-08
MLR	1	7332.15	8.67E-03	1.18E-06	-9.11E-05	-1.24E-08	1.79E-03	2.45E-07	-3.45E-04	-4.71E-08	-2.10E-04	-2.86E-08	-5.94E-04	-8.10E-08
	2 [(a)]	7275.03	5.74E-04	7.90E-08	1.86E-04	2.56E-08	-7.71E-04	-1.06E-07	-1.16E-04	-1.60E-08	-1.07E-05	-1.47E-09	-7.86E-05	-1.08E-08
	3	7395.00	5.18E-03	7.00E-07	-3.10E-04	-4.20E-08	9.32E-04	1.26E-07	-1.36E-04	-1.84E-08	-8.41E-05	-1.14E-08	1.23E-04	1.66E-08
	4	7360.36	8.31E-03	1.13E-06	-1.27E-04	-1.73E-08	8.22E-03	1.12E-06	-2.08E-04	-2.83E-08	-1.44E-04	-1.95E-08	-2.01E-04	-2.74E-08
SEC	1[(a)]	7099.82	8.20E-03	1.15E-06	7.26E-04	1.02E-07	4.52E-03	6.37E-07	-3.13E-04	-4.41E-08	-3.27E-04	-4.60E-08	-4.51E-04	-6.35E-08
	2	7382.23	7.28E-03	9.87E-07	5.85E-04	7.92E-08	3.11E-03	4.21E-07	-1.01E-04	-1.37E-08	1.34E-04	1.82E-08	5.42E-05	7.35E-09
	3	7363.72	3.12E-03	4.24E-07	-7.70E-04	-1.05E-07	4.14E-03	5.63E-07	2.38E-04	3.23E-08	6.20E-05	8.41E-09	4.25E-06	5.78E-10
	4	7390.88	1.03E-02	1.40E-06	-1.40E-04	-1.89E-08	4.63E-03	6.26E-07	-1.37E-04	-1.85E-08	7.77E-06	1.05E-09	2.74E-04	3.70E-08
CBD	1	7368.82	7.66E-03	1.04E-06	5.52E-04	7.49E-08	4.94E-03	6.70E-07	-2.03E-04	-2.76E-08	-3.77E-04	-5.12E-08	-4.38E-04	-5.94E-08
	2	7390.39	9.27E-03	1.25E-06	4.96E-04	6.71E-08	4.94E-03	6.68E-07	2.45E-04	3.31E-08	1.35E-04	1.82E-08	-7.09E-05	-9.59E-09
	3	7484.45	1.30E-02	1.73E-06	-1.34E-05	-1.80E-09	6.94E-03	9.27E-07	-1.98E-04	-2.65E-08	-2.16E-04	-2.89E-08	2.01E-04	2.69E-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**
	4	7435.56	2.94E-03	3.96E-07	8.37E-04	1.13E-07	1.07E-03	1.44E-07	-1.56E-04	-2.10E-08	1.91E-04	2.56E-08	-3.49E-04	-4.69E-08
SMR	1	7143.35	1.21E-02	1.70E-06	3.37E-04	4.72E-08	1.09E-02	1.52E-06	-2.36E-04	-3.30E-08	8.22E-05	1.15E-08	-3.89E-04	-5.44E-08
	2	7421.01	3.17E-03	4.28E-07	9.22E-04	1.24E-07	-1.68E-03	-2.27E-07	2.61E-04	3.51E-08	1.41E-04	1.90E-08	3.98E-05	5.36E-09
	3	6968.83	8.68E-03	1.25E-06	-9.10E-05	-1.31E-08	3.97E-03	5.70E-07	-1.43E-04	-2.06E-08	-8.28E-05	-1.19E-08	-1.17E-04	-1.68E-08
	4	698.26	2.74E-03	3.92E-06	8.01E-04	1.15E-06	1.24E-03	1.77E-06	-1.60E-04	-2.28E-07	1.31E-04	1.87E-07	-2.06E-04	-2.95E-07
Mean		6793.95	6.12E-03	9.85E-07	2.65E+02	3.60E-02	3.60E-03	5.59E-07	-1.05E-04	-2.23E-08	-4.07E-05	5.62E-10	-8.88E-05	-2.22E-08
Minimum		698.26	5.74E-04	7.90E-08	-1.02E-03	-1.97E-07	-2.30E-03	-4.54E-07	-4.01E-04	-2.28E-07	-4.22E-04	-5.75E-08	-5.94E-04	-2.95E-07
Maximum		7495.50	1.30E-02	3.92E-06	7.43E+03	1.01E+00	1.09E-02	1.77E-06	2.61E-04	4.68E-08	1.91E-04	1.87E-07	4.14E-04	8.20E-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	7370.58	2.79E+00	3.79E-04	-1.80E-02	-2.44E-06	4.83E-02	6.55E-06	2.40E-02	3.25E-06
	2	7231.36	-1.13E+00	-1.56E-04	-1.22E-01	-1.69E-05	-1.30E-01	-1.80E-05	9.15E-03	1.27E-06
	3[(a)]	7495.50	2.28E+00	3.04E-04	-2.89E-02	-3.85E-06	-5.42E-02	-7.23E-06	-1.19E-02	-1.59E-06
	4	7421.60	1.12E+00	1.51E-04	1.19E-01	1.60E-05	8.74E-02	1.18E-05	-8.00E-05	-1.08E-08
WEE	1	5051.59	1.96E+00	3.88E-04	-8.13E-02	-1.61E-05	3.95E-02	7.82E-06	-3.37E-03	-6.68E-07
	2	5055.02	4.00E+00	7.91E-04	-1.13E-01	-2.24E-05	-4.02E-02	-7.95E-06	1.70E-02	3.37E-06
	3	5188.88	2.12E+00	4.09E-04	-3.34E-02	-6.44E-06	-1.07E-01	-2.06E-05	-1.97E-02	-3.79E-06
	4	5684.01	3.35E+00	5.89E-04	-4.05E-02	-7.13E-06	-4.60E-02	-8.09E-06	-7.59E-03	-1.34E-06
WSS	1	7333.10	3.53E+00	4.81E-04	-7.05E-02	-9.61E-06	-2.68E-02	-3.65E-06	3.01E-03	4.10E-07
	2	7064.08	2.03E+00	2.87E-04	7.75E-02	1.10E-05	-4.94E-02	-6.99E-06	-6.12E-03	-8.66E-07
	3	7446.74	3.60E+00	4.83E-04	-9.09E-02	-1.22E-05	-3.72E-02	-5.00E-06	7.63E-03	1.03E-06
	4[(a)]	7378.24	2.02E+00	2.74E-04	5.05E-02	6.84E-06	-6.35E-03	-8.61E-07	3.61E-03	4.89E-07
MLR	1	7332.15	3.20E+00	4.36E-04	-3.63E-02	-4.95E-06	-4.85E-02	-6.61E-06	-6.70E-03	-9.14E-07
	2 [(a)]	7275.03	2.35E+00	3.23E-04	-4.15E-02	-5.70E-06	-2.41E-02	-3.31E-06	9.28E-03	1.28E-06
	3	7395.00	1.92E+00	2.60E-04	-1.22E-02	-1.65E-06	5.03E-02	6.80E-06	-9.36E-03	-1.27E-06
	4	7360.36	-1.06E+00	-1.44E-04	-1.19E-01	-1.62E-05	3.80E-02	5.16E-06	2.48E-03	3.37E-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[(a)]	7099.82	2.60E+00	3.66E-04	-4.81E-02	-6.77E-06	2.79E-02	3.93E-06	-8.48E-03	-1.19E-06
	2	7382.23	4.09E+00	5.54E-04	-1.23E-01	-1.67E-05	2.95E-02	4.00E-06	3.93E-03	5.32E-07
	3	7363.72	3.19E+00	4.33E-04	2.98E-02	4.05E-06	-4.49E-02	-6.10E-06	8.21E-03	1.12E-06
	4	7390.88	3.19E+00	4.32E-04	-1.42E-01	-1.92E-05	9.45E-02	1.28E-05	-6.91E-03	-9.35E-07
CBD	1	7368.82	2.18E+00	2.96E-04	-8.62E-02	-1.17E-05	9.94E-03	1.35E-06	-1.48E-02	-2.01E-06
	2	7390.39	1.00E+00	1.35E-04	2.34E-01	3.17E-05	-7.77E-02	-1.05E-05	2.09E-02	2.83E-06
	3	7484.45	3.13E+00	4.18E-04	-4.64E-02	-6.20E-06	1.53E-02	2.04E-06	-6.65E-03	-8.89E-07
	4	7435.56	8.65E-01	1.16E-04	0.00E+00	0.00E+00	-1.96E-02	-2.64E-06	3.52E-03	4.74E-07
SMR	1	7143.35	2.55E+00	3.57E-04	-7.97E-02	-1.12E-05	6.07E-02	8.50E-06	-4.86E-03	-6.80E-07
	2	7421.01	1.42E+00	1.91E-04	-5.25E-02	-7.07E-06	5.79E-02	7.80E-06	5.12E-03	6.90E-07
	3	6968.83	2.06E+00	2.96E-04	8.98E-02	1.29E-05	3.78E-02	5.42E-06	-1.60E-04	-2.29E-08
	4	698.26	2.87E+00	4.11E-03	5.39E-02	7.72E-05	-1.74E-02	-2.49E-05	4.32E-03	6.18E-06
Mean		6793.95	2.26E+00	4.63E-04	-2.61E-02	-1.59E-06	-4.73E-03	-1.73E-06	5.55E-04	2.53E-07
Minimum		698.26	-1.13E+00	-1.56E-04	-1.42E-01	-2.24E-05	-1.30E-01	-2.49E-05	-1.97E-02	-3.79E-06
Maximum		7495.50	4.09E+00	4.11E-03	2.34E-01	7.72E-05	9.45E-02	1.28E-05	2.40E-02	6.18E-06

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

(a) Average of primary and duplicate samples

Table G.6 – Round 45 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				^{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]
WQSP-1	45	3/15/2023	1.72E+00	4.50E-01	1.79E-03	=	1.76E-02	6.48E-03	1.43E-03	=	2.90E-01	7.75E-02	1.58E-03	=
WQSP-2	45	3/15/2023	1.59E+00	3.60E-01	1.72E-03	=	1.87E-02	6.22E-03	1.25E-03	=	2.39E-01	5.59E-02	1.48E-03	=
WQSP-3	45	4/12/2023	1.44E-01	2.03E-02	1.26E-03	=	3.89E-03	1.65E-03	8.61E-04	=	2.31E-02	4.50E-03	1.11E-03	=
WQSP-4	45	10/12/2023	4.48E-01	6.28E-02	1.28E-03	=	6.61E-03	2.15E-03	7.58E-04	=	7.44E-02	1.17E-02	1.35E-03	=
WQSP-5	45	4/25/2023	5.15E-01	7.40E-02	1.17E-03	=	2.00E-02	4.54E-03	8.17E-04	=	7.49E-02	1.22E-02	1.11E-03	=
WQSP-6	45	8/3/2023	5.32E-01	8.60E-02	1.43E-03	=	8.36E-03	2.85E-03	9.45E-04	=	6.72E-02	1.24E-02	1.33E-03	=
Location	Round	Sample 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,e]
WQSP-1	45	3/15/2023	1.61E-04	3.75E-04	6.72E-04	U	1.73E-04	3.68E-04	6.75E-04	U	3.28E-04	4.42E-04	6.82E-04	UJ
WQSP-2	45	3/15/2023	-4.38E-05	1.49E-04	6.85E-04	U	-4.82E-05	1.56E-04	6.99E-04	U	-6.81E-05	1.96E-04	8.55E-04	UJ
WQSP-3	45	4/12/2023	1.01E-04	3.17E-04	6.75E-04	U	-9.81E-05	2.32E-04	8.20E-04	U	1.36E-04	4.44E-04	9.14E-04	U
WQSP-4	45	10/12/2023	5.08E-05	3.03E-04	6.97E-04	U	-8.87E-05	2.05E-04	7.35E-04	U	1.25E-04	4.43E-04	8.23E-04	U
WQSP-5	45	4/25/2023	9.66E-05	2.98E-04	7.06E-04	U	-1.07E-04	2.36E-04	7.76E-04	U	3.21E-04	4.84E-04	8.08E-04	U
WQSP-6	45	8/3/2023	-5.93E-05	1.92E-04	7.69E-04	U	-1.24E-04	2.78E-04	9.14E-04	U	4.83E-04	5.12E-04	6.69E-04	U

Location	Round	Sample Date	^{40}K				^{60}Co				^{137}Cs			
			[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]
WQSP-1	45	3/15/2023	2.70E+01	1.22E+01	1.74E+01	U	3.09E-01	1.07E+00	1.19E+00	U	-4.82E-01	1.01E+00	1.09E+00	U
WQSP-2	45	3/15/2023	1.37E+01	3.24E+00	4.10E+00	=	-1.78E-02	1.17E-01	2.05E-01	U	3.16E-03	9.69E-02	1.83E-01	U
WQSP-3	45	4/12/2023	4.09E+01	4.63E+00	3.84E+00	=	-2.11E-02	1.25E-01	2.29E-01	U	-3.93E-03	1.07E-01	1.91E-01	U
WQSP-4	45	10/12/2023	3.13E+01	1.07E+01	1.37E+01	=	-3.98E-01	1.48E+00	1.59E+00	U	7.38E-01	1.01E+00	1.44E+00	U
WQSP-5	45	4/25/2023	2.20E+01	1.08E+01	1.57E+01	=	3.84E-01	1.14E+00	1.16E+00	U	3.98E-01	8.33E-01	1.03E+00	U
WQSP-6	45	8/3/2023	1.82E+01	9.66E+00	1.73E+01	=	7.62E-02	1.24E+00	1.48E+00	U	6.63E-01	8.77E-01	1.29E+00	U

Location	Round	Sample Date	^{90}Sr			
			[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
WQSP-1	45	3/15/2023	1.07E-02	1.83E-02	1.46E-02	U
WQSP-2	45	3/15/2023	3.87E-04	1.67E-02	1.45E-02	U
WQSP-3	45	4/12/2023	-7.22E-03	2.48E-02	1.99E-02	U
WQSP-4	45	10/12/2023	1.46E-03	2.44E-02	1.91E-02	U
WQSP-5	45	4/25/2023	-4.44E-03	1.69E-02	1.90E-02	U
WQSP-6	45	8/3/2023	-1.39E-02	2.05E-02	2.05E-02	U

Notes: Units are becquerels per liter (Bq/L).

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted
(b) TPU=Total Propagated Uncertainty.
(c) MDC=Minimum Detectable Concentration.
(d) Qualifier. Indicates whether radionuclide was detected. Equal sign (=) denotes detected; U denotes undetected.
(e) UJ denotes a nuclide that was not detected above the reported MDC and 2 sigma counting uncertainty and a quality deficiency affected the data making the reported data more uncertain.

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]
HIL	4/13/2023	2.23E-02	4.53E-03	1.36E-03	=	2.59E-04	4.93E-04	8.78E-04	U	1.52E-02	3.47E-03	1.24E-03	=
NOY	4/13/2023	1.00E-02	2.65E-03	1.36E-03	=	6.28E-04	6.61E-04	8.50E-04	U	8.40E-03	2.37E-03	1.26E-03	=
TUT	4/13/2023	1.49E-02	3.29E-03	1.31E-03	=	8.86E-04	7.66E-04	8.10E-04	=	1.58E-02	3.43E-03	1.19E-03	=
IDN	5/11/2023	6.73E-03	2.22E-03	1.43E-03	=	4.65E-04	6.51E-04	1.02E-03	U	7.72E-03	2.41E-03	1.29E-03	=
PKT	5/11/2023	4.52E-03	1.64E-03	1.32E-03	=	5.79E-04	6.49E-04	8.32E-04	U	3.62E-03	1.44E-03	1.23E-03	=
LST	5/24/2023	3.40E-02	6.82E-03	1.39E-03	=	1.99E-03	1.24E-03	8.52E-04	=	3.26E-02	6.60E-03	1.31E-03	=
LST Dup	5/24/2023	4.41E-02	1.04E-02	1.54E-03	=	5.00E-03	2.36E-03	1.14E-03	=	3.55E-02	8.66E-03	1.43E-03	=
PCN	5/25/2023	2.43E-01	3.86E-02	1.36E-03	=	1.60E-02	4.10E-03	8.40E-04	=	1.09E-01	1.83E-02	1.28E-03	=
RED	6/13/2023	3.59E-02	7.67E-03	1.46E-03	=	1.73E-03	1.22E-03	9.82E-04	=	2.44E-02	5.65E-03	1.35E-03	=
CBD	6/14/2023	9.59E-02	1.38E-02	1.30E-03	=	2.88E-03	1.34E-03	8.13E-04	=	4.47E-02	7.21E-03	1.15E-03	=
BRA	6/14/2023	1.22E-01	1.67E-02	1.25E-03	=	4.30E-03	1.61E-03	7.61E-04	=	6.42E-02	9.48E-03	1.13E-03	=
COY[g]	6/14/2023	1.29E-01	1.88E-02	1.34E-03	=	3.20E-03	1.45E-03	9.38E-04	=	6.37E-02	1.01E-02	1.15E-03	=
UPR	6/14/2023	2.02E-01	3.38E-02	1.39E-03	=	7.59E-03	2.70E-03	9.89E-04	=	1.49E-01	2.55E-02	1.37E-03	=
COW[e]	6/14/2023	7.10E-04	7.58E-04	1.48E-03	U	-5.31E-05	2.02E-04	9.78E-04	U	7.72E-04	7.30E-04	1.25E-03	U
FWT	6/14/2023	8.24E-02	1.20E-02	1.27E-03	=	1.75E-03	1.06E-03	8.57E-04	=	2.81E-02	5.04E-03	1.15E-03	=
SWL[f]	6/15/2023	2.61E-02	5.12E-03	1.31E-03	=	2.46E-04	4.96E-04	9.66E-04	U	1.21E-02	2.99E-03	1.19E-03	=
BHT	10/4/2023	1.07E-02	2.83E-03	1.41E-03	=	4.16E-04	6.13E-04	8.51E-04	U	6.78E-03	2.13E-03	1.38E-03	=

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

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(b) TPU=Total propagated uncertainty.
(c) MDC= Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected. Equal sign (=) denotes detected; U denotes 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 (BRA).

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]
HIL	4/13/2023	5.27E-05	3.27E-04	6.54E-04	U	1.40E-04	4.41E-04	7.89E-04	U	2.49E-04	4.37E-04	8.70E-04	U
NOY	4/13/2023	-1.14E-04	2.50E-04	7.80E-04	U	2.21E-04	4.34E-04	7.25E-04	U	7.55E-05	3.62E-04	8.57E-04	U
TUT	4/13/2023	-2.20E-05	3.80E-04	7.72E-04	U	3.50E-05	3.39E-04	7.58E-04	U	3.97E-04	5.86E-04	9.11E-04	U
IDN	5/11/2023	-6.91E-05	1.86E-04	7.54E-04	U	-9.89E-05	2.22E-04	8.16E-04	U	-1.45E-04	2.80E-04	9.66E-04	U
PKT	5/11/2023	5.12E-05	3.50E-04	7.70E-04	U	3.39E-04	5.19E-04	7.75E-04	U	-1.25E-04	2.96E-04	1.05E-03	U
LST	5/24/2023	-7.24E-05	2.01E-04	7.17E-04	U	6.74E-05	3.51E-04	7.81E-04	U	9.36E-05	2.99E-04	7.77E-04	U
LST Dup	5/24/2023	-7.34E-05	2.04E-04	7.92E-04	U	7.50E-04	7.63E-04	9.70E-04	U	5.73E-04	5.55E-04	7.21E-04	U
PCN	5/25/2023	-1.63E-04	3.11E-04	1.00E-03	U	4.06E-05	3.93E-04	9.33E-04	U	4.34E-04	5.32E-04	7.47E-04	U
RED	6/13/2023	-8.83E-05	2.20E-04	7.48E-04	U	6.36E-05	3.46E-04	7.71E-04	U	-2.09E-04	4.52E-04	1.40E-03	U
CBD	6/14/2023	-3.07E-05	1.25E-04	6.18E-04	U	-7.00E-05	1.88E-04	7.41E-04	U	5.56E-05	3.15E-04	7.54E-04	U
BRA	6/14/2023	-8.57E-05	2.24E-04	8.21E-04	U	1.66E-04	5.04E-04	9.50E-04	U	4.01E-04	5.47E-04	8.79E-04	U
COY[g]	6/14/2023	-4.29E-05	1.46E-04	6.42E-04	U	-1.28E-04	2.52E-04	7.77E-04	U	2.78E-04	4.49E-04	7.88E-04	U
UPR	6/14/2023	9.52E-05	4.96E-04	9.62E-04	U	6.10E-05	5.20E-04	1.15E-03	U	4.00E-05	3.88E-04	8.30E-04	U
COW[e]	6/14/2023	-1.03E-04	2.27E-04	7.21E-04	U	-8.64E-09	3.57E-04	8.83E-04	U	2.69E-04	4.87E-04	8.26E-04	U
FWT	6/14/2023	-7.14E-05	1.98E-04	6.91E-04	U	-6.17E-05	1.84E-04	8.45E-04	U	9.15E-06	3.74E-04	9.12E-04	U
SWL[f]	6/15/2023	-1.13E-04	2.48E-04	8.94E-04	U	-7.95E-05	2.08E-04	8.01E-04	U	1.82E-04	4.00E-04	7.59E-04	U
BHT	10/4/2023	-8.98E-05	2.16E-04	6.71E-04	U	1.57E-04	4.45E-04	7.88E-04	U	4.28E-04	7.34E-04	1.10E-03	U

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

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(b) TPU= Total propagated uncertainty.
(c) MDC= Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected Equal sign (=) denotes detected; U denotes 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 (BRA).

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]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
HIL	4/13/2023	1.56E+00	1.80E+00	3.00E+00	U	6.72E-02	1.26E-01	2.31E-01	U
NOY	4/13/2023	3.79E+00	1.63E+00	3.69E+00	=	1.61E-02	1.32E-01	2.35E-01	U
TUT	4/13/2023	2.30E+00	1.42E+00	3.09E+00	U	2.53E-02	1.29E-01	2.49E-01	U
IDN	5/11/2023	2.85E+00	1.57E+00	3.46E+00	U	-1.81E-02	1.24E-01	2.28E-01	U
PKT	5/11/2023	7.68E-01	1.85E+00	3.52E+00	U	7.78E-03	2.11E-01	3.89E-01	U
LST	5/24/2023	3.28E+00	1.63E+00	3.56E+00	U	8.03E-02	1.40E-01	1.75E-01	U
LST Dup	5/24/2023	1.40E-01	1.51E-01	3.02E-01	U	-2.48E-03	1.26E-02	2.30E-02	U
PCN	5/25/2023	1.19E+00	1.36E+01	1.58E+00	U	-2.55E-01	1.44E+00	1.54E+00	U
RED	6/13/2023	2.98E+00	1.51E+00	3.35E+00	U	-3.14E-02	1.37E-01	2.39E-01	U
CBD	6/14/2023	2.72E+00	1.66E+00	3.51E+00	U	-2.28E-03	1.15E-01	1.97E-01	U
BRA	6/14/2023	6.88E+00	1.30E+01	1.70E+01	U	1.32E-01	1.41E+00	1.53E+00	U
COY[g]	6/14/2023	3.40E+00	1.72E+00	3.72E+00	U	-8.10E-03	1.43E-01	1.97E-01	U
UPR	6/14/2023	3.39E+00	1.68E+00	3.63E+00	U	5.26E-02	1.10E-01	2.17E-01	U
COW[e]	6/14/2023	8.13E+00	1.06E+01	1.52E+01	U	3.00E-01	1.25E+00	1.57E+00	U
FWT	6/14/2023	2.34E+00	1.43E+00	3.17E+00	U	4.54E-02	1.50E-01	2.45E-01	U
SWL[f]	6/15/2023	1.09E+01	2.76E+00	3.46E+00	=	1.67E-02	1.18E-01	2.33E-01	U
BHT	10/4/2023	1.44E+01	1.12E+01	1.75E+01	U	6.56E-02	1.25E+00	1.50E+00	U

Location	Sampling Date	137Cs				90Sr			
		[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
HIL	4/13/2023	1.35E-03	1.19E-01	2.21E-01	U	-1.18E-03	1.85E-02	1.82E-02	U
NOY	4/13/2023	-9.60E-03	1.31E-01	2.40E-01	U	1.19E-02	2.08E-02	1.85E-02	U
RLK	4/13/2023	1.71E-02	1.04E-01	1.98E-01	U	-6.63E-03	1.95E-02	1.83E-02	U
IDN	5/11/2023	-9.39E-02	1.43E-01	2.50E-01	U	-1.01E-02	1.97E-02	1.83E-02	U
PKT	5/11/2023	1.79E-02	3.15E-01	5.59E-01	U	-4.21E-03	1.90E-02	1.83E-02	U
LST	5/24/2023	-1.43E-01	1.41E-01	2.24E-01	U	-6.19E-04	1.98E-02	1.83E-02	U
LST Dup	5/24/2023	-1.40E-03	1.02E-02	1.91E-02	U	-6.95E-03	2.11E-02	1.84E-02	U
PCN	5/25/2023	4.54E-01	8.23E-01	1.18E+00	U	5.79E-03	1.98E-02	1.83E-02	U
RED	6/13/2023	1.61E-02	1.32E-01	2.36E-01	U	3.43E-03	1.98E-02	1.83E-02	U
CBD	6/14/2023	9.03E-02	1.03E-01	2.13E-01	U	1.21E-03	1.92E-02	1.83E-02	U
BRA	6/14/2023	-1.37E-01	1.06E+00	1.34E+00	U	7.89E-04	1.74E-02	1.79E-02	U
COY [g]	6/14/2023	2.74E-02	1.37E-01	2.56E-01	U	5.28E-03	1.84E-02	1.82E-02	U
UPR	6/14/2023	5.62E-02	1.08E-01	2.16E-01	U	-2.15E-02	2.11E-02	1.86E-02	U
COW [e]	6/14/2023	6.09E-01	9.77E-01	1.36E+00	U	-2.08E-03	1.93E-02	1.83E-02	U
FWT	6/14/2023	-1.37E-02	1.31E-01	2.42E-01	U	-1.20E-02	1.98E-02	1.84E-02	U
SWL[f]	6/15/2023	1.09E-01	1.20E-01	2.41E-01	U	8.14E-03	2.07E-02	1.85E-02	U
BHT	10/4/2023	-2.77E-01	1.11E+00	1.37E+00	U	3.79E-03	2.12E-02	1.95E-02	U

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

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples 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 Equal sign (=) denotes detected; U denotes 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 (BRA).

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]
HIL	4/13/2023	1.91E-02	4.34E-03	1.22E-03	=	1.75E-03	9.33E-04	6.70E-04	=	2.38E-02	5.21E-03	1.13E-03	=
NOY	4/13/2023	1.69E-02	3.73E-03	1.21E-03	=	9.58E-04	6.52E-04	6.76E-04	=	2.00E-02	4.27E-03	1.11E-03	=
RLK	4/13/2023	1.99E-02	4.46E-03	1.22E-03	=	2.10E-03	1.02E-03	6.59E-04	=	2.40E-02	5.22E-03	1.13E-03	=
IDN	5/11/2023	1.71E-02	4.00E-03	1.23E-03	=	1.21E-03	7.60E-04	6.42E-04	=	1.82E-02	4.20E-03	1.15E-03	=
PKT	5/11/2023	2.72E-02	5.86E-03	1.22E-03	=	2.22E-03	1.05E-03	6.64E-04	=	2.72E-02	5.86E-03	1.13E-03	=
LST	5/24/2023	1.41E-02	3.67E-03	1.24E-03	=	1.89E-03	1.02E-03	6.73E-04	=	1.51E-02	3.88E-03	1.17E-03	=
PCN	5/25/2023	2.53E-02	5.17E-03	1.21E-03	=	1.58E-03	8.39E-04	6.32E-04	=	2.01E-02	4.26E-03	1.12E-03	=
RED	6/13/2023	1.23E-02	2.34E-03	1.14E-03	=	6.92E-04	4.72E-04	5.48E-04	=	1.07E-02	2.11E-03	1.05E-03	=
RED Dup	6/13/2023	1.81E-02	3.33E-03	1.15E-03	=	1.30E-03	6.69E-04	5.61E-04	=	1.57E-02	2.97E-03	1.07E-03	=
BHT	6/13/2023	2.08E-02	4.04E-03	1.20E-03	=	7.14E-04	5.38E-04	6.28E-04	=	1.87E-02	3.71E-03	1.09E-03	=
CBD	6/14/2023	1.72E-02	2.98E-03	1.15E-03	=	1.02E-03	5.80E-04	5.70E-04	=	1.49E-02	2.67E-03	1.05E-03	=
BRA	6/14/2023	2.71E-02	4.74E-03	1.18E-03	=	2.33E-03	9.49E-04	5.81E-04	=	2.93E-02	5.06E-03	1.08E-03	=
UPR	6/14/2023	1.67E-02	3.17E-03	1.17E-03	=	1.74E-03	8.05E-04	5.89E-04	=	1.58E-02	3.04E-03	1.08E-03	=

Notes: See Appendix C for sampling location codes. Units are in becquerels per gram (Bq/g), dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.

(b) TPU= Total propagated uncertainty.

(c) MDC= Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected. Equal sign (=) denotes detected; U denotes 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]
HIL	4/13/2023	1.39E-04	2.45E-04	4.16E-04	U	5.11E-04	4.58E-04	5.19E-04	U	2.05E-04	3.06E-04	5.79E-04	U
NOY	4/13/2023	-2.29E-05	7.43E-05	3.47E-04	U	9.96E-05	1.90E-04	4.25E-04	U	-4.51E-05	1.07E-04	5.25E-04	U
RLK	4/13/2023	9.88E-05	1.88E-04	3.45E-04	U	1.84E-05	1.57E-04	4.30E-04	U	2.08E-04	2.76E-04	5.51E-04	U
IDN	5/11/2023	-6.13E-05	1.23E-04	3.96E-04	U	-5.90E-05	1.20E-04	4.83E-04	U	1.49E-04	2.70E-04	5.64E-04	U
PKT	5/11/2023	1.04E-04	2.09E-04	3.63E-04	U	4.29E-04	3.71E-04	4.64E-04	U	2.84E-04	3.49E-04	5.75E-04	U
LST	5/24/2023	2.45E-05	1.52E-04	3.65E-04	U	1.83E-04	2.70E-04	4.48E-04	U	9.96E-05	2.64E-04	5.88E-04	U
PCN	5/25/2023	4.68E-05	1.50E-04	3.44E-04	U	8.45E-05	2.17E-04	4.45E-04	U	0.00E+00	1.98E-04	5.47E-04	U
RED	6/13/2023	-5.83E-05	1.44E-04	5.19E-04	U	4.28E-05	2.23E-04	5.87E-04	U	3.85E-05	1.49E-04	5.32E-04	U
RED Dup	6/13/2023	6.97E-05	1.79E-04	3.24E-04	U	2.20E-05	1.36E-04	3.94E-04	U	8.41E-05	1.64E-04	4.77E-04	U
BHT	6/13/2023	3.73E-05	1.35E-04	3.16E-04	U	2.58E-04	2.75E-04	4.15E-04	U	1.56E-04	2.09E-04	4.81E-04	U
CBD	6/14/2023	1.04E-04	1.72E-04	3.08E-04	U	2.73E-05	1.42E-04	4.04E-04	U	3.16E-04	2.75E-04	4.96E-04	U
BRA	6/14/2023	2.67E-05	1.51E-04	3.60E-04	U	-5.53E-05	1.14E-04	4.51E-04	U	1.31E-04	2.15E-04	4.90E-04	U
UPR	6/14/2023	-1.89E-05	6.41E-05	3.13E-04	U	5.64E-05	1.92E-04	4.11E-04	U	4.02E-05	1.28E-04	4.84E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.
(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(b) TPU= Total propagated uncertainty.
(c) MDC= Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected. Equal sign (=) denotes detected; U denotes 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)

Location	Date	^{40}K				^{60}Co			
		[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
HIL	4/13/2023	9.16E-01	7.54E-02	3.41E-02	=	-5.86E-04	1.28E-03	2.31E-03	U
NOY	4/13/2023	8.88E-01	5.66E-02	3.62E-02	=	-6.95E-04	1.09E-03	1.91E-03	U
RLK	4/13/2023	9.19E-01	5.79E-02	2.90E-02	=	-2.97E-04	1.28E-03	2.20E-03	U
IDN	5/11/2023	4.16E-01	3.48E-02	2.60E-02	=	9.43E-06	7.52E-04	1.44E-03	U
PKT	5/11/2023	8.05E-01	5.46E-02	3.30E-02	=	-3.82E-04	1.18E-03	2.13E-03	U
LST	5/24/2023	4.85E-01	3.68E-02	2.41E-02	=	2.11E-05	8.45E-04	1.60E-03	U
PCN	5/25/2023	3.96E-01	3.20E-02	2.31E-02	=	-1.12E-04	6.09E-04	1.14E-03	U
RED	6/13/2023	1.98E-01	2.12E-02	1.82E-02	=	1.32E-04	5.14E-04	1.02E-03	U
RED Dup	6/13/2023	2.10E-01	1.99E-02	1.56E-02	=	1.08E-04	4.98E-04	9.74E-04	U
BHT	6/13/2023	4.47E-01	3.49E-02	2.33E-02	=	1.01E-05	8.09E-04	1.53E-03	U
CBD	6/14/2023	2.48E-01	2.60E-02	2.44E-02	=	1.77E-04	8.29E-04	1.51E-03	U
BRA	6/14/2023	3.01E-01	2.52E-02	2.01E-02	=	2.23E-04	6.63E-04	1.26E-03	U
UPR	6/14/2023	2.70E-01	3.00E-02	1.82E-02	=	3.43E-04	7.95E-04	1.66E-03	U

Location	Date	^{137}Cs				^{90}Sr			
		[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
HIL	4/13/2023	3.05E-03	2.07E-03	3.32E-03	U	-7.31E-04	1.18E-02	1.75E-02	U
NOY	4/13/2023	2.98E-03	1.62E-03	2.57E-03	=	-5.76E-03	1.11E-02	1.74E-02	U
RLK	4/13/2023	2.41E-04	1.21E-03	2.14E-03	U	-5.08E-03	1.21E-02	1.76E-02	U
IDN	5/11/2023	4.07E-04	9.42E-04	1.74E-03	U	-5.03E-03	1.10E-02	1.74E-02	U
PKT	5/11/2023	9.23E-03	2.10E-03	2.92E-03	=	3.41E-04	1.14E-02	1.75E-02	U
LST	5/24/2023	1.70E-03	1.27E-03	2.06E-03	U	-5.96E-03	1.16E-02	1.75E-02	U
PCN	5/25/2023	4.65E-04	6.44E-04	1.25E-03	U	-7.60E-03	1.12E-02	1.74E-02	U
RED	6/13/2023	4.12E-04	6.77E-04	1.28E-03	U	-2.32E-03	1.01E-02	1.78E-02	U
RED Dup	6/13/2023	2.52E-04	5.53E-04	1.04E-03	U	-4.28E-03	1.01E-02	1.78E-02	U
BHT	6/13/2023	2.55E-03	1.10E-03	1.66E-03	=	-2.58E-03	1.01E-02	1.78E-02	U
CBD	6/14/2023	1.31E-04	6.97E-04	1.23E-03	U	6.24E-03	1.04E-02	1.78E-02	U
BRA	6/14/2023	-4.75E-04	7.24E-04	1.18E-03	U	2.72E-03	1.05E-02	1.78E-02	U
UPR	6/14/2023	4.58E-05	6.93E-04	1.32E-03	U	-4.27E-03	1.01E-02	1.78E-02	U

(a) Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.
(b) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(c) TPU= Total propagated uncertainty.
(d) MDC= Minimum detectable concentration.
(e) Qualifier. Indicates whether radionuclide was detected Equal sign (=) denotes detected; U denotes undetected.

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,e]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
WFF	0-2	3/16/2023	5.94E-03	1.51E-03	9.03E-04	=	6.65E-04	4.82E-04	5.42E-04	=	4.81E-03	1.32E-03	8.78E-04	=
WFF	2-5	3/16/2023	5.07E-03	1.49E-03	9.25E-04	=	5.43E-04	4.78E-04	6.07E-04	U	5.06E-03	1.48E-03	9.04E-04	=
WFF	5-10	3/16/2023	6.12E-03	1.59E-03	8.99E-04	=	3.38E-04	3.56E-04	5.56E-04	U	6.78E-03	1.71E-03	8.86E-04	=
MLR	0-2	3/16/2023	1.01E-02	1.99E-03	8.76E-04	=	5.02E-04	4.05E-04	5.31E-04	U	9.58E-03	1.92E-03	8.55E-04	=
MLR	2-5	3/16/2023	1.20E-02	3.10E-03	1.00E-03	=	1.30E-03	8.25E-04	6.79E-04	=	1.51E-02	3.69E-03	9.85E-04	=
MLR	5-10	3/16/2023	1.21E-02	2.74E-03	9.42E-04	=	8.33E-04	6.10E-04	6.46E-04	=	1.25E-02	2.81E-03	9.08E-04	=
MLR Dup	0-2	3/16/2023	1.02E-02	2.09E-03	8.91E-04	=	6.21E-04	4.83E-04	5.45E-04	=	1.02E-02	2.08E-03	8.76E-04	=
MLR Dup	2-5	3/16/2023	1.27E-02	2.76E-03	9.05E-04	=	9.45E-04	6.19E-04	6.11E-04	=	1.34E-02	2.87E-03	8.99E-04	=
MLR Dup	5-10	3/16/2023	1.47E-02	3.33E-03	9.37E-04	=	1.27E-03	7.54E-04	6.40E-04	=	1.25E-02	2.94E-03	9.22E-04	=
WEE	0-2	3/22/2023	5.26E-03	1.55E-03	9.18E-04	=	6.37E-04	5.23E-04	6.22E-04	=	4.55E-03	1.41E-03	8.96E-04	=
WEE	2-5	3/22/2023	7.65E-03	1.93E-03	9.28E-04	=	5.43E-04	4.61E-04	5.79E-04	U	8.92E-03	2.14E-03	8.86E-04	=
WEE	5-10	3/22/2023	7.14E-03	1.72E-03	9.03E-04	=	7.22E-04	5.32E-04	6.08E-04	=	6.43E-03	1.60E-03	8.68E-04	=
SMR	0-2	4/6/2023	1.88E-02	3.95E-03	9.41E-04	=	1.76E-03	8.75E-04	6.11E-04	=	1.92E-02	4.01E-03	9.06E-04	=
SMR	2-5	4/6/2023	1.73E-02	3.29E-03	9.07E-04	=	2.50E-03	9.84E-04	5.73E-04	=	1.98E-02	3.67E-03	8.74E-04	=
SMR	5-10	4/6/2023	1.84E-02	3.29E-03	9.62E-04	=	8.17E-04	5.23E-04	5.73E-04	NJ	1.94E-02	3.43E-03	8.18E-04	=
SEC	0-2	4/6/2023	1.03E-02	2.09E-03	9.53E-04	=	1.18E-03	6.19E-04	5.59E-04	NJ	1.42E-02	2.65E-03	8.03E-04	=
SEC	2-5	4/6/2023	1.12E-02	2.33E-03	9.76E-04	=	4.48E-04	4.12E-04	5.84E-04	NJ	9.76E-03	2.11E-03	8.26E-04	=
SEC	5-10	4/6/2023	1.27E-02	2.47E-03	9.65E-04	=	4.66E-04	4.10E-04	5.70E-04	NJ	1.13E-02	2.27E-03	8.23E-04	=
WSS	0-2	4/6/2023	1.07E-02	2.29E-03	9.91E-04	=	8.36E-04	5.47E-04	5.73E-04	NJ	9.27E-03	2.05E-03	8.31E-04	=
WSS	2-5	4/6/2023	8.23E-03	1.97E-03	9.78E-04	=	5.76E-04	4.74E-04	6.13E-04	NJ	8.20E-03	1.96E-03	8.42E-04	=
WSS	5-10	4/6/2023	7.94E-03	1.72E-03	9.57E-04	=	1.95E-04	2.82E-04	5.90E-04	NJ	7.78E-03	1.69E-03	8.16E-04	=

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(b) TPU= Total propagated uncertainty.
(c) MDC= Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected Equal sign (=) denotes detected; U denotes undetected.
(e) NJ denotes a nuclide present at an estimated quantity.

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				^{238}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	3/16/2023	-4.39E-05	1.01E-04	3.82E-04	U	1.97E-04	2.56E-04	4.27E-04	U	5.53E-05	2.03E-04	5.51E-04	U
WFF	2-5	3/16/2023	6.28E-06	1.70E-04	4.28E-04	U	1.36E-04	2.42E-04	4.56E-04	U	5.94E-06	1.61E-04	5.43E-04	U
WFF	5-10	3/16/2023	6.47E-05	2.29E-04	4.73E-04	U	-4.90E-05	1.12E-04	4.86E-04	U	3.67E-05	1.25E-04	5.00E-04	U
MLR	0-2	3/16/2023	-4.19E-06	1.77E-04	4.53E-04	U	3.87E-04	3.49E-04	4.45E-04	U	1.54E-04	2.04E-04	5.09E-04	U
MLR	2-5	3/16/2023	-1.90E-06	1.59E-04	4.10E-04	U	3.63E-04	3.12E-04	4.11E-04	U	2.27E-04	2.82E-04	5.52E-04	U
MLR	5-10	3/16/2023	-3.36E-05	9.66E-05	4.15E-04	U	1.61E-04	2.75E-04	4.72E-04	U	3.93E-04	3.17E-04	5.16E-04	U
MLR Dup	0-2	3/16/2023	-6.04E-05	1.23E-04	4.58E-04	U	1.46E-04	2.46E-04	4.59E-04	U	2.79E-05	1.45E-04	5.24E-04	U
MLR Dup	2-5	3/16/2023	3.51E-04	3.80E-04	4.83E-04	U	1.65E-04	2.72E-04	5.12E-04	U	2.14E-04	2.42E-04	5.11E-04	U
MLR Dup	5-10	3/16/2023	2.04E-05	3.24E-04	7.21E-04	U	-7.73E-05	1.92E-04	8.48E-04	U	-4.94E-05	1.34E-04	7.25E-04	U
WEE	0-2	3/22/2023	-2.28E-05	7.74E-05	3.94E-04	U	9.55E-05	2.16E-04	4.75E-04	U	2.05E-04	2.26E-04	5.08E-04	U
WEE	2-5	3/22/2023	-1.87E-05	6.68E-05	3.77E-04	U	8.28E-05	1.99E-04	4.52E-04	U	1.51E-04	2.07E-04	5.10E-04	U
WEE	5-10	3/22/2023	-3.84E-05	9.74E-05	4.08E-04	U	6.82E-05	2.15E-04	4.74E-04	U	-1.98E-05	7.07E-05	5.28E-04	U
SMR	0-2	4/6/2023	1.05E-04	1.95E-04	3.87E-04	U	4.28E-06	1.75E-04	4.48E-04	U	9.84E-05	1.77E-04	5.11E-04	U
SMR	2-5	4/6/2023	-3.34E-05	9.28E-05	4.00E-04	U	8.46E-05	2.17E-04	4.87E-04	U	-2.17E-05	7.37E-05	5.58E-04	U
SMR	5-10	4/6/2023	1.31E-04	2.41E-04	4.27E-04	U	-5.59E-05	1.16E-04	4.79E-04	U	7.18E-05	1.78E-04	5.12E-04	U
SEC	0-2	4/6/2023	-4.27E-05	9.80E-05	3.72E-04	U	-4.07E-05	9.56E-05	4.36E-04	U	1.12E-04	2.30E-04	5.49E-04	U
SEC	2-5	4/6/2023	-5.83E-05	1.21E-04	4.34E-04	U	1.08E-05	1.72E-04	4.80E-04	U	6.54E-05	1.99E-04	5.45E-04	U
SEC	5-10	4/6/2023	-7.23E-05	1.40E-04	4.87E-04	U	1.86E-05	1.80E-04	5.15E-04	U	4.16E-05	1.41E-04	5.27E-04	U
WSS	0-2	4/6/2023	-6.51E-05	1.24E-04	4.40E-04	U	-5.08E-05	1.09E-04	4.53E-04	U	8.77E-05	1.54E-04	4.94E-04	U
WSS	2-5	4/6/2023	-2.01E-06	1.68E-04	4.23E-04	U	1.42E-04	2.26E-04	4.41E-04	U	8.46E-05	1.91E-04	5.32E-04	U
WSS	5-10	4/6/2023	-2.82E-05	8.11E-05	3.67E-04	U	1.41E-05	1.57E-04	4.39E-04	U	9.53E-05	1.72E-04	5.13E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(b) TPU= Total propagated uncertainty.
(c) MDC= Minimum detectable concentration.
(d) Qualifier indicates whether radionuclide was detected Equal sign (=) denotes detected; U denotes 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]	Q[d,e]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
WFF	0-2	3/16/2023	1.59E-01	1.57E-02	1.25E-02	=	-7.31E-05	4.16E-04	7.55E-04	U
WFF	2-5	3/16/2023	1.58E-01	1.96E-02	1.23E-02	=	2.00E-04	6.20E-04	1.25E-03	U
WFF	5-10	3/16/2023	1.57E-01	1.73E-02	1.53E-02	=	8.00E-06	4.87E-04	9.18E-04	U
MLR	0-2	3/16/2023	2.88E-01	2.23E-02	1.54E-02	=	-3.46E-05	4.24E-04	8.05E-04	U
MLR	2-5	3/16/2023	2.76E-01	2.20E-02	1.59E-02	=	4.46E-05	4.72E-04	8.93E-04	U
MLR	5-10	3/16/2023	2.70E-01	2.36E-02	1.85E-02	=	5.86E-05	4.91E-04	9.49E-04	U
MLR Dup	0-2	3/16/2023	2.97E-01	2.38E-02	1.76E-02	=	-1.36E-04	5.18E-04	9.33E-04	U
MLR Dup	2-5	3/16/2023	3.10E-01	2.43E-02	1.59E-02	NJ	-1.65E-04	4.64E-04	8.60E-04	U
MLR Dup	5-10	3/16/2023	2.83E-01	2.41E-02	1.81E-02	NJ	-5.94E-05	5.11E-04	9.66E-04	U
WEE	0-2	3/22/2023	1.62E-01	2.00E-02	1.22E-02	NJ	-4.08E-04	6.22E-04	1.05E-03	U
WEE	2-5	3/22/2023	1.81E-01	1.75E-02	1.45E-02	NJ	2.19E-05	5.24E-04	9.85E-04	U
WEE	5-10	3/22/2023	1.73E-01	2.15E-02	1.49E-02	NJ	7.48E-05	5.85E-04	1.17E-03	U
SMR	0-2	4/6/2023	7.30E-01	4.15E-02	1.92E-02	NJ	-5.84E-04	7.12E-04	1.22E-03	U
SMR	2-5	4/6/2023	6.78E-01	3.82E-02	1.75E-02	NJ	-4.84E-04	6.18E-04	1.07E-03	U
SMR	5-10	4/6/2023	7.01E-01	3.96E-02	1.52E-02	=	-2.63E-05	6.26E-04	1.17E-03	U
SEC	0-2	4/6/2023	1.72E-01	1.57E-02	1.21E-02	=	9.91E-05	3.55E-04	6.97E-04	U
SEC	2-5	4/6/2023	1.68E-01	1.99E-02	1.21E-02	=	4.91E-04	5.06E-04	1.16E-03	U
SEC	5-10	4/6/2023	1.81E-01	1.75E-02	1.51E-02	=	-3.36E-04	4.14E-04	6.93E-04	U
WSS	0-2	4/6/2023	2.01E-01	1.75E-02	1.07E-02	=	3.16E-04	4.72E-04	9.54E-04	U
WSS	2-5	4/6/2023	2.06E-01	1.79E-02	1.16E-02	=	-1.07E-04	4.01E-04	7.20E-04	U
WSS	5-10	4/6/2023	1.61E-01	2.02E-02	1.55E-02	=	2.56E-04	4.58E-04	1.02E-03	U

Location	Depth (cm)	Sampling Date	^{137}Cs				^{90}Sr			
			[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
WFF	0-2	3/16/2023	7.21E-04	5.92E-04	9.68E-04	U	2.16E-03	1.12E-02	1.57E-02	U
WFF	2-5	3/16/2023	1.38E-03	7.86E-04	1.21E-03	=	2.79E-03	1.03E-02	1.56E-02	U
WFF	5-10	3/16/2023	1.25E-03	7.87E-04	1.26E-03	U	6.83E-03	1.05E-02	1.57E-02	U
MLR	0-2	3/16/2023	2.44E-03	9.22E-04	1.41E-03	=	4.85E-03	1.04E-02	1.55E-02	U
MLR	2-5	3/16/2023	3.68E-03	8.99E-04	1.25E-03	=	-2.47E-03	1.04E-02	1.56E-02	U
MLR	5-10	3/16/2023	7.11E-04	5.78E-04	1.14E-03	U	-3.09E-03	1.02E-02	1.56E-02	U
MLR Dup	0-2	3/16/2023	1.49E-03	7.96E-04	1.25E-03	=	2.29E-03	1.02E-02	1.55E-02	U
MLR Dup	2-5	3/16/2023	1.04E-03	7.20E-04	1.16E-03	U	1.24E-03	1.35E-02	1.54E-02	U
MLR Dup	5-10	3/16/2023	9.73E-04	5.30E-04	1.10E-03	U	-2.86E-03	1.38E-02	1.54E-02	U
WEE	0-2	3/22/2023	1.97E-03	7.13E-04	1.56E-03	=	2.53E-03	1.42E-02	1.56E-02	U
WEE	2-5	3/22/2023	2.33E-03	7.71E-04	1.13E-03	=	-2.23E-03	1.47E-02	1.57E-02	U
WEE	5-10	3/22/2023	1.62E-03	7.32E-04	1.56E-03	=	1.01E-02	1.43E-02	1.56E-02	U
SMR	0-2	4/6/2023	9.30E-05	6.38E-04	1.09E-03	U	-7.32E-03	1.34E-02	1.55E-02	U
SMR	2-5	4/6/2023	4.25E-04	5.71E-04	1.09E-03	U	-1.39E-03	1.36E-02	1.55E-02	U
SMR	5-10	4/6/2023	1.80E-04	6.04E-04	1.06E-03	U	-2.82E-03	1.11E-02	1.85E-02	U
SEC	0-2	4/6/2023	1.47E-03	5.27E-04	7.56E-04	=	-1.12E-03	1.08E-02	1.85E-02	U
SEC	2-5	4/6/2023	1.67E-03	9.82E-04	1.55E-03	=	-1.44E-03	1.05E-02	1.84E-02	U
SEC	5-10	4/6/2023	1.01E-03	4.93E-04	1.01E-03	U	-4.05E-04	1.06E-02	1.84E-02	U
WSS	0-2	4/6/2023	1.25E-04	4.48E-04	7.96E-04	U	-4.26E-03	1.10E-02	1.85E-02	U
WSS	2-5	4/6/2023	4.80E-04	4.79E-04	7.91E-04	U	3.11E-05	1.13E-02	1.85E-02	U
WSS	5-10	4/6/2023	6.68E-04	5.56E-04	1.14E-03	U	-4.44E-04	1.05E-02	1.84E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.

(b) TPU= Total propagated uncertainty.

(c) MDC= Minimum detectable concentration.

(d) Qualifier. Indicates whether radionuclide was detected Equal sign (=) denotes detected; U denotes undetected.

(e) NJ denotes a nuclide present at an estimated quantity.

Table G.16 – Uranium Isotopes, Plutonium Isotopes, and Americium Concentrations in Vegetation Samples Collected at or 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]
SMR	9/28/2023	4.70E-04	2.08E-04	9.56E-04	U	6.64E-05	8.28E-05	3.05E-04	U	6.18E-04	2.45E-04	1.02E-03	U
SEC	9/28/2023	4.92E-04	2.08E-04	9.53E-04	U	-3.04E-06	1.61E-05	3.00E-04	U	2.76E-04	1.51E-04	1.02E-03	U
MLR	9/28/2023	1.03E-03	2.98E-04	9.47E-04	=	4.63E-05	7.21E-05	2.97E-04	U	9.88E-04	2.91E-04	1.01E-03	U
WFF	10/5/2023	5.59E-04	2.08E-04	9.47E-04	U	5.43E-05	6.87E-05	2.93E-04	U	6.20E-04	2.20E-04	1.01E-03	U
WSS	10/5/2023	3.47E-04	1.66E-04	9.51E-04	U	1.81E-05	4.38E-05	2.96E-04	U	2.63E-04	1.42E-04	1.02E-03	U
WEE	10/5/2023	3.57E-04	1.86E-04	9.61E-04	U	-6.72E-06	2.55E-05	3.10E-04	U	3.40E-04	1.79E-04	1.03E-03	U
WEE Dup	10/5/2023	4.79E-04	2.13E-04	9.56E-04	U	1.39E-05	5.37E-05	3.07E-04	U	6.62E-04	2.60E-04	1.02E-03	U
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]
SMR	9/28/2023	-7.95E-06	2.14E-05	1.93E-04	U	-1.24E-05	2.67E-05	2.58E-04	U	1.99E-05	4.13E-05	4.11E-04	U
SEC	9/28/2023	-7.88E-06	2.12E-05	1.89E-04	U	2.11E-05	4.65E-05	2.55E-04	U	7.68E-06	3.42E-05	4.14E-04	U
MLR	9/28/2023	-6.61E-06	1.78E-05	1.83E-04	U	-9.90E-06	2.17E-05	2.51E-04	U	-1.10E-05	2.37E-05	4.11E-04	U
WFF	10/5/2023	-9.85E-07	4.16E-05	1.96E-04	U	-1.23E-05	2.65E-05	2.58E-04	U	3.75E-05	8.03E-05	4.48E-04	U
WSS	10/5/2023	-6.95E-06	1.87E-05	1.84E-04	U	6.07E-06	3.16E-05	2.50E-04	U	-1.50E-06	3.21E-05	4.06E-04	U
WEE	10/5/2023	-4.53E-06	1.54E-05	1.85E-04	U	2.04E-05	4.22E-05	2.51E-04	U	4.36E-06	2.98E-05	4.07E-04	U
WEE Dup	10/5/2023	-1.25E-05	2.54E-05	1.88E-04	U	3.56E-06	3.44E-05	2.51E-04	U	-7.89E-06	1.85E-05	4.05E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples may have a negative value when background radioactivity is subtracted.
(b) TPA= Total propagated uncertainty.
(c) Minimum detectable concentration.
(d) Qualifier. Indicates whether radionuclide was detected Equal sign (=) denotes detected; U denotes 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]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
SMR	9/28/2023	9.40E-01	1.20E-01	8.81E-02	=	1.22E-03	3.55E-03	7.21E-03	U
SEC	9/28/2023	6.42E-01	8.32E-02	7.85E-02	=	2.72E-03	2.46E-03	4.85E-03	U
MLR	9/28/2023	1.84E+00	1.86E-01	8.08E-02	=	2.51E-03	3.05E-03	5.79E-03	U
WFF	10/5/2023	5.45E-01	8.34E-02	9.63E-02	=	-1.01E-03	2.24E-03	4.08E-03	U
WSS	10/5/2023	4.85E-01	7.46E-02	7.79E-02	=	5.75E-04	2.38E-03	4.64E-03	U
WEE	10/5/2023	6.09E-01	7.10E-02	5.86E-02	=	-4.09E-04	1.75E-03	3.34E-03	U
WEE Dup	10/5/2023	6.32E-01	8.84E-02	5.72E-02	=	-2.59E-03	2.93E-03	4.92E-03	U
Location	**Sampling Date**	**^{137}Cs**				**^{90}Sr**			
		[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
SMR	9/28/2023	1.97E-03	2.83E-03	5.78E-03	U	4.42E-04	2.53E-03	1.82E-02	U
SEC	9/28/2023	-6.34E-05	2.58E-03	4.76E-03	U	1.44E-03	2.61E-03	1.82E-02	U
MLR	9/28/2023	-2.53E-03	2.89E-03	4.43E-03	U	1.46E-03	2.47E-03	1.82E-02	U
WFF	10/5/2023	8.75E-04	1.92E-03	3.74E-03	U	1.93E-03	2.62E-03	1.82E-02	U
WSS	10/5/2023	-3.73E-03	2.59E-03	4.03E-03	U	-3.01E-04	2.53E-03	1.82E-02	U
WEE	10/5/2023	5.15E-04	1.98E-03	3.58E-03	U	1.14E-03	2.53E-03	1.82E-02	U
WEE Dup	10/5/2023	1.33E-03	2.89E-03	5.16E-03	U	6.50E-04	2.53E-03	1.82E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples 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 Equal sign (=) denotes detected; U denotes undetected.

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]
Deer	SOO[e]	1/9/2023	1.13E-05	4.98E-06	8.39E-04	U	2.17E-06	2.30E-06	2.04E-04	U	7.56E-06	3.99E-06	5.65E-04	U
Deer	SOO[e]	1/9/2023	3.44E-05	1.01E-05	8.39E-04	U	4.30E-07	1.52E-06	2.04E-04	U	8.47E-06	4.45E-06	5.65E-04	U
Deer	SOO[e]	6/14/2023	2.43E-05	7.23E-06	8.46E-04	U	2.27E-06	2.23E-06	3.02E-04	U	1.04E-05	4.37E-06	7.70E-04	U
Fish	CBD	6/28/2023	1.73E-03	3.08E-04	8.48E-04	=	9.72E-05	2.89E-05	3.05E-04	U	8.09E-04	1.51E-04	7.72E-04	=
Rabbit	SOO[e]	10/26/2023	5.92E-05	1.17E-05	9.38E-04	U	3.63E-06	2.68E-06	2.31E-04	U	4.54E-05	9.75E-06	9.34E-04	U
Fish	BRA	11/29/2023	1.53E-04	2.78E-05	1.91E-03	U	5.71E-06	2.85E-06	2.13E-04	U	8.42E-05	1.65E-05	8.61E-04	U
Rabbit	WIPP	12/6/2023	8.97E-05	2.69E-05	1.91E-03	U	3.61E-06	2.94E-06	2.13E-04	U	8.61E-05	2.59E-05	8.61E-04	U
Beef	SOO[e]	12/14/2023	7.21E-05	1.35E-05	1.91E-03	U	3.51E-06	1.96E-06	2.12E-04	U	6.07E-05	1.17E-05	8.61E-04	U
Type	**Location**	**Sampling Date**	**^{238}Pu**				**$^{239/240}$Pu**				**^{241}Am**			
			[RN][a]	2 σ TPU[b]	MDC[c]	Q[d,f]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d,f]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
Deer	SOO[e]	1/9/2023	-3.08E-07	1.05E-06	1.58E-04	U	-6.46E-07	1.54E-06	1.97E-04	U	9.66E-07	1.28E-06	2.98E-04	U
Deer	SOO[e]	1/9/2023	8.37E-07	2.86E-06	1.59E-04	U	-8.77E-07	2.08E-06	1.98E-04	U	2.83E-07	1.02E-06	2.98E-04	U
Deer	SOO[e]	6/14/2023	-1.14E-06	2.98E-06	9.46E-05	UJ	-1.01E-06	2.78E-06	2.25E-04	UJ	1.51E-06	1.69E-06	2.05E-04	U
Fish	CBD	6/28/2023	-1.14E-06	2.98E-06	9.46E-05	U	-1.01E-06	2.78E-06	2.25E-04	U	7.34E-07	3.27E-06	2.17E-04	U
Rabbit	SOO[e]	10/26/2023	7.30E-07	4.15E-06	1.52E-04	UJ	-1.23E-06	2.91E-06	1.99E-04	UJ	2.53E-06	2.43E-06	3.67E-04	U
Fish	BRA	11/29/2023	5.47E-07	1.41E-06	1.43E-04	U	2.03E-05	8.75E-06	1.98E-04	U	5.11E-07	7.80E-07	3.65E-04	U
Rabbit	WIPP	12/6/2023	-2.45E-07	5.79E-07	1.43E-04	U	1.49E-05	6.19E-06	1.98E-04	U	6.00E-07	7.45E-07	3.65E-04	U
Beef	SOO[e]	12/14/2023	8.26E-07	1.49E-06	1.43E-04	U	1.20E-05	5.85E-06	1.98E-04	U	3.46E-06	1.55E-06	3.65E-04	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples 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 Equal sign (=) denotes detected; U denotes undetected.

(e) SOO = sample of opportunity.

(f) UJ denotes a nuclide that was not detected above the reported MDC and 2 sigma counting uncertainty and a quality deficiency affected the data making the reported data more uncertain.

Table G.19 – Gamma Radionuclides and ^{90}Sr Radionuclide Concentrations in Fauna Samples

Type	Location	Sampling Date	^{40}K				^{60}Co			
			[RN][a]	2 σ TPU[b]	MDC[c]	Q[d,g]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d,f]
Deer	SOO(e)	1/9/2023	2.93E-01	4.98E-02	3.61E-02	NJ	3.97E-04	3.42E-03	4.15E-03	UJ
Deer	SOO(e)	1/9/2023	1.13E-01	3.89E-02	2.06E-02	NJ	-4.33E-03	5.65E-03	4.56E-03	UJ
Deer	SOO(e)	6/14/2023	3.12E-01	2.09E-02	1.18E-02	=	2.30E-04	3.11E-04	6.54E-04	U
Fish	CBD	6/28/2023	5.27E-01	1.10E-01	1.14E-01	=	7.54E-03	1.01E-02	1.19E-02	U
Rabbit	SOO(e)	10/26/2023	1.40E-01	2.35E-02	5.36E-02	=	7.64E-04	2.34E-03	2.98E-03	U
Fish	BRA	11/29/2023	7.34E-02	7.98E-03	6.45E-03	=	1.30E-04	2.17E-04	4.09E-04	U
Rabbit	WIPP	12/6/2023	8.31E-02	7.96E-03	6.31E-03	=	1.46E-04	1.82E-04	2.80E-04	U
Beef	SOO(e)	12/14/2023	1.22E-01	9.28E-03	6.25E-03	=	-8.08E-05	1.47E-04	2.67E-04	U
Type	**Location**	**Sampling Date**	^{137}Cs				^{90}Sr			
			[RN][a]	2 σ TPU[b]	MDC[c]	Q[d,f]	[RN][a]	2 σ TPU[b]	MDC[c]	Q[d]
Deer	SOO(e)	1/9/2023	7.85E-04	2.57E-03	3.46E-03	UJ	4.44E-05	5.65E-05	1.19E-02	U
Deer	SOO(e)	1/9/2023	2.11E-03	3.00E-03	3.80E-03	UJ	4.32E-05	8.01E-05	1.19E-02	U
Deer	SOO(e)	6/14/2023	-2.44E-04	2.88E-04	4.92E-04	U	-2.72E-06	6.34E-05	1.55E-02	U
Fish	CBD	6/28/2023	4.98E-02	4.10E-01	5.34E-01	U	4.57E-04	1.47E-04	1.55E-02	U
Rabbit	SOO(e)	10/26/2023	8.37E-04	6.90E-03	1.14E-01	U	7.91E-04	1.82E-04	1.58E-02	U
Fish	BRA	11/29/2023	8.43E-05	2.35E-04	4.44E-04	U	3.09E-05	3.70E-05	1.44E-02	U
Rabbit	WIPP	12/6/2023	-8.97E-05	2.11E-04	3.52E-04	U	2.91E-04	4.95E-05	1.44E-02	U
Beef	SOO(e)	12/14/2023	9.95E-05	1.87E-04	3.45E-04	U	1.97E-05	3.31E-05	1.44E-02	U

Notes: See Appendix C for sampling location codes. Units are in Bq/g, dry weight.

(a) Radionuclide activity. Only radionuclides with activities greater than 2 σ TPU and the MDC are considered detections. Samples 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 Equal sign (=) denotes detected; U denotes undetected.
(e) SOO = sample of opportunity.
(f) UJ denotes a nuclide that was not detected above the report MDC and 2 sigma counting uncertainty and a quality deficiency affected the data making the report data more uncertain.
(g) NJ denotes a nuclide present at an estimated quantity.