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Carlsbad Field Office

Waste Isolation Pilot Plant
Environmental Monitoring Plan

DOE/WIPP-99-2194

Revision 16

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CHANGE HISTORY SUMMARY

REVISION NUMBER	DATE ISSUED	DESCRIPTION OF CHANGES
15	10/31/24	• Sample location codes added after Acronyms and Abbreviations, thus removed from that list. • Stations F and G added for potential airborne effluent particulate sampling locations. • Figures depicting the former PPA configuration updated to current one. • Section added on emerging contaminants of concern. • Management assessment responsibilities updated. • Other revisions for clarity.
16	10/27/25	• OSTI declaration updated. • Removed reference to obsolete DOE O 436.1A and revised text to reference current WIPP documents. • A statement about Plutonium-242 was added to section 5.1. • All references to Stations A, B, and H were removed, as these locations are now defunct. Station F was removed as this is not a NESHAP sampling location. • Revised all applicable text related to Pecos River sampling, including fish, surface water, and sediment. This sampling discontinued as of end of July 2025. • Information on interceptor wells was added to section 5.2.3. • Soil/vegetation and surface water/sediment figure combined into one figure, now figure 5.4. • Updated section 5.3.6 for PFAS results discussion.

ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ASER	Annual Site Environmental Report
ASME	American Society of Mechanical Engineers
BECR	Biennial Environmental Compliance Report
CAA	central accumulation area
CBFO	Carlsbad Field Office
CFR	Code of Federal Regulations
CH	contact-handled
CofC/COC	chain of custody
CY	calendar year
DRVMP	Disposal Room VOC Monitoring Program
DMP	Detection Monitoring Program
DOE	U.S. Department of Energy
DOELAP	U.S. Department of Energy Laboratory Accreditation Program
EE	event evaluation
EDO	environmental data operation
EM&H	Environmental Monitoring & Hydrology
EMP	Environmental Monitoring Plan
EMS	Environmental Management Systems
EPA	U.S. Environmental Protection Agency
EUA	Exclusive Use Area
FAS	fixed air sampler
FEIS	Final Environmental Impact Statement
GC/MS	gas chromatography/mass spectrometry
GMP	Groundwater Monitoring Program
HEPA	high-efficiency particulate air
HPS	Health Physics Society
HWDU	Hazardous Waste Disposal Unit
ISO	International Organization for Standardization
IVS	Interim Ventilation System
LO-VOL	low-volume
LUR	land use request
MOC	Management and Operating Contractor
MOU	memorandum of understanding
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMED	New Mexico Environment Department

NMAC	New Mexico Administrative Code
NMDGF	New Mexico Department of Game and Fish
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
PASK	passive air sampling kit
PAW	perched anthropogenic water
Permit	Hazardous Waste Facility Permit
PIC	Potential Impact Category
PPA	Property Protection Area
Pub. L.	Public Law
PZ	piezometer
QA	quality assurance
QAPD	quality assurance program description
QC	quality control
RCRA	Resource Conservation and Recovery Act
RER	relative error ratio
RH	remote-handled
RPD	relative percent difference
RVMP	Repository VOC Monitoring Program
scfm	standard cubic feet per minute
SSP	Site Sustainability Plan
SVS	Supplemental Ventilation System
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TRU	transuranic
VOC	volatile organic compound
WHS	Waste Handling Shaft
WIPP	Waste Isolation Pilot Plant
WLMP	Water Level Monitoring Program
WRA	WIPP Records Archive

SAMPLE LOCATION CODES

Excerpt of WP 02-EM3001

BRPE	Brine Retention Pond East (DP-831)
BRPW	Brine Retention Pond West (DP-831)
CBD	Carlsbad
FWT	Fresh Water Tank
GSB	Guard and Security Building
H19	Evaporation Pond H-19 (DP-831)
MET	Meteorological Tower Building
MLR	Mills Ranch
SEC	Southeast Control
SLT	Salt Hoist
SMR	Smith Ranch
STB	Southeast of Training Building
SWL	Sewage Lagoon
WEE	WIPP East
WFF	WIPP Far Field
WSS	WIPP South

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Carlsbad Field Office (CBFO) and the Management and Operating Contractor (MOC) are committed to environmental protection and the implementation of sound stewardship practices that protect the air, water, land, and other natural and cultural resources. Provisions for protection are implemented via the Waste Isolation Pilot Plant (WIPP) Project environmental policy and the WIPP Environmental Management System (EMS). Sustainability goals, as directed by the DOE, are achieved through the Site Sustainability Plan (SSP) and the WIPP EMS. This Environmental Monitoring Plan (EMP) was developed as a key document to meet commitments and to conform with International Organization for Standardization (ISO) 14001:2015, Environmental Management Systems.

The CBFO and MOC are also committed to maintaining compliance with DOE Order 458.1, Radiation Protection of the Public and the Environment. The environmental monitoring requirements established in DOE Order 458.1 are implemented through this EMP. Monitoring is performed to protect the safety and health of the public and workers and the protection of the environment. Monitoring results associated with this EMP are reported annually in accordance with DOE Order 231.1B, Environment, Safety and Health Reporting.

The Environmental Monitoring Program at the WIPP is conducted to detect and quantify releases due to DOE activities; characterize releases at and in DOE/WIPP properties; and support assessment of potential public exposure through available pathways (e.g., air, water, soil, vegetation, and biota/fauna). This EMP documents the elements needed to establish and maintain effective monitoring activities, including:

- Verifying and supporting compliance with applicable federal, state, and local environmental laws, regulations, permits, and orders, including elements of DOE Order 458.1.
- Establishing background data and characterizing trends in the physical, chemical, and biological condition of effluent and environmental media using data assessments and statistical analysis.
- Identifying potential environmental contamination and evaluating the need for remedial actions or measures to mitigate the problem using a graded approach, process by which the level of analysis, documentation, and actions demonstrate regulatory compliance with applicable regulatory limits in environmental media. Quality assurance (QA) is driven by a quality assurance program description (QAPD) implemented in WP 13-1, Waste Isolation Pilot Plant Quality Assurance Program Description. All QA practices flow down into the monitoring program through the CBFO QAPD and are adopted in WP 13-1. Section 7.0 of this EMP further describes the QA program.
- Detecting, quantifying, and characterizing unplanned releases, and reporting per DOE Order 232.2A, Occurrence Reporting and Processing of Operations

Information, implemented by WP 15-CA1010, Reporting Occurrences and Processing.

- Evaluating the effectiveness of effluent treatment and control and pollution abatement programs.
- Assessing the radiological dose to the public and biota.
- Determining compliance with commitments made in environmental impact statements, environmental assessments, documented safety analyses, or other DOE documents.
- Compliance with Discharge Permit DP-831 requirements.
- Compliance with the Hazardous Waste Facility Permit to include Part 5 and Attachment L, Groundwater Detection Monitoring and Part 4 and Attachment N, Volatile Organic Compound Monitoring.

This EMP describes the rationale and design criteria for the Environmental Monitoring Program, the extent and frequency of monitoring and measurements, procedures for laboratory analyses, QA requirements, program implementation procedures, and direction for the preparation and disposition of reports (e.g., the WIPP Annual Site Environmental Report [ASER], required by DOE Order 231.1B). This EMP describes radiological environmental monitoring, non-radiological environmental monitoring, and land management and surveillance programs during the facility's operational phase. It also discusses the WIPP QA/Quality Control (QC) program as it relates to environmental monitoring. Revisions to the EMP may be necessary to allow the use of advanced technology and new data collection techniques. This EMP is reviewed annually and revised as needed, to document any changes made to the environmental monitoring program.

This EMP is part of an overall program designed to ensure that appropriate capabilities are maintained for monitoring and assessing routine and unplanned releases of radioactive materials, and assessing doses to the public, in accordance with the requirements of DOE Order 458.1. The specific requirement of DOE Order 458.1 to implement a documented environmental radiological protection program is satisfied by the implementation of this EMP, including sub-tier manuals and procedures. Additionally, WP 12-5, Waste Isolation Pilot Plant Radiation Safety Manual, including implementing sub-tier radiological control program documents relating to radiation protection of the public and the environment, reporting of radiological release occurrences, and environmental radiological surveillance satisfies this objective. Environmental surveillance and effluent monitoring data and assessments are reported to the public annually in the WIPP ASER in accordance with DOE Order 231.1B.

This EMP is prepared for WIPP using concepts contained in guidance documents including DOE-HDBK-1216-2015, Environmental Radiological Effluent Monitoring and Environmental Surveillance.

This EMP describes other environmental conditions at WIPP, including:

- WIPP and its mission.
- The local environment.
- An overview of the methodology used to assess radiological consequences to the public.

Environmental monitoring activities at WIPP generally fall into four categories:

- Collection of samples from various media – air, water, soil, vegetation, fauna, etc., and analyzing them for specific variables.
- Evaluating whether WIPP activities cause adverse environmental impacts.
- Preparing and publishing documents showing compliance or noncompliance with federal, state, and local regulations.
- Taking corrective action when an adverse impact on the environment is identified due to any radiological or non-radiological source.

A number of provisions designed to mitigate potential environmental impacts appear in DOE/WIPP-93-004, Waste Isolation Pilot Plant Land Management Plan, and in statements of work issued to contractors involved in the operation of the WIPP facility. Provisions include:

- Protection of environmental resources including avoidance of unnecessary damage to vegetation, wildlife, and soil by controlling traffic, preventing erosion, minimizing disturbance zones, and cleaning up spills.
- Protection of air resources including mitigation of airborne radioactive contaminants by filtration and containment, the control of hydrocarbon emissions by using approved fuels, the suppression of dust by spraying with water, and the monitoring and control of noise.
- Protection of water resources including the use of lined impoundments such as the sewage treatment system (i.e., Facultative Lagoon System) for controlling suspended materials, solutes, and other pollutants; lined storm water ponds; lined salt storage ponds; lined salt cells; and shipment of radioactive brines from the underground to approved low-level waste facilities for disposal.
- Preservation and recovery of historical, archaeological, and cultural resources including the delay of construction activities as necessary to investigate and mitigate impacts to historical or archaeological resources managed by the WIPP Land Use Coordinator through the land use request (LUR) process.
- Post-construction remediation or reclamation including the removal of temporary construction facilities, access roads, stockpiles, and work areas, as well as the restoration of all damaged landscape features outside the limits of approved work

areas. Existing and new contracts will be reviewed for opportunities for sustainable resilient remediation.

The DOE and MOC must also comply with specified permitting and approval requirements of several federal and state regulatory agencies.

2.0 PROJECT DESCRIPTION

The primary purpose of WIPP is to dispose of defense-generated transuranic (TRU) waste, some of which is TRU-mixed waste. Waste containing more than 100 nanocuries of alpha-emitting TRU isotopes per gram of waste is considered TRU waste, with half-lives greater than 20 years, except for (A) high-level radioactive waste; (B) waste that the DOE Secretary has determined, with the concurrence of the U.S. Environmental Protection Agency (EPA) Administrator, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with Title 10 Code of Federal Regulations (CFR) Part 61, Licensing Requirements for Land Disposal of Radioactive Waste. TRU-mixed waste is TRU waste that is also a hazardous waste as defined by the New Mexico Hazardous Waste Act and 20.4.1.200 New Mexico Administrative Code (NMAC), incorporating 40 CFR § 261.3. The WIPP Land Withdrawal Act established the location, agency responsibilities, and parameters within which such disposal could proceed (Pub. L. 102–579, 1992, as amended by Pub. L. 104–201, 1996).

Contact-handled (CH) and remote-handled (RH) TRU wastes are received and disposed of at the WIPP facility. The CH waste consists of TRU waste that has a surface dose rate not greater than 200 millirem per hour and therefore can be handled without additional shielding to protect personnel. The RH waste is TRU waste that, due to higher levels of penetrating radiation, must be shielded and handled remotely. Waste is classified as RH when the surface dose rate is 200 millirem per hour or greater but not exceeding 1,000 rems per hour.

The CH and RH wastes are emplaced in rooms and adjacent access drifts that have been excavated from the Salado Formation, a thick sequence of salt beds. The disposal horizon is located at a depth of approximately 2,150 feet (655.3 meters). When a disposal room will no longer receive waste for emplacement, ventilation barriers are erected. After waste emplacement is complete in a panel, the panel is removed from active ventilation.

When WIPP is decommissioned, specially designed shaft seals and closure systems will be placed in the excavated shafts and the drifts. Geologic pressures and the plasticity of the salt will result in the excavation’s gradual closure due to salt creep. This closure will encapsulate and isolate waste within the Salado Formation, providing permanent disposal.

3.0 SITE CHARACTERISTICS

3.1 Geography

The WIPP site is located in Eddy County in southeastern New Mexico (figure 3.1) within the Pecos Valley section of the southern Great Plains physiographic province (Powers et al., 1978). The center of the WIPP site is 26 miles (42 kilometers) east of Carlsbad in an area known as Los Medaños (the dunes). Los Medaños is a relatively flat, sparsely inhabited plateau with little surface water. The WIPP site (figure 3.2, excerpted from DOE/WIPP-93-004) consists of 16 sections of DOE-owned federal land in Township 22 South, Range 31 East, New Mexico Principal Meridian.

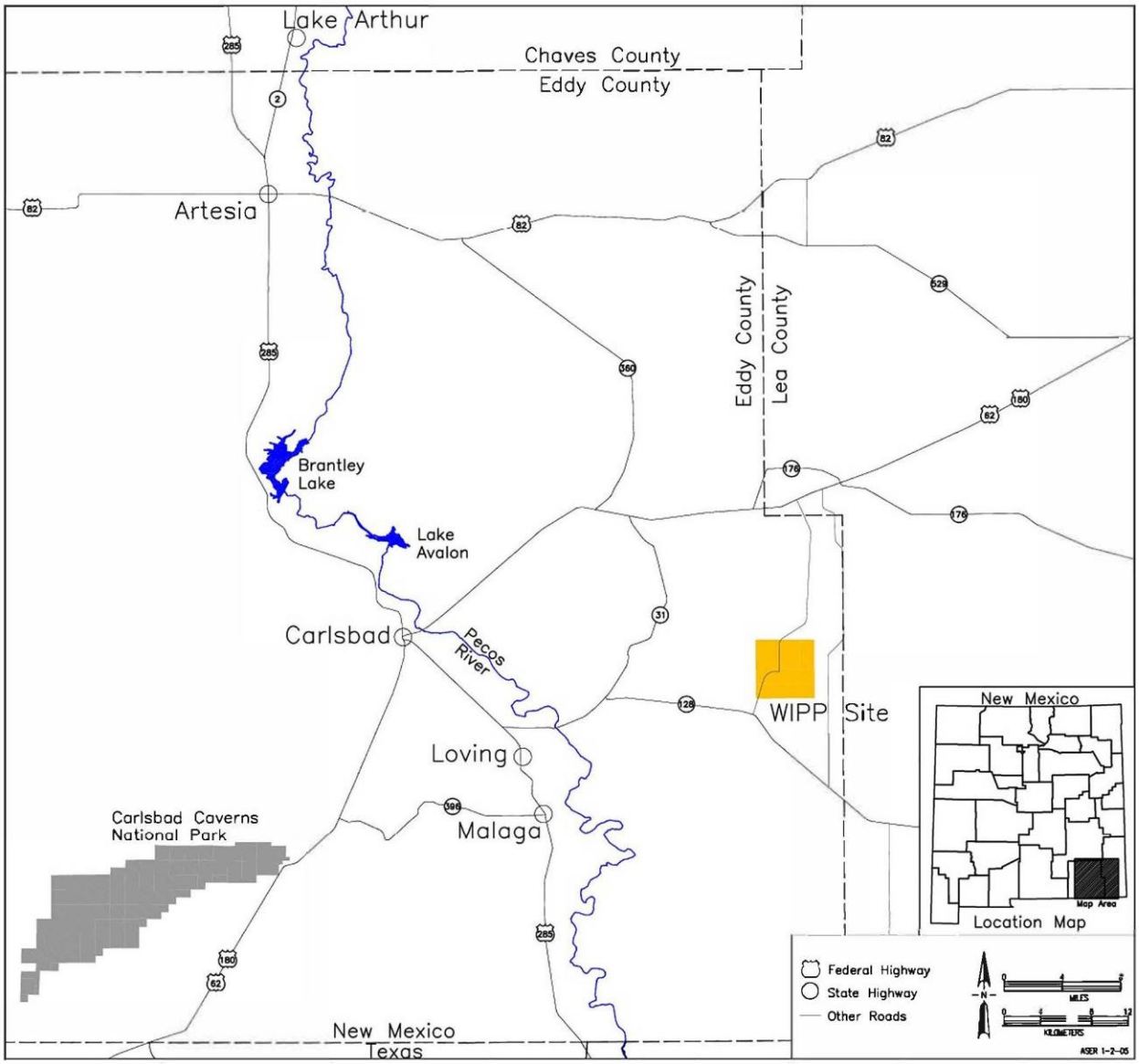


Figure 3.1 – WIPP Site Location

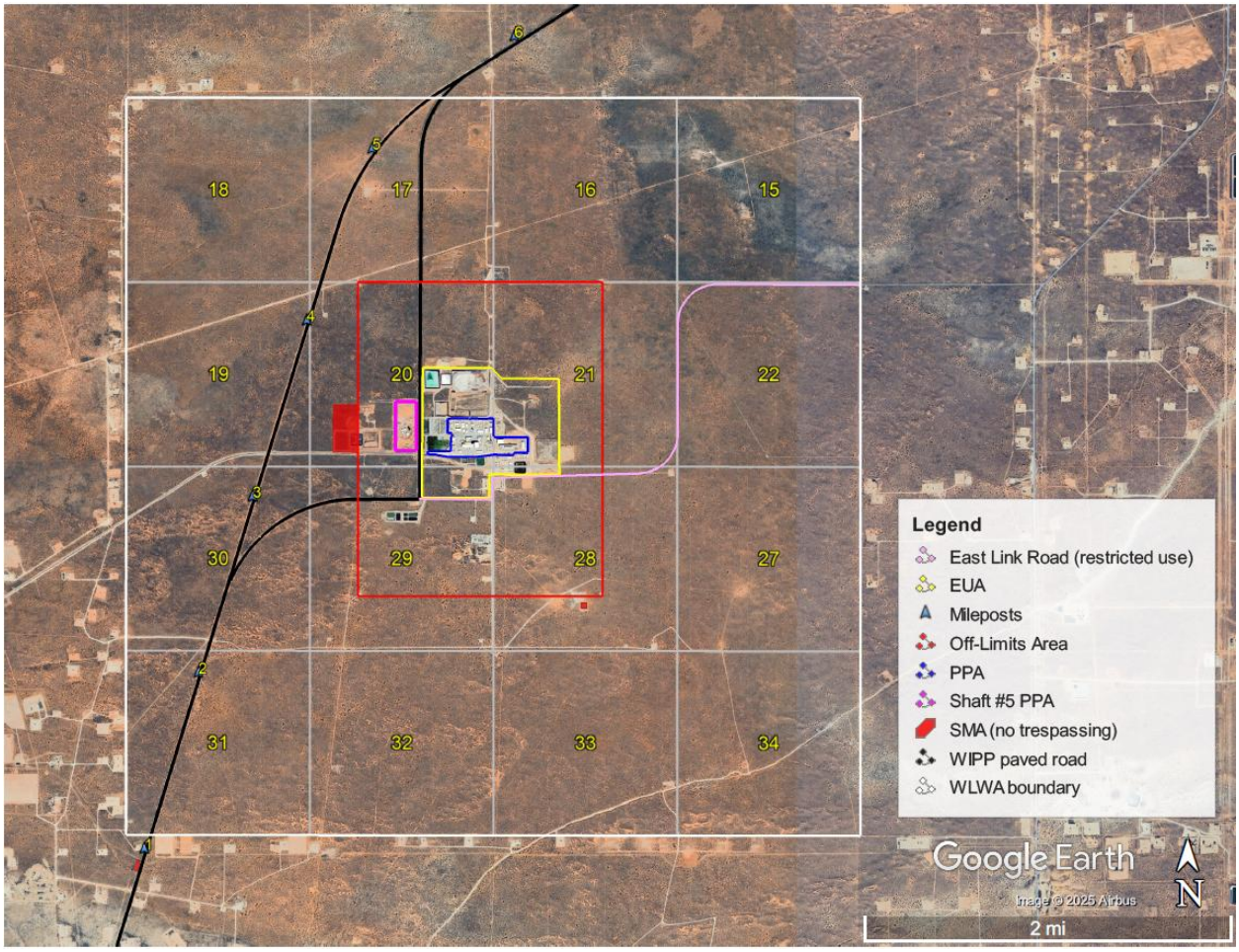


Figure 3.2 – WIPP Site Property Areas

3.2 Geology

The soils of Los Medaños are sandy and well-drained, with a well-developed caliche layer occurring below 3.3 feet (1 meter). There are no integrated natural surface drainage features at WIPP. Scattered throughout the local area are numerous livestock watering ponds (tanks) and shallow playas that retain water sporadically. The nearest of these playas is located approximately 7 miles southwest of WIPP. Geologically, WIPP is part of the northern portion of the Delaware Basin, one of the westernmost sedimentary basins known collectively as the Permian Basin. Figure 3.3 illustrates the local generalized stratigraphy.

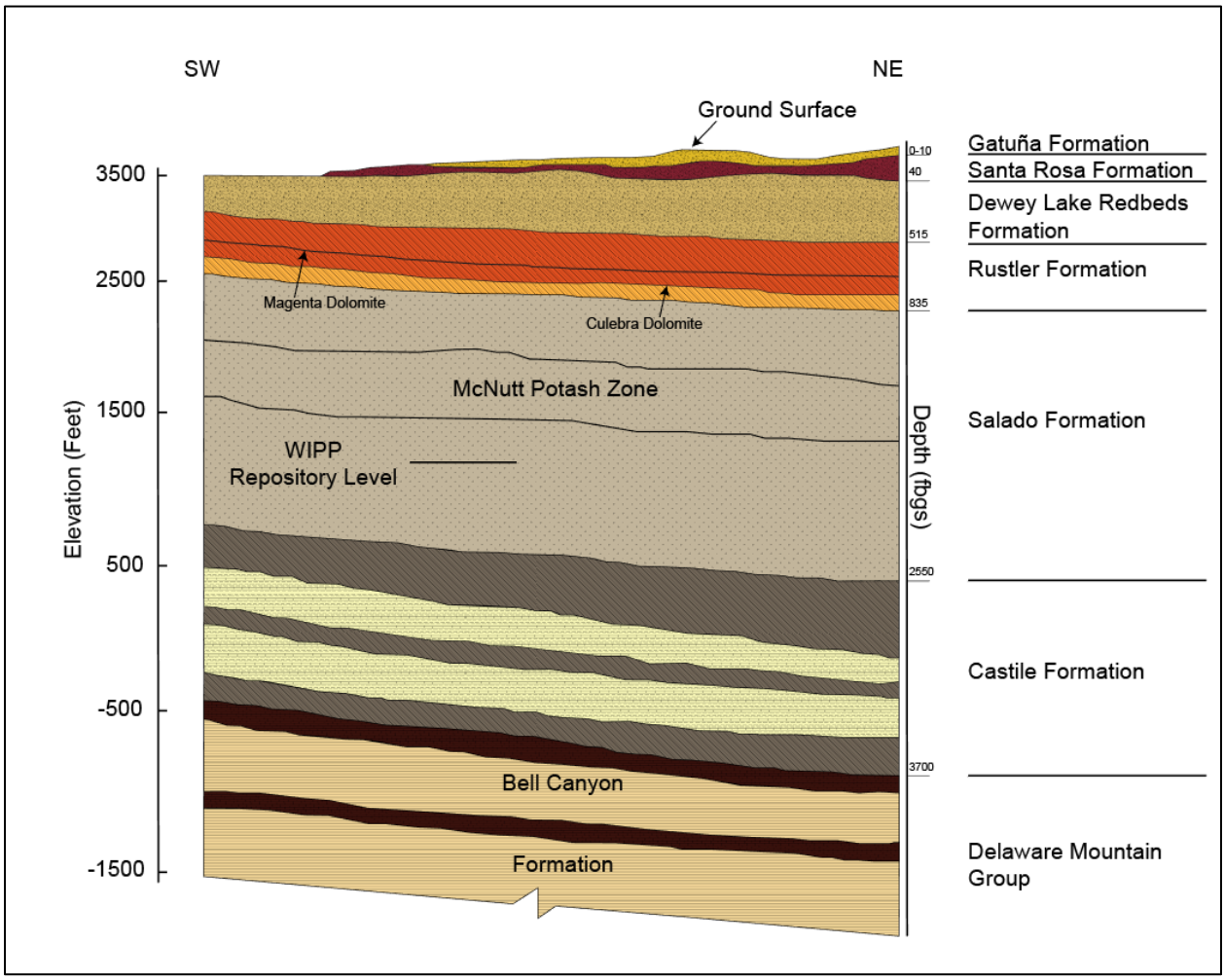


Figure 3.3 – Generalized Stratigraphy of the WIPP Site

3.3 Climate

The climate of the region is semiarid, with variable temperatures, low precipitation and humidity, and a high evaporation rate. Winds are mostly from the southeast and moderate. In late winter and spring, there are strong west winds and dust storms (Environmental Impact Statement, DOE/EIS-0026).

Precipitation at WIPP is relatively low, averaging 11 to 13 inches (28 to 33 centimeters) annually, and is unevenly distributed throughout the year. Winter is the season of least precipitation, averaging less than 0.6 inches (1.5 centimeters) of rainfall per month. Snow averages about 5 inches (13 centimeters) per year at WIPP and seldom remains on the ground for more than a day at a time because of the typically above-freezing temperatures in the afternoon. Approximately half the annual precipitation comes from frequent thunderstorms in June through September (DOE/EIS-0026).

Temperatures are moderate throughout the year, although seasonal changes are distinct. Mean annual temperatures in southeastern New Mexico are near 60 °F (15.6 °C). In the winter (December through February), nighttime lows average near 23 °F (-5 °C), and daytime highs average about 55 °F (12.7 °C). In the summer (June through August), the daytime temperature exceeds 90 °F (32.2 °C) approximately 75 percent of the time (DOE/EIS-0026).

3.4 Hydrology

The nearest large surface water body (Salt Lake) is located approximately 7 miles (13 kilometers) west-southwest of the WIPP site in Nash Draw. The Pecos River is located 14 miles (22.4 kilometers) southwest of the WIPP site.

Several water-bearing zones have been studied near WIPP. The most significant are the Culebra Dolomite and Magenta Dolomite Members of the Rustler Formation, which consist primarily of fractured dolomite. These dolomite units produce brackish to saline water. Another saline zone identified occurs at the Rustler-Salado contact, which contains very little water at the WIPP site. It was exposed during shaft construction and produced only a small amount of brine seepage. Other water-bearing zones that have been evaluated as part of site characterization include the middle Dewey Lake Formation and the overlying Triassic Dockum Group above the repository, and the Bell Canyon and Castile Formations below the repository.

The Dewey Lake Redbeds Formation (Dewey Lake) (figure 3.3), which contains limited amounts of fresh water, is composed of alternating thin, even beds of siltstone and mudstone with lenticular interbeds of fine-grained sandstone. Exploratory drilling during the WIPP site hydrogeologic evaluation did not identify a continuous zone of saturation within the Dewey Lake. The few Dewey Lake wells yielding water for domestic and livestock purposes are believed to be completed in the thin, discontinuous lenticular sands where favorable groundwater recharge occurs (Mercer, 1983). Water in the middle Dewey Lake is a perched natural water-bearing zone as identified in WQSP-6a and PZ-17b.

Unlike the natural groundwater in the middle Dewey Lake (WQSP-6a and PZ-17b), perched anthropogenic water (PAW) occurs beneath the WIPP site at a depth of less than 100 feet below ground surface at the contact between the lower Santa Rosa Formation (Santa Rosa) and upper Dewey Lake. This PAW yields generally less than 1 gallon per minute in monitoring wells and piezometers (PZs) and contains high concentrations of total dissolved solids (TDS) and chlorides. The origin of this water is believed to be primarily from anthropogenic sources (Daniel B. Stephens, 2003). The PAW occurs not only under the WIPP site surface facilities but also about a half mile south of the Waste Handling Shaft (WHS).

The PAW occurs in the uppermost Permo-Triassic Dewey Lake and basal Triassic Santa Rosa. Some wells in the PZ series produced dry cuttings in the uppermost Dewey Lake Formation, indicating that saturation was limited to the Santa Rosa/Dewey Lake formational contact.

3.5 Ecology

The biota of Los Medaños represents a transition between the northern Chihuahuan Desert and the southern Great Plains. The sandy soils form stabilized shrub coppice dunes interspersed with swales.

Shrubs and grasses are the most prominent components of the local flora. The area vegetation is comprised of shinnery oak dune and grassland aspects that include perennial grasses (e.g., grama, dropseed, three-awn) and shrubs (e.g., fourwing saltbush). Honey mesquite is an invasive tree that is ubiquitous in the area.

The area supports an abundant and diverse population of mammals. Black-tailed jackrabbits and desert cottontails are the most observed. Other primary mammals include mule deer, desert-dwelling rodents, and carnivores such as the coyote, gray fox, badger, and striped skunk.

A large variety of bird species are also found in the region. Densities vary according to migration, food, and habitat availability. Scaled quail, mourning dove, loggerhead shrike, pyrrhuloxia, and black-throated sparrows are examples of bird inhabitants. The Harris’s hawk, Chihuahuan raven, Swainson’s hawk, Northern harrier, and American kestrel may be found at WIPP.

Numerous varieties of amphibians and reptiles also occupy the WIPP site and its vicinity. Characteristic reptiles in the region include the western (ornate) box turtle, side-blotched lizard, western whiptail, bullsnake (gophersnake), and prairie rattlesnake. Representative amphibians are the tiger salamander, red-spotted toad, and plains spadefoot toad.

A more detailed listing of biota species occurring near or on the WIPP Land Withdrawal Area is provided in DOE/WIPP-93-004. A summary of the ecological baseline surveys appears in Appendix H of the Final Environmental Impact Statement (DOE/EIS-0026).

4.0 DOSE CALCULATIONS

This section discusses dose calculations involving off-site dose assessment.

DOE/WIPP-07-3372, Waste Isolation Pilot Plant Documented Safety Analysis, section 7.6, Radiation Exposure Control, summarizes the occupational dose limits and administrative control levels at WIPP.

The WIPP environmental program is designed to meet the expectation that during normal operations there is no detectable radiological contamination release to the environment. Even for routine periodic emissions calculations, the dose estimates have proved far below any regulatory limit for a dose to a member of the public.

The DOE, with regards to the WIPP facility, is required to comply with environmental radiation protection standards per 40 CFR Part 191, Subpart A, Environmental Standards for Management and Storage. The WIPP-relevant portion of 40 CFR § 191.03(b) describes limits of facility dose to a member of the public in the general environment and applies at the Exclusive Use Area (EUA) fence line (figure 3.2). This requirement is described in section 2.5 of EPA 402-R-97-001, Guidance for the Implementation of EPA's Standards for Management and Storage of Transuranic Waste (40 CFR Part 191, Subpart A) at the Waste Isolation Pilot Plant (WIPP). Documentation of compliance is acceptable, per section 2.7 of the guidance, using the Clean Air Act Assessment Package-1988 (CAP88-PC) computer code.

WIPP must comply with the reporting requirements established in 40 CFR Part 61, Subpart H, and the memorandum of understanding (MOU) dated May 16, 1995.

Emission monitoring and compliance procedures for DOE facilities (40 CFR § 61.93[a]) require the use of CAP88-PC or other approved procedures, to calculate effective dose equivalents to members of the public. Calculations using the CAP88-PC model are made to verify that the annual effective dose equivalent to the maximally exposed individual, resulting from normal operations conducted at the WIPP facility, is below the 10-millirem-per-year limit given in 40 CFR Part 61, Subpart H, and the 0.1-millirem-per-year-limit for periodic confirmatory measurements (1.0 percent of 10 millirem per year), and is within the public dose limits of DOE Order 458.1.

Annual screening results are reported in the ASER demonstrating compliance with the DOE Order 458.1 dose constraint requirements for the protection of biota.

5.0 ENVIRONMENTAL MONITORING PROGRAM

Each facility under the control of the DOE is required to ensure the early identification of, and appropriate response to, potential adverse environmental impacts associated with operations. This must include appropriate preoperational characterization and assessment, and effluent monitoring. The DOE has complied with this requirement by compiling preoperational radiological and non-radiological data to use as a baseline for evaluating operational monitoring results.

An analysis of the historical preoperational data is contained in the following documents:

- Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Report (DOE/WIPP-98-2285).
- Addendum 1, Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Update Report (IT Corporation, 2000).
- Statistical Summary of the Radiological Baseline for WIPP (DOE/WIPP-92-037).
- Summary of the Salt Impact Studies at WIPP, 1984 to 1990 (DOE/WIPP-92-038).
- A Study of Disturbed Land Reclamation Techniques for the WIPP (DOE/WIPP-92-039).
- Background Water Quality Characterization Report for the WIPP (DOE/WIPP-92-013).

The environmental sampling programs used to establish the preoperational baseline were originally defined in chapter 5 of DOE/WIPP-88-028, Operational Environmental Monitoring Plan for the Waste Isolation Pilot Plant (DOE, 1989). The plan evolved into the current WIPP EMP. This EMP describes the current environmental monitoring efforts at WIPP during the operational (disposal) phase. Environmental monitoring data are summarized and published in the ASER as required by DOE Order 231.1B.

5.1 Guidelines

Effluent monitoring and environmental surveillance programs are conducted in compliance with DOE and other applicable federal, state, and local radiation standards and requirements. It is essential that radionuclides in effluent streams and the ambient environmental media are properly and accurately measured.

The DOE guidance documents (DOE, 1981, 1991, 2015) are utilized to ensure monitoring programs are adequate and demonstrate adequate protection to the public and the environment. These guidance documents state that the factors that should be considered in determining the relative level of environmental surveillance required at a facility include the following:

- Potential hazard of the materials released, considering both expected quantities and relative radiotoxicity.
- Extent to which facility operations are routine and unchanging.
- Need for supplementing and complementing effluent monitoring.
- Size and distribution of the exposed population.
- Cost-effectiveness of increments to the environmental surveillance program.
- Availability of measurement techniques that will provide sufficiently sensitive comparisons with applicable standard and background measurements.

Use of the above factors, and results of the risk analysis in the safety analyses for WIPP, indicate that operational dose estimates for WIPP are significantly below dose criteria, and are consistent with DOE's as low as reasonably achievable (ALARA), 10 CFR § 835.2, Definitions, concept. The WIPP EMP encompasses a comprehensive set of variables that detect environmental impacts. Also, the EMP scope and intensity may be adjusted using a graded approach appropriate to the situation, in response to changing facility processes, environmental conditions, and program results.

The values of the variables measured are derived from environmental radiological analysis of particulates in air; surface water, sediments, soils, and biota; the status of the local biological community; and groundwater quality measurements. Environmental samples are analyzed for natural uranium ($^{233/234}$U, ^{235}U, and ^{238}U) and potassium (^{40}K); TRU actinides expected to be present in the waste, plutonium (^{238}Pu, $^{239/240}$Pu) and americium (^{241}Am); major fission products, cesium (^{137}Cs) and strontium (^{90}Sr); and activation product of reactor structural materials, cobalt (^{60}Co). The WIPP Airborne Effluent Particulate Monitoring Program also monitors for these same radionuclides with the exception of ^{235}U, ^{40}K, and ^{60}Co because they are not part of the source term from CH and RH TRU radionuclides with the highest potential to deliver a dose to an off-site receptor. Plutonium-242 is not analyzed even though it is included among the ten Compliance Certification Application radionuclides. This radionuclide represents a very small fraction of the total activity in the TRU-mixed waste initially emplaced in the repository. It is not a target radionuclide due to the limited presence of this radionuclide and because it is used as a laboratory tracer that is not easily replaced in the radioanalytical process.

Non-radiological portions of the program focus on the WIPP site or immediate area surrounding WIPP, whereas radiological surveillance generally covers a broader geographical area including nearby ranches, villages, and cities within a radius of 50 miles (80 kilometers) from the central point of the WIPP site. Environmental monitoring will continue at WIPP during project operations and through decommissioning and beyond.

The goal of the environmental monitoring program is to determine if the local ecosystem has been impacted during the pre-disposal and disposal phases of WIPP and, if so, to evaluate the severity, geographic extent, and environmental significance. Table 5.1, Environmental Monitoring Sampling, and table 5.2, Environmental Monitoring Sampling Analytical Array summarize the environmental media sampled, frequency, analytical array, and number of sampling stations. These two tables summarize the upper-tier sampling requirements. Other locations may be sampled and additional analyses will be performed as needed. Environmental and ecological sampling during operations will be adjusted, as appropriate, to fit the needs of the project.

The geographic scope of radiological sampling is based on projections of potential release pathways for the types of radionuclides in WIPP wastes, which are primarily through airborne transport. The radioisotopes measured, all of which are particulate in form, are selected from those contained in the repository that have the potential for contributing 10 percent or more of the overall calculated annual dose to a member of the public. Also, the surrounding population centers are monitored, even though release scenarios involving radiation doses to residents of those population centers are improbable.

Sampling and related activities are conducted in accordance with WIPP procedures. Standard sampling practices and techniques are used (see section 6.0, Data Analysis).

Quality assurance has been established within the framework of WP 13-1, Waste Isolation Pilot Plant Quality Assurance Program Description (QAPD), and is referenced in section 7.0 of this EMP. When WIPP data are received, they are verified, validated, evaluated, and presented in the ASER and other various regulatory submittals.

Data are stored in various electronic databases on the network where they are backed up daily. Databases may be considered as spreadsheets, worksheets, workbooks, and other software applications for organizing and storing data electronically. Databases are maintained by the Environmental Monitoring & Hydrology (EM&H) group as data are added. Data are maintained through the records inventory and disposition schedule program per WP 15-RM, WIPP Records Management Program Plan. Each sampling program has a records inventory and disposition schedule, which defines the specific retention times and storage location of the records. When the data retention time for WIPP storage has been achieved, records are sent to the WIPP Records Archive (WRA) for permanent storage. Records are scanned and placed in the Documentum Database maintained by the WRA. Retrieval of records can be from Documentum or files on site depending on the status.

5.2 Radiological Environmental Monitoring

Each sampling subprogram of radiological environmental monitoring is described below.

5.2.1 Airborne Effluent Particulate Sampling

The WIPP facility's effluent particulate monitoring stations (figure 5.1) include:

- Station C – samples represent air exiting the Waste Handling Building stack.
- Station G – samples represent air exiting the Exhaust Shaft through the Underground Ventilation System stack.

Skid-mounted fixed air samplers (FAS) may be used at each station to collect representative samples of airborne particulates. There are primarily two stations used at any given time (Station C and Station G). The Exhaust Shaft outflow station is Station G. Exhaust Shaft outflow FAS filters are routinely collected daily, or as needed. Station C FAS filters are collected weekly, or as needed. These locations are considered a PIC 3 source since the dose has the potential to emit radiological contaminants greater than 0.0001 percent and less than or equal to 0.01 percent of the allowable limit in accordance with the American National Standards Institute/Health Physics Society (ANSI/HPS) standard N13.1-1999 (ANSI, 1999). Filters from these stations are typically analyzed for gross alpha and beta activity after short-lived naturally occurring radioactivity (e.g., isotopes of radon) has decayed. The radioactivity-screened sample filters are then composited and submitted to the analytical lab for isotopic analysis. Generally, Exhaust Shaft outflow samples are composited monthly, and Station C samples are composited quarterly. The results are reported annually in the Annual Periodic Confirmatory Measurement National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance Report, summarized in the ASER, and reported every other year (on an annual basis) in the Biennial Environmental Compliance Report (BECR).



Figure 5.1 – Airborne Effluent Particulate Sampling Locations

5.2.2 Airborne Ambient Particulate Sampling

Air emissions are the most credible exposure pathway to the public from WIPP. Therefore, airborne ambient particulate sampling for alpha-emitting radionuclides is emphasized in the EMP as a primary component of environmental surveillance. Ambient air is the surrounding atmosphere, usually the outside air, as it exists around people, animals, plants, and structures. It does not include the air immediately adjacent to emission sources (DOE, 2015). Air sampling results are used to trend environmental radiological levels and determine if there has been a deviation from established baseline and current background radiological levels.

To determine the number of ambient air sampling stations and their placement, demographic and meteorological data for WIPP were examined to determine the distance to local population centers, the population distribution, and the wind speed frequency distribution and weighing factors, which are scaled to equal the desired number of sampling locations. Locations were selected to avoid areas where large (non-respirable) fugitive dust particles can dominate the sample.

The DOE guidance documents specify maintaining linear flow rates across particulate filters at between 20 and 50 meters/minute (DOE, 1981, 1991, 2015) and a collection height of 1 to 2 meters above ground level which is approximately the height of inhalation for adults (DOE, 2015). Generally, low-volume (LO-VOL) air particulate samplers operate at an average flow rate of 2 standard cubic feet per minute (scfm) (0.056 cubic meters/minute) with a maximum of ± 0.2 scfm (± 0.0056 cubic meters/minute) deviation and a current sample head height between 5 feet 6 inches (1.68 meters) and 6 feet 2 inches (1.88 meters). Filters used for sampling are 47 millimeters, round glass-fiber filters. The linear flow rate is calculated as the flow rate divided by the surface area of the filter. The legacy/current operational flow rate of 2 scfm provides a linear flow rate of approximately 33 meters/minute, which is within the guidance specifications. Legacy installations for samplers were done in accordance with siting criteria contained in regulations and standards in effect at the time (DOE/WIPP 88-025). Location and sample head heights were updated in calendar year (CY) 2014 to meet the basic criteria of DOE guidance and the EPA 40 CFR Part 58 Appendix E, Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring, specifications for PM_{10} particulate air sampling.

The current LO-VOL sampling array (figures 5.2 and 5.3) consists of seven primary sampling stations (designated with subprogram code AL), the locations of which provide as much continuity as possible between baseline and operational data. These legacy/primary LO-VOL samplers are at Carlsbad, Smith Ranch, Mills Ranch, WIPP South, WIPP East, WIPP Far Field, and Southeast Control. These are respectively designated AL-CBD, AL-SMR, AL-MLR, AL-WSS, AL-WEE, AL-WFF, and AL-SEC. The Southeast Control background location is approximately 12 miles southeast of WIPP Station G in the predominant upwind direction from WIPP. One duplicate sampler is installed at a primary sampling location and moved every calendar quarter to a different primary sampling location as a quality control measure. Exclusive of the Carlsbad location, soil and vegetation sampling are also performed near these locations as described in section 5.2.5.

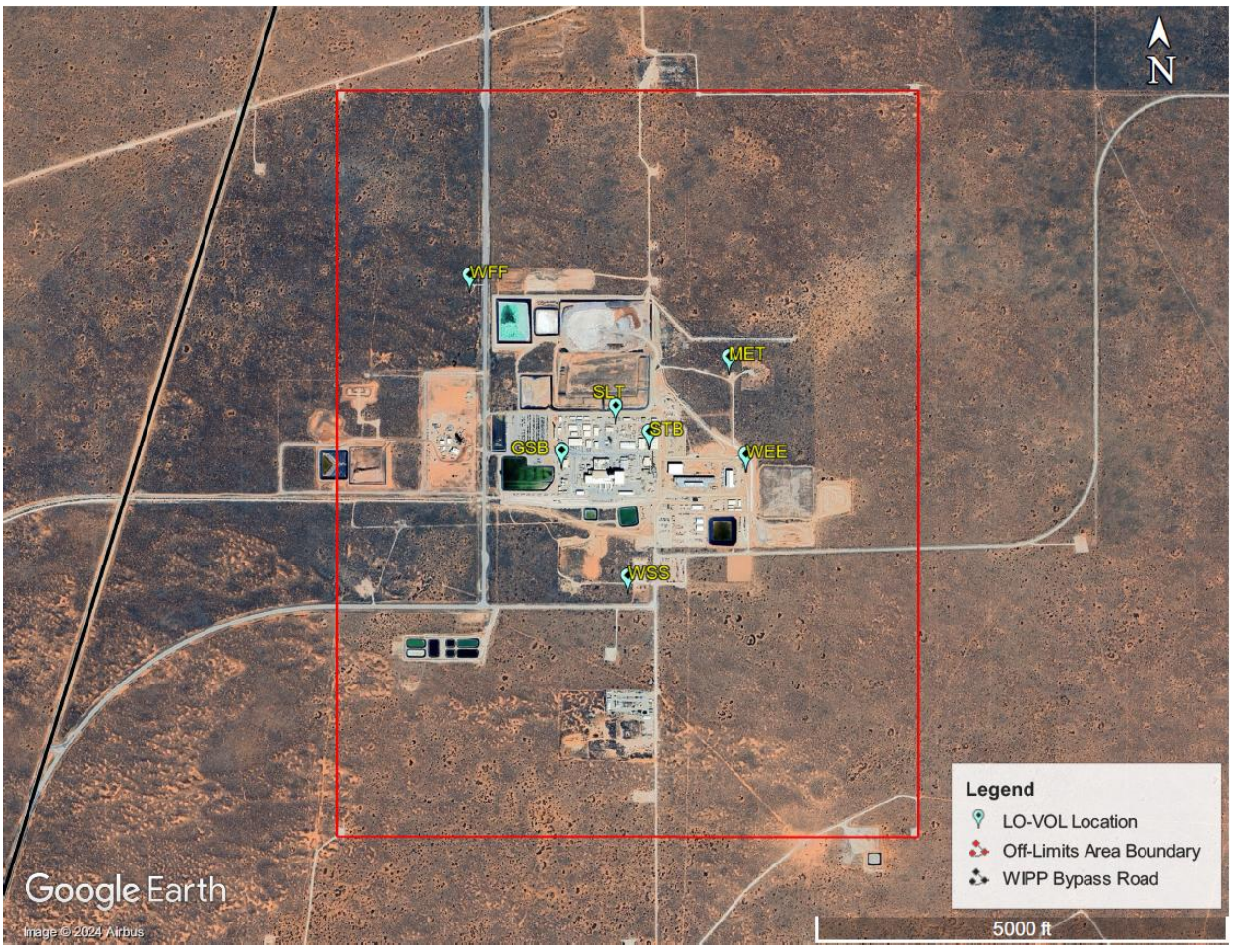


Figure 5.2 – WIPP Airborne Ambient Particulate Sampling Locations

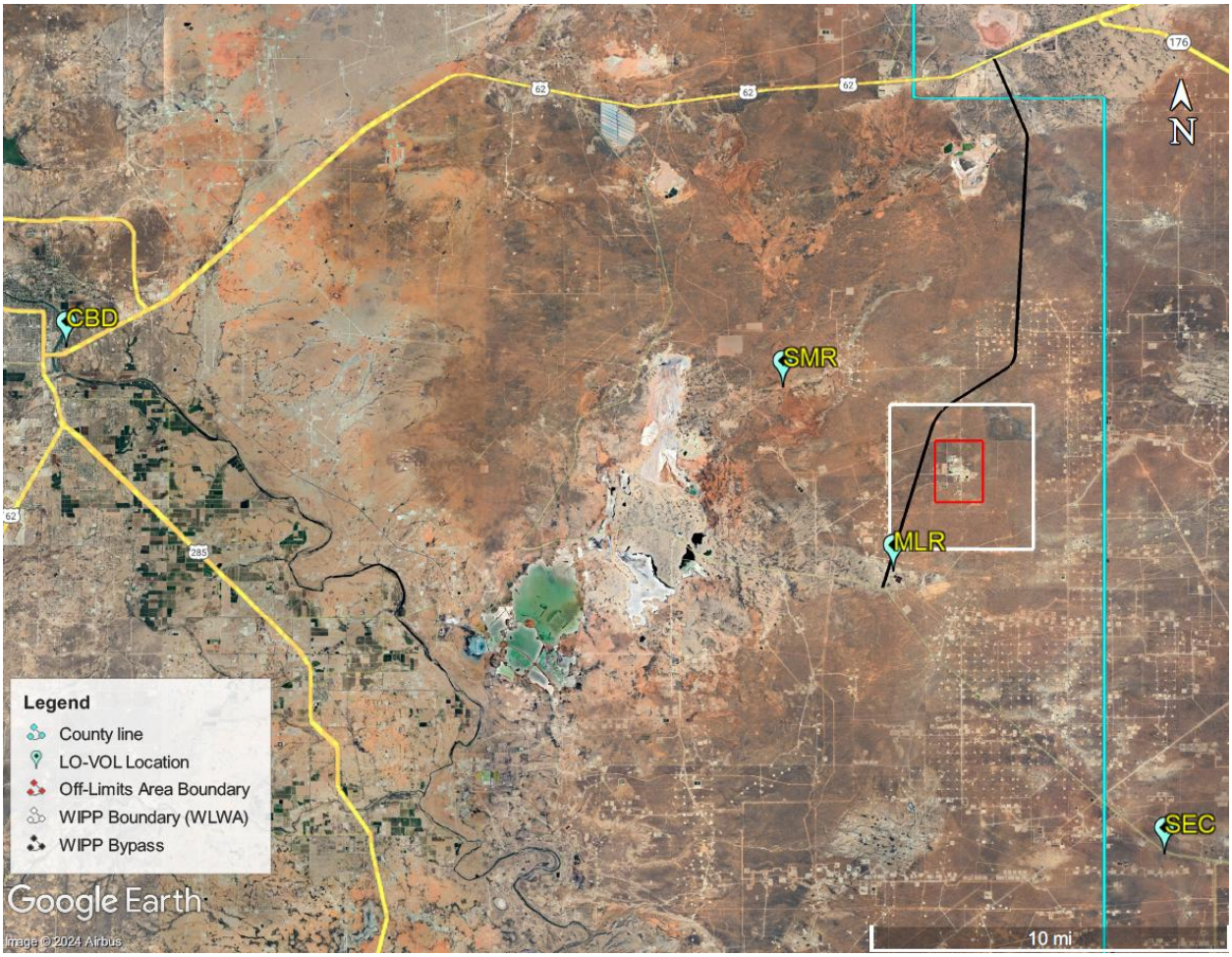


Figure 5.3 – Regional Airborne Ambient Particulate Sampling Locations

Installed in CY 2014 at each of the seven primary locations were event evaluation samplers (designated with subprogram code EE), running with an identical set of operational parameters (e.g., sample head height, flow sample head configuration, flow rates, sample filter type/size, analytical suite when analyzed) as the co-located primary samplers. Co-located samplers are minimally 1 meter apart to preclude airflow interference and no more than 4 meters apart, per 40 CFR Part 58, Appendix E. The EE sample filters are to be preferentially exchanged for screening analysis in the case of an accidental release of radionuclides, leaving the primary sampler to continue to integrate the sample at the location on the normal schedule. These are designated EE-CBD, EE-SMR, EE-MLR, EE-WSS, EE-WEE, EE-WFF, and EE-SEC (figures 5.2 and 5.3).

An additional set of LO-VOL EE samplers was added in CY 2014 (figure 5.2). This set consists of four on-site samplers that collect ambient air both inside the Property Protection Area (PPA), and just outside the PPA within several hundred meters of the PPA fence at selected locations to fill in gaps not covered by the primary samplers. These are designated EE-MET, EE-GSB, EE-SLT, and EE-STB.

Ambient airborne particulate sampling at samplers is performed in accordance with WP 02-EM1012, Airborne Particulate Sampling, which includes steps for exchanging LO-VOL filters, desiccation, weighing, and transmittal to a laboratory for determining gross alpha and beta activity using a gas-flow proportional counter. As needed (e.g., during power outages, or construction activities), portable (solar powered) sampling units can be used and may have slightly different operational parameters. Quarterly composites of filters from each primary location undergo target radionuclide analysis as indicated in table 5.2. Event evaluation sample filters are held as backup for radioisotope analysis as needed. Although these airborne ambient particulate samplers are typically not used as quantitative effluent monitoring samplers, the calculated concentrations may be used to support dispersion estimates derived from the airborne effluent particulate samples or provide backup monitoring.

In the case of a detected, unplanned release, emergency response and radiological control measures include immediate screening of applicable EE samplers for radioactivity by radiological protection teams per WP 12-ER4924, Radiological Field Monitoring.

Table 5.1 – Environmental Monitoring Sampling

Program	Type of Sample	Number of Sampling Locations[1]	Sampling Frequency
Radiological	(1) Airborne effluent particulate	Stations C and G	Periodic/confirmatory (batched as monthly or quarterly composites)
	(2) Airborne ambient particulate	11 (EE at each with 7 co-located AL samples) (figures 5.2 and 5.3)	Weekly (batched as quarterly composites)
	(3) Liquid effluent	WHS sump and other collection points	As needed
	(4) Biotic (wild fauna)		
	Quail species, Rabbits (Desert Cottontail), Javelina (Collared Peccary), Mule Deer	Variable	As available
	(5) Biotic (Beef)	Variable	As available and as permitted by rancher
	(6) Vegetation	6 (figure 5.4)	Annual, as available
	(7) Soil	6 (figure 5.4)	Annual, as available
	(8) Surface water	11 (8 co-located with sediment and 3 on site) (figure 5.4)	Annual, as available
	(9) Sediment	8 (figure 5.4)	Annual, as available
	(10) Groundwater (Detection Monitoring Program [DMP] wells)	6 (figure 5.6)	Annual
	(11) H19, PAW, and Dewey Lake wells (DP-831, Conditions 41 and 57, respectively)	20 (H19 and 19 wells) (figure 5.7)	Minimum one sample within the first year of DP-831 (requirement met in 2022)

Table 5.1 – Environmental Monitoring Sampling (continued)			
Program	**Type of Sample**	**Sampling Locations[1]**	**Sampling Frequency**
Non-radiological	(12) Meteorology	1	Continuous
	(13) Volatile organic compound (VOC) Monitoring – Permit Part 4 and Attachment N		
	VOCs – Surface	2	2 times per week
	VOC – Disposal Room	Variable, based on number of rooms with emplaced waste in active panel	Routinely once every two weeks; increasing to weekly as needed per Permit conditions
	(14) Groundwater (DMP wells)	6 (figure 5.6)	Annual
	(15) PAW and Dewey Lake wells (DP-831, conditions 57, 58, and 59)	19 (figure 5.7)	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 (one sample requirement met in 2022)
	(16) H19 and Salt Storage Pond 4 (DP-831, condition 40)	2 (figure 5.7)	Semi-annual
	(17) Effluent Lagoon A (DP-831, condition 34)	1 (figure 5.7)	Semi-annual
	(18) Effluent Lagoon B and C (DP-831, condition 35)	2 (figure 5.7)	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[2]
Non-radiological	(20) Salt Storage Ponds 1, 2, 3, and 5 (DP-831, condition 47)	4 (figure 5.7)	Annually after a significant storm event[2]
	(21) H19 inorganics and organics (DP-831, conditions 41 and 42, respectively)	1 (figure 5.7)	Minimum one sample within the first year of DP-831 (requirement met in 2022)
	(22) BRPE and BRPW (DP-831, condition 44).	2	Quarterly rotation, a minimum of four consecutive quarterly sampling events

[1] Values presented are location counts. Actual sample numbers may be higher when including duplicates and blanks. The number of certain types of samples taken can be impacted by access restrictions or location conditions. 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 also vary. For example, the number of rabbits available as samples of opportunity will vary.
[2] A significant storm event is defined as the DP-831 threshold of 2 inches or greater in a 24-hour period.

Table 5.2 – Environmental Monitoring Sampling Analytical Array	
Type of Sample	**Analysis**
(1) Airborne effluent particulate	^{241}Am, ^{137}Cs, ^{238}Pu, $^{239/240}$Pu, ^{90}Sr, $^{233/234}$U, ^{238}U
(2) Airborne ambient particulate	Target radionuclides[1], gross alpha, gross beta, and total suspended particulate weight and air volume. Gross alpha and beta weekly; radionuclides for quarterly composites.
(3) Liquid effluent	Target radionuclides[1]
(4) Biotic (wild fauna)	Target radionuclides[1]
(5) Biotic (beef)	Target radionuclides[1]
(6) Vegetation	Target radionuclides[1]
(7) Soil	Target radionuclides[1]
(8) Surface water	Target radionuclides[1]
(9) Sediment	Target radionuclides[1]
(10) Groundwater (DMP wells)	Target radionuclides[1]
(11) H19, PAW, and Dewey Lake wells (DP-831, conditions 41 and 57, respectively)	Radioactivity: combined ^{226}Ra and ^{228}Ra
(12) Meteorology	Temperature, wind speed, wind direction, precipitation, relative humidity, barometric pressure, and solar radiation
(13) VOC (air) monitoring	Permit-required target VOCs, tentatively identified VOCs, and other VOCs as requested or directed by the New Mexico Environment Department
(14) Groundwater (DMP wells)	Indicator parameters and hazardous constituents[2]
(15) PAW and Dewey Lake wells (DP-831, conditions 57, 58, and 59)	Condition 57, first-year field parameters for temperature, pH, specific conductance (field measure); uranium; combined ^{226}Ra and ^{228}Ra Condition 58, semi-annual field parameters for temperature, pH, and specific conductance; SO_4, TDS, Cl Condition 59, semi-annual for total Kjeldahl nitrogen (TKN) and NO_3-N (for PZ-17a and PZ-17b only)
(16) H19 and Salt Storage Pond 4 (DP-831, condition 40)	SO_4, TDS, Cl
(17) Effluent Lagoon A (DP-831, condition 34)	TKN, NO_3-N, TDS, Cl, SO_4
(18) Effluent Lagoons B and C (DP-831, condition 35)	TDS, Cl, SO_4
(19) Storm Water Ponds 1, 2, and 3 (DP-831, condition 39)	SO_4, TDS, Cl
(20) Salt Storage Ponds 1, 2, 3, and 5 (DP-831, condition 47)	SO_4, TDS, Cl
(21) H19 inorganics and organics (DP-831, conditions 41 and 42, respectively)	Inorganics listed in condition 41 Organics listed in condition 42
(22) BRPE and BRPW (DP-831, condition 44)	Every constituent listed in subsection A of NMAC 20.6.2.3103 (standards for groundwater of 10,000 mg/L TDS concentration or less)

[1] Target radionuclides: ^{241}Am, ^{60}Co, ^{137}Cs, ^{40}K, ^{238}Pu, $^{239/240}$Pu, ^{90}Sr, $^{233/234}$U, ^{235}U, ^{238}U

[2] Permit Part 5, Section 5.4. Specific hazardous constituents required by Permit appear in 40 CFR Part 264, Appendix IX.

5.2.3 Liquid Effluent Sampling

DOE Order 458.1 sets dose limits and requires monitoring of liquid effluent streams. The most recent DOE handbook update, Environmental Radiological Effluent Monitoring and Environmental Surveillance, DOE-HDBK-1216-2015 (DOE, 2022), sets the standard for meeting the requirements of DOE Order 458.1. Liquid effluent sampling is necessary to quantify radionuclides released to the environment and to alert operators of process inconsistencies and malfunctions of system controls.

Above-ground condensation from underground ventilation ducts, and seepage from the repository passages and shafts contribute a stream of potentially radiologically contaminated aqueous fluids that is managed within site radiological controls. Fluids determined to be detectably contaminated are shipped to an offsite facility authorized to accept such materials for disposition. None of these fluids are released to the environment at the WIPP site.

There is a sump in the WHS that collects liquids from throughout the WHS, as well as interceptor wells that collect water from beneath the mine floor. Water collected from these sources may be sampled and analyzed for target radionuclides as shown in table 5.2. The liquid effluent would then be characterized and disposed of in accordance with applicable regulations.

Brine collected from the ventilation ducts and the underground repository are sampled and analyzed for radioactive and hazardous waste constituents. Since the only hazardous waste constituents that can reasonably contaminate the brine associated with the repository are the metals, total Resource Conservation and Recovery Act (RCRA) metals are performed on the brine to determine the hazardous waste characterization of the brine.

As discussed above, water collects in various places from either condensation or groundwater seepage. Examples include:

- In the ventilation ductwork on the surface, water condenses on the walls of the ductwork where it dissolves salt from the mine air. The ductwork brine drains into collection basins.
- The WHS has a sump located at the bottom of the shaft. Water collects in the sump from condensation on the walls of the shaft and by groundwater seepage. This water dissolves salt on the sides and in the sump of the WHS and then collects in the shaft sump.
- Interceptor wells collect water from beneath the mine floor and is pumped into tanks considered a RCRA central accumulation area (CAA).

Because the water dissolves salt in these instances, the water becomes saturated with salt and becomes brine.

Water is pumped from the various collection basins at the ventilation ductwork and the WHS sump into 300-gallon totes. The full totes are staged in an area designated as a radiation area and are managed as mixed low-level radiological waste pending analyses. Samples are taken from the totes and may be analyzed for RCRA heavy metals, plutonium, and americium.

Water is pumped from the underground interceptor wells into two 275-gallon tanks at the CAA. When the tanks are full, they are emptied into totes and brought to the surface and staged in an area designated as a radiation area and are managed as mixed low-level radiological waste pending analyses. Samples are taken from the totes and may be analyzed for RCRA heavy metals, plutonium, and americium.

Depending on the outcome of the analyses mentioned above, the brine can be disposed of in one of four ways:

1. If no RCRA or radiological constituent is detected, then the brine will be disposed of in Evaporation Pond H-19 (H19).

2. If only RCRA metals are detected, then the brine will be disposed of as hazardous waste at a permitted off-site facility.

3. If only plutonium and/or americium are detected, then the brine will be disposed of as low-level radiological waste at a permitted off-site facility.

4. If RCRA metals are detected along with plutonium and/or americium, then the brine is disposed of as mixed low-level radiological waste at a permitted off-site facility.

5.2.4 Biotic Sampling

Biotic sampling (wild fauna) is authorized under a collector’s permit issued by the New Mexico Department of Game and Fish (NMDGF) and is performed in accordance with WP 02-EM1011, Biotic Sampling. Samples are collected in the same general area as other sample media (see figure 5.4) and as allowed by permit. In addition, beef from range cattle is collected when available and authorized by the rancher. Collection and analysis of biotic samples (e.g., quail, rabbit [cottontail], beef, mule deer, and javelina) will accomplish the following:

- An evaluation of the potential radiation doses received by way of human consumption.
- A prediction of the possible contaminant concentrations in available biota.
- Monitoring of trends in environmental contamination and possible long-term accumulation of radionuclides.

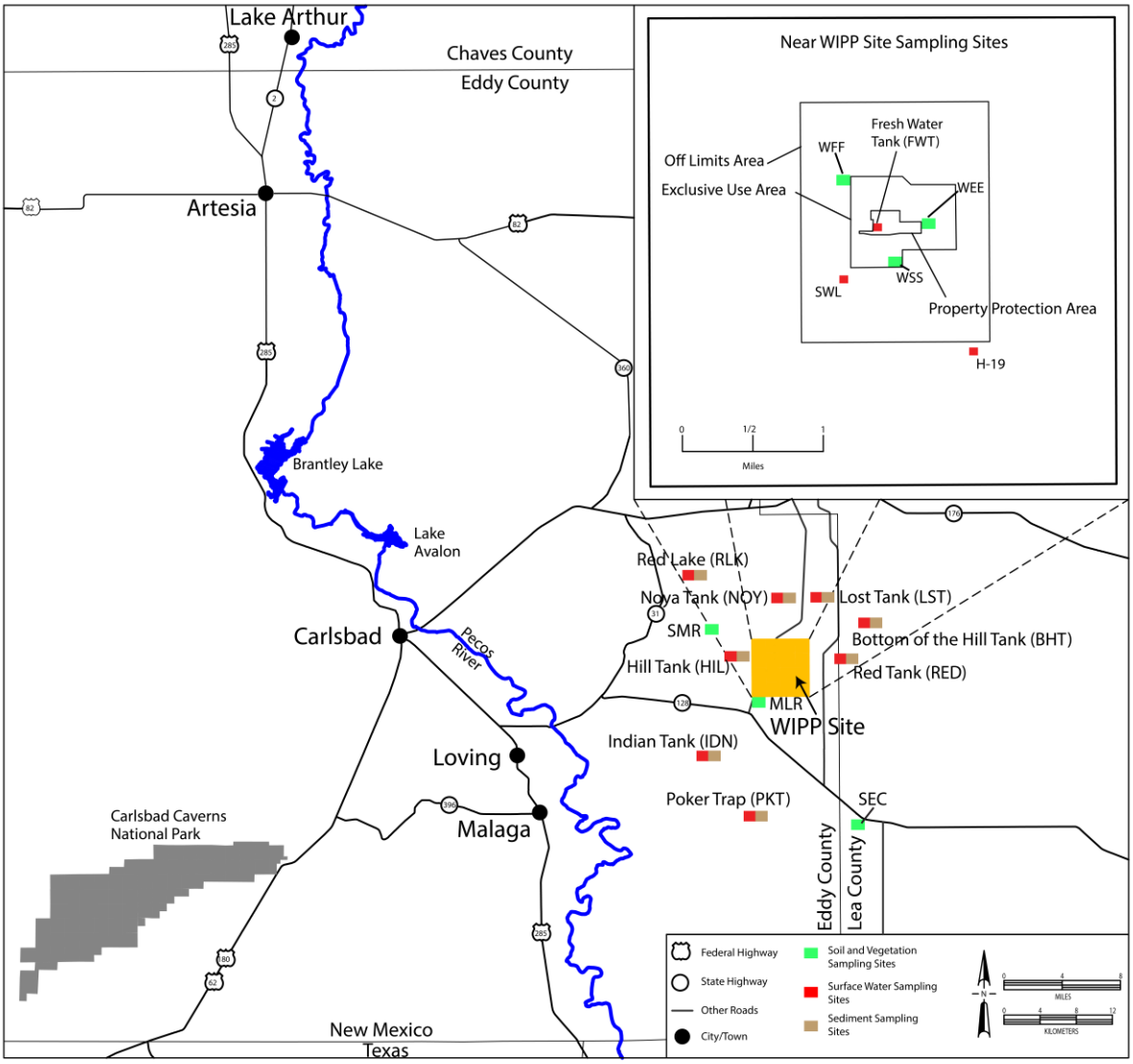


Figure 5.4 – Radiological Sampling Locations

DOE-HDBK-1216-2015 (DOE, 2022) indicates that game birds and mammals hunted locally should be sampled to verify the radionuclide levels available for public uptake. The original basis for sampling game at WIPP recommended collection during the hunting season within 25 km of WIPP (DOE/WIPP 88-025), but samples can also be collected during the year when the opportunity arises. Quail are collected annually, as available, near the WIPP site using baited traps. Range cattle (beef), mule deer, rabbit (cottontail), and javelina (collared peccary) sampling is opportunistic, primarily through animal/vehicle collisions on the roads in the WIPP vicinity. For quail and rabbit, collection and analysis of whole samples (as found) are performed. This reduces the handling of the samples and thus the potential for contamination and is conservative when considering typical human consumption. For quail, several specimens are composited to

meet analytical mass requirements. For mule deer, javelina, and cattle, muscle tissue (with organ tissue, as feasible) is removed for sample analysis. Samples are analyzed as shown in table 5.2.

5.2.5 Soil and Vegetation Sampling

Soil and vegetation samples are collected annually from the six locations shown in figure 5.4. Routinely, one location is randomly selected each year for a duplicate collection. Sampling locations are co-located in the vicinity of six of the legacy air particulate sampling locations, as recommended in HASL-300, Environmental Measurement Laboratory Procedures Manual (DOE,1997), and DOE-HDBK-1216-2015 (DOE, 2022). The annual frequency of sampling also follows the guidance contained in DOE-HDBK-1216-2015 (DOE, 2022) for obtaining long-term accumulation trends. Samples are currently being collected per WP 02-EM1009, Soil and Vegetation Sampling. Soils are routinely collected in three nominal incremental profiles: surface (shallow) soil (0 to 2 centimeters [0 to 0.8 inches]), intermediate soil (2 to 5 centimeters [0.8 to 2 inches]), and deep soil (5 to 10 centimeters [2 to 4 inches]). The soil and vegetation samples are analyzed as indicated in table 5.2, and the analytical results are compared to background levels shown as time-series plots in the ASER.

5.2.6 Surface Water Sampling

Surface water collection is performed in accordance with WP 02-EM1017, Surface Water and Sediment Sampling at 11 locations. Routinely, two locations are randomly selected each year for a duplicate collection and a sample of a deionized water blank is included. Surface water samples are co-collected with sediment samples annually (see table 5.1), from up to eight off-site locations, in the WIPP vicinity as shown in figure 5.4. Naturally occurring surface water is absent within the WIPP Land Withdrawal Area. The sampling locations selected represent potential livestock uptake locations in the WIPP vicinity and provide time-series data concerning the surface water pathway. Eight surface water catchment basins are used by area ranches to collect precipitation runoff water for livestock. These are Noya Tank, Red Tank, Indian Tank, Lost Tank, Bottom of the Hill Tank, Poker Trap, Red Lake, and Hill Tank. Red Lake is within 1 mile of the Tut Tank location (eliminated in CY 2023) and has fewer access problems. Analyses are performed as specified in table 5.2. Some of the locations are on private property and are sampled when access is granted and when water is available.

Three on-site surface water locations do not have concurrent sediment sampling requirements. These locations are Fresh Water Tank (FWT), H19, and Sewage Lagoon (SWL). Domestic water at the site is sampled from the pump house as surface water with location code FWT. This water is from the WIPP water supply system (Double Eagle), piped in from a remote public water-well source, but is categorized as surface water because it is altered due to on-site chlorination and sampled from a faucet in the pump house. The pump house and associated tankage is the facility that receives and stores the fresh water that is supplied to the site. This water and samples from H19 and Facultative Lagoon System (composite of available water in the lagoons and identified as SWL) are sampled annually and analyzed for the constituents listed in table 5.2.

The Facultative Lagoon System and H19 also have non-radiological analysis requirements, to meet DP-831 requirements, as discussed in section 5.3.5.

All the sampling in the environmental surface water monitoring program is conducted using a grab sample technique. There are no permanent sample stations, equipment, or conduit tubing involved in using this technique.

5.2.7 Sediment Sampling

Sediment sampling is performed in accordance with WP 02-EM1017, Surface Water and Sediment Sampling at eight locations shown in figure 5.4. Routinely, one location is randomly selected each year for a duplicate collection. Sediment samples are collected annually from near the WIPP site and analyzed for target radionuclides noted in table 5.2. The sediment sample locations are co-located with eight off-site surface water sample locations. The analytical results for the sediment sample analysis are reported annually in the ASER and serve to provide data for long-term trend assessments.

5.2.8 Groundwater Sampling

Groundwater, which may potentially be affected by DOE operations, must be monitored to detect and document the effects of such operations on groundwater quality and to show compliance with applicable federal and state laws and regulations. The Groundwater Monitoring Programs (GMPs) are conducted on or near the WIPP site to:

- Obtain data to determine baseline conditions of groundwater quality.
- Demonstrate compliance with and implementation of applicable regulations and DOE orders.
- Provide data for the early detection of groundwater contamination.
- Identify existing and potential groundwater contamination sources and to monitor these sources.
- Provide data upon which decisions can be made concerning land disposal practices and the management and protection of groundwater resources.

Though listed under the radiological program, meeting the requirements of DOE Order 458.1 and the guidelines of the DOE Handbook of Environmental Radiological Effluent Monitoring and Environmental Surveillance, DOE-HDBK-1216-2015 (DOE, 2022), the GMP also supports the Detection Monitoring Program (DMP) as mandated by 20.4.1 NMAC and the EPA Compliance Certification Application as mandated by 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. These DMP requirements dictate a broader set of non-radiological indicator parameters and hazardous constituents for measurement. The GMP includes two subprograms, the Water Level Monitoring Program (WLMP) and the DMP.

The WLMP involves collecting monthly water level measurements from available Culebra wells (figure 5.5) at and near WIPP, in accordance with Permit Attachment L, Table L-4 and WP 02-1, WIPP Groundwater Monitoring Program Plan. Groundwater surface elevations are monitored monthly to supplement the area water-level database and to help define regional changes in groundwater gradients and flow directions. These data are reported with Permit-required groundwater reports and in the ASER. Groundwater level measurements are performed in accordance with WP 02-EM1014, Groundwater Level Measurement. The collection of groundwater-level data assists the DOE in meeting performance assessment requirements, regulatory compliance requirements, and permitting requirements.

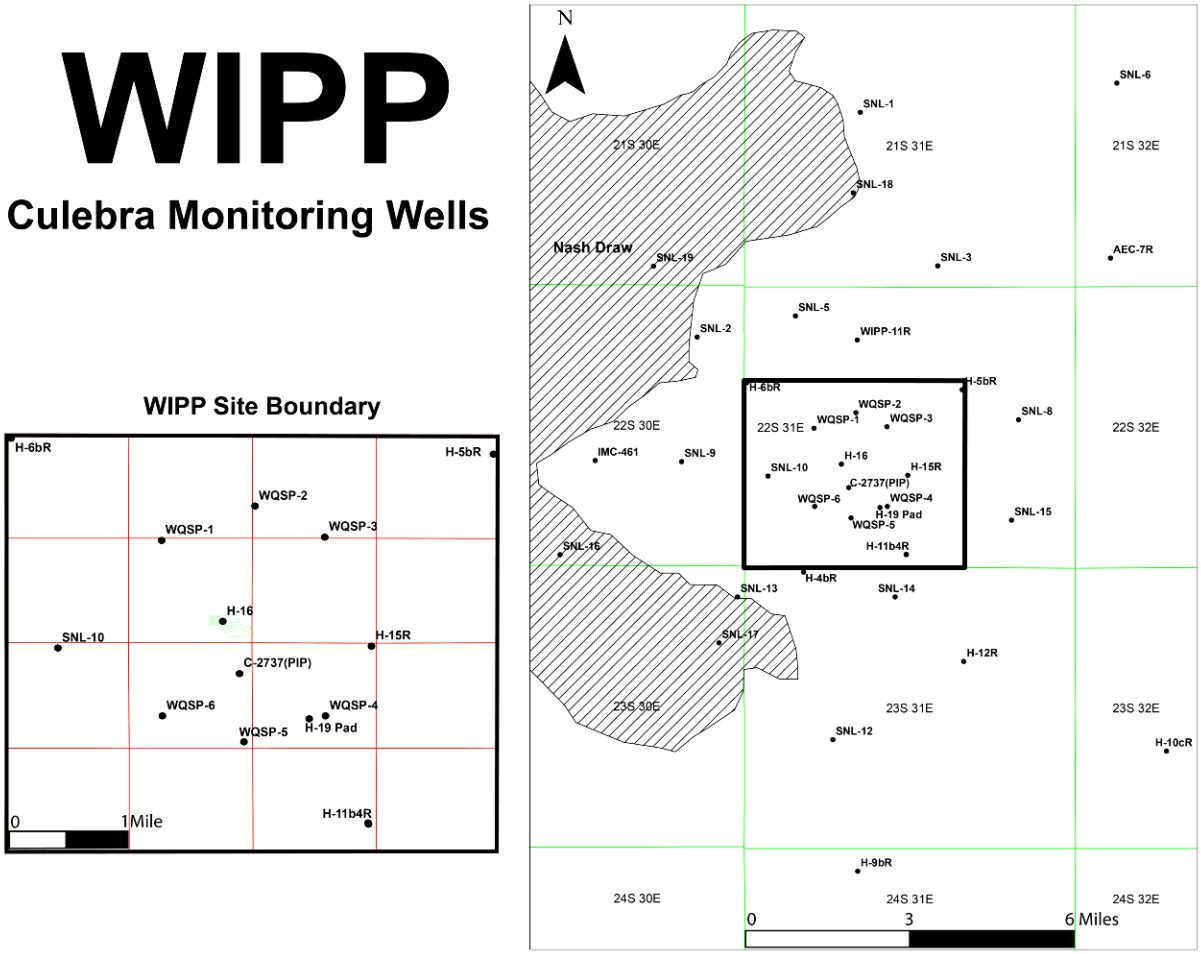


Figure 5.5 – Groundwater Level Surveillance Wells

The DMP groundwater samples are collected from the wells illustrated in figure 5.6. Both field parameters and final samples are collected. Field parameter measurements are taken at regular intervals and analyzed in the mobile field laboratory for various physical and chemical characteristics, called field indicator parameters. The field parameter data are used to determine whether the sample is representative of undisturbed groundwater as a direct function of the volume of water being purged from the well. As required by the

WIPP Hazardous Waste Facility Permit (Permit), the wells will be purged no more than three well-bore volumes or until field parameters have stabilized, whichever occurs first, before final samples are collected. The final samples are sent to an analytical laboratory for analysis of hazardous constituents and indicator parameters. Samples are also sent for analysis of target radionuclides shown in table 5.2. The protocols for the collection and analysis of final samples and field parameter measurements are contained in WP 02-EM1010, Field Parameter Measurements and Final Sample Collection.

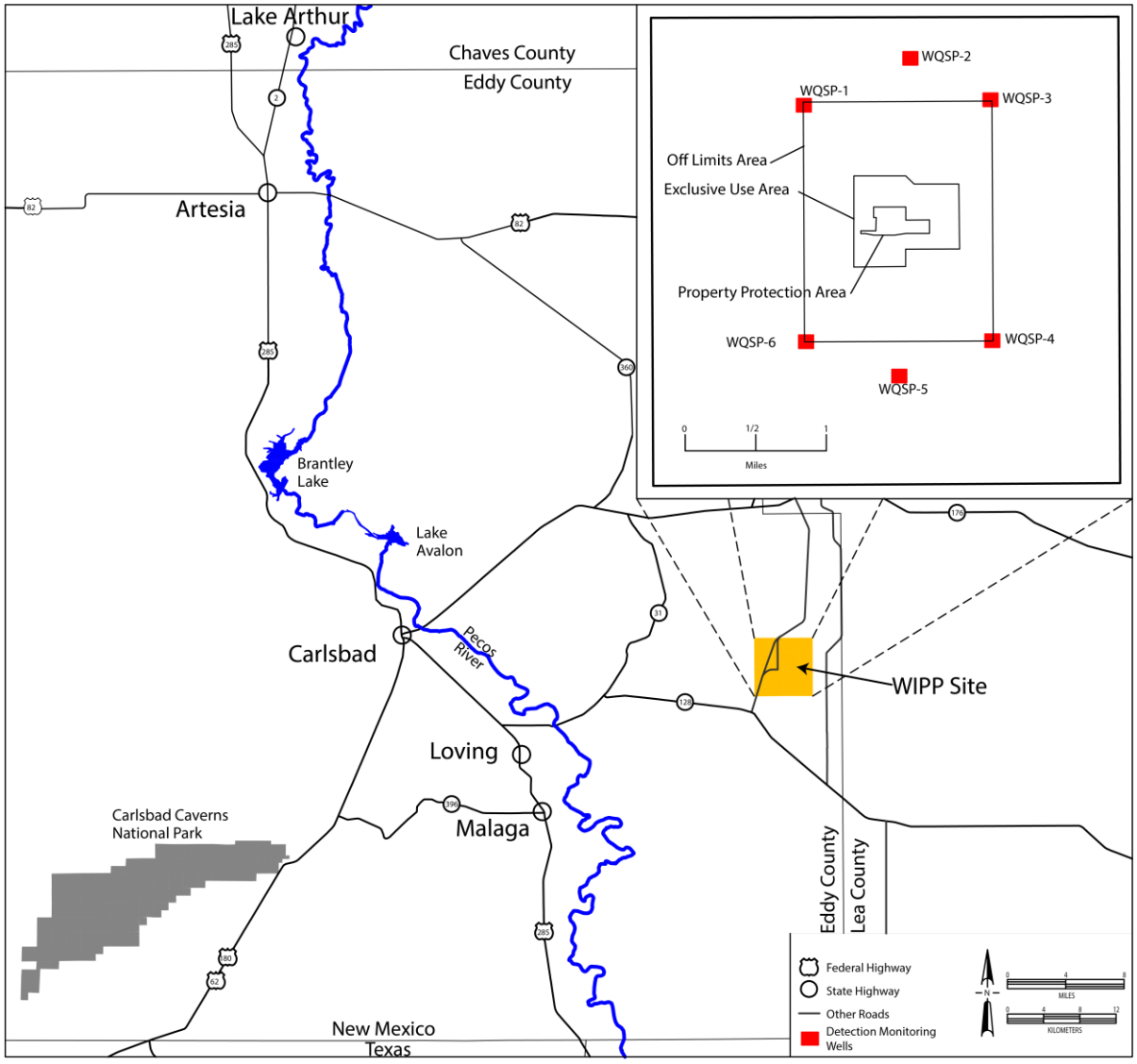


Figure 5.6 – Detection Monitoring Program Wells

DMP sampling is performed annually in six wells at WIPP. Duplicates and blanks are also routinely collected for each well. WQSP-1 through WQSP-6 are completed in the Culebra Dolomite Member of the Rustler Formation. The wells are constructed to EPA standards to

meet the DMP standards under the Permit. The analytical results for samples collected from the DMP wells are reported as required by the Permit and in the ASER.

5.3 Non-radiological Environmental Monitoring

Non-radiological environmental monitoring activities at WIPP are governed by a comprehensive set of sampling programs designed to detect and quantify the impacts of construction and operational activities. The requirements and objectives of both preoperational and operational non-radiological environmental monitoring are described in the Final Environmental Impact Statement (FEIS), Waste Isolation Pilot Plant (DOE/EIS-0026).

5.3.1 Meteorological Monitoring

Atmospheric releases are the most credible pathway during WIPP operations. The WIPP Meteorological Program, established according to DOE-HDBK-1216-2015 (DOE, 2022), addresses the monitoring of potential releases. DOE-HDBK-1216-2015 (DOE, 2022) provides guidance on how each DOE site is to establish a meteorological monitoring program appropriate for the activities at the site and for the local topography and demography. Meteorological variables are monitored and recorded to supplement the characterization of the local environment and facilitate the interpretation of data from other environmental monitoring activities at WIPP. The WIPP Meteorological Program is performed in accordance with WP 02-EM.01, WIPP Meteorological Program, which was written with the guidance contained in EPA-454/R-99-005, Meteorological Monitoring Guidance for Regulatory Modeling Applications.

The meteorological monitoring station is a 52-meter (170-foot) tower located in the northeast corner of the EUA. Temperature, wind speed, and wind direction are monitored at 2, 10, and 50 meters (7, 33, and 164 feet, respectively); barometric pressure, humidity, solar radiation, and precipitation are also monitored at this location. Measurements are recorded in the Central Monitoring System, which tracks numerous real-time variables on a centralized computer system. Data are sent off to be validated and certified by a qualified meteorologist before use in transport and dispersion analyses for safety-basis documents.

5.3.2 VOC Monitoring

A Repository VOC Monitoring Program (RVMP) was initially implemented as specified in the Permit after approval by the New Mexico Environment Department (NMED) on October 27, 1999. The VOC monitoring program is a requirement per Permit Part 4 and Attachment N. The RVMP is designed to monitor the VOC emissions that may be present in the exhaust air from the Underground Hazardous Waste Disposal Units (HWDUs) and that are attributable to TRU-mixed waste emplaced in the underground. The VOC monitoring program’s objective is to confirm that the running annual average risk to the non-waste surface worker due to VOCs in the air emissions from the HWDUs do not exceed the specified Permit regulatory limits. An Underground HWDU is a single excavated panel consisting of seven rooms and two access drifts designated for disposal

of TRU waste. The target analytes selected for monitoring together represent approximately 99 percent of the carcinogenic risk due to air emissions of VOCs.

The Permit-required repository VOC sampling locations are Station VOC-C, located on the west side of Building 489, and a background location, Station VOC-D, near groundwater monitoring well WQSP-4 (figure 5.7). The sampling methods used for VOC monitoring are based on the concepts contained in the EPA Compendium Method TO-15 (EPA, 1999). Routine collection of a 24-hour time-integrated sample is conducted two times per week, per Permit Attachment N, Section N-3d(1). Other sampling details are described in WP 12-VC1685, Subatmospheric Air Sampling in Passivated Canisters.

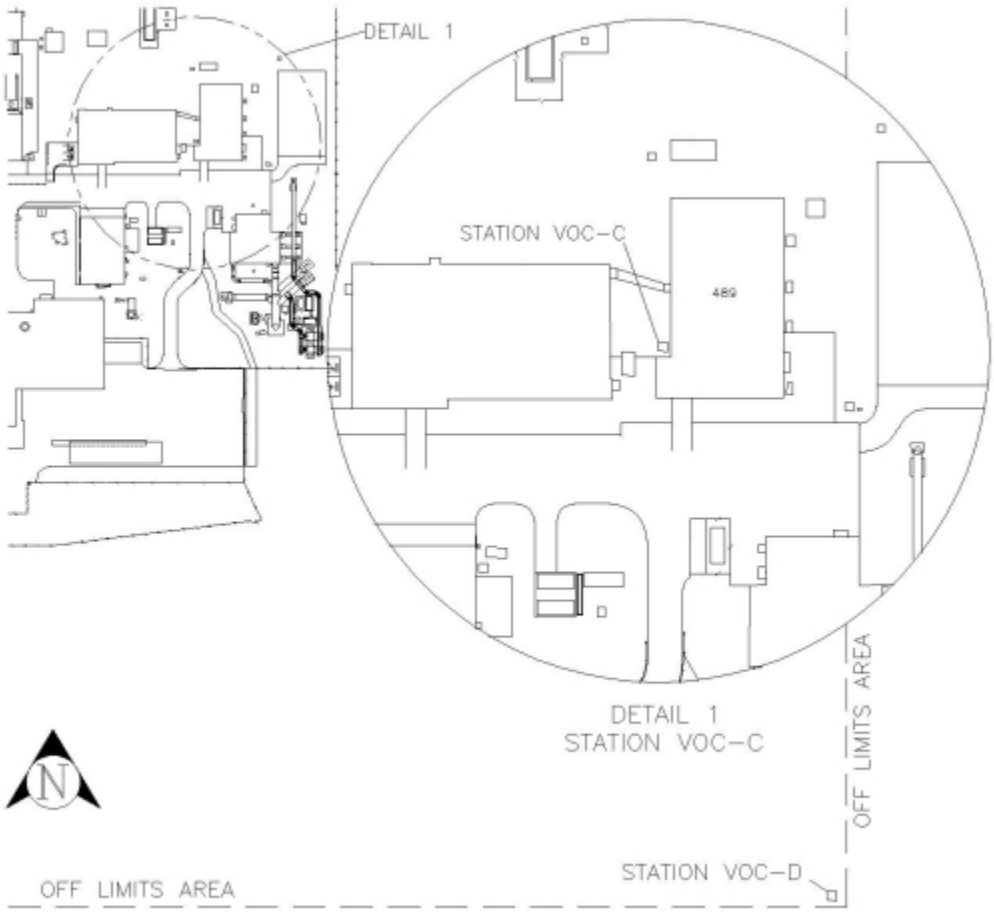


Figure 5.7 Permit-required repository VOC sampling locations (VOC-C and VOC-D)

The Disposal Room VOC Monitoring Program (DRVMP) is designed to measure airborne VOC concentrations within disposal rooms of open/active panels. In accordance with Permit Attachment N, Section N-3d(2), this sampling is routinely performed once every 2 weeks but increasing to weekly as needed per Permit conditions. The DRVMP was implemented to confirm that the concentration of VOCs in the air of closed and active rooms of an open/active panel does not exceed the specified Permit regulatory limits. Excluding Room 1, sample heads are installed in the intake and exhaust drift of the disposal rooms of an Underground HWDU. Only one sample head is installed in Room 1, in the exhaust drift. Monitoring of a closed room of an active panel routinely occurs at both the inlet (intake) and exhaust locations. Monitoring of a disposal room receiving waste for emplacement occurs only at the exhaust location. Excluding Room 1 intake, disposal room VOC monitoring of closed and active rooms of an active panel is performed until the commencement of panel closure activities (i.e., completion of ventilation barriers in Room 1).

Analysis of the samples is performed at a contract laboratory using standard operating procedures that are based on the concepts found in EPA Compendium Method TO-15, the EPA Contract Laboratory Program Volatile Organics Analysis of Ambient Air in Canisters (EPA, 1994), or EPA Method SW-846 8260B (EPA, 1996). Additional program details can be found in WP 12-VC.01, Volatile Organic Compound Monitoring Plan. The Permittees shall report to the Secretary semi-annually in April and October the data and analysis of the VOC Monitoring Plan and summary results are also included in the ASER.

5.3.3 Groundwater Surveillance

The WIPP groundwater DMP is described in section 5.2.8. Table 5.2 indicates the non-radiological groundwater parameters monitored using standard wet chemistry analytical methods. These methods are used to quantify standard indicator parameters such as pH, specific conductance, specific gravity, and temperature. In addition to the indicator parameters, data are also gathered for hazardous constituents listed in Part 5 of the Permit. Hazardous constituents listed in Part 5 include metals, VOCs, and semi-volatile organic compounds.

5.3.4 WIPP Perched Anthropogenic Water and Dewey Lake Monitoring

The objective of monitoring PAW and Dewey Lake wells is to establish, by means of water-level monitoring and water sample analysis, accurate and representative data in compliance with DP-831. Monitoring of the PAW and natural groundwater of the Dewey Lake Formation through time is used to determine the effectiveness of source-control measures. Water levels are taken quarterly from the wells shown in figure 5.7, and samples are taken semi-annually from 19 of these wells (table 5.1). Depth-to-water measurements are performed for PAW and Dewey Lake wells per DP-831, condition 56. Measurements are obtained using WP 02-EM1014, Groundwater Level Measurement.

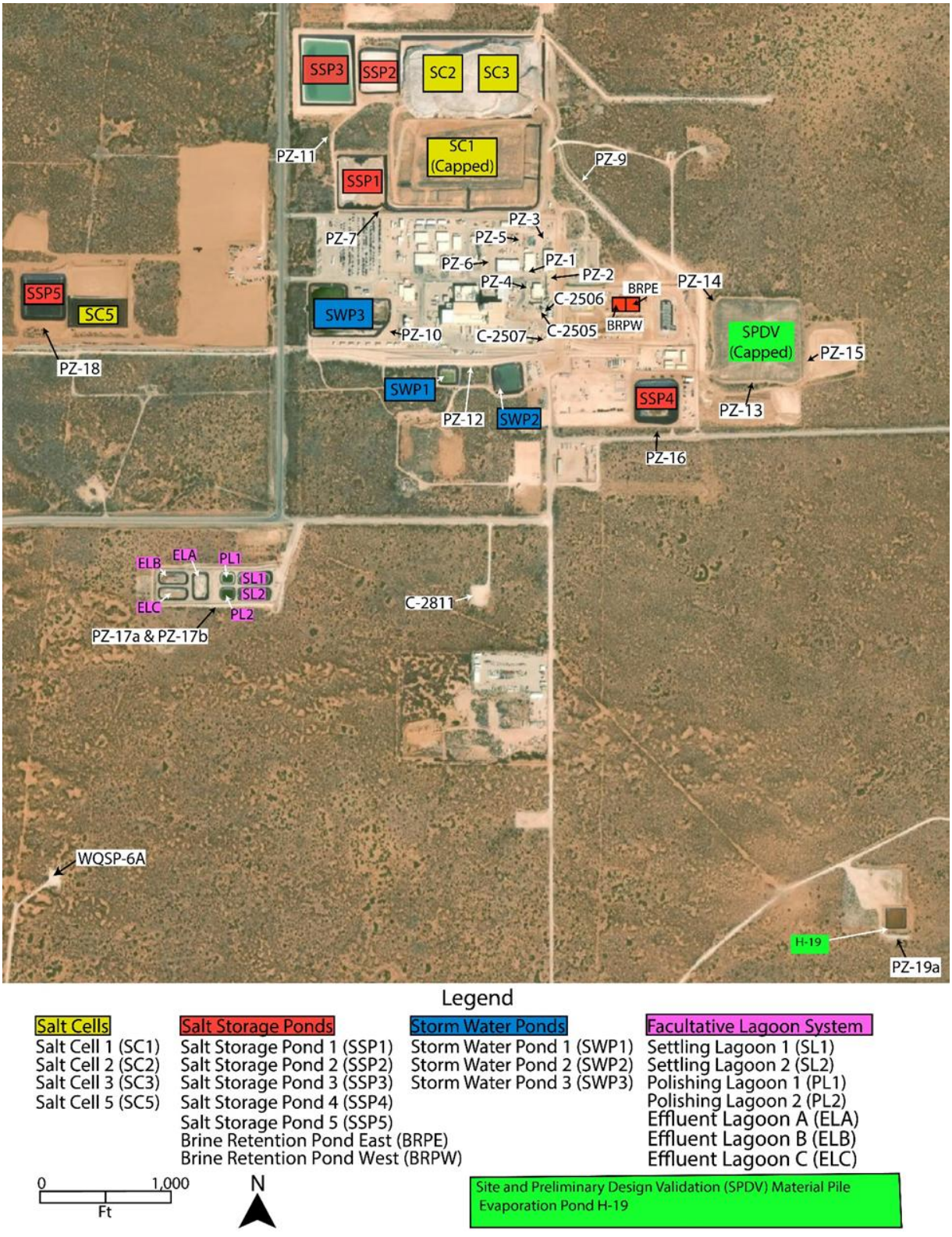


Figure 5.8 – Monitoring Wells and Surface Impoundment Locations

The general chemistry of the wells is monitored for parameters specified in DP-831, using standard analytical methods. Analysis is performed for the parameters in table 5.2. Additionally, field indicator parameters measured are temperature, pH, and specific conductance. Field indicator samples and final samples are collected from the wells in accordance with WP 02-EC1003, Low Flow Groundwater Purging and Sampling. With the renewed DP-831, issued January 28, 2022, uranium and radioactivity for combined ^{226}Ra and ^{228}Ra were added. These are only required to be analyzed for a minimum of one sample from each well, within the first year of the permit issuance. Additionally, PZ-17a (routinely dry) and PZ-17b will be analyzed semi-annually for TKN and NO_3-N. Laboratory data will be used to identify spatial and temporal changes in chemistry beneath and adjacent to the WIPP site. For results newly exceeding groundwater quality standards identified in NMAC 20.6.2.3103, with no previous exceedances, confirmatory samples will be obtained and analyzed (per DP-831, condition 64).

Monitoring wells WQSP-6a and PZ-17b are intended to monitor the natural groundwater of the middle Dewey Lake Formation, which occurs in the subsurface at the southern end of the WIPP facility (per DP-831, conditions 57 and 58). Well PZ-19b was also intended to measure the middle Dewey Lake natural groundwater but was plugged after drilling the core hole as it was determined to be dry. All other piezometer wells are intended to monitor the PAW and source-control measures. Any well not sampled must be documented with an associated reason and any well not measured for water level must be documented with an associated reason (per DP-831, condition 61). Additional details on PAW monitoring can be found in WP 02-2, WIPP Discharge Permit 831 Monitoring and Maintenance Plan.

5.3.5 DP-831 Infiltration Control Sampling

Infiltration controls have been constructed in accordance with DP-831 to minimize the infiltration of storm water runoff. These include Storm Water Ponds 1, 2, and 3, Salt Storage Ponds 1, 2, 3, 4, and 5 (figure 5.8), along with berms and ditches associated with these ponds. As specified in DP-831 and WP 02-EM1001, Facultative Lagoon System, H19, and Infiltration Control Impoundments Sampling, water samples are collected annually after a significant storm event from Salt Storage Ponds 1, 2, 3, 5, and Storm Water Ponds 1, 2, and 3. Samples are analyzed as shown in table 5.2. A significant storm event is defined as the DP-831 threshold of 2 inches or greater in a 24-hour period.

Salt Storage Pond 4 (synonymous with Brine Salt Storage Pond 4 as used in the DP-831) is sampled semi-annually as indicated in table 5.1. Samples from this location are analyzed as indicated in table 5.2.

The WIPP Facultative Lagoon System is designed with multiple lagoons to biologically treat industrial and domestic wastewater (sewage). The system consists of seven synthetically lined impoundments, which include two settling lagoons (Settling Lagoons 1 and 2), two polishing lagoons (Polishing Lagoons 1 and 2), and three effluent lagoons (A, B, and C). The Facultative Lagoon System is operated in accordance with DP-831 issued by NMED. Permit DP-831 outlines operating, monitoring, reporting, and contingency measures for unplanned discharges, as well as closure requirements.

As specified in DP-831 and described in WP 02-EM1001, water samples are taken from Effluent Lagoon A on a semi-annual basis. Samples from Effluent Lagoons B and C are collected only when industrial wastewater is discharged into the impoundment(s) as indicated in table 5.1. Samples from these locations are analyzed as indicated in table 5.2. Figure 5.8 shows the location of the Facultative Lagoon Impoundments.

Evaporation Pond H-19 is a single, synthetically lined evaporation pond permitted for evaporative disposal of nonhazardous industrial wastewater collected from the following sources: brine, purge waters from sampling and developing WIPP facility monitoring wells, condensate from the Exhaust Shaft fan ductwork on the surface, and water collected from the Waste Shaft sump, Exhaust Shaft interception wells, and other observation boreholes in the underground. Brine collected from the underground interception wells is discharged into H19, provided it is not radiologically contaminated or exceeds RCRA thresholds. Fluids determined to be detectably contaminated are shipped to an off-site facility authorized to accept such materials for disposition. The operation, maintenance, monitoring, and closure of the evaporation pond are described in DP-831. Evaporation Pond H-19 (location shown in figure 5.8) is sampled in accordance with the “during the first year” requirements and semi-annually as indicated in table 5.1. Samples from this location are analyzed as indicated in table 5.2.

At least one sample will be collected quarterly rotating between Brine Retention Pond East (BRPE) and Brine Retention Pond West (BRPW) of the liquid present and sample analyzed as indicated in table 5.2. After four consecutive quarterly sampling events, a reduction in the sampling frequency and/or analyte list set forth in DP-831 may be requested (per DP-831, condition 44).

Additional details on infiltration control sampling can be found in DP-831 and WP 02-2, WIPP Discharge Permit 831 Monitoring and Maintenance Plan.

5.3.6 Emerging Contaminants of Concern

In recent years, there has been increasing regulatory interest in emerging contaminants of concern which 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.

The WIPP facility 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 WIPP 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 measure PFAS in the environment, WIPP developed a PFAS sampling plan in 2024 to sample nine groundwater monitoring wells and two lagoons of the Facultative Lagoon System. Excluding waste from portable restrooms, all domestic wastewater derived from the WIPP facility is discharged into the Facultative Lagoon System. With respect to groundwater, nine monitoring wells completed in three water-bearing zones were included in the sampling plan. All six of the DMP wells were sampled, along with wells PZ-7, PZ-10, and WQSP-6a. Settling Lagoons 1 and 2 of the Facultative Lagoon System were also sampled. Initial baseline sampling was performed in 2024 and subsequent sampling may be performed as needed. Results of the 2024 sampling are reported in Per- and Polyfluoroalkyl Substances (PFAS) Sampling Report for the Waste Isolation Pilot Plant (DOE, 2024).

5.4 Land Management

Parties who desire to conduct activities that affect lands under the jurisdiction of the DOE outside the PPA may be required to prepare an LUR. An LUR consists of a narrative description of the project, a completed Environmental Compliance Review form (for WIPP-related projects), and a map depicting the location of the proposed activity. The LUR is used to determine if applicable regulatory requirements have been met before the approval of a proposed project. An LUR is submitted to the Land Use Coordinator by any organization desiring to complete any construction, rights-of-way, pipeline easements, or similar actions within the WIPP site boundary and on lands used in the operation of WIPP, under the management of the DOE (DOE/WIPP-93-004). The LUR is then reviewed by the CBFO National Environmental Policy Act (NEPA) Compliance Officer for approval. Additional details on LUR requirements can be found in DOE/WIPP-93-004.

5.5 Oil and Gas Surveillance

Surveillance of oil and gas activities within 1 mile of the WIPP boundary is conducted at accessible locations in accordance with the U.S. Department of the Interior Bureau of Land Management/DOE MOU (DOE, 2012). Oil and gas activities within the defined land sectors are monitored periodically to identify new activities associated with oil and gas exploration/production, including:

- Survey staking.
- Geophysical exploration.
- Pipeline construction.
- Drilling.

- Wellhead workovers.
- Changes in well status.
- Anomalous occurrences (e.g., leaks, spills, accidents, noxious weeds, etc.).

Data from this activity may be used to support the Delaware Basin Drilling Surveillance Program for estimating the probability of human intrusion by drilling for the WIPP performance assessment, in support of compliance recertification applications occurring every 5 years. In addition, observations of drilling activities adjacent to the WIPP site boundary are used to determine that no driller encroaches into the Land Withdrawal Area as described in DOE/WIPP-93-004.

Activities that implement the Land Management MOU elements are described in WP 02-EM1024, Environmental Field Work and Land Management.

6.0 DATA ANALYSIS

As needed, statistical methods may be used to analyze data collected in some of the environmental monitoring subprograms. This section describes general statistical methods that can be used for analyzing data. The goal of statistical data analysis is to provide an objective and reliable means for comparing measurements to the objectives of the data collection program, typically to determine whether the data indicate compliance with limits. Only those statistical tests that properly represent the data within the tested set and are necessary to demonstrate the desired information are used.

The data from sample media may be graphed by analyte to evaluate analytical consistency presented in a time trend plot. Should a discrepancy be noted during this review, an in-depth evaluation can be performed to identify the source of the deviation (e.g., statistical outlier or analytical technique/error). This is particularly useful with the DMP results.

Data analysis is required for each parameter before a statistically valid interpretation can be achieved. Data analysis at each of these levels is considered for each parameter. The levels of data analysis are:

1. Determination of accuracy for each point measurement by quantification and control of precision and bias.

2. Evaluation of the effects of correlation on the expected value of the point measurement due to location and time of sampling.

3. Identification of the appropriate model of variability (i.e., probability density distribution) for each point measurement and the calculation of descriptive statistics based on the chosen model.

4. Treatment of data anomalies.

5. Interpretation of data through statistically valid comparisons (tests) and trend analysis.

6. Each of these levels of data analysis is described below. Program requirements for data analysis are covered in more detail in subprogram plans and procedures.

6.1 Accuracy

Accuracy is the closeness of a measurement to its actual, or true, value. Accuracy is controlled by two basic elements: bias (consistent over or underestimation of the true value) and precision (concentration of repeated measurements around a central [expected] value). Accuracy is maximized when bias is minimized, and precision is maximized.

To some extent, precision and bias are controlled by strict adherence to sample collection, handling, and measurement protocols. Environmental Monitoring plans and procedures specify the protocols for those functions performed at WIPP.

The remaining element of precision and bias is quantitatively estimated through periodic performance of the following measurements:

- Measurement of field duplicate/replicate samples.
- Repeated measurement of the same sample (laboratory duplicate).
- Measurement of blank samples.
- Measurement of standard spiked samples (samples of an equivalent medium containing a known amount of the target analyte).

The measurement of duplicate samples is used for assessing precision incurred through the entire process of sample collection, handling, and measurement. Repeated measurements are used to determine the amount of imprecision attributable to measurement. Blanks are analyzed to monitor the purity of reagents attributing bias to the sample results during collection of samples and laboratory analysis. Contract laboratories performing WIPP sample analyses may be required to participate in performance evaluation programs and pass specific criteria set forth for measuring precision and accuracy.

The methods for satisfying these requirements will depend upon the sampling and measurement characteristics of each parameter. Generally, these specifications will be followed:

- One field duplicate sample is collected for each ten samples collected.
- One repeated measurement is made for each discrete set of samples analyzed, or for each tenth sample analyzed, whichever is more frequent.

- One blank sample is analyzed for each discrete set of samples analyzed (for radioactivity counts, the background count is not considered a blank).
- Spiked samples are measured.

Variations from these specifications may be required due to peculiarities of the individual parameters and are stated in the analysis for that parameter.

6.2 Temporal and Spatial Analysis

Environmental variables are classified as random variables, or more precisely stochastic processes, and are functions of space and time. The effect of one or both of these two factors on the expected value of a point measurement is statistically evaluated through spatial analysis and time series analysis. However, these methods often require extensive sampling efforts that are in excess of the practical requirements of the WIPP EMP. The application of these methods to a particular variable must, therefore, be limited by consideration of its significance in the final interpretation of the data. For specific statistical analyses, DOE-HDBK-1216-2015 (DOE, 2022) provides detailed guidance.

In particular, spatial analysis has limited use in this program, although the effect of spatial correlation on the interpretation of the data is considered for each parameter. Spatial variability is accounted for by the use of predetermined key sampling locations. Data analysis is performed on a location-specific basis, or data from different locations are combined only when the data are considered to be statistically homogeneous.

Trend analysis plays a more important role in data analysis for the EMP. Variables may be reported as time series, either in tabular form or plots. For key time series variables, these plots are in the form of control charts on which control limits will be identified based on the preoperational database, fixed standards, control location databases, or other standards for comparison.

6.3 Distributions and Descriptive Statistics

Descriptive statistics may be calculated for homogeneous data sets. These would include a central value and a standard deviation. The central value is the mean of the data. The standard deviation is calculated and used as a basis for the reported range in variation. Typically, ± 2 standard deviations (approximately a 95 percent confidence level) from the mean are plotted on the graphs.

6.4 Data Anomalies

Historical data and trend charts are maintained on parameters and constituents for which analysis is performed in the DMP. The historical databases with established control limits at the 95 percent confidence level (or ± 2 standard deviations from the mean) are used in identifying an outlier. The 95 percent confidence level means that 5 percent, or 1 out of 20, normal results are expected to fall outside the limits. For analytical measurements reported as non-detect or below the method detection limit, the practical quantitation limit (which is between 3 and 10 times the method detection limit) is set as the upper threshold. An investigation is prompted by reviewing the sampling process and verifying that the data quality objectives were met. The data are qualified accordingly and documented when the analytical results indicate matrix contamination, method problems encountered during analysis, or an inconsistent sampling is identified. All analytical results are included in the charts but excluded in establishing control limits if a known error has been identified. Including outliers in calculating control limits generates a range of values too broad or too small.

6.5 Data Comparisons

Comparisons between data sets may be performed using standard statistical tests. The selection of the specific test is dependent upon the relative power of the test and the degree to which the underlying requirements of the test are met. In addition to tests comparing data from distinct locations and times, trend analyses may be performed on time series where sufficient data exist. A 95 percent confidence level will be used for the final interpretation of DMP results. A 99 percent confidence level may be used for the radiological monitoring program.

6.6 Laboratory Procedures

Environmental sampling plans and procedures used to obtain quality results for WIPP are contained and described in the following documents:

- WP 02-1, WIPP Groundwater Monitoring Program Plan,
- The environmental monitoring or compliance procedures of the WP 02-EM and WP 02-EC series,
- The VOC monitoring plans and procedures of the WP 12-VC series, and
- WP 13-1, Waste Isolation Pilot Plant Quality Assurance Program Description.

WIPP has analytical capabilities at the WIPP facility (radiological screening), as well as subcontracted analytical support. Each laboratory is responsible for maintaining an approved QA program for each of the programs discussed in section 5.0.

6.7 Sample Handling

6.7.1 Sample Identification and Tracking

There is a sample number used to uniquely identify environmental samples collected. Many of the environmental monitoring subprograms use a sample number containing sample-specific information used to accurately identify sample type, sample location, date, and sequence of sampling event, as described in WP 02-EM3001, Administrative Processes for Environmental Monitoring and Hydrology Programs. The VOC Monitoring Programs, WP 12-VC.01, Volatile Organic Compound Monitoring Plan, and WP 02-1, WIPP Groundwater Monitoring Program Plan, use different systems of sample identification. A detailed description of the sample identification for radiological and non-radiological samples, including sample identification, calculations, computer inputs, and other applicable reviews, are described in environmental sampling procedures. Field data sheets are also maintained in accordance with procedures. The sample tracking is performed from collection to delivery at the laboratory.

6.7.2 Sampling Schedule

The sample type, location, and frequency of collection are noted in table 5.1. The sampling schedule at WIPP is based on waste composition, climate, and demography.

6.7.3 Environmental Activity Levels

During operations, TRU waste will remain in sealed containers. After the February 2014 unplanned radiological release event, extensive environmental direct measurement and media sampling of air, soil, and vegetation were performed. With the exception of a single initial air sample, no results for TRU radionuclides were found to be statistically above expected background levels outside the EUA. Therefore, radionuclide levels in environmental samples remained at background during recovery and future operations. Environmental samples are collected in accordance with accepted practices and widely recognized methodologies and criteria for environmental monitoring (e.g., principles of DOE-HDBK-1216-2015 (DOE, 2022) as reflected in the environmental monitoring procedures of the WP 02-EM series).

6.7.4 Packaging and Shipping of Samples

Environmental samples sent for off-site analysis are packaged and shipped in accordance with transportation regulations and specific sampling procedures. These procedures outline the chain-of-custody requirements that ensure the integrity of samples. Chain-of-Custody (CofC, also COC) is maintained for samples in accordance with WP 02-EM3001. WIPP does not handle high-activity radiological samples in the environmental monitoring programs. Contract laboratories are required to follow QA/QC procedures to ensure that cross-contamination between high- and low-activity samples will not occur.

The laboratory must be approved through an evaluation to be put on the qualified supplier list. Before proceeding with exercising a contract to analyze samples, the

contract laboratory must pass strict QA laboratory evaluations. The quality of the data from contract analytical laboratories is verified by (1) participation in inter-laboratory cross-checks, when feasible, (2) duplicate and blank sample analysis, and (3) occasional comparison of results from sample duplicates or splits.

7.0 QUALITY ASSURANCE

This section defines the policies and procedures that have been implemented at WIPP to provide confidence in the quality of environmental data. The QA practices that cover monitoring activities at WIPP are consistent with applicable elements of the 18-element format in the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) NQA-1, Quality Assurance Program Requirements for Nuclear Facilities (ANSI, 1989) and DOE-STD-1112-2019, U.S. Department of Energy Laboratory Accreditation Program (DOELAP) for Radiobioassay (DOE, 2019). All QA practices flow down into the monitoring program through the CBFO QAPD and are adopted in WP 13-1.

In WP 13-1, WIPP QA requirements and responsibilities are defined. The format of the QAPD is based on the QA criteria of 10 CFR § 830.122, Quality Assurance Criteria. The QAPD also addresses certain EPA QA requirements extracted from the EPA QA/G-5, Guidance for Quality Assurance Project Plans (EPA/240/R-02/009). The QAPD contains requirements that apply to environmental data operations (i.e., compliance activities associated with the collection and analysis of environmental samples, including data reduction, handling, reporting, and records management).

A comprehensive QA program has been implemented to ensure that the data collected are representative of actual concentrations in the environment. Each contract laboratory is responsible for maintaining an approved QA program detailing the following:

- Routine calibration of instruments.
- Frequent source and background checks (as applicable).
- Routine yield determinations of radiochemical procedures (as applicable).
- Replicate/duplicate analyses to check precision.
- Standard and spike analyses to check accuracy.
- Tracking expiration dates of reagents to ensure that chemical purity, which could affect the results of the analytical process, is not compromised.
- Data review by primary and secondary personnel for data entry accuracy.
- Verification and validation of data in accordance with approved plans and implementing procedures.
- All reporting documents are reviewed for accuracy.

The accuracy of chemical or radiochemistry analysis is ensured using standards traceable to the National Institute of Standards and Technology and participation in a performance evaluation program, as feasible.

7.1 Goal

The MOC QA policy sets a goal to perform all work in such a manner that the required quality is attained or exceeded. To attain this goal, the MOC has developed and implemented a formal QA program that is tailored for activities associated with receipt of TRU waste, including operational safety, environmental compliance, and performance assessment.

7.2 Program Elements

The WIPP QA program elements that are applicable to the EMP are provided in the 10 CFR § 830.122 criteria. These elements establish the applicable QA requirements that are required for compliance activities associated with the collection and analysis of environmental samples, including data analysis, handling, reporting, and records management.

7.2.1 Program

The WIPP Environmental Monitoring and laboratory program documents and statements of work address specific environmental data operations (EDOs) as required by the QAPD. Environmental data operations project descriptions incorporate the following elements, as appropriate:

- Data accuracy (i.e., the degree to which data agree with an accepted reference or true value).
- Data precision (i.e., a measure of agreement between comparable data gathered or developed under similar conditions expressed in terms of a standard deviation. Measurement is also expressed as relative percent difference [RPD] or relative error ratio [RER] for samples analyzed for radionuclides).
- Data representativeness (i.e., the degree to which data accurately and precisely represent a characteristic of a population, a parameter, variations at a sample point, or environmental conditions).
- Data completeness (i.e., a measure of the amount of valid data obtained compared to the amount that was expected).
- Data comparability (i.e., a measure of confidence with which one data set can be compared to another).
- Data reproducibility (i.e., a measure of the variability among measurements of the same sample by different laboratories).

- Data validation (i.e., a systematic process for reviewing a body of data against a set of criteria to provide assurance [QA objectives/indicators] that the data are adequate for their intended use).
- Data verification (i.e., a systematic process for reviewing a body of data to verify completeness).

7.2.2 Personnel Training and Qualification

The WIPP training program has been designed to ensure that personnel performing work can perform their assigned task proficiently. Personnel who perform work that requires special skills or abilities are required to meet the qualification requirements for that specific task unless directly supervised by a qualified person.

7.2.3 Quality Improvement

The quality improvement process has been established and implemented to improve quality and provide corrective action procedures. Corrective action and nonconformance procedures for activities associated with environmental data collection are identified in environmental monitoring and laboratory program documents and statements of work. The following elements are addressed:

- Predetermined limits for data acceptability beyond which corrective action is required.
- Process for tracking, verification, and closeout.
- Identification of individuals responsible for initiating corrective action and individuals responsible for verifying and approving implementation of the corrective action.

Corrective action may be initiated through routine operations, performance audits, system audits, inter-/intra-laboratory comparison studies, or performance demonstrations conducted by the DOE's Carlsbad Field Office.

7.2.4 Documents and Records

Procedures are established that control the preparation, review, approval, issuance, use, and revision of documents that establish policies, prescribe work, specify requirements, establish design, or that are being used for the performance of quality-related activities. Procedures are also in place to ensure that records are specified, prepared, reviewed, approved, and maintained to accurately reflect completed work. This process is described in WP 15-RM, WIPP Records Management Program Plan. The WIPP Records Management Program Plan provides a project-wide records management system that coordinates the collection, maintenance, identification, and preservation of WIPP records.

Records generated through environmental monitoring activities, including the ASER and key supporting documents, are controlled and maintained in accordance with

WP 15-RM. This document also provides the interpretations and guidance necessary to meet the records management requirements for the creation, maintenance, use, and disposition of records that document and support the WIPP mission.

Complete, accurate, and auditable environmental monitoring program records will be maintained. The RIDS governs environmental monitoring records management.

7.2.5 Work Processes

Work is strategically planned using the data quality objective process described in DOE/CBFO-94-1012, Quality Assurance Program Document (DOE, n.d., DOE/CBFO-94-1012), and in the MOC quality assurance implementing document, WP 13-1. Work is then performed to established technical standards and administrative controls. The design of sampling methodology, use of equipment, and required processes are documented and approved. The following requirements for sample design are addressed in environmental monitoring program documents:

- Description of techniques or guidelines used to select sampling locations.
- Specific sampling procedures to be used.
- Charts, flow diagrams, or tables delineating sampling program operations.
- A description of containers, procedures, reagents, etc., used for sample collection, preservation, transportation, and storage.
- Special conditions for the preparation of sampling equipment and containers to avoid sample contamination.
- Sample preservation methods and holding times.
- Time considerations for shipment of samples to the laboratory.
- Sample custody or CofC procedures.
- Forms, notebooks, databases, and procedures to be used to document sample history, sampling conditions, and required analyses.

The sample size for environmental samples must be large enough to meet minimum detectable activity requirements and minimize counting uncertainties without excessively long count times (radiological analyses). If possible, a sufficient sample should be available for re-analyses or confirmation of results as well as to analyze one duplicate sample per batch. The analytical laboratory may request additional sample volume or provide specific collection directions in addition to the routine field procedure protocols for specific media.

Samples collected for environmental compliance activities or WIPP site validation are controlled by approved CofC procedures. The actual practices used are documented. The following sample custody procedures are specified in the environmental monitoring program documents.

- For field sampling operations:
  - Requirements for the preparation of reagents or supplies which become an integral part of the sample.
  - Forms for recording the location and specific considerations associated with sample acquisition.
  - Specific sample preservation methods.
  - Sample labels containing all information necessary for effective sample tracking.
- For laboratory operations:
  - Identification of the responsible party to act as sample custodian at the laboratory facility authorized to sign for incoming field samples, obtain documents of shipment, and to verify the data entered into the same custody records.
  - A laboratory sample custody log consisting of serially numbered standard lab-tracking report sheets.
  - Specification of laboratory sample custody procedures for sample handling, storage, and disbursement for analysis.

Custody records are treated as permanent QA records by the recipient upon final transmission of the analytical data.

Requirements for laboratory calibration are documented and include:

- A written description of the calibration process used for major measurement parameters.
- Frequency of calibration.
- Calibration standards to be used, as well as their sources and traceability.

Environmental monitoring and laboratory program documents contain required preventive maintenance of equipment used for the collection and measurement of environmental data and identify processes for controlling the analyses of samples collected for environmental data operations activities. Calibration of required equipment used by WIPP personnel for this EMP is coordinated through the WIPP Metrology Department for a third-party calibration company to perform.

7.2.6 Design

The design of sampling methodologies is documented and approved. Requirements for sample design are addressed in environmental program documents and DOE guidance documents and Orders, including the design considerations listed in section 7.2.5. In addition, requirements for verification and validation of calculations and sample results

by independent personnel are included in the QA plan that controls the environmental program operations.

7.2.7 Procurement

The control of procurement documents ensures that procured items and services meet established requirements and specifications. Basic procurement requirements include:

- Applicable design specifications and other order requirements are referenced in documents for the procurement of items and services.
- The existence of a supplier QA program consistent with applicable requirements.
- The existence of written procedures that control the procurement actions involved in the preparation, review, approval, control, and changes of procurement documents.

7.2.8 Inspection and Acceptance Testing

Inspection and acceptance testing of specified items and processes are conducted using acceptance and performance criteria established by WP 13-1.

Equipment used for inspections and tests is calibrated and maintained in accordance with procedures and statements of work. These documents describe the calibration process, calibration frequency, and calibration standards to be used, as well as their sources and traceability.

All subcontractor equipment is inspected by safety professionals upon arrival to perform the work and periodically throughout the work evolution (e.g., drilling rigs).

7.2.9 Management Assessment

The EM&H manager is responsible for required management assessments, as prescribed by WP 13-1 and implemented per WP 15-CA.09, Management Assessment Program. As stated in the implementing procedure, “managers shall periodically assess their management processes and identify problems that hinder their organization from achieving its directives. Managers shall regularly perform or direct performance of management assessment of programs, systems, and processes under their cognizance while retaining responsibility for the assessment results and response, including timely resolution of issues.” Identified issues are addressed per WP 15-GM1002, Integrated Issues Management. The manager should refer to the implementing procedure to ensure compliance with requirements.

Senior management assembles input from the following sources to form the basis of a management assessment:

- Line management's self-assessment reports.
- Independent assessment reports.
- Corrective action reports, including conditions adverse to quality, nonconformance reports, program deficiency reports, audit reports, and requests for corrective action.

Following the assessment, the effectiveness of the QA program is documented. Further, areas for quality improvement (for significant non-conformances or high-risk items/activities), preventive or corrective actions, milestones for completion, responsibility assignments, trend analysis, and lessons learned are documented.

7.2.10 Independent Assessment

Independent assessments are performed to verify procedure compliance and are also used to prove independent oversight of the self-assessment process performed by line management. Independent assessments focus on improving items and processes by emphasizing the line organization's achievement of quality. Results from independent assessments are transmitted to senior management as input for determining the effectiveness of the integrated QA program. In this regard, personnel performing independent assessments act in a management advisory function.

8.0 REFERENCES

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