40 CFR Part 191
Subparts B and C
Compliance Recertification Application 2026
for the
Waste Isolation Pilot Plant

Appendix MON-2026
Compliance Monitoring Program

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
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Compliance Recertification Application 2026
Appendix MON-2026

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ACRONYMS AND ABBREVIATIONS

CARD	Compliance Application Review Document
CBFO	Carlsbad Field Office
CCA	Compliance Certification Application
CFR	Code of Federal Regulations
CMP	Compliance Monitoring Program
COMP	Compliance Monitoring Parameter
CRA	Compliance Recertification Application
DBDSP	Delaware Basin Drilling Surveillance Program
DMP	Detection Monitoring Program
DOE	U.S. Department of Energy
DRZ	disturbed rock zone
EPA	U.S. Environmental Protection Agency
FEP	feature, event, or process
ft	feet
GMP	Groundwater Monitoring Program
GMPP	Groundwater Monitoring Program Plan
kg	kilogram
MOC	Management and Operating Contractor
PA	performance assessment
QA	quality assurance
QAPD	Quality Assurance Program Document
SMP	Subsidence Monitoring Program
WDS	Waste Data System
WIPP	Waste Isolation Pilot Plant

MON-1.0 INTRODUCTION

This appendix to the 2026 Compliance Recertification Application (CRA-2026) describes the Compliance Monitoring Program (CMP) developed to meet commitments contained in the U.S. Department of Energy's (DOE's) initial Compliance Certification Application (CCA) to the U.S. Environmental Protection Agency (EPA), which demonstrated compliance with radioactive waste disposal regulations of 40 CFR Part 191, Subparts B and C (U.S. EPA 1993) and the certification criteria in 40 CFR Part 194 (U.S. EPA 1996). This appendix does not address monitoring activities intended to demonstrate compliance with 40 CFR Part 191, Subpart A.

Title 40 CFR 194.42, provides criteria to demonstrate compliance with the assurance requirement at 40 CFR 191.14(b) to monitor the Waste Isolation Pilot Plant (WIPP) disposal system. The monitoring activities described in this appendix are performed as an assurance measure to detect substantial and detrimental deviations from expected disposal system performance. This program consists of a pre-closure and post-closure monitoring program using monitoring techniques that do not jeopardize the isolation of the waste.

The pre-closure monitoring program will be conducted until the shafts are sealed (40 CFR 194.42 [c]). After the shafts are sealed, post-closure monitoring will be initiated in accordance with the specifications described in Appendix MON-4.0, Post-closure (Long-term) Monitoring. Post-closure monitoring will continue until the DOE demonstrates to the EPA that there are no significant concerns to be addressed by further monitoring. The CMP serves to verify that disposal system behavior remains consistent with the assumptions, parameter distributions, and conceptual models used in the WIPP Performance Assessment (PA), and to provide early detection of any substantial and detrimental deviations from expected disposal system performance. Because long-term containment under 40 CFR § 191.13 applies to cumulative releases over the 10,000-year regulatory period, the CMP monitors observable physical and environmental indicators to evaluate whether disposal system performance aligns with baseline PA expectations (Kicker and Jackson 2025).

This appendix specifically describes how:

- The 10 compliance monitoring parameters are derived from the data;
- Information and data are extracted from the various WIPP monitoring and sampling programs;
- The assessments are made against repository performance expectations; and
- The results are reported to the EPA.

The scope of technical activities, data analysis, assessments, and reporting of results under the CMP has not changed since the CRA-2019 (U.S. DOE 2019a) was submitted to the EPA in March 2019.

MON-1.1 Compliance Monitoring Program

This appendix describes the CMP for the WIPP facility. Compliance monitoring concentrates on the following areas:

- The Geotechnical Engineering Program
- The Groundwater Monitoring Program (GMP)
- The Delaware Basin Drilling Surveillance Program (DBDSP)
- The Subsidence Monitoring Program (SMP)
- Waste Inventory Monitoring Based on Waste Data System (WDS)

The data and information collected since the data cut-off date for CRA-2019 for the above-listed programs are recorded or referenced in Appendix DATA-2026 in Appendices DATA-2.0, DATA-3.0, DATA-4.0, DATA-5.0, and DATA-7.0. The descriptions provided in this appendix are specific to the CMP and meet the requirements of 40 CFR 191.14(b) and 40 CFR 194.42.

MON-1.2 Pre-closure and Post-closure Monitoring

The requirements of 40 CFR 191.14(b) and 40 CFR 194.42 serve as the regulatory basis for pre-closure and post-closure monitoring. These requirements specify that disposal systems must be monitored to detect substantial and detrimental deviations from expected disposal system performance.

MON-1.3 Monitoring Assessment

Pursuant to 40 CFR 194.42(a), the DOE is required to perform an analysis that would determine the effects of various parameters on the performance of the disposal system and use the results in pre-closure and post-closure monitoring plans. The disposal system performance analysis identified 10 parameters to be monitored and assessed within the CMP. The 10 monitoring parameters are listed in Appendix MON-2.1, Compliance Certification/Recertification. The pre-closure monitoring activities for these 10 parameters include the following:

- Identifying activities required to comply with the monitoring requirements of 40 CFR Part 191, Subparts B and C, during the pre-closure phase of the project;
- Identifying which organizations collect the data, process the data, and compare results to expected values;
- Outlining the schedule for compliance monitoring;
- Summarizing the quality assurance (QA) requirements applicable to the CMP.

MON-1.4 Appendix Summary

Appendix MON-2.0, Compliance Monitoring Program Requirements, identifies the monitoring requirements of 40 CFR Part 191 Subparts B and C in keeping with the criteria of 40 CFR Part 194. Appendix MON-3.0, Pre-closure Compliance Monitoring, describes the pre-closure monitoring program associated with each monitoring parameter, including the monitoring schedules and program outputs. Appendix MON-4.0, Post-closure (Long-term) Monitoring, describes the planned post-closure monitoring. Appendix MON-5.0, Monitoring Programs Quality Assurance Requirements, describes the QA requirements applicable to the CMP. Appendix MON-6.0, Reporting and Assessment, describes the communicating and reporting of CMP results and evaluations.

MON-2.0 COMPLIANCE MONITORING PROGRAM REQUIREMENTS

The DOE's pre-closure and post-closure CMP defines programs to assess the performance of specific aspects of the disposal system. The relevant monitoring requirements are identified in the following:

- 40 CFR 191.14(b)
- 40 CFR 194.42
- The May 18, 1998, 40 CFR Part 194 Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision, Section VIII.D.4, Monitoring (U.S. EPA 1998a).

MON-2.1 Compliance Certification/Recertification

The original approach used to develop the CMP was based on the results of the parameter analysis documented in the CCA, Chapter 7.0, and Appendix MON, Attachment MONPAR (U.S. DOE 1996). The MONPAR analysis looked for potentially significant parameters used in the PA that could be used in pre-closure and post-closure monitoring programs. Significant parameters are defined in 40 CFR 194.4(c) as those that "affect the system's ability to contain waste or the ability to verify predictions about the future performance of the disposal system." The EPA documented its approval of the DOE monitoring approach in the Compliance Certification Decision (U.S. EPA 1998a) and the Compliance Application Review Document (CARD) 42 (U.S. EPA 1998b). The DOE reassessed the CCA, Appendix MON, Attachment MONPAR, for the CRA-2004 (U.S. DOE 2004), CRA-2009 (U.S. DOE 2009), CRA-2014, (U.S. DOE 2014) and CRA-2019 (U.S. DOE 2019a) and determined the original conclusions and monitoring parameters identified in Attachment MONPAR remain valid and unchanged (Kirkes and Wagner 2003, Wagner 2008, Wagner 2013, and Wagner 2018). In 2023, the DOE again assessed the original MONPAR analysis used to determine which monitoring parameters should be included in the CMP. The 2023 reassessment included changes from the Replacement Panels Planned Change Request PA (U.S. DOE 2024a). This assessment states that based on the review of activities, conditions, and experimental programs that occurred since the CRA-2019, the reassessment

concluded that the conclusions of the MONPAR analysis remained valid (Kicker 2023). Kicker (2025) subsequently stated that based on the Kicker (2023) reassessment and the review of subsequent changes in PA, as documented in Hansen et al. (2025), it was determined that the conclusions of the MONPAR analysis remain valid and its conclusions continue to be adequate for inclusion in CRA-2026.

The EPA-approved monitoring approach recognizes that the DOE will monitor 10 parameters, to be monitored during the pre-closure period. These parameters are:

1. Creep closure and stress
2. Extent of brittle deformation
3. Initiation of brittle deformation
4. Displacement of deformation features
5. Change in Culebra Dolomite Member of the Rustler Formation (hereafter referred to as Culebra) groundwater composition
6. Change in Culebra groundwater flow
7. Drilling rate
8. Probability of encountering a Castile Formation (hereafter referred to as Castile) brine reservoir
9. Subsidence
10. Waste activity

The CRA-2004, Appendix MON-2004, Attachment A, describes the DOE's plan for post-closure monitoring. The DOE will revisit this plan for post-closure monitoring before the end of WIPP facility operations.

The monitoring parameters that have related PA parameters include:

- Drilling rate in the Delaware Basin
- Probability of encountering a Castile brine reservoir
- Change in Culebra groundwater flow
- Change in Culebra groundwater composition
- Waste activity

The other monitoring parameters are related to either the EPA's list of potential monitoring parameters in 40 CFR 194.42 or screening decisions for repository features, events, or processes (FEPs). Table MON-1 describes the related PA parameters and the related FEPs.

Five separate monitoring programs (described in Appendices MON-3.1, MON-3.2, MON-3.3, MON-3.4, and MON-3.5) are used to collect data on the 10 parameters. Each monitoring program focuses on the collection of field data. The programs that generate or evaluate the data are described in Appendix MON-6.0, Reporting and Assessment. Results from each monitoring program are documented individually in annual reports (see Appendix DATA-2026), while the assessment results of the 10 parameters are documented and reported in annual compliance monitoring parameter (COMP) assessment reports (Wagner and Hayes 2019; Wagner and Hayes 2020; Kicker et al. 2021; Kicker et al. 2022; Kicker et al. 2023; Kicker and Jackson 2024; and Kicker and Jackson 2025).

MON-3.0 PRE-CLOSURE COMPLIANCE MONITORING

This section describes the pre-closure CMP, including the resulting data. Table MON-1 below lists the 10 compliance monitoring parameters, associated monitoring program for each, frequency of data collection and reporting, related PA parameters, related FEP decisions used to support the PA, and evaluation cycle associated with each parameter (Appendix DATA-2026).

Table MON-1. Monitoring Parameters Relationship to PA and FEPs

Monitored Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Creep Closure and Stress	Geotechnical Monitoring Program	Weekly to bi-monthly, based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Elastic properties of halite and anhydrite (e.g., Young's Modulus, shear modulus, Poisson's ratio, specific heat); creep constitutive model; plastic constants for the consolidation of the waste/backfill.	Salt Creep (W20); Excavation-Induced Changes in Stress (W19); Changes in the Stress Field (W21); Pressurization (W26); Consolidation of Waste (W32).	Data are evaluated annually and reported in COMP-2.2.
Extent of Brittle Deformation	Geotechnical Monitoring Program	Weekly to bi-monthly, based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Disturbed rock zone (DRZ) parameters (e.g., extent, permeability); intrinsic shaft DRZ permeability.	DRZ (W18); Roof Falls (W22); Underground Boreholes (W39); Consolidation of Shaft Seals (W36).	Data are evaluated annually and reported in COMP-2.2.

Monitored Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Initiation of Brittle Deformation	Geotechnical Monitoring Program	Weekly to bi-monthly, based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Anhydrite fracturing model parameters (e.g., fracture initiation pressure, increment for full fracturing, fracture permeability enhancement); DRZ Properties.	Disruption Due to Gas Effects (W25).	Data are evaluated annually and reported in COMP-2.2.
Displacement of Deformation Features	Geotechnical Monitoring Program	Weekly to bi-monthly, based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Not directly related to a PA parameter; provides related repository operational data on initiation or displacement of major brittle deformation features in the roof or surrounding rock.	DRZ (W18); Salt Creep (W20); and Changes in the Stress Field (W21).	Data are evaluated annually and reported in COMP-2.2.
Culebra Groundwater Composition	Groundwater Monitoring Program	Data are collected annually and reported annually.	Average Culebra brines composition, which are represented through analysis of major ions, and matrix distribution coefficient for uranium (IV, VI), plutonium (III, IV), thorium (IV), and americium (III). The matrix distribution coefficient is not a sensitive PA parameter.	Groundwater Geochemistry (N33) and Actinide Sorption (W61).	Data are evaluated annually and reported in COMP-2.3.

Monitored Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Change in Culebra Groundwater Flow	Groundwater Monitoring Program	Data are collected monthly and reported annually.	Culebra transmissivity, fracture and matrix porosity, fracture spacing, dispersivity, and climate index; changes in Culebra groundwater flow are important to performance relative to inadvertent intrusion events and are, therefore, incorporated into the PA.	Saturated Groundwater Flow (N23), Unsaturated Groundwater Flow (N24), Groundwater Discharge (N53), Groundwater Recharge (N54), Infiltration (N55), Changes in Groundwater Recharge and Discharge (N56), Precipitation (e.g., rainfall) (N59), and Temperature (N60).	Data are evaluated annually and reported in COMP-2.3.
Drilling Rate	Delaware Basin Drilling Surveillance Program	As well records are available (on a weekly basis). Data are reported annually.	Required PA parameter per 40 CFR 194.33. The Drilling Rate is important to performance relative to inadvertent human intrusion events and is, therefore, incorporated into the PA.	Drilling Fluid Flow (H21)	Data are evaluated annually and reported in COMP-2.1.
Probability of Encountering a Castile Brine Reservoir	Delaware Basin Drilling Surveillance Program	As drilling records are received. Data are reported annually.	Probability of encountering a Castile brine reservoir.	Drilling Fluid Flow (H21)	Data are evaluated annually and reported in COMP-2.1.

Monitored Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Subsidence	Subsidence Monitoring Program	Data are reported annually or as determined necessary by the DOE.	Not directly related to a PA parameter. Can provide spatial information on surface subsidence (if any) over the influence area of the underground openings during operations.	Changes in Groundwater Flow Due to Mining (H37); Regional Uplift and Subsidence (N5); Borehole-Induced Solution and Subsidence (H34); Subsidence (W23).	Data are evaluated annually or as determined necessary by the DOE; reported in COMP-2.2
Waste Activity	Waste Inventory Monitoring Based on Waste Data System	Continually updated as waste is approved for shipment to the WIPP and emplaced. Data are reported annually.	Waste activity	Waste Inventory (W2); Heterogeneity of Waste Forms (W3).	Data are evaluated annually and reported in COMP-2.4

MON-3.1 Geotechnical Engineering Program Plan

The Geotechnical Engineering Program provides geologic information related to geotechnical characteristics and assesses the stability and performance of the underground WIPP facility. The WIPP Geotechnical Engineering Program Plan (WIPP 2023a) defines the field programs and investigations conducted by the Management and Operating Contractor (MOC). The geotechnical monitoring activities identified in Table MON-1 are included in the plan, which provides for the collection of data as part of the Geomechanical Monitoring and Geosciences Programs described below.

MON-3.1.1 Geomechanical Monitoring Program

The data collected under the Geomechanical Monitoring Program are used to track short-term and long-term geotechnical performance of underground openings and support routine safety and stability of the excavations. These data are used to identify areas of potential instability, allowing corrective action to be taken in a timely manner. Four of the monitored parameters listed in Table MON-1 are measured under this program using the following geomechanical instruments: tape extensometers, convergence meters, borehole extensometers, piezometers, strain gauges, load cells, crack meters, and other instruments installed in the shafts and drifts of the WIPP facility.

MON-3.1.1.1 Scope

The activities associated with the Geomechanical Monitoring Program are designed to:

- Maintain and augment the geotechnical instrumentation system in the WIPP underground and upgrade the automatic data acquisition system, as necessary.
- Monitor geotechnical instrumentation on a regular basis and maintain a current database of instrument readings.
- Evaluate the geotechnical measurements and prepare regular reports that document the data and analyses used to infer the stability of underground openings.
- Recommend corrective or preventive measures to ensure excavation stability and safe operation of the facility.

MON-3.1.1.2 Schedule

The schedule for geomechanical monitoring of an area may vary as part of operational excavation monitoring or research testing. Routine tasks, including installation and monitoring of the instruments, are governed by approved WIPP procedures. Instruments are monitored remotely with data loggers or read manually. Activities that are in development, or are not expected to be performed routinely, are performed in accordance with test plans that include or reference the appropriate procedures to ensure all necessary steps for completion are conducted.

MON-3.1.1.3 Program Output

Remotely polled instruments are connected to a surface computer through a system of cables, termination boxes, and data loggers. Manually read instruments are monitored using electronic read-out boxes and mechanical measuring devices. In general, monitoring data are collected from functional instruments at the intervals specified in Table MON-1 (ranging from weekly to bi-monthly or quarterly); however, more frequent readings are initiated to track detected changes or as determined necessary by the responsible technical staff.

Data analysis is performed on an annual basis and is published annually in the Geotechnical Analysis Report (U.S. DOE 2018a, U.S. DOE 2019b, U.S. DOE 2020a, U.S. DOE 2021a, U.S. DOE 2022a, U.S. DOE 2023a, U.S. DOE 2024b).

An assessment of convergence measurements and other geotechnical observations is made after each round of data collection. The results of each assessment are distributed to affected underground repository operations, engineering, and safety managers.

MON-3.1.2 Geosciences Program

The Geosciences Program involves activities that continue confirmation of site suitability through surface and underground field investigations. These activities generate data used in monitoring the repository and in rock mechanics studies. Information from the Geosciences Program is used to document the existing geologic conditions and characteristics and monitor for changes resulting from the excavations. Activities associated with this program include geologic and fracture mapping, maintenance of a facility for the storage of geologic samples (the Core Library), and other activities performed as needed. These activities generate data related to four parameters listed in Table MON-1.

MON-3.1.2.1 Scope

Site investigations are performed as required, or as determined useful, for enhancement of the site geologic characterization knowledge base. The activities associated with the Geosciences Program are designed to:

- Provide additional site geological characterization based on geologic mapping of excavations and core logging.
- Maintain a current database on mineralogy, chemistry, and textural feature characteristics of the local geology.
- Maintain a current level of knowledge on the geohydrology of the regional stratigraphic formations based on geologic, hydrologic, and geochemical data.

MON-3.1.2.2 Schedule

The following activities are performed on the indicated schedule:

- Geologic Mapping. Geologic mapping is conducted in newly excavated areas and other areas when deemed necessary by cognizant individuals.
- All drifts and rooms in which geologic mapping was not conducted are visually inspected by cognizant individuals within three months of excavation to verify that the exposed rock units are laterally continuous and similar to those exposed in the mapped areas of the facility. Any unusual features are reported in the annual geotechnical analysis reports.
- Fracture Mapping - Fracture mapping is performed and carried out by cognizant individuals at locations selected in accordance with accepted industry practice. Observations from boreholes and excavated surfaces are used in performance assessments of the underground facility.
- Core Library Operations – The MOC maintains a repository for geologic samples that have been determined necessary for long-term storage. Approved WIPP procedures define the

proper methods for maintaining the sample repository, the submittal of core to the Core Library, maintenance of the Core Storage Facility (inventory, handling, and distribution), authorization for access to view the core on-site, and authorization to remove samples from the library.

MON-3.1.2.3 Program Output

Data analysis is performed on an annual basis and is published annually in the Geotechnical Analysis Report (DOE 2018a, U.S. DOE 2019b, U.S. DOE 2020a, U.S. DOE 2021a, U.S. DOE 2022a, U.S. DOE 2023a, and U.S. DOE 2024b).

MON-3.2 Groundwater Monitoring Program

The GMP, which collects groundwater data from numerous wells at and near the WIPP facility, is conducted under the WIPP Groundwater Monitoring Program Plan (GMPP) (WIPP 2024a). This GMP addresses the requirements for sample collection and analysis, groundwater surface elevation monitoring, determination of groundwater flow rate and direction, data management, and reporting of groundwater monitoring data. It also describes the plugging and abandonment of monitoring wells, as well as quality assurance/quality control elements and associated data acceptance criteria. For the CMP, the relevant components of the GMP are the Detection Monitoring Program (DMP) and the Water-Level Monitoring Program (WLMP).

Groundwater monitoring at the WIPP facility is focused on the nearest water-bearing unit above the repository in the Culebra Dolomite Member of the Rustler Formation (Culebra) because it represents the most significant hydrologic contaminant migration pathway to the accessible environment or point for any release caused by an inadvertent human intrusion.

Data obtained through the GMP are also used to support the characterization of two monitoring parameters listed in Table MON-1 Details on how the program is implemented are provided in the GMPP.

MON-3.2.1 Scope

There are six compliance wells completed in the Culebra, three upgradient (north) and three downgradient (south) of the WIPP shaft area, that are part of the DMP and were used to establish background (baseline) water quality in accordance with Resource Conservation and Recovery Act standards. These include DMP wells WQSP-1 through WQSP-6. Water samples are collected from these wells and analyzed for certain chemical and physical parameters. This activity generates data in support of the Culebra Groundwater Composition parameter, which is based on the concentration of the following major ions:

Cations: Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}

Anions: Cl^{-}, HCO_3^{-}, SO_4^{2-}

The results of DMP analyses are compared to baseline results in order to determine stability of the major ion concentrations, thereby ensuring consistency with the conceptual model of solute transport in the Culebra.

Water level data are collected under the WLMP to assess changes in Culebra groundwater flow. Water level measurements are monitored routinely in DMP wells and other wells that are widely distributed across the WIPP monitoring network. Water levels are used to derive the equivalent freshwater hydraulic heads, from which potentiometric surface is determined. Hydraulic gradients are calculated from the potentiometric surface and used to infer groundwater flow direction. If changes in water level(s) occur greater than two feet in any DMP well over the course of a calendar year, the cause is investigated, and any potential impact on the long-term performance of the repository is assessed. Abnormal, unexplained changes in groundwater surface elevation will be evaluated to determine if they indicate changes in site recharge/discharge, which could affect the assumptions regarding the placement of DMP wells.

MON-3.2.1.1 Sampling and Reporting for Water Quality

Each DMP well will be purged to no more than three well-bore volumes or until groundwater field parameters stabilize and are, therefore, representative of undisturbed groundwater, whichever comes first. At that time, final samples will be collected. Groundwater field parameters are those chemical-indicator parameters measured in a field laboratory and include pH, specific gravity, specific conductance, and temperature. Well stabilization occurs when the field-analyzed parameters are within ± 5% for three consecutive measurements. A well-bore volume is the volume of water from the static water level to the bottom of the well sump. The final samples are submitted to an analytical laboratory for analysis.

The sample tracking system at the WIPP facility uses a chain-of-custody for analysis forms. The primary consideration for storage or transportation is that samples shall be analyzed within the prescribed holding times for the analytes of interest. Procedure WP 02-EM1010 (WIPP 2024c) provides instructions for proper sample tracking and shipment protocol to ensure that samples are analyzed within prescribed periods.

MON-3.2.1.2 Sampling and Reporting for Water Level Fluctuations

Water level measurements are taken in the six DMP wells (WQSP-1 through WQSP-6) and other available WIPP wells in the monitoring network (see Appendix HYDRO- 2026, Figure HYDRO-1. Location of WIPP Wells and Well Pads). The water level monitoring measurements are used to identify water level fluctuations.

In addition to the water level measurements, groundwater density is determined. This density is used to convert the water level measurements to equivalent freshwater heads for developing potentiometric surface maps.

MON-3.2.2 Schedule

The six DMP wells are sampled and analyzed annually to compare to the baseline water quality. In addition, groundwater density is determined in the wells on an annual basis.

The groundwater levels are measured monthly in the DMP wells and other accessible Culebra wells within the WIPP monitoring network. Water levels are measured quarterly in redundant wells at well pads where two or more wells are completed within the same interval.

Additional information related to groundwater monitoring activities and program outputs are documented in CRA-2026 Appendix HYDRO. The frequencies for DMP sampling and water-level measurement are listed in Table MON-2.

Table MON-2. WIPP GMP Sample Collection and Water Level Monitoring Frequency

Type of Well	Frequency
Water Quality Sampling	
DMP wells (WQSP-1 through WQSP-6)	Annually
Water Level Monitoring	
DMP wells (WQSP-1 through WQSP-6)	Monthly and prior to sampling events
Other wells in the WIPP monitoring network	Monthly (quarterly on redundant wells where two or more wells are completed in the same interval)
Groundwater Density	
Wells in the WIPP monitoring network	Annually

MON-3.2.3 Program Outputs

The data and results of the GMP are summarized and published annually in the WIPP Annual Site Environmental Report (U.S. DOE 2018b, U.S. DOE 2019c, U.S. DOE 2020b, U.S. DOE 2021b, U.S. DOE 2022b, U.S. DOE 2023b, and U.S. DOE 2024c).

MON-3.3 Delaware Basin Drilling Surveillance Program

The DBDSP is described in the Delaware Basin Drilling Surveillance Plan (WIPP 2024b). This plan provides the framework for the surveillance of drilling activities within the Delaware Basin, with specific emphasis on the nine-township area surrounding the WIPP site. The DBDSP implements activities associated with the collection of information related to two of the parameters listed in Table MON-1.

In addition to these two parameters, the DBDSP collects information on the following activities:

- Borehole plugging
- Enhanced oil recovery

- Natural gas storage
- Solution mining
- Potash mining
- Seismic events

MON-3.3.1 Scope

The DBDSP provides active surveillance of drilling activities within the Delaware Basin, which is a sub-basin of the Permian Basin. The WIPP PA includes the potential impacts of drilling on the performance of the disposal system. The number of deep boreholes drilled per square kilometer is a parameter used in PA calculations for inadvertent intrusion scenarios. This parameter is based on actual drilling rates within the Delaware Basin over the last 100 years, as required by 40 CFR 194.33 (U.S. EPA 1996).

The DBDSP continues to collect new data by expanding the existing database. The results of this program are used to detect any substantial deviations from the assumptions used in the previous PA. Collecting additional information about resource exploration and resource activities and practices within the entire Delaware Basin includes information to determine whether the drilling scenarios, assumptions, and probabilities used in the PA will continue to be valid for each recertification cycle of the WIPP disposal system.

Drilling information for the study area is obtained through commercially available electronic databases; the records of government agencies such as the Railroad Commission of Texas; the New Mexico Oil Conservation Division; New Mexico and Texas State Engineers; and the Bureau of Land Management. Additionally, surveys are sent to area drillers and interviews are conducted with them. The electronic database is updated weekly to reflect drilling activities in the Delaware Basin. Records of government agencies are updated as they become available.

MON-3.3.2 Schedule

Table MON-3 shows the frequency of DBDSP data collection.

Table MON-3. DBDSP Data Collection Schedule

Information Collected	Frequency
Borehole plugging	Weekly
Enhanced recovery	Quarterly
Gas storage	Annually
Solution mining	Annually
Potash mining	Annually
Seismic events	Monthly
Drilling-related activities	Weekly
Probability of encountering a Castile brine reservoir	Annually

Information Collected	Frequency
Drilling rate calculations	Annually
Natural gas and CO^2 pipeline construction	Biennial
Field visits	Unscheduled

MON-3.3.3 Program Outputs

The DBDSP updates and maintains a database of drilling activities and related practices in the Delaware Basin. This activity will continue until 100 years after repository closure or until the DOE can demonstrate to the EPA that there are no significant concerns that require further surveillance. For the nine-township area surrounding the WIPP disposal system, the following information is maintained:

- Plugging and abandonment activities, including descriptions of plugging configurations
- The fraction of plugged and abandoned boreholes that are sealed
- Well conversion activities (injection, disposal, water)
- Injection-well operations (disposal and secondary recovery)
- Drilling activities, including borehole depths, diameters, and type and amount of drilling fluid
- Ownership of state and federal minerals and hydrocarbon leases within the area
- Occurrences of pressurized brine within the Castile

Data collected and recorded by the DBDSP are reported annually in the Delaware Basin Monitoring Annual Report (U.S. DOE 2018c, U.S. DOE 2019d, U.S. DOE 2020c, U.S. DOE 2021c, U.S. DOE 2022c, U.S. DOE 2024d, and U.S. DOE 2025a).

MON-3.4 Subsidence Monitoring Program

The SMP is described in detail in the WIPP Underground and Surface Surveying Program (WIPP 2023b). Subsidence monitoring measures the vertical movement of the land surface relative to a reference location using state-of-the-art leveling equipment. The technique used to monitor subsidence involves measuring the vertical height difference between two or more markers placed on a surface a known distance away from each other using a leveling survey. A reference benchmark is used as the standard and the relative movement of the other benchmark(s) is measured to detect vertical movement over time. Subsidence measurements are relative because the reference is fixed only with respect to the subsidence marker(s).

MON-3.4.1 Scope

The activities associated with the SMP are designed to:

- Provide time-related spatial information on surface subsidence within 152.4 meters (500 feet [ft]) surrounding the waste shaft during the operational phase of the repository.
- Provide time-related spatial information on surface subsidence over the influence area of the underground openings for comparison with subsidence predictions.
- Maintain a database of subsidence data.

Subsidence monitoring is conducted to detect substantial and detrimental deviations from expected repository performance by comparing actual subsidence to predicted subsidence. With current technology, vertical elevation can be measured at a precision of 0.0305 centimeters (0.001 ft).

Subsidence data currently being compiled will be compared to subsidence predictions. In addition, subsidence monitoring during the operational phase generates data to establish a baseline against which long-term subsidence data and information may be evaluated.

MON-3.4.2 Schedule

Subsidence surveys are performed annually throughout the operational period. After closure of the repository, subsidence surveys will be performed at 10-year intervals for at least 100 years or until the DOE demonstrates to the EPA that there are no significant concerns to be addressed by further monitoring.

MON-3.4.3 Program Outputs

The SMP generates annual surface subsidence data for 37 kilometers (km) (23 miles [mi]) of leveling loops on approximately 77 monuments. Results are reported annually in the WIPP Subsidence Monument Leveling Survey (U.S. DOE 2018d, U.S. DOE 2020d, U.S. DOE 2021d, U.S. DOE 2022d, U.S. DOE 2023c, and U.S. DOE 2025b).

MON-3.5 Waste Inventory Monitoring Based on WIPP Waste Data System

Information on the waste activity parameter is measured or estimated by generator sites through waste characterization activities. Sites are required to report certain information in the WIPP WDS. Reports are generated to tabulate key waste parameters for waste that has been emplaced in the WIPP repository, including cellulose, plastic, rubber, and ferrous materials. The waste activity parameter includes tracking the total waste material parameter weights and curie content of the 10 radionuclides listed in Appendix MON-3.5.1.

MON-3.5.1 Scope

Radionuclide inventory data and material parameter weights for every container of waste placed in the WIPP underground repository are submitted to the WDS database at the time waste is certified for shipment to the WIPP facility. The waste activity parameters being tracked and reported include radiological activity (in curies) emplaced during the 40 CFR 194.4(b)(4) (U.S. EPA 1996) reporting period and the cumulative activity since waste was first emplaced in the repository. The radionuclides being tracked (in curies) include:

- americium-241
- plutonium-238
- plutonium-239
- plutonium-240
- plutonium-242
- uranium-233
- uranium-234
- uranium-238
- strontium-90
- cesium-137

The material parameter weights that are annually tracked and reported in the 40 CFR 194.4(b)(4) report include:

- A repository maximum limit for emplaced cellulose, plastic, and rubber materials of 2.2×10^7 kilograms (kg)
- A repository minimum for emplaced ferrous metals of 2×10^7 kg
- A repository minimum for emplaced nonferrous metals of 2×10^3 kg

MON-3.5.2 Schedule

A current collection of radionuclide inventory data and material parameter weights for the WIPP is maintained within the WDS, and data reports can be generated at any time.

MON-3.5.3 Program Outputs

The data collected for the waste activity parameter is tracked by the WDS. The WDS annually generates a Waste Emplacement Summary Report that is submitted each November to the EPA in the annual 40 CFR 194.4(b)(4) report (U.S. DOE 2018e, U.S. DOE 2019e, U.S. DOE 2020e, U.S. DOE 2021e, U.S. DOE 2023d, U.S. DOE 2023e, and U.S. DOE 2024e). In addition, to aid the EPA, an EPA Dashboard is available on the WDS for their use and they can call up any of the following reports at their discretion.

- Container Query
- Nuclide Report
- Waste Emplacement Report
- Summary of Waste Emplacement Inventory Report
- Emplacement by Container Type Report
- Emplacement History Overview

The DOE also provides the public with access to the WDS via the Public Access System for WDS at http://www.wipp.energy.gov/WDSPA/. This service provides the ability to query the WDS for information on disposed containers of transuranic waste. Container data is available 14 days after emplacement in the WIPP repository.

MON-4.0 POST-CLOSURE (LONG-TERM) MONITORING

A Post-closure Monitoring Plan was addressed in Appendix MON, Section 5 of the CCA (U.S. DOE 1996) and subsequently, in Appendix MON-2004, Attachment A of CRA-2004 (U.S. DOE 2004). Prior to facility closure (sealing of the shaft) a final Post-closure Monitoring Plan will be developed; however, it will not be implemented until after facility closure. When the final Post-closure Monitoring Plan is written, the historic monitoring data collected per the requirements of the Pre-closure Monitoring Plan, which will support post-closure monitoring, will be analyzed.

MON-5.0 MONITORING PROGRAMS QUALITY ASSURANCE REQUIREMENTS

Work performed under the DOE CMP meets the quality standards by complying with the requirements of the criteria of 40 CFR 194.22(a) (2)(ii) (U.S. EPA 1996) and is controlled by the application of the Carlsbad Field Office (CBFO) Quality Assurance Program Document (QAPD) (U.S. DOE 2023f). Waste information is controlled by implementing the relevant QA requirements at generator sites.

In addition to the management requirements, such as document and record control established in the QAPD, requirements related to sampling and monitoring activities are specified. In particular, the following two sections of the QAPD are directly related to the performance of monitoring work and the control of samples:

- QAPD, Section 2.4 – Inspection and Testing
    - Qualification of personnel
    - Inspection
    - Test requirements
    - Monitoring, measuring, testing, and data collection
    - Use and control of measuring and test equipment
    - Calibration

- QAPD, Section 4.0 – Sample Control Requirements

    - Sample control
    - Sample identification
    - Handling, storing, and shipping samples
    - Disposition of nonconforming samples

WIPP monitoring programs are subject to EPA inspections in accordance with 40 CFR 194.21 (U.S. EPA 1996).

The CMP relies on the individual monitoring plan's QA program to ensure compliance with DOE WIPP requirements for data quality assessments, objectives, and analyses. Each sampling and monitoring program is implemented through individual implementation plans, which include the QA descriptions, objectives, and references to the applicable governing QA document.

MON-6.0 REPORTING AND ASSESSMENT

Information flow is controlled to ensure important monitoring results are communicated to the appropriate individuals and groups.

MON-6.1 Monitoring Data Reporting

The monitoring programs that generate data used in the CMP are implemented and coordinated by the MOC.

MON-6.1.1 CMP Assessment Report

The results of the CMP are reported in the COMP assessment (Wagner and Hayes 2019; Wagner and Hayes 2020; Kicker et al. 2021; Kicker et al. 2022; Kicker et al. 2023b; Kicker and Jackson 2024; and Kicker and Jackson 2025). The Annual COMP Assessment Reports are provided to the EPA with each recertification application as references to Appendix DATA.

The CMP results may indicate two general cases: normal or expected conditions, in which results are generally consistent with existing data, parameter values, and conceptual models; and anomalous conditions, in which results are inconsistent with existing data, parameter values, or conceptual models. The Scientific Advisor determines whether these results are consistent with expected conditions modeled in the PA or screening decisions used to support the compliance determination. The report also recommends whether the CMP should be modified based on the results of the monitoring programs.

MON-6.1.2 External Reporting

The DOE reviews the recommendations of the MOC and the Scientific Advisor to evaluate their significance. Significance is determined based on consideration of the following criteria:

- Containment requirements established pursuant to 40 CFR 191.13 (U.S. EPA 1993) are, or are expected to be, exceeded.
- Releases from previously emplaced waste that lead to committed effective doses that are, or are expected to be, in excess of those established pursuant to 40 CFR 191.15 (U.S. EPA 1993) (not including emissions from operations covered pursuant to 40 CFR Part 191 Subpart A).
- Releases that have caused, or are expected to cause, concentrations of radionuclides (or estimated doses due to radionuclides in underground sources of drinking water in the accessible environment) to exceed the limits established pursuant to 40 CFR Part 191 Subpart C.

If the monitoring results meet any of these criteria, they are considered significant. Significant monitoring results are promptly reported to the EPA. The report is accompanied by a recommended course of action, including the appropriate external reporting. If the monitoring results exceed or possibly exceed containment requirements or release limits as specified in 40 CFR 194.4(b)(3)(ii), the CBFO will immediately cease emplacement of waste in the WIPP repository and notify the EPA within 24 hours.

If the DOE discovers a condition or activity that differs significantly from what is indicated in the most recent compliance application but does not involve conditions or activities listed in 40 CFR 194.4(b)(3)(ii), then the difference shall be reported in writing to the EPA within 10 calendar days of discovery. For normal conditions where monitoring results are within expectations, the COMP assessment documents these conditions (Wagner and Hayes 2019; Wagner and Hayes 2020; Kicker et al. 2021; Kicker et al. 2022; Kicker et al. 2023; Kicker and Jackson 2024; and Kicker and Jackson 2025).

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