Title 40 CFR Part 191
Subparts B and C
Compliance Recertification Application 2014
for the
Waste Isolation Pilot Plant

Appendix MON-2014
WIPP Monitoring Programs

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

Compliance Recertification Application 2014
Appendix MON-2014

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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
cm	centimeter
CMP	Compliance Monitoring Program
CRA	Compliance Recertification Application
DBDSP	Delaware Basin Drilling Surveillance 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	Geotechnical Monitoring Program
GDMPP	Groundwater Detection Monitoring Program Plan
GWMP	Groundwater Monitoring Program
GWMPP	Groundwater Monitoring Program Plan
kg	kilogram
km	kilometer
m	meter
M&OC	Management and Operating Contractor
mi	mile
NMED	New Mexico Environment Department
PA	performance assessment
QA	quality assurance
QAPD	Quality Assurance Program Document
SMP	Subsidence Monitoring Program
WIPP	Waste Isolation Pilot Plant
WQSP	Water Quality Sampling Program
WDS	Waste Data System

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MON-1.0 Introduction

This appendix to the 2014 Compliance Recertification Application (CRA-2014) describes a specific monitoring program that was developed to meet commitments contained in the U.S. Department of Energy's (DOE's) application to the U.S. Environmental Protection Agency (EPA), which demonstrated compliance with radioactive waste disposal regulations 40 CFR Part 191 Subparts B and C and the certification criteria in 40 CFR Part 194. This appendix does not address monitoring activities intended to demonstrate compliance with 40 CFR Part 191 Subpart A.

The monitoring activities described are performed as assurance measures to detect substantial and detrimental deviations from expected disposal system performance. This program consists of a preclosure and postclosure monitoring program using monitoring techniques that do not jeopardize the isolation of the waste. The program must be conducted until the DOE and the EPA agree there are no significant concerns to be addressed by further monitoring. The long-term performance expectations for the disposal system are derived from conceptual models, scenarios, and assumptions developed for the Waste Isolation Pilot Plant (WIPP) performance assessment (PA).

The activities performed for the overall monitoring programs at the WIPP facility comprehensively address the range of regulatory requirements at departmental, state, and federal levels. This appendix addresses activities relevant to monitoring the disposal system. This document provides an overview of the Compliance Monitoring Program (CMP) and 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.
- The results are reported to the EPA.

On January 3, 2002, the DOE Carlsbad Field Office (CBFO) submitted a letter to the EPA (Triay 2002). This letter requested Appendix MON be rewritten to incorporate the portions of Appendices Environmental Monitoring Plan (EMP), Groundwater Surveillance Program Plan (GWMP), Geotechnical Monitoring Plan (GTMP), Subsidence Monitoring Plan (SMP), and Delaware Basin Drilling Monitoring Plan (DMP) required to demonstrate compliance with 40 CFR § 191.14(b) (U.S. EPA 1993) in accordance with the criteria established by 40 CFR § 194.42 (U.S. EPA 1996). The EPA approved the request in a letter to CBFO on March 15, 2002 (Marcinowski 2002).

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 (GWMP)
- 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 2009 Compliance Recertification Application (CRA-2009) (U.S. DOE 2009a) for the above-listed programs are recorded or referenced in Appendix DATA-2014. The descriptions provided in this appendix are specific to the CMP and, thus, the requirements of section 191.14(b) and section 194.42.

MON-1.2 Preclosure and Postclosure Monitoring

The requirements of 40 CFR § 191.14, section 194.42, the initial EPA certification (U.S. EPA 1998a), the 2006 Recertification (U.S. EPA 2006), and the 2010 Recertification (U.S. EPA 2010) serve as the regulatory basis for preclosure and postclosure monitoring. These requirements specify that disposal systems must be monitored to detect substantial and detrimental deviation from expected disposal system performance.

MON-1.3 Monitoring Assessment

The DOE was required by 40 CFR § 194.42(a) to perform an analysis that would determine the effects of various parameters on the performance of the disposal system, and to use the results in preclosure and postclosure monitoring plans. The disposal system performance analysis identified 10 monitoring parameters, listed in Section MON-2.1, to be monitored and assessed within the CMP. The discussion of preclosure monitoring activities for these 10 parameters includes the following:

- Identifying activities required to comply with the monitoring requirements of the EPA's certification and recertification of compliance with Part 191 Subparts B and C during the preclosure phase of the project
- Identifying organizations that generate the monitoring data, organizations that convert the data to monitoring parameters and assess the results against expected results, and the organization that reports the results of the assessments to the EPA
- Identifying the compliance monitoring schedule
- Providing an overview of quality assurance (QA) requirements applicable to the CMP

MON-1.4 Appendix Summary

Section MON-2.0 identifies the monitoring requirements of Part 191 Subparts B and C in keeping with the criteria of Part 194. Section MON-3.0 describes the preclosure monitoring program associated with each monitoring parameter, the monitoring schedules, and program outputs. Section MON 4-0 describes the planned postclosure monitoring. Section MON-5.0 describes the QA requirements applicable to the CMP. Section MON-6.0 describes the process of communicating and reporting CMP results and evaluations.

MON-2.0 Compliance Monitoring Program Requirements

The DOE's preclosure and postclosure CMP defines programs to assess the performance of specific aspects of the disposal system. The relevant monitoring requirements are identified in:

- Section 191.14(b)
- Section 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)
- The CRA-2004, Chapter 7.0, Section 7.2
- The CRA-2009, Section 42.0, Monitoring (40 CFR § 194.42)

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 Compliance Certification Application (CCA), Chapter 7.0, and Appendix MON, Attachment MONPAR (U.S. DOE 1996). The EPA documented its approval of the DOE monitoring approach in the compliance certification decision (U.S. EPA 1998a) and Compliance Application Review Document (CARD) 42 (U.S. EPA 1998b). In the CRA-2004, Appendix MON-2004 was rewritten to incorporate portions of Appendices EMP, GWMP, GTMP, SMP, and DMP that were not revised for the CRA-2004. The DOE reassessed the CCA, Appendix MON, Attachment MONPAR, for the CRA-2004 and determined the original conclusions and monitoring parameters identified in MONPAR remain valid and unchanged (Kirkes and Wagner 2003). For the CRA-2009, the DOE once again assessed the original MONPAR analysis used to determine which monitoring parameters should be included in the CMP. Based on the review of operational activities, conditions, monitoring data, PA, and experimental programs that occurred since the CRA-2004, the reassessment states, "the conclusions of the MONPAR analysis remain valid and its conclusions continue to be adequate for inclusion in the CRA-2009" (Wagner 2008). An assessment of the program was made again in 2013 to determine if changes should be made to the CMP. This assessment determined that the conclusions of the original MONPAR assessment remain valid; therefore no changes are needed to the program (Wagner 2013). The annual compliance monitoring reports also concluded that no changes to the monitoring program are recommended (Wagner and Hillesheim 2008 and Wagner and Hillesheim 2009; Wagner and Kuhlman 2010; Wagner, Kuhlman and Johnson 2011 and Wagner, Kuhlman and Johnson 2012).

The EPA-approved monitoring approach recognizes that the DOE will monitor 10 parameters. These parameters are:

1. Creep closure and stresses
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 the Castile) brine reservoir
9. Subsidence
10. Waste activity

All of the above parameters are being monitored during the preclosure period.

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

The monitoring parameters that have related PA parameters include:

- Drilling rate
- 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.

The data used to determine the 10 monitoring parameters of the CMP are generated by 5 separate monitoring programs (described in Sections MON-3.1, MON-3.2, MON-3.3, MON-3.4, and MON-3.5). Each monitoring program focuses on the collection of field data. The programs that generate or evaluate the data are described in Section MON-6.0. Results from each monitoring program are documented individually in annual reports (see Appendix DATA-2014), while the assessment results of the 10 parameters are documented and reported in a compliance monitoring parameter assessment reports (Wagner and Hillesheim 2008 and Wagner and Hillesheim 2009;

Wagner and Kuhlman 2010; Wagner, Kuhlman and Johnson 2011 and Wagner, Kuhlman and Johnson 2012).

As stated earlier, if any of the data, parameters, or observations are not consistent with expectations as defined in Section MON-6.1.1, the CMP process requires addressing concerns and developing recommendations. Results from monitoring programs will be generated on an ongoing basis throughout the operational period of the repository. Compliance monitoring data are provided to the cognizant individuals and organizations within the project and evaluated for their significance, and the evaluation results and data summaries are reported to the EPA. Section MON-6.0 describes the process of communicating and reporting CMP results and evaluations.

Table MON-1. Monitoring Parameters

Monitoring Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Creep Closure and Stresses	Geotechnical Monitoring Program (GMP)	Various data calls from weekly to monthly based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Not directly related to a PA parameter. May provide a short-term (operational) observation of the geomechanical response of repository excavation. Can provide confidence in the creep closure model.	Salt creep, excavation-induced stress changes, changes in stress field, pressurization.	Data are evaluated annually and during recertification
Extent of Brittle Deformation	GMP	Various data calls from weekly to monthly based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Not directly related to a PA parameter. Can provide confidence in the long-term behavior of the disturbed rock zone (DRZ), as modeled. Intrinsic shaft DRZ permeability and effective shaft seal permeability is calculated from this parameter.	DRZ, roof falls, consolidation of seals.	Data are evaluated annually and during recertification.

Monitoring Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Initiation of Brittle Deformation	GMP	Various data calls from weekly to monthly based on repository conditions, instrumentation, and data collection system. Data are reported annually.	Not directly related to a PA parameter. Can provide confidence in the anhydrite fracture model implemented in the BRAGFLO code. May provide related repository observation data on initiation or displacement of major brittle deformation features in the roof or surrounding rock.	Disruption due to gas effects.	Data are evaluated annually and during recertification.
Displacement of Deformation Features	GMP	Various data calls from weekly to 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.	Stability of open panel.	Data are evaluated annually and during recertification.
Culebra Groundwater Composition	Groundwater Monitoring Program (GWMP)	Data are collected annually and reported annually.	Average Culebra brines composition and matrix distribution coefficient for uranium (IV, VI), plutonium (III, IV), thorium (IV), americium (III). Matrix distribution coefficient is not a sensitive PA parameter.	Groundwater geochemistry, actinide sorption.	Data are evaluated annually and during recertification.

Monitoring Parameter	Monitoring Program	Frequency of Data Collection and Reporting	Related PA Parameter	Related FEPs	Evaluation Cycle
Change in Culebra Groundwater Flow	GWMP	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 and incorporated into the PA.	Groundwater flow and recharge.	Data are evaluated annually and during recertification.
Drilling Rate	DBDSP	As well records are received (weekly and monthly basis). Data are reported annually.	Required PA parameter per 40 CFR § 194.33. The Drilling Rate is important to performance and incorporated into the PA.	Drilling Fluid Flow	Data are evaluated annually and during recertification
Probability of Encountering a Castile Brine Reservoir	DBDSP	As drilling records are received. . Data are reported annually.	Probability of Encountering a Castile Brine Reservoir	Drilling Fluid Flow	Data are evaluated annually and during recertification
Subsidence	SMP	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 to groundwater flow due to mining effects; subsidence baseline.	Data are evaluated annually or as determined necessary by the DOE.
Waste Activity	Waste Inventory Monitoring Based on WDS	Continually updated as waste is approved for shipment to the WIPP and emplaced. . Data are reported annually.	Waste Activity	Waste Inventory Monitoring Based on WDS	Data are evaluated annually and during recertification

The 10 parameters above are called *compliance monitoring parameters*. As discussed previously, the EPA determined during the original WIPP certification and the 2004 and 2009 recertifications that these parameters met the regulatory monitoring requirements.

MON-3.0 Preclosure Compliance Monitoring

This section describes the preclosure CMP and the resulting data. The 10 parameters, associated monitoring program for each, frequency of data collection and reporting, related PA parameters, and related FEPs decisions used to support the PA are listed in Table MON-1.

MON-3.1 Geotechnical Engineering Program Plan

The WIPP Geotechnical Engineering Program Plan (Nuclear Waste Partnership LLC 2012a) defines the field programs and investigations carried out by the Geotechnical Engineering Section within the Management and Operating Contractor (M&OC). The Geotechnical Engineering Program provides geologic information related to geotechnical characteristics and assesses the stability and performance of the underground facility. The geotechnical monitoring activities identified in Table MON-1 are included as part of the WIPP Geotechnical Engineering Program Plan. This plan provides for the collection of data as described in the Geomechanical Monitoring Program and the Geosciences Program.

MON-3.1.1 Geomechanical Monitoring Program

The data collected as part of the Geomechanical Monitoring Program is usedto validate the WIPP design, track short-term and long-term geotechnical performance behavior of underground openings, and support routine safety and stability evaluations of the excavations. From an operational point of view, geomechanical data are used to identify areas of potential instability allow corrective action to be taken in a timely manner. For underground opening behavior, in situ data were used to model long-term disposal system performance. Geomechanical monitoring instrumentation generates data related to the following four parameters:

1. Creep closure and stresses
2. Extent of brittle deformation
3. Initiation of brittle deformation
4. Displacement of deformation feature

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 instrumentation data and prepare regular reports that document the data and analyses describing the stability and performance 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 process by which geomechanical monitoring of an area is initiated may vary as part of operational excavation monitoring or research testing. Installation and monitoring of the instruments is governed by approved WIPP procedures. Instrumentation is monitored remotely using data loggers, or is read manually. Routine tasks are carried out according to approved WIPP procedures. Activities which are in development, or which are not expected to be performed routinely, are performed in accordance with industry standards and individual activity plans that supplement the Geotechnical Engineering Program Plan.

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. Instrumentation is located in the shafts and drifts, including tape extensometer stations, convergence meters, borehole extensometers, piezometers, embedment strain gauges, stress gauges, inclinometers, load cells, and crack meters. Monitoring data are collected on a quarterly basis at a minimum, but more frequent readings may be collected as determined by the cognizant engineer or cognizant manager. Instruments are read as designated in Table MON-1.

MON-3.1.1.3 Program Output

Data analysis is performed on an annual basis and is published annually in the Geotechnical Analysis Report (U.S. DOE 2009b, U.S. DOE 2010a, U.S. DOE 2011a, and U.S. DOE 2012a).

An assessment of convergence measurements and 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

Geosciences activities document existing geologic conditions and characteristics and monitor for changes resulting from the excavations. These activities generate data related to the following four parameters:

1. Creep closure and stresses
2. Extent of brittle deformation
3. Initiation of brittle deformation
4. Displacement of deformation features

MON-3.1.2.1 Scope

The Geosciences Program implements field activities such as geologic mapping of the facility and near-surface stratigraphic horizons, core logging, and geophysical surveys. 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 to monitor for changes resulting from excavations. Activities associated with this program include geologic and fracture mapping, maintenance of a facility for the storage of geologic samples (the Core Library), seismic monitoring and evaluation, and other activities performed as needed. These activities characterize, demonstrate the continuity of, and document the geology at the site.

MON-3.1.2.2 Schedule

The following activities are performed on the indicated schedule:

- Seismic Monitoring. Regional seismic monitoring and evaluation are conducted by the New Mexico Institute of Mining and Technology. The network is operated continuously and monitoring results are reported quarterly.

- Geologic Mapping. Geologic mapping is conducted in newly excavated areas and in other areas when deemed necessary by the cognizant engineer or Geotechnical Engineering Manager.

- At a minimum, a complete analysis of geotechnical data is performed annually. The geotechnical activities will continue throughout the operational period.

MON-3.1.2.3 Program Output

Data analysis is performed on an annual basis and is published annually in the Geotechnical Analysis Report (U.S. DOE 2009b, U.S. DOE 2010a, U.S. DOE 2011a, and U.S. DOE 2012a).

MON-3.2 Groundwater Monitoring Program

Groundwater monitoring at the WIPP facility is carried out under the WIPP Groundwater Monitoring Program Plan (GWMPP) (Nuclear Waste Partnership LLC 2012b). The purpose of the GWMP is to collect groundwater data from numerous wells located at and near the facility.

The Culebra is the focus of the GWMP. It has been extensively studied during past hydrologic characterization programs, and was found to be the most likely hydrologic pathway to the accessible environment or compliance point for any potential human-intrusion-caused release scenario.

Data obtained through the GWMP are also used to support the following two monitoring parameters:

1. Culebra groundwater composition
2. Culebra groundwater flow parameters

Details on how the program is implemented are provided in the GWMPP (Nuclear Waste Partnership LLC 2012b).

On January 31, 2012, the New Mexico Environment Department (NMED) submitted a letter from Dave Martin, Cabinet Secretary, to Edward Ziemianski, Interim Manager of the Carlsbad Field Office, and Farok Sharif, Washington TRU Solutions, transmitting a Class 2 Permit Modification Request, EPA I.D. Number NM4890139088-TSDF (NMED 2012a). As a result of this modification, changes were made to the Culebra Water Quality Sampling Program. The groundwater composition sampling frequency and the method for reporting the change in the groundwater flow parameter was changed. Prior to 2012, sampling was conducted semi-annually. The sampling frequency was changed to annual sampling, based on 15 years of data that indicated little or no change in constituent concentrations. The change also aligned the 40 CFR § 194.42 Compliance Monitoring Program requirements with the WIPP Groundwater Detection Monitoring Program Plan (GDMPP) as defined in the WIPP Hazardous Waste Facility Permit (NMED 2012b).

MON-3.2.1 Scope

The GWMPP addresses requirements for sample collection, groundwater surface elevation monitoring, groundwater flow direction monitoring, data management, and reporting of groundwater monitoring data. It also identifies analytical parameters selected to assess groundwater quality.

Six Culebra wells were drilled as part of the WIPP GWMP: Water Quality Sampling Program (WQSP) 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 calls for analysis of the following ions:

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

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

Water level data are collected to assess changes in Culebra groundwater flow. Water level measurements are tracked over time using WQSP wells and other wells that are widely distributed across the WIPP area to monitor potentiometric surface and groundwater flow directions. If changes in water level(s) occur, the cause is investigated, and any potential impact on the long-term performance of the repository is assessed.

MON-3.2.1.1 Sampling and Reporting for Water Quality

Sampling for water quality is performed at six groundwater monitoring wells. The Culebra is monitored using wells WQSP-1 through WQSP-6. It should be noted that the program previously monitored well WQSP-6a in the Dewey Lake Red Beds Formation. However, the change in the WIPP GDMPP introduced through a NMED Class 2 Permit Modification Request removed this well from the sampling and reporting program.

Field parameter measurements are used by the sampling team to determine when purged groundwater is representative of the undisturbed native groundwater of the Culebra. After well stabilization, final samples are collected for submittal to analytical laboratories. The field indicator parameters are pH, temperature, specific conductance, and specific gravity. Each well is purged no more than three well bore volumes, or until field parameters stabilize, whichever occurs first. Well stabilization occurs when field-analyzed parameters are within ± 5% of three consecutive measurements. Should field parameters not stabilize after 3 well bore volumes have been purged, a notation is made in the field data sheets, where appropriate, and final samples are obtained.

When the field indicator parameters have stabilized, indicating that the sample is representative of the Culebra, final samples are collected in the appropriate type of container for the specific analysis to meet state and federal groundwater requirements. The final samples are submitted to a laboratory for analysis. Section MON-3.2.1 lists the analytes needed to support the PA parameter.

Samples are tracked and managed in accordance with WIPP facility standard operating procedures to assure samples are analyzed within prescribed time periods.

MON-3.2.1.2 Sampling and Reporting for Water Level Fluctuations

Water level measurements are taken in the six groundwater monitoring wells (WQSP-1 through WQSP-6) and other available WIPP wells in the monitoring network (Appendix HYDRO-2014, Figure HYDRO-1. Location of WIPP Wells and Well pads). The water level monitoring will be used to identify water level fluctuations.

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

MON-3.2.2 Schedule

Background water quality in both the upgradient and downgradient monitoring wells has been established for the WIPP facility. The six WQSP monitoring wells constructed for the GWMP are sampled on an annual basis to compare to the baseline water quality. Prior to 2012, sampling was conducted semi-annually. The sampling frequency was changed to an annual basis, based on 15 years of data that indicated little or no change in constituent concentrations. The change also aligned the 40 CFR 194.42 Compliance Monitoring Program requirements with the WIPP

GDMPP. The change in the WIPP GDMPP was introduced through a NMED Class 2 Permit Modification Request.

The groundwater level is measured by monitoring the wells on at least a monthly basis. Groundwater level measurements are monitored and collected for other WIPP wells, as well as for the WQSP wells. The water levels are determined monthly in at least one accessible, completed interval at each available well pad, and quarterly in redundant wells at well pads where two or more wells are completed in the same interval. Groundwater level measurements are primarily used to examine changes in groundwater flow rate and direction to identify any changes pertinent to compliance.

The characteristics of the GWMP, such as the frequency of sampling and the location of the sampled wells, will be reevaluated if significant changes are observed in the groundwater flow direction or gradient. Reporting frequencies are listed in Table MON-2.

Table MON-2. WIPP GWMP Sample Collection and Water Level Reporting Frequency

Type of Well	Frequency
Water Quality Sampling	
WQSP wells (six)	Annually
Water Level Monitoring	
WQSP wells (six)	Monthly and before sampling events
Other available WIPP wells	Monthly and quarterly on selected wells

MON-3.2.3 Program Outputs

The groundwater samples are analyzed to quantify Culebra groundwater parameters and water quality parameters listed in Section MON-3.2.1.

The GWMP also generates Culebra water level data. The data and results of the GWMP are summarized and published on an annual basis in the WIPP Annual Site Environmental Report (U.S. DOE 2008a, U.S. DOE 2009c, U.S. DOE 2010b, U.S. DOE 2011b, and U.S. DOE 2012b).

MON-3.3 Delaware Basin Drilling Surveillance Program

The DBDSP is described in the Delaware Basin Drilling Surveillance Plan (Nuclear Waste Partnership LLC 2012c). 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 mandates the collection of information related to the following two parameters:

1. Probability of encountering a Castile brine reservoir
2. Drilling rate

In addition to the parameters listed above, the DBDSP collects information on the following activities:

- Borehole plugging
- Enhanced recovery
- Natural gas storage
- Solution mining
- Potash mining
- Seismic events

MON-3.3.1 Scope

The DBDSP is to provide for active surveillance of drilling activities within the Delaware Basin. The WIPP PA includes the 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 results of the DBDSP continue to expand the existing database. The results of this program are used to detect any substantial deviations from the assumptions used in the previous PA (see Section MON-3.3.2, Table MON-3). Collecting additional information about resource exploration and exploitation activities and practices in the Delaware Basin provides information to determine whether the drilling scenarios, assumptions, and probabilities used in the PA will continue to be valid for each five-year recertification of the WIPP disposal system.

Drilling information for the study area is obtained through commercially available electronic databases and the records of government agencies. 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	Monthly
Gas storage	Annually
Solution mining	Annually
Potash mining	Annually
Seismic events	Quarterly
Drilling-related	Weekly
Probability of encountering a Castile brine reservoir	Weekly
Drilling rate calculations	Quarterly

MON-3.3.3 Program Outputs

DBDSP results are used to update and maintain a database of drilling activities and related practices in the Delaware Basin. For the nine-township area surrounding the WIPP dispoal system, the DBDSP updates and maintains a database containing the following information:

- 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 as a result of the DBDSP are reported annually in the Delaware Basin Monitoring Annual Report (U.S. DOE 2008b, U.S. DOE 2009d, U.S. DOE 2010c, U.S. DOE 2011c, and U.S. DOE 2012c).

MON-3.4 Subsidence Monitoring Program

The SMP is described in detail in the WIPP Underground and Surface Surveying Program (Nuclear Waste Partnership LLC 2012d). Subsidence monitoring measures 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 (m) (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

With current technology, vertical elevation can be measured at a precision of 0.0305 centimeters (cm) (0.001 ft). Subsidence monitoring was chosen by the DOE as a long-term monitoring tool because it effectively meets the requirements in section 191.14(b). Subsidence monitoring is conducted to detect substantial and detrimental deviations from expected repository performance by comparing actual subsidence to predicted subsidence.

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 operations period. After closure of the repository, subsidence surveys will be performed at 10-year intervals for at least 100 years or until no further useful information may be obtained through continued monitoring.

MON-3.4.3 Program Outputs

The SMP generates annual surface subsidence data for 24.14 kilometers (km) (15 miles (mi)) of leveling loops through 48 monuments. Results are reported annually in the WIPP Subsidence Monument Leveling Survey (U.S. DOE 2008c, U.S. DOE 2009e, U.S. DOE 2010d, U.S. DOE 2011d, U.S. DOE 2012d, and U.S. DOE 2012e).

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, formerly called the WIPP Waste Information System, or WWIS. Reports are generated to tabulate key waste parameters for waste that has been emplaced in the WIPP repository. The waste activity parameter includes tracking the total waste material parameter weights and curie content of the 10 radionuclides listed in Section MON-3.5.3.

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 section 194.4(b)(4) report include:

- A repository maximum limit for emplaced cellulose, plastic and rubber materials of 2.2 x10^7 kg
- A repository minimum for emplaced ferrous metals of 2 X 10^7 kg
- A repository minimum for emplaced nonferrous metals of 2 X 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 2008d, U.S. DOE 2009f, U.S. DOE 2010e, U.S. DOE 2011e, and U.S. DOE 2012f). . 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

MON-4.0 Postclosure (Long Term) Monitoring

The final Postclosure Monitoring Plan will be developed prior to final facility closure (sealing of the shafts), but will not be implemented until after facility closure. When the final Postclosure Monitoring Plan is written, the historic monitoring data collected per the requirements of this Preclosure Monitoring Plan that will support postclosure monitoring will be analyzed.

MON-5.0 Monitoring Programs Quality Assurance Requirements

The quality of the work performed under the DOE CMP is accomplished per the criteria of 40 CFR § 194.22(a)(2)(ii) (U.S. EPA 1996) and controlled by the application of the CBFO Quality Assurance Program Document (QAPD) (U.S. DOE 2010f). Waste information is controlled by implementing the relevant quality assurance 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:

- 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

- 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 M&OC.

MON-6.1.1 CMP Assessment Report

The results of the CMP are reported in the compliance assessment report (Wagner and Hillesheim 2008 and Wagner and Hillesheim 2009; Wagner and Kuhlman 2010; Wagner, Kuhlman and Johnson 2011 and Wagner, Kuhlman and Johnson 2012). The Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment Reports are provided to the EPA with each recertification 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 DOE 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 if the CMP should be modified based on results of the monitoring programs.

MON-6.1.2 External Reporting

The DOE reviews the recommendations of the M&OC 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 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 Part 191 Subpart C.

If monitoring results meet any of these criteria, the results 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 section 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 CMP assessment documents these conditions (Wagner and Hillesheim 2008 and Wagner and Hillesheim 2009; Wagner and Kuhlman 2010; Wagner, Kuhlman and Johnson 2011 and Wagner, Kuhlman and Johnson 2012).

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