Waste Isolation Pilot Plant
Delaware Basin Monitoring Annual Report

DOE/WIPP-24-2308

Revision 0



Effective Date: February 25, 2025

United States Department of Energy
Carlsbad Field Office

This document has been submitted as required to:
U.S. Department of Energy
Office of Scientific and Technical Information PO Box
62 Oak Ridge, TN 37831 (865) 576-8401

Additional information about this document may be obtained by calling 1-800-336-9477.

Unlimited, publicly available full-text scientific and technical reports produced since 1991 are available online at Information Bridge (www.osti.gov/bridge).

U.S. Department of Energy and its contractors may obtain full-text reports produced prior to 1991 in paper form, for a processing fee, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062 Phone: (865) 576-8401
Fax: (865) 576-5728
Email: reports@osti.gov

Available for sale to the public from:

U.S. Department of Commerce National Technical Information Service 5301 Shawnee
Rd Alexandria, VA 22312
Phone: (800) 553-6847 or (703) 605-6000
Fax: (703) 605-6900
Email: info@ntis.gov

Waste Isolation Pilot Plant
Delaware Basin Monitoring Annual Report

DOE/WIPP-24-2308

Revision 0

Effective Date: February 25, 2025

U.S. Department of Energy Carlsbad Field Office

Approved by: MICHAEL GERLE

Digitally signed by MICHAEL GERLE
Date: 2025.02.25 06:59:39 -07'00'

Michael Gerle, Director
Environmental Regulatory Compliance Division
Carlsbad Field Office

Date

Change History Summary

Revision Number	Description of Changes
0	Initial issue.

List of Acronyms and Abbreviations

API	American Petroleum Institute
BLM	Bureau of Land Management
CARD	Compliance Application Review Document
CCA	Compliance Certification Application
CFR	Code of Federal Regulations
CRA	Compliance Recertification Application
DBDSP	Delaware Basin Drilling Surveillance Program
DBWTA	Delaware Basin Well Tracking Application
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DPA	Designated Potash Area
EPA	U.S. Environmental Protection Agency
H_2S	hydrogen sulfide
JITC	Joint Industry Technical Committee
N/A	not applicable
NMOCD	New Mexico Oil Conservation Division
NMT	New Mexico Tech
PA	Performance Assessment
SRA	Seismic Response Area
SWD	salt water disposal
USGS	United States Geological Society
WIPP	Waste Isolation Pilot Plant

Table of Contents

1.0 DELAWARE BASIN DRILLING SURVEILLANCE PROGRAM 8

2.0 2024 UPDATES 9

2.1 Miscellaneous Drilling Information 10
2.1.1 Drilling Techniques 10
2.1.2 Air Drilling 11
2.2 Shallow Drilling Events 11
2.3 Deep Drilling Events 12
2.4 Deep Drilling Rate 13
2.5 Drilling Activities Outside the Nine-Township Area 14
2.6 Castile Brine Encounters 14
2.7 Borehole Permeability Assessment – Plugging Practices 15
2.8 Seismic Activity in the Delaware Basin 17
2.9 Nine-Township Injection Wells 17
2.10 Nine-Township Salt Water Disposal Wells 18
2.11 Mining 18
2.11.1 Potash Mining 18
2.11.2 Solution Mining 18
2.12 New Drilling Technology 19
2.13 Alternative Energy Activities 19
2.14 Survey of Well Operators for Drilling Information 19

3.0 REFERENCES 19

List of Figures

Figure 1. WIPP Site, Delaware Bain, and Nine-Township Area 23
Figure 2. Well Status in the Nine-Township Area 24
Figure 3. Typical Well Structure and General Stratigraphy Near the WIPP Site 25
Figure 4. Typical Borehole Plug Configurations in the Delaware Basin 26
Figure 5. Plugged Wells in the Nine-Township Area Surrounding WIPP 27
Figure 6. Seismic Monitoring Stations for the Delaware Basin around WIPP 28
Figure 7. Active Injection and SWD Wells in the Nine-Township Area 29
Figure 8. Typical Injection or SWD Well 30
Figure 9. Potash Areas in the Vicinity of the WIPP Site 31

List of Tables

Table 1. Casing Sizes Used in the Nine-Township Area 32
Table 2. Bit Sizes Used in the Nine-Township Area 33
Table 3. Air-drilled Wells in the NM Portion of the Delaware Basin 34
Table 4. Shallow Well Type/Status in the Delaware Basin 35
Table 5. Deep Well Type/Status in the Delaware Basin 36
Table 6. Drilling Rates for the Delaware Basin 37
Table 7. Castile Brine Encounters in the Vicinity of the WIPP Site 38
Table 8. Plug Types and Frequencies 41
Table 9. Seismic Activity within the Delaware Basin Boundary 42
Table 10. Injection and SWD Well Information for the Nine-Township Area 43
Table 11. Brine Well Status/Type in the NM Portion of the Delaware Basin 45

1.0 DELAWARE BASIN DRILLING SURVEILLANCE PROGRAM

This annual report of the Delaware Basin Drilling Surveillance Program (DBDSP) is provided to the U.S. Department of Energy (DOE) Carlsbad Field Office and made available to the U.S. Environmental Protection Agency (EPA) as prescribed by Title 40 Code of Federal Regulations (CFR) §194.4(b)(4). Information from the Delaware Basin Monitoring Annual Report is summarized and evaluated for input into the recertification process as defined in 40 CFR §194.15 (EPA 1996). The reporting period for this report is from September 1, 2023, to August 31, 2024.

The DBDSP is designed to monitor drilling activities in the vicinity of the Waste Isolation Pilot Plant (WIPP) site and throughout the Delaware Basin and to generate a "drilling rate." The drilling rate is the frequency of deep drilling within the Delaware Basin over the 100-year period preceding the preparation of a compliance certification (or recertification) application. This program implements key elements of the criteria in 40 CFR §194.33, to consider drilling events in a performance assessment (PA) required by Subpart B, *Environmental Standards for Disposal*, of 40 CFR Part 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes* (EPA 1993).

Subpart B of 40 CFR Part 191 provides the environmental standards for the disposal of radioactive waste. Results from the PA must demonstrate a reasonable expectation that, for 10,000 years after disposal, cumulative releases of radionuclides to the accessible environment will likely not exceed the limits set by the EPA standard of 40 CFR §191.13. The PA model predicts the likelihood, frequency, and severity of a radionuclide release due to potential future events and processes that could affect disposal performance, including inadvertent human intrusion into the repository. The most severe form of human intrusion into the WIPP repository is deep drilling for natural resources (EPA 1996); therefore, the deep drilling rate is a key input parameter for PA. Deep drilling is defined as boreholes reaching or exceeding the repository depth. The shallowest depth of the repository is currently the back elevation of Panel 8, which measures 2,104 feet; the repository could not be directly breached by boreholes less than this depth. In the Compliance Certification Application (CCA), Appendix SCR (DOE 1996), the DOE recommended removal of shallow drilling from PA consideration because of low consequences. The EPA concurred with the exclusion of shallow drilling from PA consideration (EPA 1998b).

Section 194.33 of 40 CFR Part 194 (EPA 1996) identifies the Delaware Basin as the geographical area for determination of the historical rate of drilling for resources. The DBDSP monitors for mining, drilling, and drilling-related activities occurring within the Delaware Basin because the PAs must examine deep drilling that may potentially affect the performance of the disposal system during the regulatory time frame.

The Delaware Basin is defined in 40 CFR §194.2 as follows:

> Delaware Basin means those surface and subsurface features which lie inside the boundary formed to the north, east and west of the

> [WIPP] disposal system, by the innermost edge of the Capitan Reef, and formed, to the south, by a straight line drawn from the southeastern point of the Davis Mountains to the most southwestern point of the Glass Mountains.

The Delaware Basin, depicted in Figure 1, includes all or parts of Brewster, Culberson, Jeff Davis, Loving, Pecos, Reeves, Ward, and Winkler counties in west Texas (TX) and portions of Eddy and Lea counties in southeastern New Mexico (NM). The Delaware Basin lies within the Permian Basin. The DBDSP recognizes deep and shallow drilling as "drilling that has occurred for each resource in the Delaware Basin over the past 100 years prior to the time at which a compliance application is prepared," in accordance with the criteria established in 40 CFR §194.33.

For the evaluation of borehole plugging practices, the Delaware Basin Drilling Surveillance Plan (LATA 2024) emphasizes the nine-township area surrounding the WIPP site, which includes townships 21 through 23 south and ranges 30 through 32 east (of the NM Principal Meridian) in southeastern NM. Day (2023) represented the nine-township as a more appropriate area of interest because the geology differs to the east of the WIPP site into Texas, thus drilling and plugging practices are also different than the wells drilled near the WIPP site. The DBDSP reports plugged wells in the nine-township area surrounding the WIPP site, truncated on the northern edge by the Delaware Basin boundary, as presented in Figure 1. Figure 2 depicts the status for wells in the nine-township area as of September 1, 2024. The DBDSP provides data to build on the information presented in the CCA, Appendix DEL (DOE 1996); the Compliance Recertification Application (CRA)-2004, Appendix DATA (DOE 2004); the CRA-2009, Appendix DATA (DOE 2009); the CRA-2014, Appendix DATA-2014 (DOE 2014); the CRA-2019, Appendix DATA-2019, Appendix PA-2019 (DOE 2019); and the WIPP Hazardous Waste Facility Permit (NMED 2023).

2.0 2024 UPDATES

The following items are recent updates related to the DBDSP:

- The DBDSP is using a new method to collect seismic activity data. Since April 1, 2024, seismic activity data have been gathered directly from the United States Geological Survey (USGS) instead of New Mexico Tech (NMT), whose contract expired.

- A revision of Table 8 provides plugged borehole information for the nine-township area, truncated on the northern edge by the Delaware Basin boundary. This update is consistent with Figure 5 and the rationale described in the 2023 annual report (DOE 2023).

During this reporting period, there were no observations of noncompliance observed. A noncompliance is a violation of either Bureau of Land Management or New Mexico Oil Conservation Division rules.

2.1 Miscellaneous Drilling Information

In 40 CFR §194.33(c), the EPA directed that PA assessments should assume that future drilling practices and technology will remain consistent with practices in the Delaware Basin at the time an application is prepared and enumerated minimum drilling traits to be considered. This provision led to the formulation of scenarios to account for these activities in PA. The following information was gathered and documented in the CCA, Appendix DEL (DOE 1996) to help develop and inform various aspects of the human intrusion scenarios used in WIPP PA calculations.

- Casing diameters
- Borehole depths
- Instances of encountering pressurized brine in the Castile Formation
- Types of drilling fluids
- Borehole plugs and characteristics

The DBDSP data set includes the total borehole length for horizontal wells drilled in the Delaware Basin. Vertical depths of boreholes range from 9 feet to 28,133 feet. The shallowest oil well recorded in the Delaware Basin last year was 1,028 feet in Reeves County, TX. The deepest was 27,700 feet in Ward County, TX. Both wells are outside the nine-township area.

The DBDSP data set includes the casing size and depth for each borehole section drilled during the reporting period within the nine-township area (Table 1). Drill bit size is a reportable element, and hole sizes are reported on sundry notices (miscellaneous forms) maintained by the New Mexico Oil Conservation Division (NMOCD) and Bureau of Land Management (BLM). Table 2 shows the documented bit sizes used in drilling wells within the nine-township area during the reporting period. The typical hole and casing sizes near the WIPP site are shown in Figure 3.

2.1.1 Drilling Techniques

The primary drilling technique used by area drillers during September 1, 2023, to August 31, 2024, continues to be rotary drilling. However, most wells currently drilled use horizontal (deviated) drilling techniques for the lower part of the borehole that contacts the targeted production zone. During the reporting period, 13 wells were spudded, but not necessarily completed, in the NM portion of the Delaware Basin. This number is derived from the Delaware Basin Well Tracking Application (DBWTA), a Microsoft® SQL server application maintained by the DBDSP.

In this reporting period, rotary drilling rigs were used to drill the 997 completed wells in the entire Delaware Basin. The completed wells included the following types: oil wells, gas wells, salt water disposal (SWD) wells, and injection wells. The 997 wells were conventionally drilled utilizing mud as a medium for circulation. Seven of these wells were completed in the nine-township area. During the reporting period, the length of the completed wells in the nine-township area was between 20,847 feet and 22,630 feet. The actual vertical depth of the

boreholes of the completed wells in the nine-township area during the reporting period was between 10,697 feet to 12,339 feet.

The CCA, Appendix DEL, reported that horizontal drilling was not often used in the Delaware Basin due to increased costs resulting from the additional drilling time needed. However, this is no longer the case because all seven wells completed during the reporting period in the nine-township area had horizontally drilled components. Melzer and Hall's 2023 report states, "horizontal drilling represents 95 percent of all rigs running in the Permian Basin."

2.1.2 Air Drilling

A method of drilling not emphasized in the 1996 CCA, Appendix DEL, is air drilling. Air drilling is not a common practice near the WIPP site, and there have been no known occurrences of air drilling in the tracked area since 1997. As defined by the oil industry, air drilling is a method of rotary drilling that uses compressed air as the circulation medium. The conventional method of removing cuttings from the wellbore is to use a flow of water or drilling mud. In some cases, compressed air removes the cuttings equally or more efficiently. The rate of penetration can increase considerably when air drilling is used. However, a fundamental problem with this technique is the penetration of formations containing water because the entry of water into the system reduces the ability of the air to remove cuttings. Air drilling occurrences are only tracked by the DBDSP in the NM portion of the Delaware Basin.

In the CCA Final Rule (FR Vol. 63 No. 95), the EPA ruled air drilling was not a common practice in the Delaware Basin and, therefore, did not have to be considered for PA (EPA 1998a); however, the DBDSP monitors well records for instances of air drilling to verify that this practice does not become a more wide-spread occurrence in the future. The records on the new wells spudded during the reporting period are reviewed as they become available at the NMOCD internet site for instances of air drilling. The records can be submitted to the NMOCD offices as late as two years after the well has been drilled. None of the records reviewed to date have indicated any additional instances of air drilling. Table 3 shows the known indications of air drilling in the NM portion of the Delaware Basin.

2.2 Shallow Drilling Events

The criteria in 40 CFR §194.33(b)(4) state that consideration of shallow drilling in PA may be limited to "only the historical rate of shallow drilling for resources of similar type and quantity to those in the controlled area." The EPA defined shallow drilling as "drilling events in the Delaware Basin that do not reach a depth of 2,150 feet below the surface relative to where such drilling occurred." Subsequently, due to the mining of Panel 8 at 2,104 feet, the definition of a deep borehole was changed from 2,150 feet to 2,104 feet accordingly. The DOE concluded in the 1996 CCA, Appendix SCR, that shallow drilling could be removed from PA consideration based on low consequence. As a result, the DOE did not include shallow drilling in its PA drilling rate calculations. In the CCA, Compliance Application Review Document (CARD) 33 (EPA 1998b),

the EPA accepted the DOE's finding that shallow drilling would have a low consequence on repository performance and would be excluded from the PA calculations.

Although the EPA acknowledged agreement in CARD 33 that shallow drilling is of low consequence and could be excluded from the PA, the DBDSP collects data on shallow wells within the boundaries of the Delaware Basin. The shallow well count indirectly factors into the current deep-drilling rate calculation described in Section 2.4 (i.e., the total known depth of boreholes is the sum of the total known deep boreholes and the total shallow boreholes). Table 4 shows a breakdown of the various types and number of shallow wells located within the Delaware Basin within the 100-year rolling time frame through the end of the current reporting period.

2.3 Deep Drilling Events

The DOE uses the historical drilling rate for resources in the Delaware Basin to calculate a future drilling rate. In calculating the frequency of future deep drilling, the EPA provided the following criteria in 40 CFR §194.33(b)(3)(i) (EPA 1996):

> Identify deep drilling that has occurred for each resource in the Delaware Basin over the past 100 years prior to the time at which a compliance application is prepared.

The DOE used the historical record of deep drilling for resources below 2,104 feet that has occurred over the past 100 years in the Delaware Basin. In the past 100 years, deep drilling has occurred for oil, gas, potash, and sulfur. The DOE used these drilling events to calculate the deep-drilling rate for the original compliance application PA (DOE 1996). The calculation used data for the period of January 1896 to June 1995. The DOE excluded historical drilling for purposes other than resource exploration and recovery (such as WIPP site investigation), from the calculation per the criteria provided in 40 CFR §194.33.

In the Delaware Basin, deep-drilling events are usually associated with oil and gas drilling. These events are identified by information obtained from commercial databases and state regulatory agencies. The DBDSP collects data on drilled wells within the Delaware Basin, making no distinction between the resources they were intended to recover (in terms of calculating the drilling rate). A centralized Microsoft® SQL Server® based well-tracking application is maintained for hydrocarbon wells in TX and NM. As the information on wells is acquired, it is entered into the well-tracking application. The TX portion of the well-tracking application contains information only on the status of the well, when it was drilled, its location, the name of the operator, and the actual vertical depth of the well. Location refers to the NM Township, Range, and Section. For reporting purposes, the TX portion is used only to calculate the drilling rate. The NM portion contains the same basic information as TX, along with the required features, events, and processes for PA-related drilling events identified in the Delaware Basin Drilling Surveillance Plan (LATA 2024).

The DBDSP continues to monitor hydrocarbon drilling activity and any new potash, sulfur, water, or monitoring wells for deep-drilling events. Information from the drilling of these wells is added to the well-tracking application maintained for these resources. During this reporting period, 997 wells were completed within the Delaware Basin. All completed wells were drilled for hydrocarbon extraction and were designated as deep-drilling events. Seven of these wells are in the nine-township area. Table 5 shows the number and type of deep wells (2,104 feet or deeper) located in the Delaware Basin, within the 100-year rolling time frame up to the end of the current reporting period of September 1, 2023, to August 31, 2024.

2.4 Deep Drilling Rate

The DBDSP calculates the drilling rate by using deep-drilling events from all resources, except WIPP project-related boreholes, as noted in Table 5, Footnote b. Wells in the "Unknown" category have drilling in progress or waiting on paperwork; the final depth of these wells is, therefore, currently unknown. These wells are included in the deep-drilling rate calculation. When the appropriate paperwork is posted, the classification status of these types of wells as either deep or shallow will be updated.

The annual (September 1 through August 31) drilling rates since the submittal of the CCA in 1996 are shown in Table 6. The 100-year period is a moving period, dating back 100 years from when the calculation is performed (or from the year of the most recent data). As each new year of data is added, the oldest year is dropped, if data exists for that year. For example, the drilling rate was calculated in 1999 using the data from 1900 to 1999. In 2000, the data from 1901 to 2000 were used to calculate the drilling rate.

The current deep drilling rate for 2024 was calculated from the information provided in Tables 4, 5, and 6. There were 35,661 boreholes (per Table 6) deeper than 2,104 feet (i.e., total deep boreholes) that were used to determine the deep drilling rate. These include 1,813 boreholes of unknown depth.

The EPA provided a formula for calculating the deep drilling rate or intrusion rate when 40 CFR Part 194 was promulgated. The EPA subsequently revised the formula to the following (EPA 2022):

$$Deep\ Drilling\ Rate\ \left(\frac{boreholes}{km^2}\right) = \frac{[(Known\ Deep\ Boreholes)+(Unknown\ Depth\ Boreholes)\ x\ \left(\frac{Known\ Deep\ Boreholes}{Total\ Known\ Depth\ Boreholes}\right)]\ x\ (10{,}000\ years)}{(23{,}102.1\ km^2)x\ (100\ years)} \quad \textit{(Eq. 1)}$$

The variables for the above equation are determined using values reports in Tables 4, 5, and 6.as follows:

Unknown Depth Boreholes = Drilling in progress or Waiting on Paperwork Boreholes (Table 5) = 1,813 *(Eq. 2)*

Known Deep Boreholes = Total Deep Boreholes (Table 6) – Unknown Depth Boreholes *(Eq. 3)*
= 35,661 – 1,813 = 33,848

Total Known Depth Boreholes = Known Deep Boreholes + Total Shallow Boreholes (Table 4) *(Eq. 4)*
= 33,848 + 4,602 = 38,450

Using these values in the deep drilling rate formula presented in Equation 1 results in a deep drilling rate of 153.4 boreholes per km^2 over 10,000 years, as follows:

$$Deep\ Drilling\ Rate\ \left(\frac{boreholes}{km^2}\right) = \frac{[(33{,}848) + (1{,}813)\ x\ \left(\frac{33{,}848}{38{,}450}\right)]\ x\ (10{,}000\ years)}{(23{,}102.1\ km^2) x\ (100\ years)} = \ 153.4\left(\frac{boreholes}{km^2}\right)$$

The deep drilling rate of 153.4 boreholes per km^2 is a significant increase from 46.8 boreholes per km^2 reported in the CCA. The deep drilling rate is anticipated to rise for many more years before it begins to drop due to the 100-year rolling timeframe used as specified by the EPA. Additionally, today's common practice is for numerous horizontal wells to be drilled on a single pad; in these cases, each well is counted as a separate well.

2.5 Drilling Activities Outside the Nine-Township Area

The DBDSP monitors drilling activities in portions of seven counties and all of one county (Loving). In the NM portion of the Delaware Basin, outside of the nine-township area, nine new wells were spudded during the reporting period. In the TX portion of the Delaware Basin, 1,300 new wells were spudded during the reporting period.

2.6 Castile Brine Encounters

The WIPP PA includes scenarios that represent a borehole that creates a flow path between the repository and a hypothetical source of pressurized brine located beneath the repository in the Castile Formation. In certain conditions, this hydraulic conduit may transfer brine from the Castile Formation to the repository, increasing waste saturation and gas generation. Repository saturation and pressure are key factors affecting the magnitude of radionuclide release to the accessible environment. Thus, the probability of a future borehole encountering Castile brine is an important input to PA. The DBDSP records indicated 40 wells encountered pressurized brine in the Castile Formation. Of these, 38 wells were hydrocarbon wells scattered over a wide area in the vicinity of the WIPP site. The remaining two wells, ERDA-6, and WIPP-12, were drilled to support WIPP site characterization.

The DBDSP researches the records of new wells drilled in the NM portion of the Delaware Basin each year by looking for instances of encounters with pressurized brine. None of the records indicated encounters with pressurized brine during the drilling of new wells spudded in the NM portion of the Delaware Basin during the reporting period. In addition, the DBDSP sends out an annual survey to operators who have completed wells in the NM portion of the Delaware Basin during the reporting period; this survey solicits information about any Castile brine encounters. The DBDSP survey requests have not generated any response to date. As a result, the program has been researching alternative methods for gathering that information. Table 7 shows known Castile brine encounters in the vicinity of the WIPP site.

The EPA has expressed an expectation that the DOE provide additional site characterization specific to the location for new repository panels located to the west of the current waste panels. The DOE has agreed to continue working with the EPA to collect this data. Zeitler (2023) evaluated the geophysical data available under two replacement panels, Panels 11 and 12. As explained in the Planned Change Request for the Use of Replacement Panels 11 and 12 (DOE 2024), this evaluation concluded that, based on the available data, a regional trend in observed brine occurrences, and the EPA model used to prescribe the current PBRINE distribution, use of the current PBRINE distribution in the PA was conservative.

2.7 Borehole Permeability Assessment – Plugging Practices

Title 40 CFR §194.33(c)(1) states,

> Future drilling practices and technology will remain consistent with practices in the Delaware Basin at the time a compliance application is prepared. Such future drilling practices shall include but shall not be limited to: The types and amounts of drilling fluids; borehole depths, diameters, and seals; and the fraction of such boreholes that are sealed by humans…

Plugging techniques near the WIPP are driven by state regulations that are in place to protect other resources present, namely potash. For wells within the Designated Potash Area (DPA), Secretary's Order No. 3324 regulations apply and require the operator to install a solid cement plug through the entire salt section and any water-bearing horizon and a bridge plug above the perforations. This plugging technique protects the mineralized potash areas and workings by requiring a continuous plug so there is virtually no chance of flooding nearby mines throughout their development and operation. The WIPP lies within the DPA, and plugging in the vicinity generally follows this technique. Older plugged wells that pre-date Order No. 3324 regulations may not be plugged in this manner. There is no process for granting exemptions. Therefore, wells not plugged per the process were either plugged before the rule existed in 1988 or the plugged wells were not properly approved by the appropriate regulatory agency (BLM or NMOCD).

When a well has been plugged and abandoned in the Delaware Basin, the DBDSP retrieves a copy of the plugging report from NMOCD. This information is added to the records maintained by the DBDSP on each well drilled within the nine-township area, truncated on the northern edge by the Delaware Basin (Day 2023). By maintaining records in such a fashion, the DOE can identify any changes or trends in plugging techniques. Table 8 shows plugging information for wells plugged and abandoned within the nine-township area for 2024. The table has been revised to include information for wells plugged within the nine-township area before this reporting period. This change was reported in the 2023 annual report (DOE 2023).

The CCA, Appendix MASS, Attachment 16-1 (DOE 1996), provides "…summary results of regulatory analyses and records research used to determine plugging and abandonment

practices in the Delaware Basin." The study within this attachment did not attempt to predict the effectiveness of plugs, but tried to identify the location and physical characteristics of plugs, which might be important to the PA. The following is stated in the Explanation of Assumptions:

> Guidance in 40 CFR Part 194 states, 'Performance assessments should assume that the permeability of sealed boreholes will be affected by natural processes, and should assume that the fraction of boreholes that will be sealed by man equals the fraction of boreholes which are currently sealed in the Delaware Basin.' The rule also states that,'...drilling practices will remain as those of today.'

The study found that plugging and abandonment regulations are followed consistently and that no wells in the basin had been left unplugged. Therefore, the PA assumes a 100 percent plugging frequency, that is, all wells have a plug installed. To determine the typical configuration and composition of a borehole plug, this same study (DOE 1996) considered plugging practices listed below to arrive at a model depicting six different types of plugging configurations (see Figure 4):

Type I Cement plugs occur at the surface, 400 – 800 feet, and 4,000 feet below the surface at the bottom of the Castile Formation.

Type II Cement plugs occur at the surface, 400 – 800 feet, 2,104 – 2,700 feet, and 4,000 feet below the surface at the bottom of the Castile Formation.

Type III Cement plugs occur at the surface, 400 – 800 feet, 800 – 2,104 feet, and 4,000 feet below the surface at the bottom of the Castile Formation.

Type IV Cement plugs occur at the surface, 400 – 800 feet, 800 – 2,104 feet, 2,104 – 2,700 feet, and 4,000 feet below the surface at the bottom of the Castile Formation.

Type V Surface plug and a plug occurs at the bottom of the Castile Formation, provided no water-bearing zones were encountered (minimum regulatory requirements). This type of plugging configuration is not common.

Type VI A solid cement plug occurs through a significant portion of the salt section (800 – 3,500 feet) and additional plugs may occur above and below the salt section plug. This plug type is typical of those used within the DPA.

Nineteen wells were plugged within the nine-township area around the WIPP during the reporting period (Table 8). The region in which data were collected for this survey is shown in Figure 5.

2.8 Seismic Activity in the Delaware Basin

Seismic events occurring within the Delaware Basin are recorded in the DBWTA. This information, historically obtained every quarter from the New Mexico Tech (NMT) Seismological Observatory, is currently accessed monthly from the USGS and entered into the database. For this reporting period, the NMT generated data were used from September 1, 2023, to March 31, 2024 (Record 2023, 2024a, and 2024b). Data obtained from the USGS were used from April 1, 2024, to August 31, 2024 (USGS 2024a). Table 9 provides information on all seismic events recorded within the Delaware Basin boundary, including the 4,633 recorded during the reporting period.

The USGS is a recognized scientific source for seismic information for the Delaware Basin. The USGS runs a 14-station network in the southeastern corner of New Mexico to target the induced seismicity in the area (Figure 6). The northernmost extent of the stations is just south of the WIPP site (USGS 2024a). The New Mexico Bureau of Geology and Mineral Resources and the Texas Bureau of Economic Geology also operate stations in the Permian Basin. The USGS reports seismic activity with magnitudes as low as 1.0 on the Richter scale but does not monitor and process seismic data in real-time, creating a degree of disparity in data sets between USGS and NMT. Stations operated by NMT have historically been able to record seismic activity as low as magnitude 0.1. The limitation of the USGS stations in detecting seismic events with magnitudes between 0.1 and 1.0 is not a significant loss of monitoring data since events this small have a negligible effect at the surface and even less so at the repository level. Earthquake magnitudes of 1.0 to 1.9 are defined by Richter as “microearthquakes, not felt; recorded by seismographs” (USGS 2024b), and several million of these earthquakes occur globally each year. Trends in seismic activity within the Delaware Basin and their impacts on repository performance will continue to be evaluated and assessed through the data publicly available via the USGS. The State Line area in SW NM, the Carlsbad and Jal areas, and the area in northern NM have caused the NMOCD to institute Seismic Response Areas (SRAs) to try and reduce the numbers and levels of future earthquakes by curtailing SWD injections (Melzer and Hall 2023). The new rules imposed by NMOCD on disposal well operators went into effect on November 23, 2021 (Sandoval 2021).

2.9 Nine-Township Injection Wells

Secondary recovery projects (also called waterfloods) in the nine-township area are used infrequently and on a small scale. Five injection wells are used for secondary recovery in the nine-township area surrounding the WIPP site (Table 10). Conoco Phillips Company operates two injection wells northwest of the site in the Cabin Lake field. The other three injection wells are operated by Oxy USA Inc. and are located south and east of the site. The five wells are used to inject fluids into the Brushy Canyon Formation of the Delaware Mountain Group at a depth of approximately 7,200 feet.

2.10 Nine-Township Salt Water Disposal Wells

The most common type of injection well is for disposing of produced water from the oil and gas wells. Figure 7 shows the locations of active injection and salt-water disposal wells in the nine-township area. Most active oil and gas wells produce brine in addition to oil and gas. Saltwater disposal wells have become necessary due to of the EPA's ruling that produced water may no longer be disposed of on the surface (EPA 2020). The oil and gas producers now dispose of this water by injecting it into approved SWD wells. In the Delaware Basin, oil producers are moving from completing SWD wells in the Delaware Mountain Group to completing them in the deeper Devonian formation. In 2022, this practice was largely abandoned around the Midland, TX, portion of the Permian Basin due to a correlation with increased seismic activity. The practice continues in NM. Figure 8 shows a typical injection or SWD well configuration. Table 10 provides information on the injection wells located in the nine-township area.

There are currently 61 active and three plugged SWD wells located in the nine-township area surrounding the WIPP site. Injection depths range from 5,051 to 18,398 feet. The volume of disposed brine depends on the number of producing oil and gas wells maintained by the operator in the immediate vicinity of the SWD well.

2.11 Mining

Resources found in the Delaware Basin that can be mined are potash, sulfur, caliche, gypsum, halite (NMBMMR 1995), and, more recently, polyhalite.

2.11.1 Potash Mining

Potash mining near the WIPP site continues as reported since the CCA, Appendix DEL. Figure 9 shows the location and the extent of the potash mines in the vicinity of the WIPP site. There have been several changes to the companies operating in the area. Most notably, only two potash companies are actively mining. Neither company has promulgated plans to sink new shafts or develop new mines.

2.11.2 Solution Mining

Solution mining is the process by which water is injected into a mineral formation, circulated to dissolve the mineral with the solution, and then pumped back to the surface where the minerals are removed from the water by evaporation. There are two active brine wells in the Delaware Basin. Brine wells are classified as Class II injection wells. In the Delaware Basin, the process involves injecting fresh water into a salt formation to create a saturated brine solution, which is then extracted and used as a drilling agent when drilling a new well. These wells are tracked by the DBDSP. Table 11 provides the status of brine wells in the Delaware Basin.

2.12 New Drilling Technology

The DBDSP found no evidence of new technologies being employed during the reporting period. Research of new technologies and their use in the Delaware Basin is ongoing.

2.13 Alternative Energy Activities

The DBDSP research alternative energy activities that impact the PA. The only alternative energy activity potentially impacting PA is the development of geothermal power. However, currently there are no known geothermal power development projects in the Delaware Basin.

2.14 Survey of Well Operators for Drilling Information

The DBDSP surveys local well operators annually to acquire drilling information typically not listed on the sundry notices supplied to the local state and federal offices by the operator or through commercial sources maintained by the DBDSP. Participation in the survey is voluntary. This survey requests information on other items of interest to the WIPP project such as hydrogen sulfide (H_2S) encounters, Castile brine encounters, and whether any section of the well was drilled with air. The survey provides additional information on drilling activities in the NM portion of the Delaware Basin. In addition to updating the survey, the DOE held an in-person meeting with the BLM and other WIPP project participants on October 4, 2023, to discuss available avenues for increasing cooperation between oil and gas operators and the WIPP project to obtain information on brine encounters within the nine-township area. As a result of this meeting, WIPP project participants were invited by the BLM to attend the Joint Industry Technical Committee (JITC) meeting on October 17, 2023. This meeting allowed operators to meet face-to-face, discuss the WIPP project's data needs, and explain how the data will be used. Although participation in the JITC meeting served to establish contact between WIPP project participants and industry operators, an email response to the March 21, 2024, survey request indicated that, due to company policies, brine encounter information could not be shared.

3.0 REFERENCES

Day, K. 2023. Memo to Steve Wagner. Subject: Borehole Plugging Practices White Paper. ERMS 578970. Carlsbad, NM: Los Alamos Technical Associates.

Los Alamos Technical Associates (LATA). 2024. Delaware Basin Drilling Surveillance Plan, Rev. 10. February 2024. WP 02-PC.02. Carlsbad, NM: Carlsbad Field Office.

Melzer, S., and R. Hall. 2023. Report on Drilling, Production, Well Stimulation, Water Injection, and Seismic Activity in the Vicinity of the WIPP site, Eddy County, New Mexico. July 2023. Melzer CO_2nsulting. RK Hall and Associates.

New Mexico Bureau of Mines and Mineral Resources (NMBMMR). 1995. Evaluation of Mineral Resources at the Waste Isolation Pilot Plant. Final Report, Vols. I-IV. Note: The agency is now New Mexico Bureau of Geology and Mineral Resources.

New Mexico Environment Department (NMED). 2023. Waste Isolation Pilot Plant Hazardous Waste Facility Permit. November 2023.

Record, A. 2023. Seismicity of the WIPP Site for the period July 1, 2023 – September 30, 2023. DOE 13-PO507726. October 6, 2023. Socorro, New Mexico: New Mexico Tech Seismological Observatory.

Record, A 2024a. Seismicity of the WIPP Site for the period October 1, 2023 – December 31, 2023. DOE 13-PO507726. January 17, 2024. Socorro, New Mexico: New Mexico Tech Seismological Observatory.

Record, A. 2024b. Seismicity of the WIPP Site for the period January 1, 2024 – March 31, 2024. DOE 13-PO507726. April 11, 2024. Socorro, New Mexico: New Mexico Tech Seismological Observatory.

Sandoval, A. 2021. Notice to Operators Immediate Response Plan for Seismic Events Related to Class II Underground Injection Control Wells. November 23, 2021. Santa Fe, NM.

U.S. Department of Energy (DOE). 1996. Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant. October 1996. DOE/CAO-1996-2184. Carlsbad, NM: Carlsbad Area Office.

U.S. Department of Energy (DOE). 2004. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant. March 2004. DOE/WIPP 2004-3231. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2009. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant. March 2009. DOE/WIPP 2009-3424. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2014. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant (March). DOE/WIPP-14-3503. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2019. Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant. March 2019. DOE/WIPP-2019-3609. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2023. Delaware Basin Monitoring Annual Report. DOE/WIPP-23- 2308. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2024. Letter from Mark Bollinger, Manager, Carlsbad Field Office, to Ms. Lee Ann B. Veal, Director, Radiation Protection Division, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency. Planned Change Request for the Use of Replacement Panels 11 and 12. March 12, 2024.

U.S. Department of the Interior (DOI). 2012. Secretary's Order No. 3324. December 2012. US Department of the Interior. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1993. "Title 40 CFR Part 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule." Federal Register, vol. 58 (December 20, 1993): 66398- 416.

U.S. Environmental Protection Agency (EPA). 1996. "Title 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; Final Rule." Federal Register, vol. 61 (February 9, 1996): 5223–45.

U.S. Environmental Protection Agency (EPA). 1998a. "Title 40 CFR Part 194, Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision; Final Rule." Federal Register, vol. 63 (May 18, 1998): 27353–406.

U.S. Environmental Protection Agency (EPA). 1998b. "CARD No. 33: Consideration of Drilling Events in Performance Assessments." Compliance Application Review Documents for the Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR 191 Disposal Regulations: Final Certification Decision. May 1998. Washington, DC: Office of Radiation and Indoor Air.

U.S. Environmental Protection Agency (EPA). 2020. Summary of Input on Oil and Gas Extraction Wastewater Management Practices Under the Clean Water Act. May 2020. EPA-821-S19-001. Washington, DC: Office of Water.

U.S. Environmental Protection Agency (EPA). 2022. Technical Support Document for Section 194.33 Review of Borehole Drilling Rate and Plugging Pattern Frequency Calculations in the CRA-2019 Performance Assessment. April 2022. EPA-HQ-OAR-2019-0534. Washington, DC: Office of Radiation and Indoor Air Center for Waste Management and Regulations.

United States Geological Survey (USGS). 2024a. https://www.usgs.gov/. Accessed September 1, 2024.

United States Geological Survey (USGS). 2024b. Boore D.M. The Richter scale: its development and use for determining earthquake source parameters. https://www.usgs.gov/publications/richter-scale-its-development-and-use-determining-earthquake-source-parameters

Zeitler, T. R. 2023. Consideration of Time Domain Electronic Magnetic (TDEM) Data for PBRINE Parameter Including Replacement Panels. ERMS 580108. Carlsbad, NM: Sandia National Laboratories.

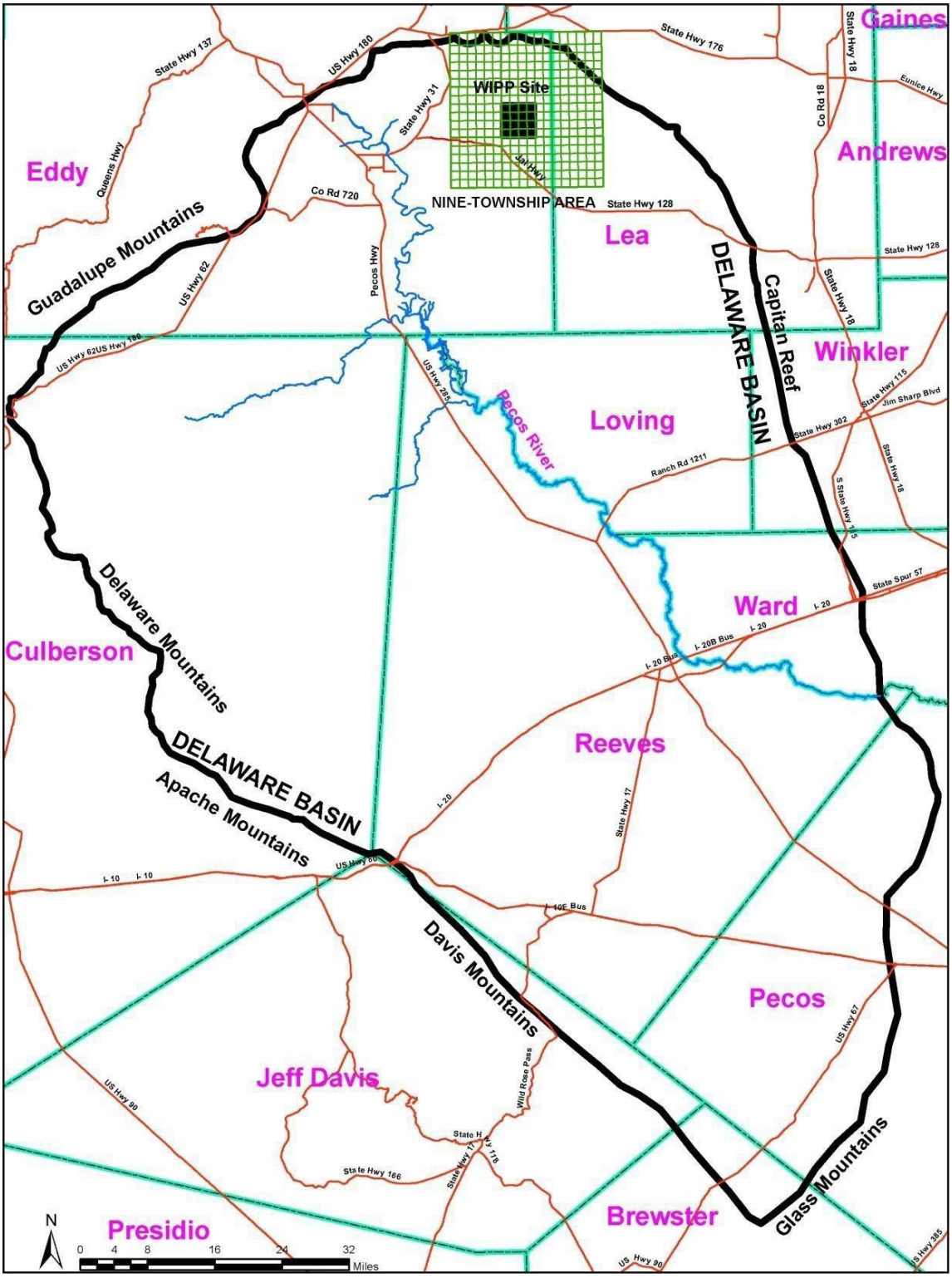


Figure 1. WIPP Site, Delaware Bain, and Nine-Township Area

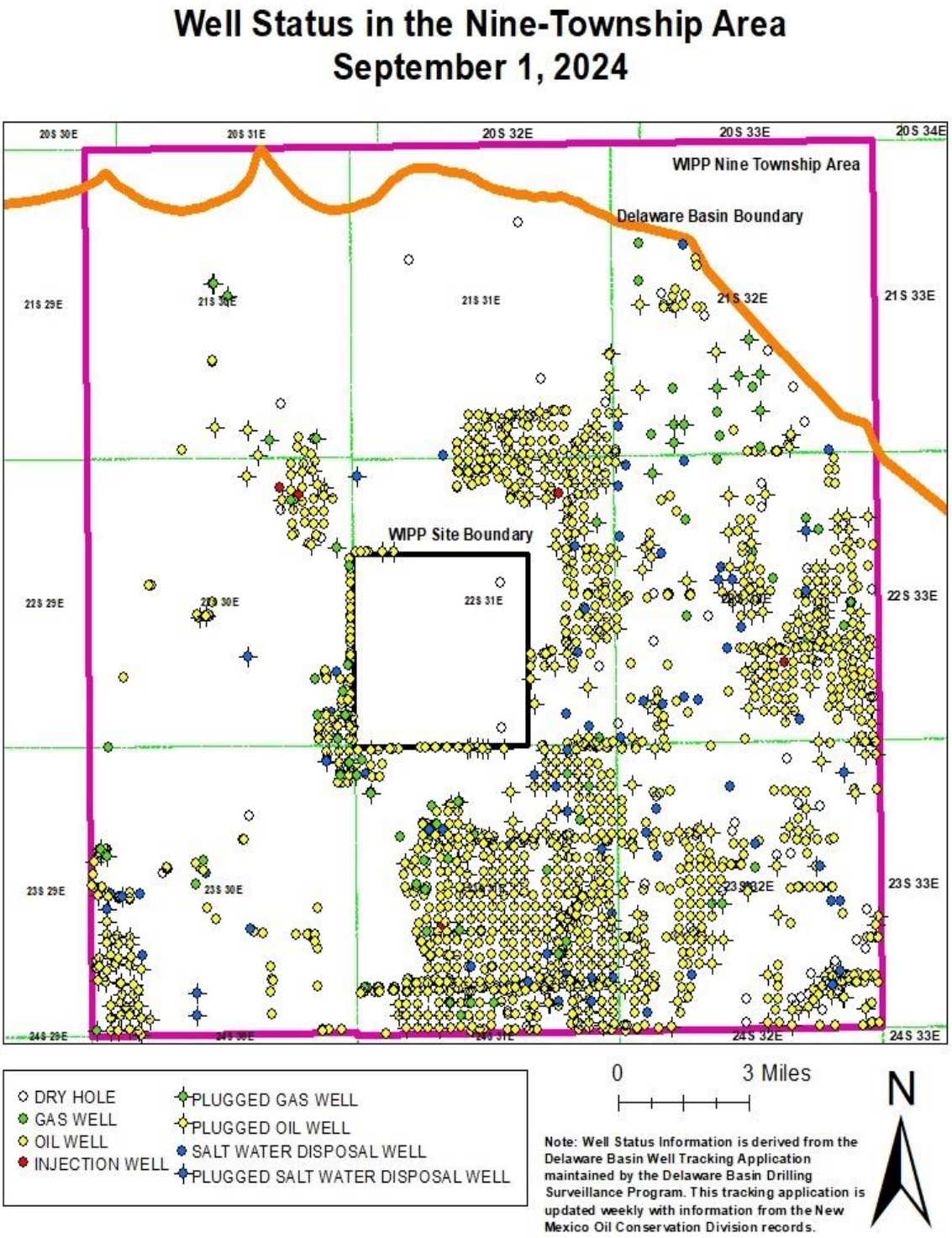


Figure 2. Well Status in the Nine-Township Area

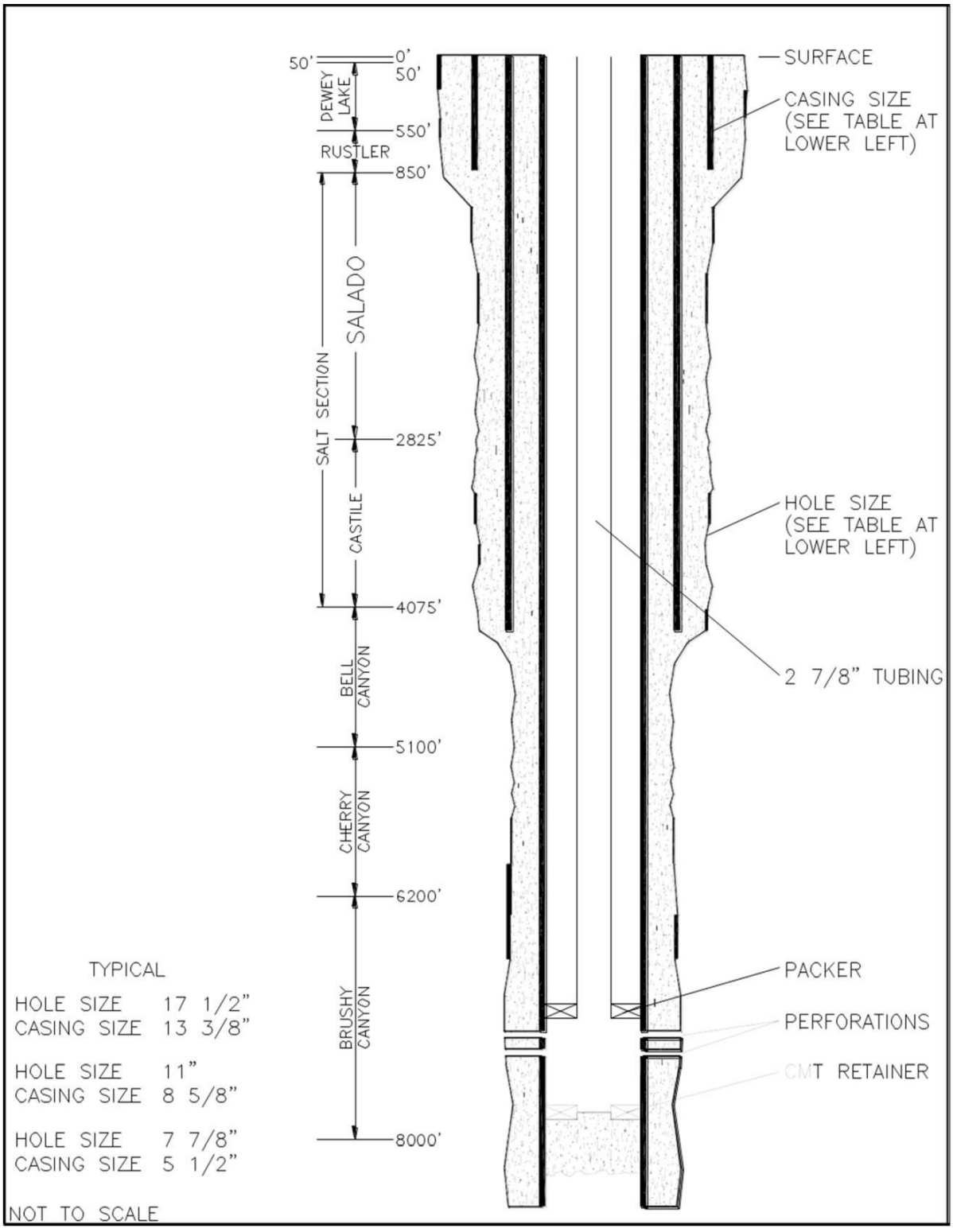


Figure 3. Typical Well Structure and General Stratigraphy Near the WIPP Site

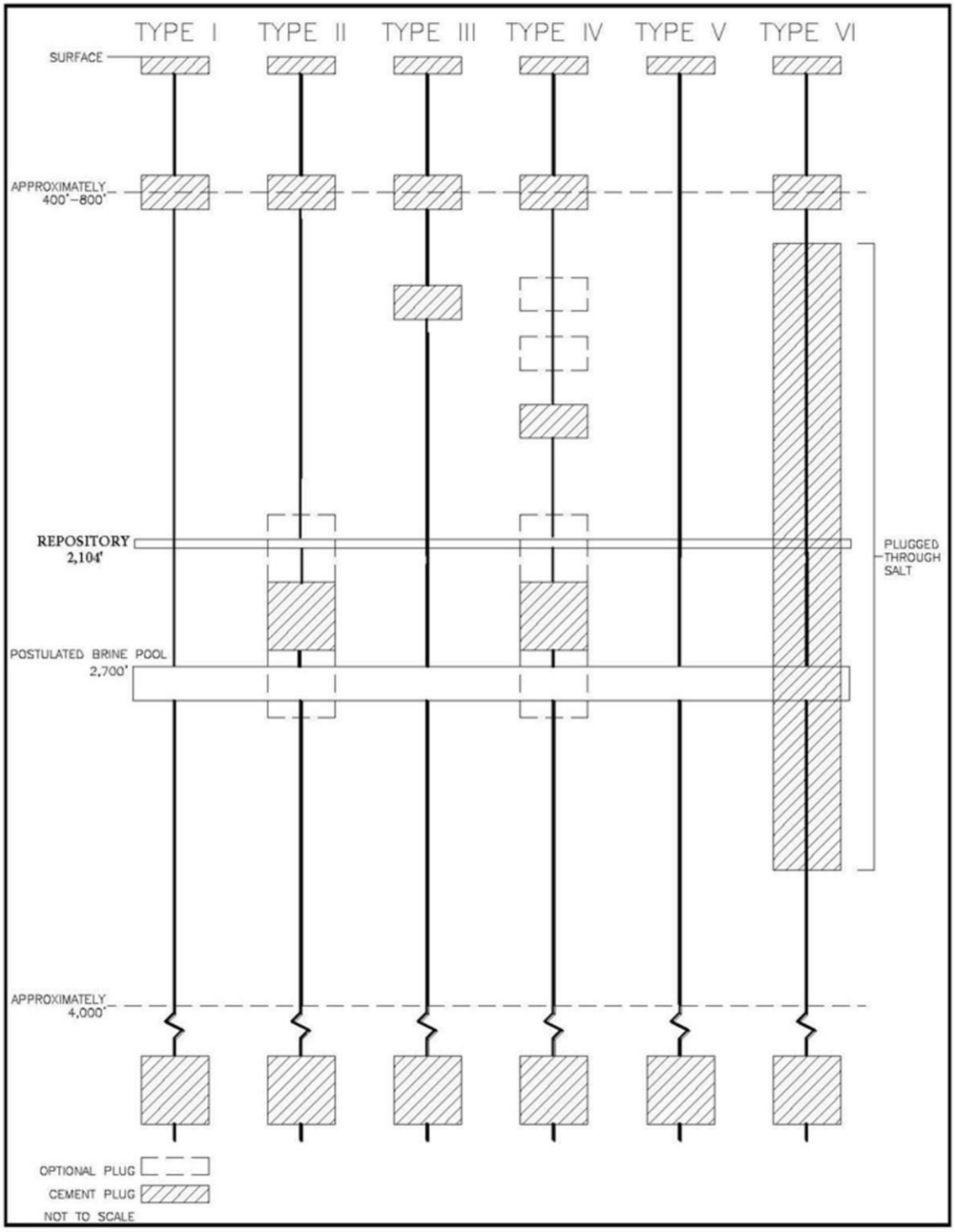


Figure 4. Typical Borehole Plug Configurations in the Delaware Basin

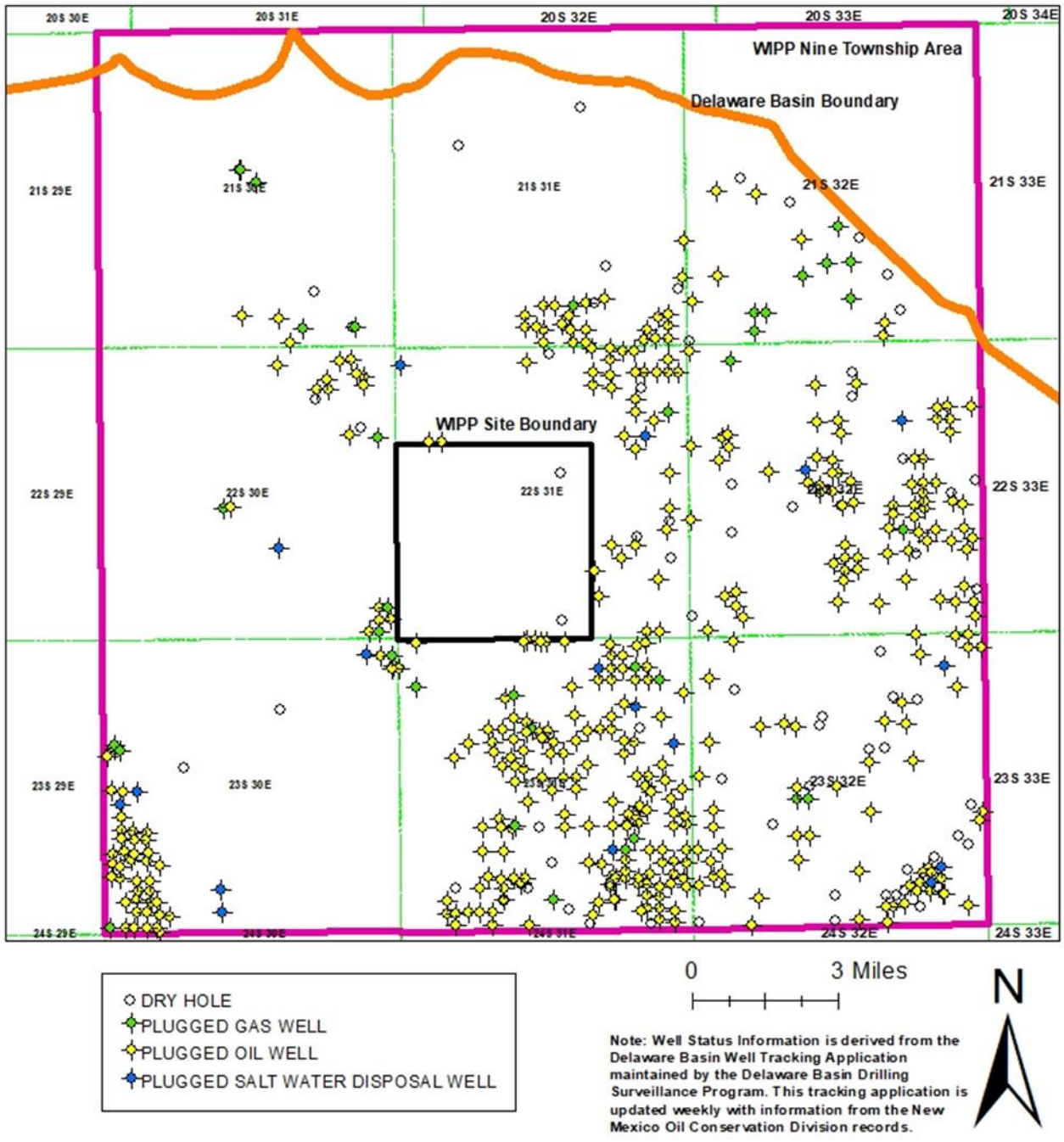


Figure 5. Plugged Wells in the Nine-Township Area Surrounding WIPP

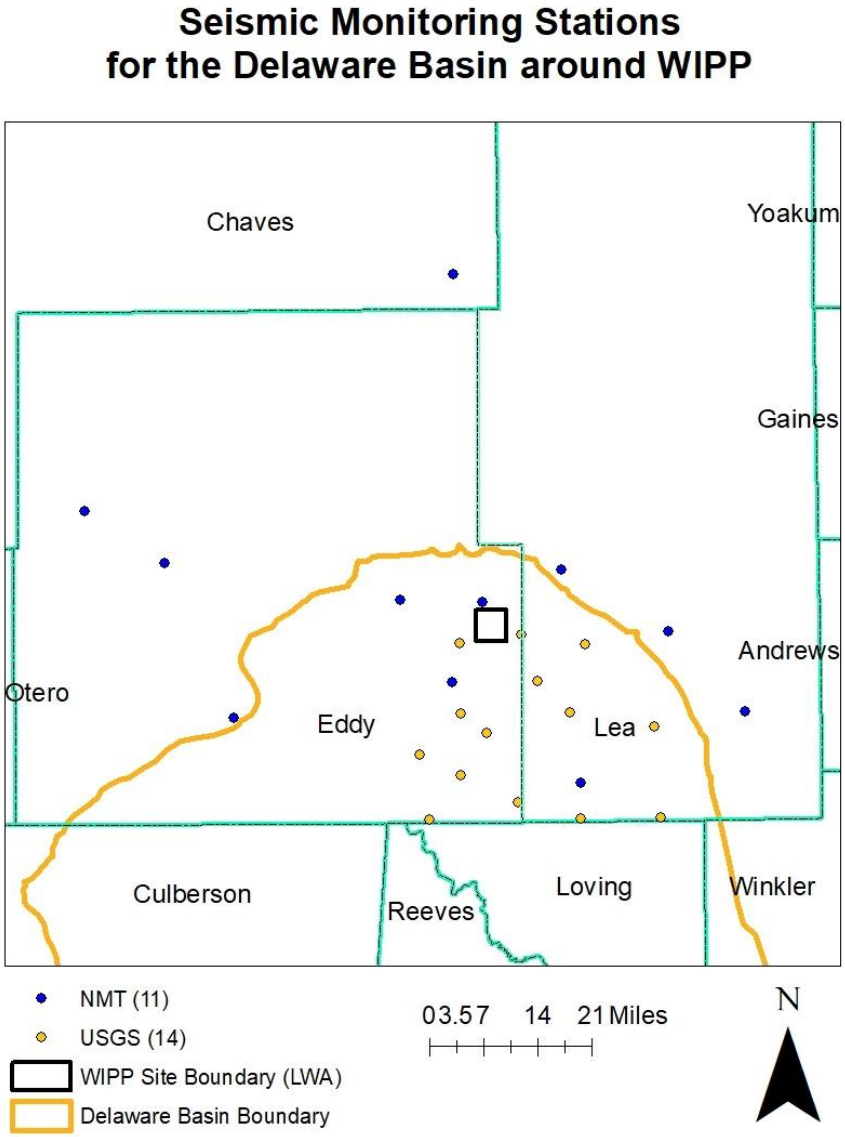


Figure 6. Seismic Monitoring Stations for the Delaware Basin around WIPP

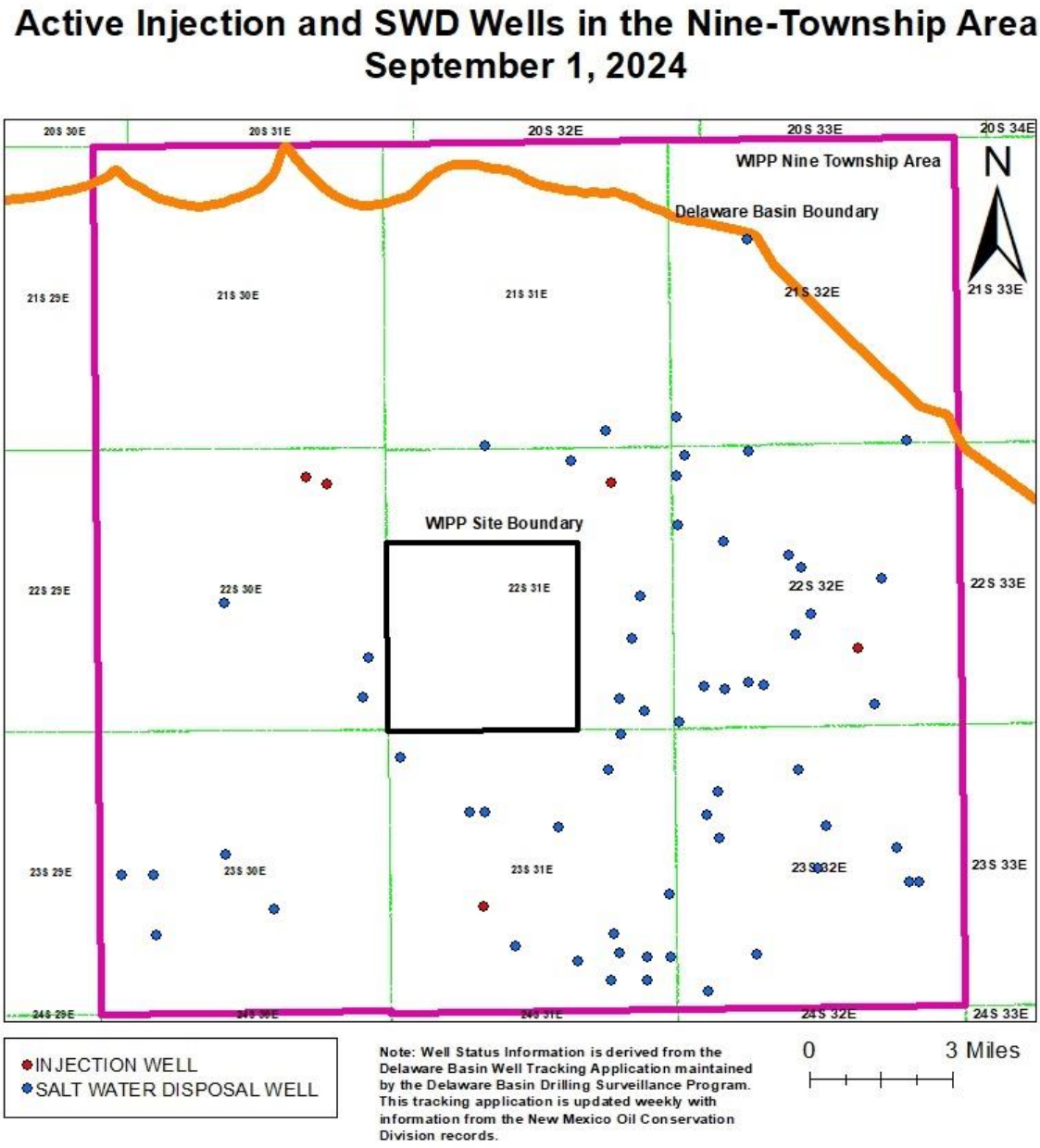


Figure 7. Active Injection and SWD Wells in the Nine-Township Area

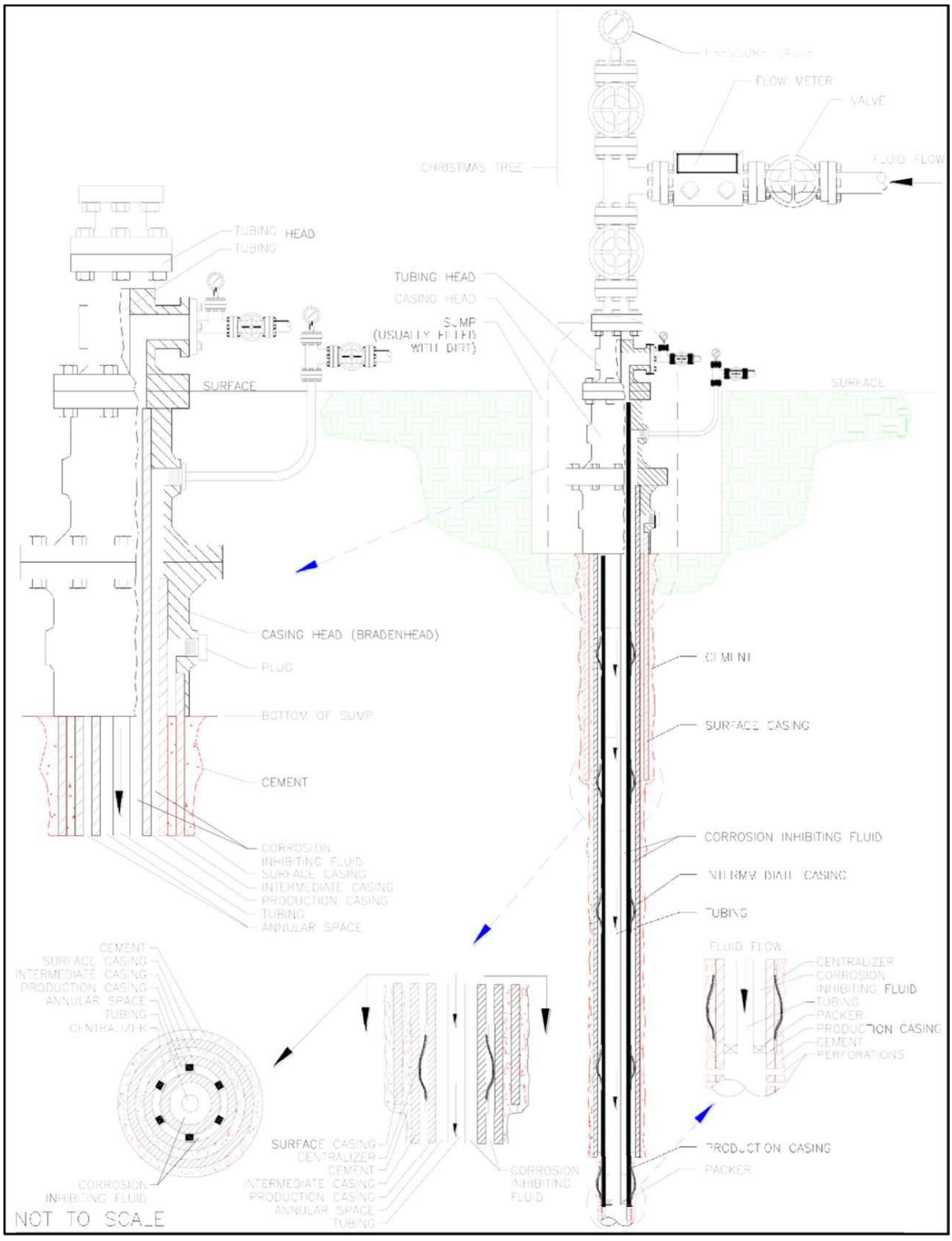


Figure 8. Typical Injection or SWD Well

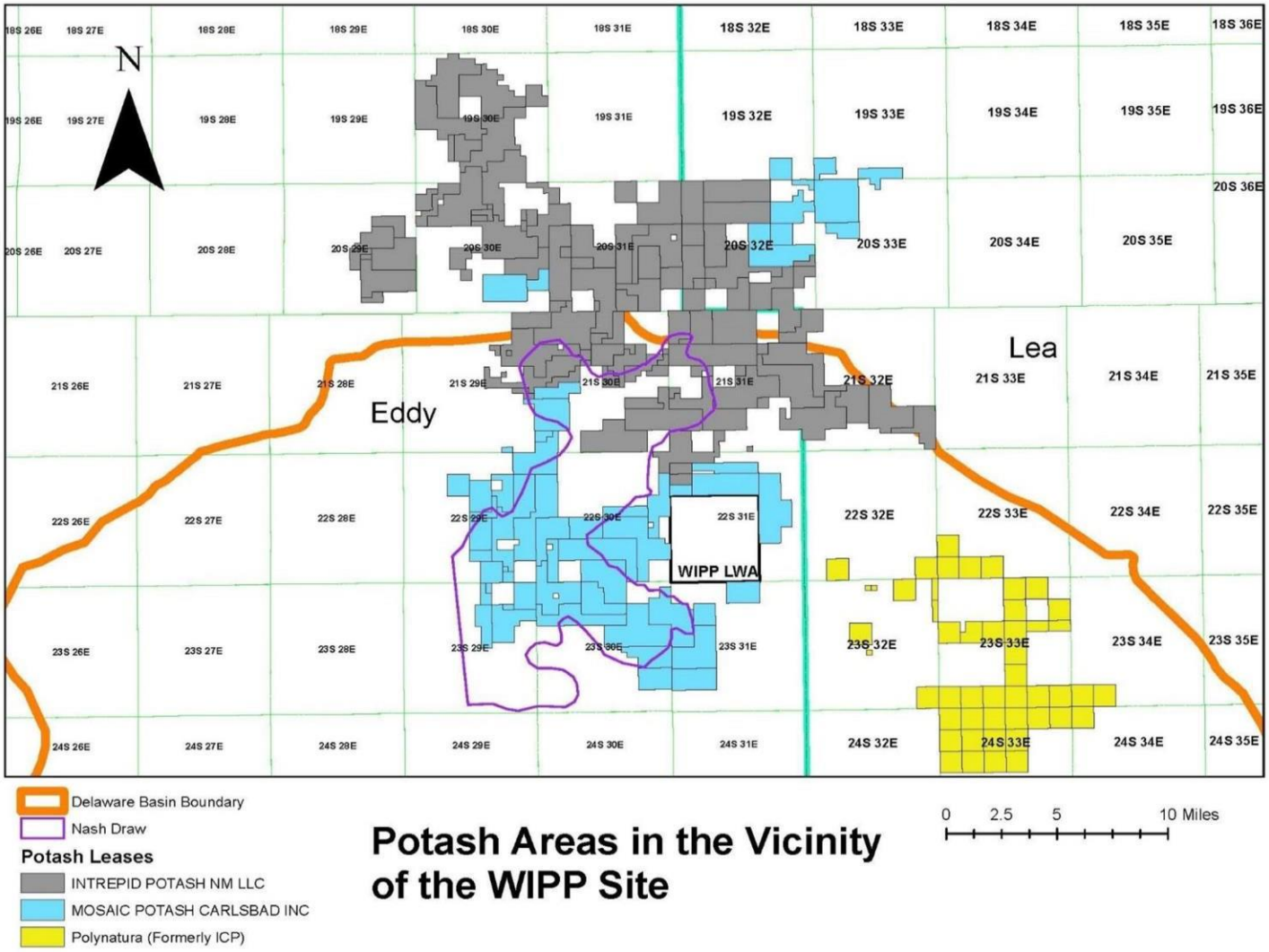


Figure 9. Potash Areas in the Vicinity of the WIPP Site

Table 1. Casing Sizes Used in the Nine-Township Area

Casing Size (inches)	Surface Casing[a]	Intermediate Casing[b]	Production Casing[c]
	Number of Wells	Number of Wells	Number of Wells
20	0	0	0
18-5/8	0	0	0
16	0	0	0
13-3/8	5	0	0
11-3/4	0	0	0
10-3/4	2	0	0
9-5/8	0	5	0
8-5/8	0	2	0
7-5/8	0	0	0
7	0	0	0
5-1/2	0	0	7
4-1/2	0	0	0

NOTE: Seven wells were completed in the nine-township area between September 1, 2023, and August 31, 2024.

a. The casing string or strings are used primarily for protecting fresh water or mineralized water resources from potential contamination during the drilling and operation of an oil or gas well, or both.

b. The string of casing set with cement after the surface casing and before the production casing that is used in the well bore to isolate, stabilize, or provide well control.

c. A casing string that is set above the reservoir interval and within which the primary completion components are installed.

Table 2. Bit Sizes Used in the Nine-Township Area

Bit Size (inches)	Surface Hole[a]	Intermediate Hole[b]	Production Hole[c]
	Number of Wells	Number of Wells	Number of Wells
26	0	0	0
24	0	0	0
20	0	0	0
18-1/2	0	0	0
17-1/2	5	0	0
16	0	0	0
14-3/4	2	0	0
12-3/4	0	0	0
12-1/4	0	5	0
11	0	0	0
10-5/8	0	0	0
9-7/8	0	2	0
8-3/4	0	0	0
8-1/2	0	0	0
7-7/8	0	0	0
7-3/4	0	0	0
7	0	0	0
6-3/4	0	0	7
6-1/8	0	0	0

NOTE: Seven wells were completed in the nine-township area between September 1, 2023, and August 31, 2024.

a. The surface hole is the shallowest part of the borehole which starts at the surface. This is where surface casing is installed.

b. The middle portion of the borehole which is between the surface and the production areas. This is where intermediate casing is installed. There can be several intermediate portions of a borehole.

c. The portion of the borehole where the production casing and primary completion components are installed.

Table 3. Air-drilled Wells in the NM Portion of the Delaware Basin

№	API №[a]	Location[b]	Well Name & №	Spud Date	Status/Type	Well Information
1	30-015-04764	21S-28E-33	Richardson & Bass #1	7/27/1961	Plugged Oil Well	Air drilled through the salt. Between 2,545 and 2,685 feet encountered water and changed from air to mud- based drilling.
2	30-025-31193	21S-32E-26	Lincoln Federal Unit #1	4/1/1991	Plugged Gas Well	Lost circulation at 1,290 feet, hole was dry drilled to 1,792 feet supposedly, air drilled from 2,984 to 4,725 feet.
3	30-015-26146	23S-26E-17	Exxon 17 Federal #1	8/1/1989	Gas Well	Air drilled through the salt from 575 to 2,707 feet.
4	30-015-02483	23S-28E-11	CP Pardue #1	10/28/1958	Plugged Oil Well	Air drilled through the salt from 390 to 2,620 feet.
5	30-015-22975	23S-28E-11	Amoco Federal 11 #1	8/4/1979	Oil Well	Air drilled from 475 to 9,700 feet.
6	30-015-23084	23S-28E-11	Amoco Federal 11 #3	2/28/1980	Oil Well	Air drilled from 6,271 to 9,692 feet.
7	30-015-22700	23S-28E-23	South Culebra Bluff Unit #3	1/21/1979	Plugged Oil Well	Air drilled from 6,345 to 8,000 feet.
8	30-015-22931	23S-28E-23	South Culebra Bluff Unit #4	8/9/1979	Plugged Oil Well	Air drilled from 450 to 9,802 feet.
9	30-015-27263	24S-31E-03	Lily ALY Federal #2	5/1/1994	Oil Well	Air drilled conductor hole to 40 feet.
10	30-015-27265	24S-31E-03	Lily ALY Federal #4	5/16/1994	Plugged Oil Well	Air drilled conductor hole to 40 feet.
11	30-025-20444	24S-34E-04	Antelope Ridge Unit #2	1/5/1965	Gas Well	Attempted to drill with gas. Had to convert to water at 1,035 feet. Tried again several times at different depths.
12	30-025-20817	24S-34E-09	Federal 9 Com #1	1/23/1974	Gas Well	Hit water while gas drilling at 4,865 ft.
13	30-025-08492	24S-34E-13	Federal Johnson #1	6/23/1958	Plugged Oil Well	Proposed to drill with air, but no information in the records indicate air drilling.
14	30-025-21741	26S-32E-20	Russell Federal #1	3/16/1966	Oil Well	Drilled with air to 1,330 feet.
15	30-025-08314	26S-32E-36	North El Mar Unit #44	2/19/1959	Oil Well	Proposed to drill with air, but no information in the records indicate air drilling.
Wells Drilled after Supplemental Information Provided to the EPA Docket in 1997						
16	30-015-29532	22S-26E-28	Sheep Draw 28 Federal #13	7/1/1997	Plugged Oil Well	Air drilled the first 358 feet.

a. API = American Petroleum Institute.

b. "Location" refers to the New Mexico Township, Range, and Section.

Table 4. Shallow Well Type/Status in the Delaware Basin

Well Status/Type	Texas	New Mexico	TOTALS
	Number of Wells	Number of Wells	Number of Wells
Brine Well	4	1	5
Core Hole	29	2	31
Dry Hole	365	148	513
Gas Well	7	8	15
Injection Well	1	0	1
Junked and Abandoned Well	63	0	63
Oil Well	108	10	118
Plugged Brine Well	2	4	6
Plugged Gas Well	4	13	17
Plugged Oil Well	30	82	112
Plugged Salt Water Disposal Well	1	7	8
Plugged Stratigraphic Test Hole	0	18	18
Potash Core Hole	0	1,664	1,664
Salt Water Disposal Well	1	1	2
Service Well	11	0	11
Stratigraphic Test Hole	1,166	1	1,167
Sulfur Core Hole	496	61	557
Water Well	0	33	33
WIPP Well/Borehole	0	209	209
Other (Mine Shafts, Gnome Project Wells)	0	52	52
TOTALS	2,288	2,314	4,602

Table 5. Deep Well Type/Status in the Delaware Basin

Well Type/Status	Texas	New Mexico	TOTALS
	Number of Wells	Number of Wells	Number of Wells
Brine Well	6	0	6
Core Hole	5	0	5
Drilling or Waiting on Paperwork[a]	1,708	105	1,813
Dry Hole	2,221	804	3,025
Gas Well	4,165	1,755	5,920
Injection Well	424	24	448
Junked and Abandoned Well	54	0	54
Oil Well	12,790	5,948	18,738
Plugged Brine Well	3	1	4
Plugged Gas Well	443	569	1,012
Plugged Injection Well	96	91	187
Plugged Oil Well	1,444	1,642	3,086
Plugged Salt Water Disposal Well	22	136	158
Plugged Service Well	7	1	8
Plugged Stratigraphic Test Hole	0	5	5
Potash Core Hole	0	274	274
Salt Water Disposal Well	484	229	713
Service Well	56	0	56
Stratigraphic Test Hole	48	7	55
Sulfur Core Hole	91	0	91
Water Well	3	0	3
WIPP Well/Borehole[b]	0	12	12
Other (Mine Shafts, Gnome Project Wells)[b]	0	13	13
TOTALS	24,070	11,616	35,686[b]

a. The 1,813 wells under the "Drilling or Waiting on Paperwork" category do not have complete paperwork classifying these wells as oil, gas, or some other type of well. These wells are included in the deep drilling rate. When the appropriate paperwork is posted, the classification of these types of wells will be updated.

b. WIPP Well/Borehole and Other (Mine Shafts, Gnome Project Wells), while important to track, do not get counted in the overall drilling rate; these omissions result in 35,661 deep boreholes being used in the deep drilling rate calculation (see Table 6).

Table 6. Drilling Rates for the Delaware Basin

Reporting Period[a] September 1 – August 31	Number of Deep Boreholes	Drilling Rate Boreholes/km^2
1996	10,804 Boreholes Deeper Than 2,150 feet	46.8
1997	11,444 Boreholes Deeper Than 2,150 feet	49.5
1998	11,616 Boreholes Deeper Than 2,150 feet	50.3
1999	11,684 Boreholes Deeper Than 2,150 feet	50.6
2000	11,828 Boreholes Deeper Than 2,150 feet	51.2
2001	12,056 Boreholes Deeper Than 2,150 feet	52.2
2002	12,139 Boreholes Deeper Than 2,150 feet	52.5
2003	12,316 Boreholes Deeper Than 2,150 feet	53.3
2004	12,531 Boreholes Deeper Than 2,150 feet	54.2
2005	12,819 Boreholes Deeper Than 2,150 feet	55.5
2006	13,171 Boreholes Deeper Than 2,150 feet	57.0
2007	13,520 Boreholes Deeper Than 2,150 feet	58.5
2008	13,824 Boreholes Deeper Than 2,150 feet	59.8
2009	14,173 Boreholes Deeper Than 2,150 feet	61.3
2010	14,403 Boreholes Deeper Than 2,150 feet	62.3
2011	14,816 Boreholes Deeper Than 2,150 feet	64.1
2012	15,558 Boreholes Deeper Than 2,150 feet	67.3
2013	16,633 Boreholes Deeper Than 2,150 feet	72.0
2014	17,937 Boreholes Deeper Than 2,150 feet	77.6
2015	19,424 Boreholes Deeper Than 2,150 feet	84.1
2016	20,429 Boreholes Deeper Than 2,150 feet	88.4
2017	21,581 Boreholes Deeper Than 2,150 feet	93.4
2018	22,886 Boreholes Deeper Than 2,150 feet	99.1
2019	24,408 Boreholes Deeper Than 2,150 feet	105.7
2020	28,669 Boreholes Deeper Than 2,150 feet	124.1
2021	29,045 Boreholes Deeper Than 2,150 feet	125.7
2022	32,079 Boreholes Deeper Than 2,104 feet	138.9
2023	33,737 Boreholes Deeper Than 2,104 feet	145.5
2024	35,661 Boreholes Deeper Than 2,104 feet	153.4

a. The data begins in 1996, which was the year the Compliance Certification Application for the WIPP was approved by the EPA.

b. A drilling rate calculation error was made in the 2023 Delaware Basin Monitoring Annual Report (DOE 2023), and the correction is reflected in this report.

Table 7. Castile Brine Encounters in the Vicinity of the WIPP Site

№	API №[a]	Location[b]	Well Name and Number	Spud Date	Status	Well Information
Original CCA-related Castile Brine Encounters - 1896 Through June 1995						
1	30-015-23045	21S-31E-26	Pogo Federal #1	10/31/1979	Plugged Oil Well	N/A
2	ERDA-6	21S-31E-35	ERDA-6	6/13/1975	Plugged WIPP Well	WIPP well, no API number.
3	30-015-23896	21S-31E-35	Federal FI #1	9/25/1981	Plugged Oil Well	N/A
4	30-015-26584	21S-31E-36	Lost Tank AIS State #1	12/7/1991	Oil Well	N/A
5	30-015-26715	21S-31E-36	Lost Tank AIS State #4	11/19/1991	Oil Well	N/A
6	30-025-31443	21S-32E-31	Lost Tank SWD #1	11/12/1991	SWD Well	N/A
7	30-015-03688	22S-29E-09	Danford Permit #1	5/18/1937	Plugged Oil Well	N/A
8	30-015-26698	22S-31E-01	Unocal AH U Federal #1	4/2/1991	Oil Well	N/A
9	30-015-26815	22S-31E-01	Molly State #1	9/25/1991	Oil Well	N/A
10	30-015-26831	22S-31E-01	Molly State #3	10/20/1991	Oil Well	N/A
11	30-015-26877	22S-31E-02	Pogo State 2 #3	11/27/1991	Plugged Oil Well	N/A
12	30-015-26723	22S-31E-11	Martha AIK Federal #3	5/6/1991	Plugged Oil Well	N/A
13	30-015-26724	22S-31E-11	Martha "AIK" Federal #4	9/2/1991	Oil Well	N/A
14	30-015-26942	22S-31E-12	Federal 12 #8	3/27/1992	Oil Well	N/A
15	30-015-26487	22S-31E-13	Neff 13 Federal #5	2/4/1991	Oil Well	N/A
16	WIPP-12	22S-31E-17	WIPP-12	11/17/1978	Plugged Monitoring Well	WIPP well, no API number.
17	30-025-27620	22S-32E-05	Bilbrey SWD #1	11/26/1981	SWD Well	N/A
18	30-025-31800	22S-32E-15	Lechuza Federal #4	12/29/1992	Plugged Oil Well	N/A

№	API №[a]	Location[b]	Well Name and Number	Spud Date	Status	Well Information
19	30-025-31576	22S-32E-16	Kiwi AKX State #1	4/28/1992	Oil Well	N/A
20	30-025-24947	22S-32E-25	Covington A Federal #1	2/7/1975	Plugged Oil Well	N/A
21	30-025-08111	22S-32E-26	Culberson #1	12/15/1944	P&A	N/A
22	30-025-31720	22S-32E-34	Red Tank 34 Federal #1	9/3/1992	Oil Well	N/A
23	30-025-08112	22S-32E-36	Richardson State #1	7/20/1962	Plugged Oil Well	N/A
24	30-025-20810	22S-32E-36	Shell State #1	2/27/1964	Oil Well	N/A
25	30-025-01799	22S-33E-20	Cloyd Permit #1	9/7/1937	Plugged Oil Well	N/A
26	30-025-01800	22S-33E-20	Cloyd Permit #2	6/22/1938	Plugged Oil Well	N/A
27	30-015-21052	23S-30E-01	Hudson Federal #1	2/25/1974	Plugged SWD Well	N/A
28	30-025-27772	22S-32E-15	Connally Federal #1	3/5/1991	Gas Well	N/A
29	30-015-26973	22S-31E-2	Flora AKF State #1	3/31/1992	Plugged Oil Well	N/A
30	30-015-28416	22S-31E-2	Pogo State 2 #2	3/31/1995	Oil Well	N/A
Castile Brine Encounters Since July 1995						
1	30-015-30857	23S-30E-01	James Ranch Unit #63	12/23/1999	Oil Well	Sulfur water encountered at 2,900 feet H_2S of 35 ppm was reported in the sulfur water but quickly dissipated to 3 ppm in a matter of minutes. Continued drilling.
2	30-015-31275	21S-31E-35	Lost Tank 35 State #4	09/11/2000	Oil Well	Estimated several hundred barrels per hour. Continued drilling.

№	API №[a]	Location[b]	Well Name and Number	Spud Date	Status	Well Information
3	30-015-31926	21S-31E-35	Lost Tank 35 State #16	2/6/2002	Oil Well	At 2,705 feet, encountered 1,000 barrels per hour. Shut-in to get room in reserve pit with pressure of 180 psi and water flow of 450 B/H. Two days later no water flow and full returns.
4	30-015-31913	22S-31E-02	Graham AKB State #8	4/12/2002	Oil Well	Estimated 105 barrels per hour. Continued drilling.
5	30-015-31513	23S-30E-01	Hudson 1 Federal #7	1/6/2001	Oil Well	Estimated initial flow at 400 to 500 barrels per hour with a total volume of 600 to 800 barrels. Continued drilling.
6	30-015-33076	22S-30E-13	Apache 13 Federal #3	11/26/2003	Oil Well	Encountered strong water flow with blowing air at 2,850-3,315 feet. No impact on the drilling process.
7	30-015-33335	21S-31E-34	Jacque AQJ State #7	3/1/2005	Plugged Oil Well	Encountered water flow of 104 barrels per hour at 2,900 feet No impact on the drilling process.
8	30-015-34221	22S-30E-13	Apache 13 Fed #8	8/19/2005	Oil Well	Encountered a severe H_2S water flow.
9	30-015-37273	23S-30E-1	James Ranch Unit #108H	12/6/2009	Oil Well	Encountered salt water flow at 2,894 feet.
10	30-015-40890	21S-31E-35	Lost Tank 35 State SWD #1	6/28/2013	SWD Well	Encountered H_2S influx from 2,678 to 3,004 feet then shut in on well.

a. API = American Petroleum Institute.
b. "Location" refers to the New Mexico Township, Range, and Section.

Table 8. Plug Types and Frequencies

Plug Type	CRA-2014 Frequency	CRA-2019 Frequency
I	26.9%	21.7%
II	20.1%	24.3%
III	29.9%	23.8%
IV	16.5%	17.9%
V	2.6%	3.5%
VI	4.0%	8.8%
TOTALS	100.0%	100.0%

		Number of Wells in the Nine-Township Area[a]											
Plug Type	Pre-2015 Totals[b]	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total	Current Frequency
I	46	1	8	10	12	10	7	9	1	1	0	105	20.7%
II	26	2	0	4	5	8	6	1	1	2	3	58	11.4%
III	54	1	14	6	0	6	10	8	7	3	4	113	22.3%
IV	17	1	2	0	2	4	0	0	3	0	3	32	6.3%
V	15	0	0	1	0	0	0	0	0	0	1	17	3.4%
VI	19	8	2	20	22	32	24	18	11	18	8	182	35.9%
TOTALS	177	13	26	41	41	60	47	36	23	24	19	507	100%

a. Numbers have been updated from prior annual reports to include wells in the nine-township area only.
b. For the sake of simplicity, all years prior to 2015 have been rolled into one column on this table.

Table 9. Seismic Activity within the Delaware Basin Boundary

County and State	№ of Total Recorded Events (all time)	№ of Recorded Events for the Reporting Period	Earliest Event	Latest Event	Smallest Magnitude	Largest Magnitude
Culberson, TX	27,181	3,184	10/27/1992	8/01/2024	0.12	4.70
Eddy, NM	672	107	11/28/1975	6/02/2024	0.25	3.70
Jeff Davis, TX	26	0	9/16/2014	1/19/2023	0.84	2.63
Lea, NM	297	29	6/23/1993	8/10/2024	0.30	3.00
Loving, TX	545	136	2/4/1976	8/01/2024	0.66	3.90
Pecos, TX	462	20	1/30/1975	8/30/2024	0.10	3.00
Reeves, TX	7,374	1,141	10/13/2008	8/01/2024	0.41	5.40
Ward, TX	343	4	9/3/1976	4/20/2024	0.08	2.80
Winkler, TX	42	12	9/24/1971	4/23/2024	1.10	3.80
TOTAL	36,942	4,633				

KEY:

Magnitude	
< 2	Very seldom ever felt
2.0 to 3.4	Barely felt
3.5 to 4.2	Felt as a rumble
4.3 to 4.9	Shakes furniture; can break dishes
to 5.9	Dislodges heavy objects; cracks walls
to 6.9	Considerable damage to buildings
to 7.3	Major damage to buildings; breaks underground pipes
7.4 to 7.9	Great damage; destroys masonry and frame buildings
8.0 or above	Complete destruction; ground moves in waves

Note: Seismic activity data source is the USGS, effective April 1, 2024.

Table 10. Injection and SWD Well Information for the Nine-Township Area

№	Location[a]	API №[b]	Type	Injection Zone	First Injection	Last Injection	Cumulative Barrels
1	21S-30E-30	30-015-04733	SWD, PLUGGED	Information not available	Information not available	Information not available	Information not available
2	21S-31E-33	30-015-29330	SWD	4,166-5,160	1998	July 2024	14,792,091
3	21S-31E-35	30-015-40890	SWD	4,355-6,320	2014	July 2024	4,571,997
4	21S-32E-08	30-025-31412	SWD	4,826-5,978	1991	May 2023	20,252,574
5	21S-32E-31	30-025-31443	SWD	4,618-6,012	1992	July 2024	10,670,000
6	21S-32E-35	30-025-44273	SWD	15,900-17,250	2018	July 2024	16,348,948
7	22S-30E-02	30-015-25758	Injection	7,200-7,264	1993	July 2024	29,548,120
8	22S-30E-02	30-015-26761	Injection	5,600-7,400	1991	July 2024	30,013,949
9	22S-30E-21	30-015-41074	SWD	15,291-16,801	2014	July 2024	33,995,159
10	22S-30E-25	30-015-33439	SWD	5,678-5,930	2010	July 2024	5,874,084
11	22S-30E-36	30-015-45691	SWD	15,610-16,730	2019	July 2024	10,121,969
12	22S-31E-02	30-015-32440	Injection	6,989-7,020	2003	February 2024	3,964,494
13	22S-31E-03	30-015-38254	SWD	5,355-6,137	2012	July 2024	7,885,896
14	22S-31E-24	30-015-26848	SWD	4,519-5,110	1991	July 2024	19,557,141
15	22S-31E-25	30-015-28281	SWD	5,634-5,987	1995	July 2024	16,608,691
16	22S-31E-35	30-015-26629	SWD	4,500-5,670	1991	August 2024	30,545,001
17	22S-31E-36	30-015-26171	SWD	4,500-5,700	1998	July 2024	12,234,073
18	22S-32E-05	30-025-27620	SWD	8,250-8,602	2004	August 2022	12,967,240
19	22S-32E-06	30-025-31227	SWD	4,626-5,730	2012	August 2024	7,392,130
20	22S-32E-06	30-025-43328	SWD	974-4,482	2018	July 2024	22,190,331
21	22S-32E-07	30-025-31076	SWD	4,676-5,814	1991	July 2023	15,289,069
22	22S-32E-14	30-025-08113	SWD	5,750-6,080	1994	July 2024	7,732,394
23	22S-32E-16	30-025-31644	SWD	5,582-6,380	2010	July 2024	3,127,338
24	22S-32E-16	30-025-31889	SWD	5,240-8,710	1995	February 2024	12,876,867
25	22S-32E-16	30-025-36006	SWD, PLUGGED	5,850-6,450	2010	October 2021	3,166,992
26	22S-32E-17	30-025-31926	SWD	6,807-6,828	2007	October 2023	3,011,631
27	22S-32E-21	30-025-08109	SWD	4,755-5,110	1994	July 2024	5,149,336
28	22S-32E-27	30-025-32436	Injection	6,831-8,388	1994	July 2024	17,393,912
29	22S-32E-28	30-025-31754	SWD	4,674-5,672	1993	July 2024	8,594,715
30	22S-32E-30	30-025-44106	SWD	3,395-4,528	2017	July 2024	41,313,474
31	22S-32E-31	30-025-20423	SWD	4,734-5,590	1993	July 2024	9,326,193
32	22S-32E-31	30-025-32093	SWD	4,590-5,626	2004	May 2024	1,577,684
33	22S-32E-32	30-025-36004	SWD	6,744-8,518	2010	November 2022	6,950,406
34	22S-32E-32	30-025-36135	SWD	5,850-6,450	2013	April 2024	4,624,636

№	Location[a]	API №[b]	Type	Injection Zone	First Injection	Last Injection	Cumulative Barrels
35	22S-32E-32	30-025-37799	SWD	5,750-6,500	2010	March 2024	6,554,461
36	22S-32E-35	30-025-33149	SWD	4,950-6,252	1995	June 2024	13,378,094
37	23S-30E-16	30-015-20899	SWD	4,433-5,952	2003	July 2024	22,044,602
38	23S-30E-19	30-015-45072	SWD	3,032-3,283	2018	July 2024	28,075,913
39	23S-30E-20	30-015-29549	SWD	4,124-4,774	2006	July 2024	4,354,258
40	23S-30E-22	30-015-33637	SWD	4,510-5,780	2012	July 2024	4,341,509
41	23S-30E-29	30-015-28808	SWD	5,370-6,380	1996	July 2024	9,108,331
42	23S-31E-02	30-015-05840	SWD	4,500-5,700	1997	July 2024	11,091,018
43	23S-31E-06	30-015-46432	SWD	15,610-16,980	2020	July 2024	14,723,927
44	23S-31E-08	30-015-32619	SWD	7,900-7,933	2004	July 2024	6,596,468
45	23S-31E-09	30-015-33368	SWD	7,744-7,952	2005	July 2024	7,836,865
46	23S-31E-15	30-015-43805	SWD	1,180-3,300	2018	July 2024	38,549,659
47	23S-31E-20	30-015-30605	Injection	7,740-7,774	2001	July 2024	15,952,585
48	23S-31E-24	30-015-43806	SWD	16,390-17,500	2018	July 2024	44,574,729
49	23S-31E-25	30-015-28817	SWD	5,776-5,920	2008	July 2024	2,351,621
50	23S-31E-25	30-015-28859	SWD	5,236-5,498	2008	July 2024	1,193,400
51	23S-31E-26	30-015-20277	SWD	4,460-5,134	1992	May 2023	5,971,108
52	23S-31E-27	30-015-27106	SWD	4,750-5,720	1998	July 2024	7,968,709
53	23S-31E-28	30-015-26194	SWD	4,295-5,570	1993	July 2024	10,451,656
54	23S-31E-35	30-015-25640	SWD	4,484-5,780	1993	July 2024	11,959,153
55	23S-31E-36	30-015-20341	SWD	5,980-6,560	1994	July 2024	44,480,992
56	23S-31E-02	30-015-29792	SWD	4,500-5,850	2000	July 2024	11,128,072
57	23S-31E-26	30-015-45235	SWD	16,513-17,894	2019	July 2024	45,998,515
58	23S-32E-04	30-025-31650	SWD	4,884-5,886	2003	July 2024	6,503,737
59	23S-32E-07	30-025-33398	SWD	4,660-6,270	2009	June 2024	3,920,692
60	23S-32E-14	30-025-26844	SWD	5,496-6,014	1991	July 2024	2,860,349
61	23S-32E-15	30-025-35524	SWD	5,786-5,942	2008	July 2024	2,155,895
62	23S-32E-18	30-025-25017	SWD	16,700-18,000	1975	July 2024	8,090,715
63	23S-32E-21	30-025-45029	SWD	1,210-4,757	2019	July 2024	22,874,265
64	23S-32E-23	30-025-33653	SWD	5,950-6,065	2000	July 2024	3,475,681
65	23S-32E-24	30-025-33521	SWD	5,925-6,042	2001	July 2024	2,790,478
66	23S-32E-29	30-025-31515	SWD	4,844-6,160	1992	July 2024	20,281,608
67	23S-32E-31	30-025-32868	SWD	5,150-5,700	1996	June 2024	6,704,467
68	23S-30E-19	30-015-28422	SWD, PLUGGED	7,010-7,070	1996	September 2020	943,863
69	23S-32E-07	30-025-33222	SWD	8,646-8,666	2024	May 2024	33

Table 11. Brine Well Status/Type in the NM Portion of the Delaware Basin

County	Location	API №	Well Name and Number	Operator	Status/Type
Eddy	22S-27E-17	30-015-22574	Eugenie #1	I & W Inc.	Plugged Brine Well
Eddy	22S-27E-17	30-015-23031	Eugenie #2	I & W Inc.	Plugged Brine Well
Eddy	22S-27E-23	30-015-28083	Dunaway #001	Permian Water Solutions, LLC	Plugged Brine Well
Eddy	22S-27E-23	30-015-28084	Dunaway #2	Permian Water Solutions, LLC	Plugged Brine Well
Eddy	22S-26E-36	30-015-21842	City Of Carlsbad # 1	Key Energy Services, LLC	Plugged Brine Well
Eddy	22S-27E-03	30-015-20331	Tracy #3	Ray Westall	Plugged Brine Well

a. "Location" refers to the New Mexico Township, Range, and Section.
b. API = American Petroleum Institute.