Waste Isolation Pilot Plant
Delaware Basin Monitoring Annual Report

DOE/WIPP-23-2308

Revision 0

Effective Date: January 4, 2024

United States Department of Energy
Carlsbad Field Office

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Approved by: MICHAEL GERLE Digitally signed by MICHAEL GERLE Date: 2024.01.04 11:33:32 -07'00' 01/04/2024

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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
DPA	Designated Potash Area
EPA	U.S. Environmental Protection Agency
H_2S	hydrogen sulfide
N/A	Not Applicable
NM	New Mexico
NMOCD	New Mexico Oil Conservation Division
PA	Performance Assessment
PAVT	Performance Assessment Verification Test
SRA	Seismic Response Areas
SWD	Salt Water Disposal
TX	Texas
WIPP	Waste Isolation Pilot Plant

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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 reevaluated 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, 2022, to August 31, 2023.

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." 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).
Results from the PA must demonstrate a reasonable expectation that, for 10,000 years after the disposal, radioactive releases from an undisturbed WIPP repository will not exceed limits set by the EPA standard. The deep drilling rate is a key input parameter for the PA model. The PA model predicts the likelihood, frequency, and severity of a radioactive release due to future inadvertent drilling into the repository.

Subpart B of 40 CFR Part 191 provides the environmental standards for the disposal of radioactive waste. To predict disposal system performance, the PA must consider the impacts of inadvertent human intrusion into the repository for 10,000 years post-closure. The most severe form of human intrusion into the WIPP repository is deep drilling (greater than or equal to the depth of the repository, i.e., 2,104 feet) for natural resources (EPA 1996). The DOE concluded in the Compliance Certification Application (CCA), Appendix SCR (DOE 1996) that shallow drilling could be removed from PA consideration based on low consequence. The EPA concurred with the exclusion of shallow drilling from consideration in PA (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. Title 40 CFR §194.32 requires this area to be monitored for mining, drilling, and drilling-related activities. 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. The monitoring of drilling activities will continue until the DOE demonstrates to the EPA that further monitoring is not warranted.

The Delaware Basin Drilling Surveillance Plan (WIPP 2021) places specific emphasis on 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. 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. The DBDSP provides data to build on the information presented in the CCA, Appendix DEL (DOE 1996); the CRA-2004, Appendix DATA (DOE 2004); the CRA-2009, Appendix DATA (DOE 2009); the CRA-2014, Appendix DATA-2014 (DOE 2014); and the CRA-2019, Appendix DATA-2019, Appendix HYDRO Attachment A (DOE 2019).

2.0 2023 UPDATES

The following items are recent updates related to the DBDSP:

- The method of calculating the deep drilling rate was modified according to EPA's Technical Support Document on 40 CFR §194.33 for the CRA-2019 (EPA 2022). See Sections 2.4 and 2.5.

- The DOE presented a memo, *Proposed Option for Borehole Plugging Area to be used for Determining Plugging Type Frequency Used in the Waste Isolation Pilot Plant Performance Assessment* (Day 2023), to the EPA. The EPA accepted the DOE's proposed change to the borehole plugging target area in February 2023 (Santillan 2023). The DBDSP will report plugged boreholes in the nine-township area, truncated on the northern edge by the Delaware Basin boundary. The DBDSP has fulfilled this update and updated Table 8 for year 2023 and Figure 5 to reflect the change.

2.1 Miscellaneous Drilling Information

The EPA provided criteria in 40 CFR §194.33(c) to address the consideration of drilling for the PA. These criteria led to the formulation of conceptual models that incorporate the effects of this activity. The conceptual models use important information as documented in the CCA, Appendix DEL (DOE 1996), such as:

- Drill collar diameter and length
- Casing diameters
- Drill pipe diameter
- Speed of drill string rotation through the Salado Formation
- Penetration rate through the Salado Formation
- Instances of air drilling
- Types of drilling fluids

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

The DBDSP data set includes the total borehole length for horizontal wells drilled in the Delaware Basin. Borehole lengths range from 9 feet to 28,133 feet. The shallowest oil well recorded in the Delaware Basin during the past year was 13,199 feet in Eddy County, NM. The deepest was 27,940 feet in Ward County, TX. Both wells are located outside the nine- township area.

The DBDSP data set includes the casing size and depth for each section of the borehole 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 in the vicinity of the WIPP site are shown in Figure 3.

2.1.2 Drilling Techniques

The primary drilling technique reported since the CCA, Appendix DEL, is rotary drilling which is still being implemented by area drillers. However, most wells currently drilled use horizontal (deviated) drilling techniques for the lower part of the borehole that contacts the targeted zone of production. There were 381 wells spudded, not necessarily completed, in the NM portion of the Delaware Basin during the reporting period. This number is derived from the Delaware Basin Well Tracking Application (DBWTA), a Microsoft® SQL server application maintained by the DBDSP.

Rotary drilling rigs were used to drill the 1,174 completed wells (entire Delaware Basin) in this reporting period. The status of completed wells includes oil wells, gas wells, salt water disposal (SWD) wells, and injection wells. The 1,174 wells were conventionally drilled utilizing mud as a medium for circulation. Twenty-nine of these wells were completed in the nine-township area. The total length of the completed wells in the nine-township area during the reporting period was between 21,237 feet and 27,351 feet. The true vertical depth of the boreholes of the completed wells in the nine-township area during the reporting period was between 9,447 feet to 12,034 feet.

The CCA, Appendix DEL, reported that horizontal drilling was not often used in the Delaware Basin because of the increased costs due to the additional drilling time needed; however, this is no longer the case. All 29 wells completed during the reporting period in the nine-township area had horizontally drilled components. Melzer and Hall (2023) state that horizontal drilling represents 95 percent of all rigs running in the Permian Basin.

2.1.3 Air Drilling

A method of hydrocarbon drilling not emphasized in the 1996 CCA, Appendix DEL, is air drilling. As defined by the oil industry, air drilling is a method of rotary drilling using 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 with equal or greater efficiency. The rate of penetration is usually increased considerably when air drilling is used; however, a fundamental problem in air drilling is the penetration of formations containing water, since the entry of water into the system reduces the ability of the air to remove cuttings. Air drilling occurrences are tracked by the DBDSP in the NM portion of the Delaware Basin only.

Stakeholders noted the air drilling scenario was not included by the DOE in the CCA and raised the following issues: (1) air drilling technology is currently successfully used in the Delaware Basin, (2) air drilling is thought to be a viable drilling technology under the hydrological and geological conditions at the WIPP site, and (3) air drilling could result in releases of naturally occurring radioactive material that are substantially greater than those considered by the DOE in the CCA. Considerable research on air drilling in the Delaware Basin has determined that, although air drilling is an alternative method of drilling wells, it is not practiced in the vicinity of the WIPP site because (1) it is against Department of the Interior, Secretary's Order 3324 (DOI, 2012) (formerly NMOCD Order R-111- P) regulations to drill with anything but saturated brine through the salt formation in the Designated Potash Area (DPA); (2) it is not economical to drill with air when a driller has to use saturated brine for the intermediate section; and (3) if water is encountered prior to or after drilling the salt formation, the driller would have to convert to a conventional system of drilling.

The DOE provided the following additional information to EPA Air Docket No. A-93-02, IV-G-7 (Kirkes 1998):

> "The well record search has continued and now includes information from the entire New Mexico portion of the Delaware Basin. Within the nine-townships surrounding the WIPP, the records showed no evidence of air drilling. One possible exception to this may be the Lincoln Federal #1. This well is said to have been air drilled due to a loss of circulation at a depth of 1290 feet, but this has not been verified. The records associated with the Lincoln Federal #1 do not contain any evidence of air drilling. Rather, this information is based on verbal communications with the operating and drilling companies involved with the well. Nonetheless, the Lincoln Federal #1 may have been drilled with air, although it was not a systematic use of the technology. Air drilling at this well was used from 2984' to 4725 merely as a mitigated attempt to continue drilling to the next casing transition depth. After this casing transition, mud drilling was used for the remainder of the hole.
>
> The area of the expanded search contains 3,756 boreholes. Of these,

> 407 well files were unavailable for viewing (in process); therefore, 3,349 well files constitute the database. Among these wells, 11 instances of air drilling were found in which any portion of the borehole was drilled with air. Only 7 of these were drilled through the Salado Formation at the depth of the repository. This results in a frequency of 7/3349, or 0.0021. This value is conservative in that it includes the Lincoln Federal #1, and four other wells which were proposed to be drilled with air, but no subsequent verification of actual drilling exists in the records."

In the CCA Final Rule (FR Vol. 63 No. 95), the EPA ruled air drilling did not have to be considered for PA; however, the DBDSP will continue to monitor for instances of air drilling (EPA 1998a).

During the summer of 1999, another search of these same records was conducted as a follow-up to the original research. This search of the records was used as a quality assurance check of the original search. The database consisted of 3,810 boreholes with only 12 records unavailable for viewing. This search added five more wells with indications of some portion of the borehole being drilled with air. None were located in the nine-township area or were air drilled through the Salado Formation. Of the five wells added to the count, one (the Sheep Draw 28 Federal #13) had the first 358 feet air drilled while the other four had the conductor casing drilled with air which consists of the first 40 feet of the borehole and is not usually reported in the drilling process. The conductor casing is typically drilled, set in place, and cemented prior to setting up the rotary drilling rig that will eventually drill the well.

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. Air drilling is not a common practice in the vicinity of the WIPP site. Table 3 shows the known indications of air drilling that have occurred in the NM portion of the Delaware Basin.

2.2 Shallow Drilling Events

The criteria in 40 CFR §194.33 require that the CCA and subsequent Compliance Recertification Applications (CRAs) adequately and accurately characterize the frequency of shallow drilling within the Delaware Basin as well as support the assumptions and determinations of the original compliance demonstration, particularly those that limit consideration of shallow drilling events based on the presence of resources of similar type and quantity found 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 [now 2,104] feet below the surface relative to where such drilling occurred." 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 and did not include any reduction in shallow drilling rates during the active and passive institutional control periods. In the CCA, Compliance Application Review Document (CARD) 33 (EPA 1998b), the EPA accepted the DOE's finding that shallow drilling would be of low consequence to repository performance and need not be included in the PA.

Although the EPA acknowledged agreement in the CARD 33 that shallow drilling is of low consequence and could be eliminated from the PA, the DBDSP collects data on wells reported to be drilled within the boundaries of the Delaware Basin. 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 rate of drilling for resources in the Delaware Basin to calculate a future drilling rate. In particular, 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. The depth of 2,104 feet was chosen because this is the shallowest depth of the repository, and the repository could not be directly breached by boreholes less than this depth. In the past 100 years, deep drilling occurred for oil, gas, potash, and sulfur. These drilling events were used in calculating a rate for deep drilling for the PA as discussed in the CCA, Appendix DEL. The calculation used data from the period of January 1896, to June 1995. Historical drilling for purposes other than resource exploration and recovery (such as WIPP site investigation) were excluded from the calculation in accordance with criteria provided in 40 CFR §194.33.

In the Delaware Basin, deep drilling events are usually associated with oil and gas drilling. Information obtained from commercial databases and state regulatory agencies is used to identify these events. The DBDSP collects data on drilled wells within the Delaware Basin, making no distinction between resources (in terms of calculating the drilling rate). A centralized Microsoft® SQL Server® based well tracking application is maintained on hydrocarbon wells for TX and NM. As information on wells is acquired, it is entered into this well tracking application. The TX portion of the well tracking application contains information only on the current status of the well, when it was drilled, its location, the name of the operator, and the true vertical depth of the well. Location refers to the NM Township, Range, and Section. For reporting purposes, the TX portion is used only for calculating 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 (WIPP 2021).

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, 1,174 were completed. All of the completed wells were drilled for hydrocarbon extraction and were deep drilling events. Twenty-nine of these wells are located 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.

2.4 Deep Drilling Rate

The EPA provided a formula for calculating the deep drilling rate or intrusion rate when 40 CFR Part 194 was promulgated. The formula was revised (EPA 2022) and is as follows:

$$Deep\ Drilling\ Rate\ \left(\frac{boreholes}{km^2}\right) = \frac{(Known\ Deep\ Boreholes + Unknown\ Boreholes)\ x\ \left(\frac{Known\ Deep\ Boreholes}{Total\ Deep\ Boreholes}\right)\ x\ (10{,}000\ years)}{(23{,}102.1\ km^2)x\ (100\ years)}$$

The DBDSP uses any deep drilling events from all resources (except WIPP project-related boreholes) to calculate the drilling or intrusion rate.

The annual (September 1 through August 31) drilling rates since the submittal of the CCA in 1996 are shown in Table 6. In addition, the 100-year period is considered a moving period; in which 100 years of data are used each time the calculation is performed. As each new year of data is added, the oldest year, if data exists for that year, is dropped. For example, the drilling rate was calculated in 1999 by 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 2023 was calculated from the information provided in Table 5 and Table 6. There were 33,737 boreholes (per Table 6) deeper than 2,104 feet that are used to determine the deep drilling rate. Applying the deep drilling rate formula presented in the equation above results in a deep drilling rate of 141.6 boreholes per km^2 over 10,000 years.

The deep drilling rate of 141.6 boreholes per km^2 is an 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 because the Delaware Basin is currently experiencing a period of increased drilling activity and because of the effect of the 100-year moving time frame used for drilling results. Using the 100-year rolling time frame currently adds the large number of wells added each year, while only a few are being removed because there were much fewer wells 100 years ago.

2.5 Drilling Activities Outside the Nine-Township Area

In the NM portion of the Delaware Basin, outside of the nine-township area, there were 381 new wells spudded during the reporting period.

In the TX portion of the Delaware Basin, 1,124 new wells were spudded during the reporting period. The DBDSP monitors drilling activities in portions of seven counties and all of one county (Loving).

2.6 Castile Brine Encounters

The WIPP PA included the assumption that a borehole results in the establishment of a flow path between the repository and a pressurized brine pocket that might be located beneath the repository in the Castile Formation. 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 wells, ERDA-6, and WIPP-12, were drilled in support of WIPP site characterization.

The DBDSP researches the well records of new wells drilled in the NM portion of the Delaware Basin each year by looking for instances of encounters with pressurized brine. As of this report, 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 pertaining to any Castile brine encounters. The DBDSP survey requests have not generated any recent response. As a result, the program has been researching alternative methods for gathering that information.

Ten wells drilled since the CCA have encountered Castile brine. Six wells were identified when WIPP site personnel performing field work spoke with area drillers and the information was documented in the DBWTA. These new encounters occurred in areas where, because of historical Castile brine encounter data (Powers, Sigda, and Holt 1996), Castile brine is expected to be encountered during the drilling process. Table 7 shows known Castile brine encounters in the vicinity of the WIPP site.

In the CCA, the probability for encountering a Castile brine reservoir was calculated at 8 percent with 30 Castile brine encounters. In the Performance Assessment Verification Test (PAVT) (MacKinnon 1997), the EPA mandated a range of 1 percent to 60 percent. These higher values did not have a significant effect on the predicted performance of the repository. The CRA-2004 continued to use the EPA's higher values, and a probability for encountering a Castile brine reservoir was not calculated. The CRA-2009 also used the values from the PAVT. For the CRA-2014, the DOE used a new probability distribution for the potential for encountering pressurized brine based on areas of known brine occurrences as well as neighboring (adjacent) wells that did not encounter pressurized brine. However, the EPA again rejected this distribution and selected their own distribution (EPA 2017). For the CRA-2019, the DOE used the EPA's new probability distribution. The DBDSP continues to monitor and collect data on the occurrences of pressurized brine; however, the EPA continues to require the use of their probability distribution.

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…" [Emphasis added].

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 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, in addition to installing a bridge plug above the perforations. This plugging technique provides protection to 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 plugging technique. Older plugged wells that pre-date the Order No. 3324 regulations may not be plugged in this manner. There is no process for granting exemptions. Therefore, wells that are 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).

In the nine-township area around WIPP, the DBDSP retrieves a copy of the plugging report from the NMOCD internet site when a well has been plugged and abandoned. This information is added to the records maintained by the DBDSP on each well drilled within the Delaware Basin. By maintaining records in such a fashion, any changes or trends to plugging techniques can be identified. Table 8 shows plugging information on the wells plugged and abandoned within the nine-township area for 2023.

The CCA, Appendix MASS, Attachment 16-1 (DOE 1996), provides a, "…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 attempted 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."

Because the study found that plugging and abandonment regulations are followed consistently and that no wells in the basin had been left unplugged, the PA should assume a 100 percent plugging frequency; that is, all wells are assumed to have some type of plug installed.

To determine the typical configuration and composition of a borehole plug, this same study considered plugging practices listed below to arrive at a model depicting six different types of plugging configurations (see Figure 4):

Type I Plugs will be located at the transition between the surface and intermediate casings and the transition between the intermediate and production casings. This area is usually the top of the Salado Formation and the bottom of the Castile Formation, roughly 800 feet and 4,000 feet below the surface, respectively.

Type II This plugging configuration has a portion of the production casing salvaged. Where the production casing was cut, a plug must be installed. If a plug occurs from 2,104 feet to 2,700 feet (above the hypothetical brine pocket) and the other plugs occur at the top of the Salado Formation and below the

Castile Formation, it is considered a Type II configuration.

Type III This configuration is the same as above except the removed production casing plug occurs above 2,104 feet.

Type IV Extra plugs, in addition to those of Type II, have been emplaced above 2,104 feet.

Type V The minimum regulatory requirements require a surface plug and a plug occurring at the bottom, provided no water-bearing zones were encountered. This type of plugging configuration is not common.

Type VI This configuration has a solid cement plug through a significant portion of the salt section. This configuration, like the others, may have additional plugs above and below the salt section plug. This plug type is typical of those used within the DPA.

There were 178 wells plugged during the reporting period that lie within the nine-township area around the WIPP. The region of data collection for this survey is shown in Figure 5 and Table 8.

2.8 Seismic Activity in the Delaware Basin

Seismic events occurring within a 300 km radius of the WIPP facility, are recorded in the DBWTA. This information is obtained every quarter from the New Mexico Tech Seismological Observatory and entered into the database. While the 300 km radius is what is recorded in the database, the DBDSP reports only those events that occur within the Delaware Basin Boundary.

Table 9 provides information on all recorded seismic events within the Delaware Basin boundary, including the 2,485 seismic events recorded during the reporting period. 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 (SRA) 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 was put into effect as of November 23, 2021 (Sandoval 2021).

2.9 Nine-Township Injection Wells

Secondary recovery projects occurring in the nine-township area are on a small scale. There are five injection wells located in the nine-township area surrounding the WIPP site.

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 injecting 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 the disposal of produced water coming from the producing formation in oil and gas wells. Figure 6 shows the location of active injection and salt water disposal wells in the nine-township area. Most active oil and gas wells produce brine water in addition to oil and gas. Salt water disposal wells have become necessary as a result of the EPA's ruling that formation 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 7 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 62 active (currently used for water disposal) SWD wells located in the nine-township area surrounding the WIPP site. Injection depths range from 3,658 to 18,398 feet. The volume of disposed brine water depends on the number of producing oil and gas wells maintained by the operator in the immediate vicinity of the SWD well. Table 10 provides information on SWD and injection wells in the nine-township area.

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 in the immediate vicinity of the WIPP site continues as reported since the CCA, Appendix DEL. Figure 8 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 that operate in the area; most notably, only two potash companies are actively mining. No plans have been promulgated by either company 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.

Two brine wells are being monitored by the NMOCD. These wells are located within the Carlsbad city limits and are within the NM portion of the Delaware Basin. Dunaway #1 and Dunaway #2 brine wells had their last inspection 8/8/2019. Both wells failed to meet standards of the NMOCD. Corrective action was done in November 2019 to comply with standards imposed by the rules and regulations of the NMOCD. In January 2022, Permian Water Solutions filed sundry notices of intent to plug and abandon both wells. The conditions of approval for the plugging and abandonment of Dunaway #1 indicated the work had to be complete by June 5, 2022. The conditions of approval for the plugging and abandonment of Dunaway # 2 indicated the work had to be completed by March 25, 2022. No subsequent reports were filed for either Dunaway well. The Carlsbad Brine Well Remediation Authority is a task force responsible for the brine well concern and budget to stabilize it.

2.12 New Drilling Technology

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 an ongoing activity.

2.13 Alternative Energy Activities

The DBDSP researches alternative energy activities that may have impact on the PA. The only alternative energy activity with the potential to impact PA is geothermal power. However, currently there are no known geothermal power projects being performed in the Delaware Basin.

2.14 Survey of Well Operators for Drilling Information

The DBDSP surveys local well operators annually to acquire drilling information normally 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, or whether any section of the well was drilled with air. The survey provides an additional source of information on drilling activities in the NM portion of the Delaware Basin. The most recent responses the DBDSP received were from 2016. No changes were made as a result of those responses.

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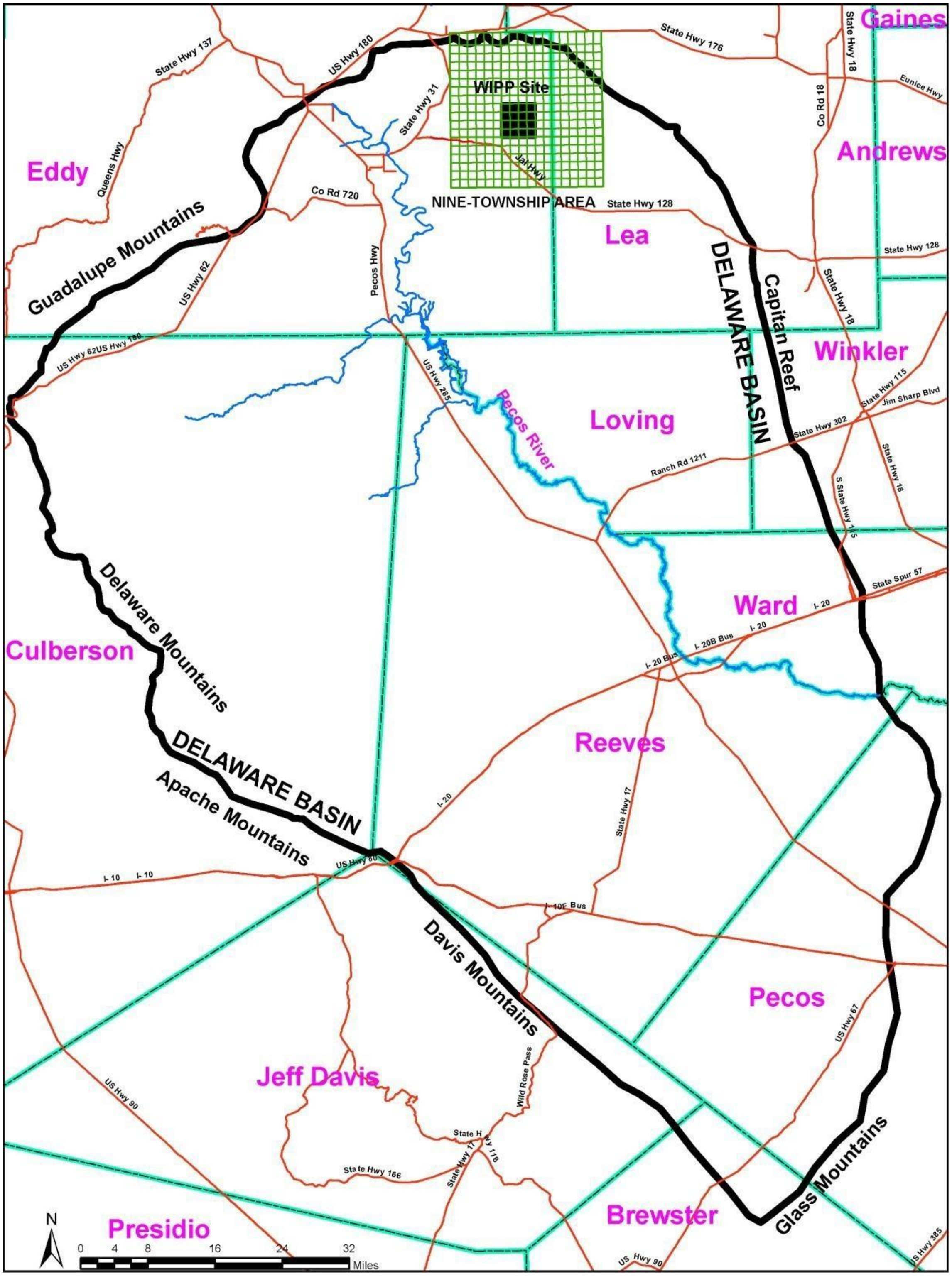

Figure 1. Waste Isolation Pilot Plant Delaware Basin Monitoring Annual Report

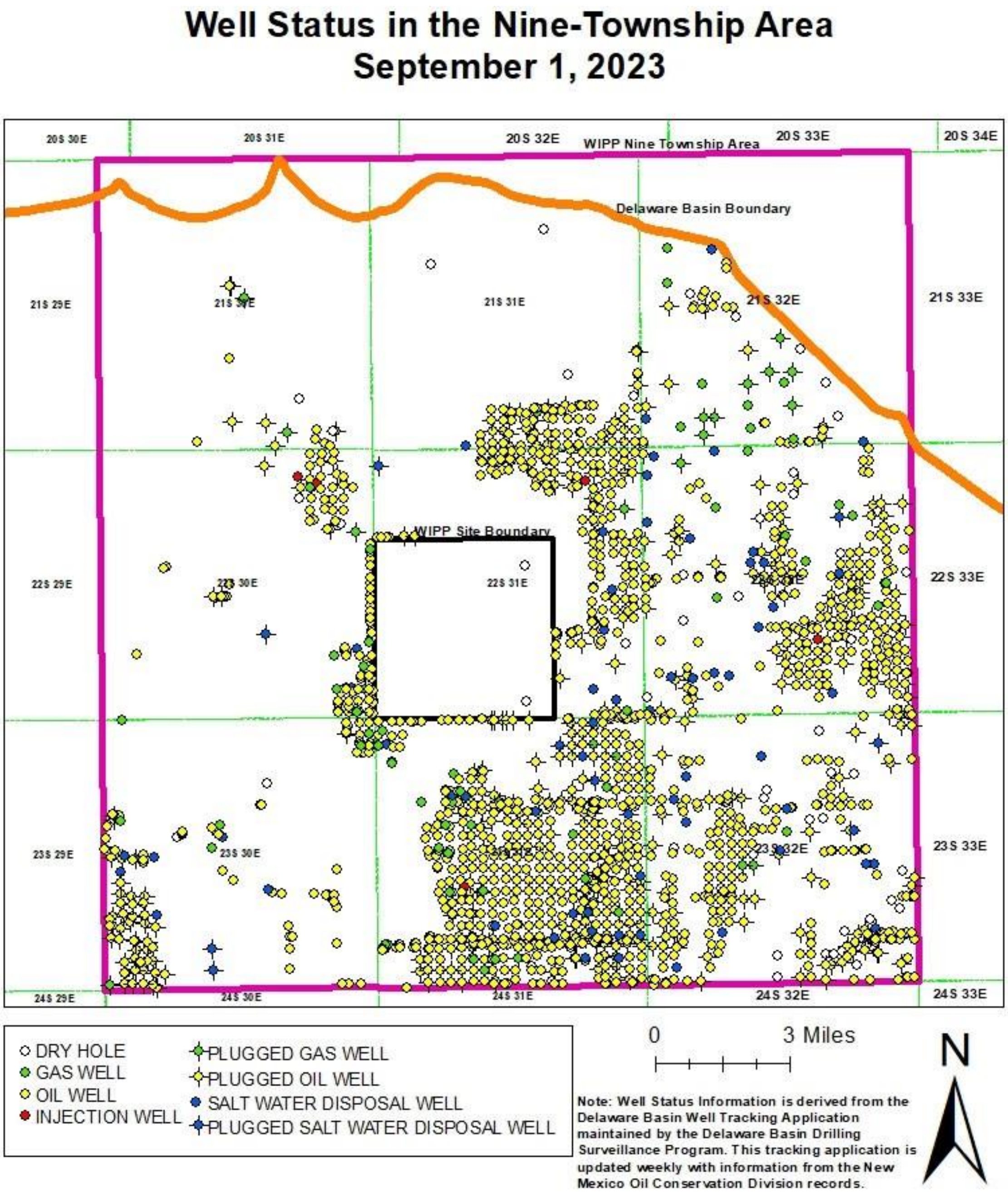

Figure 2. Well Status in the Nine-Township Area

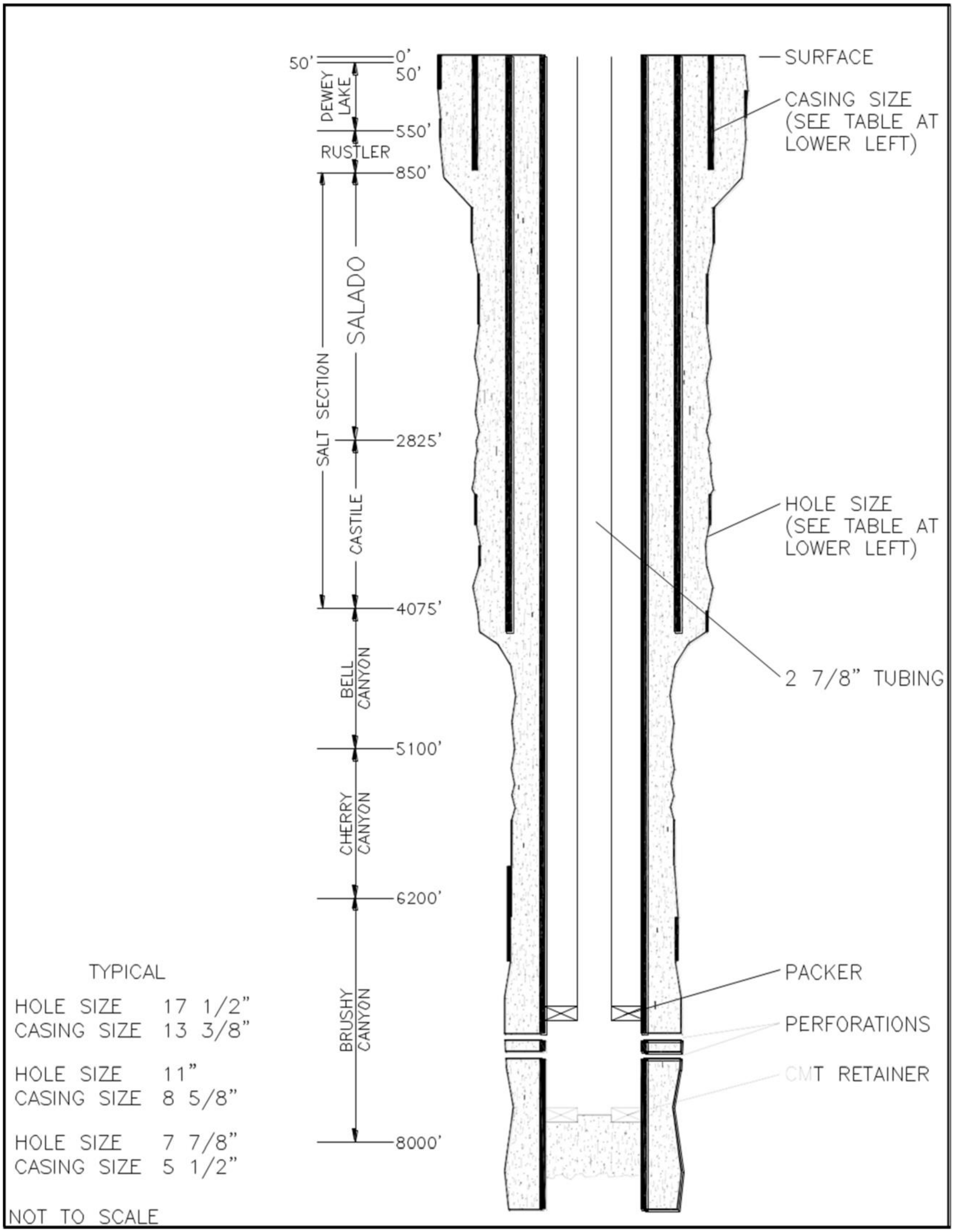

Figure 3. Typical Well Structure and General Stratigraphy Near the WIPP site

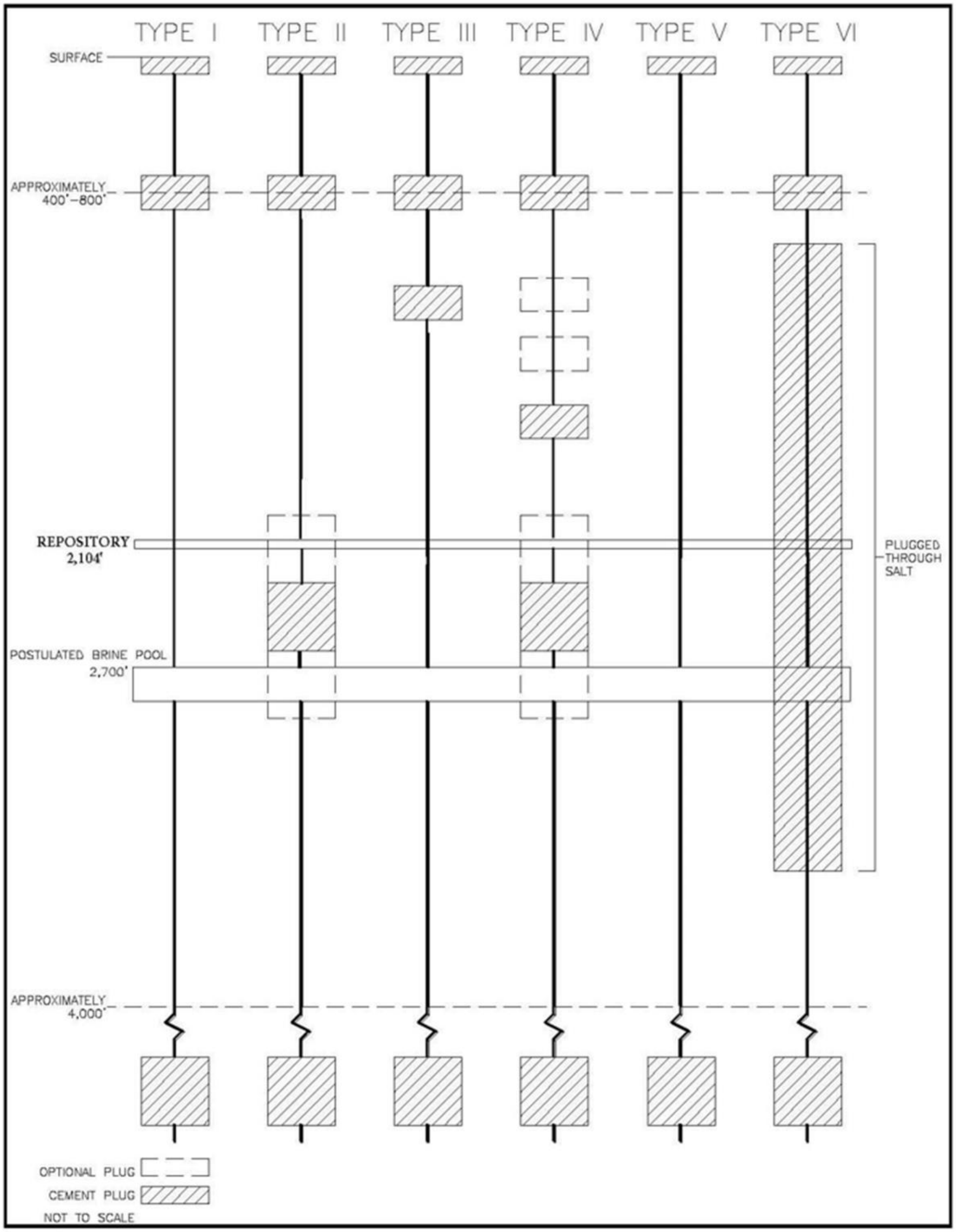

Figure 4. Typical Borehole Plug Configurations in the Delaware Basin

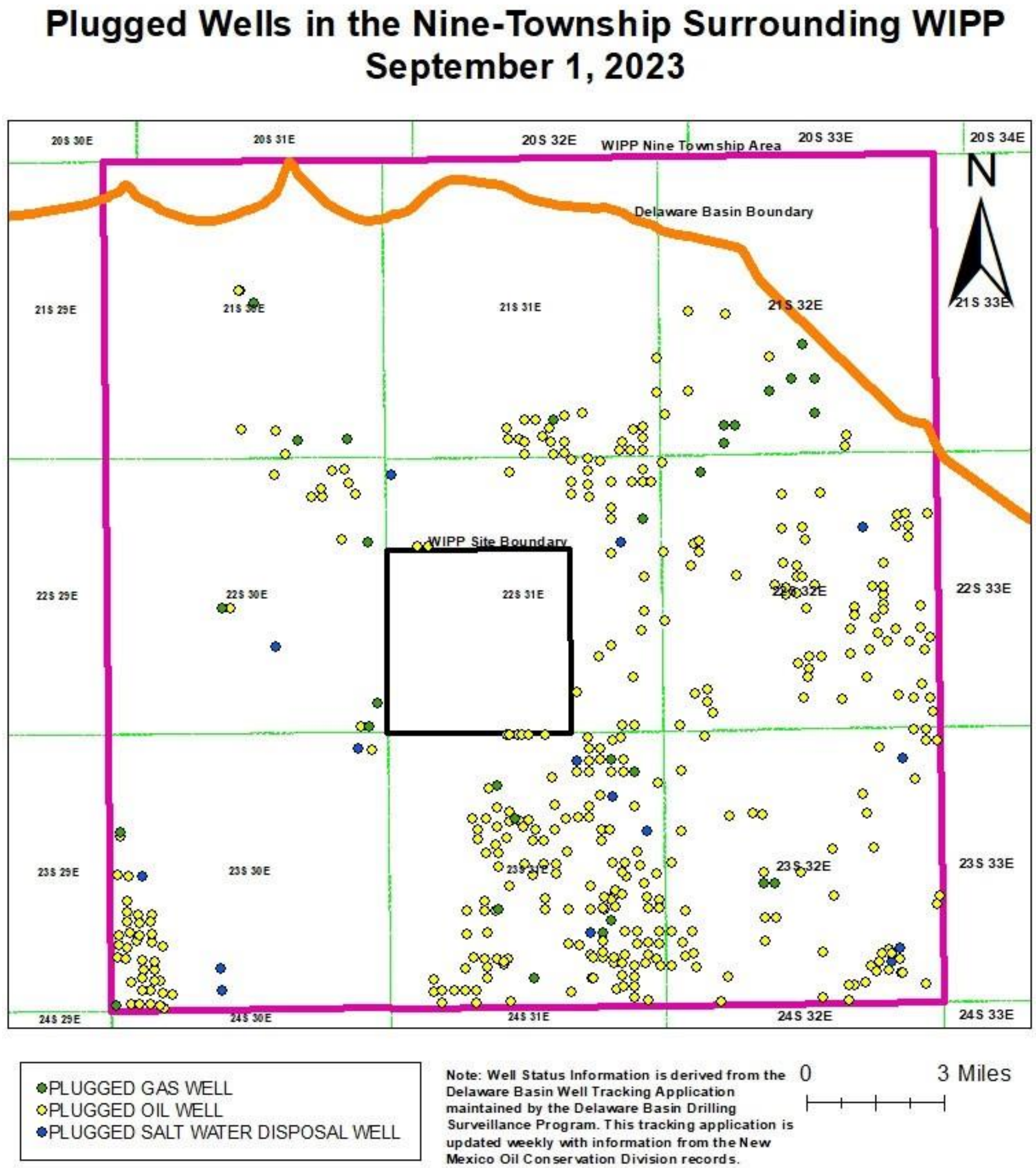

Figure 5. Plugged Wells in the Nine-Township Area Surrounding WIPP

Active Injection & SWD Wells in the Nine-Township Area
September 1, 2023

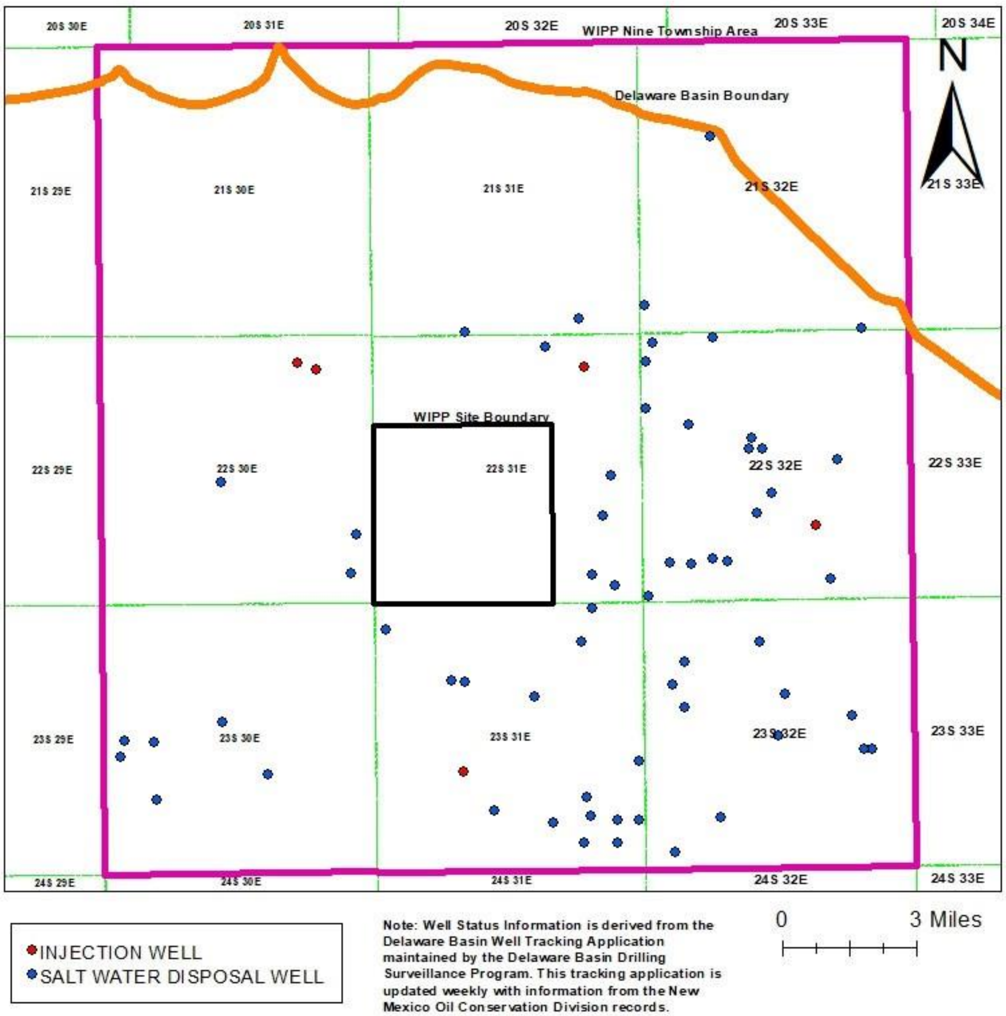

Figure 6. Active Injection and SWD Wells in the Nine-Township Area

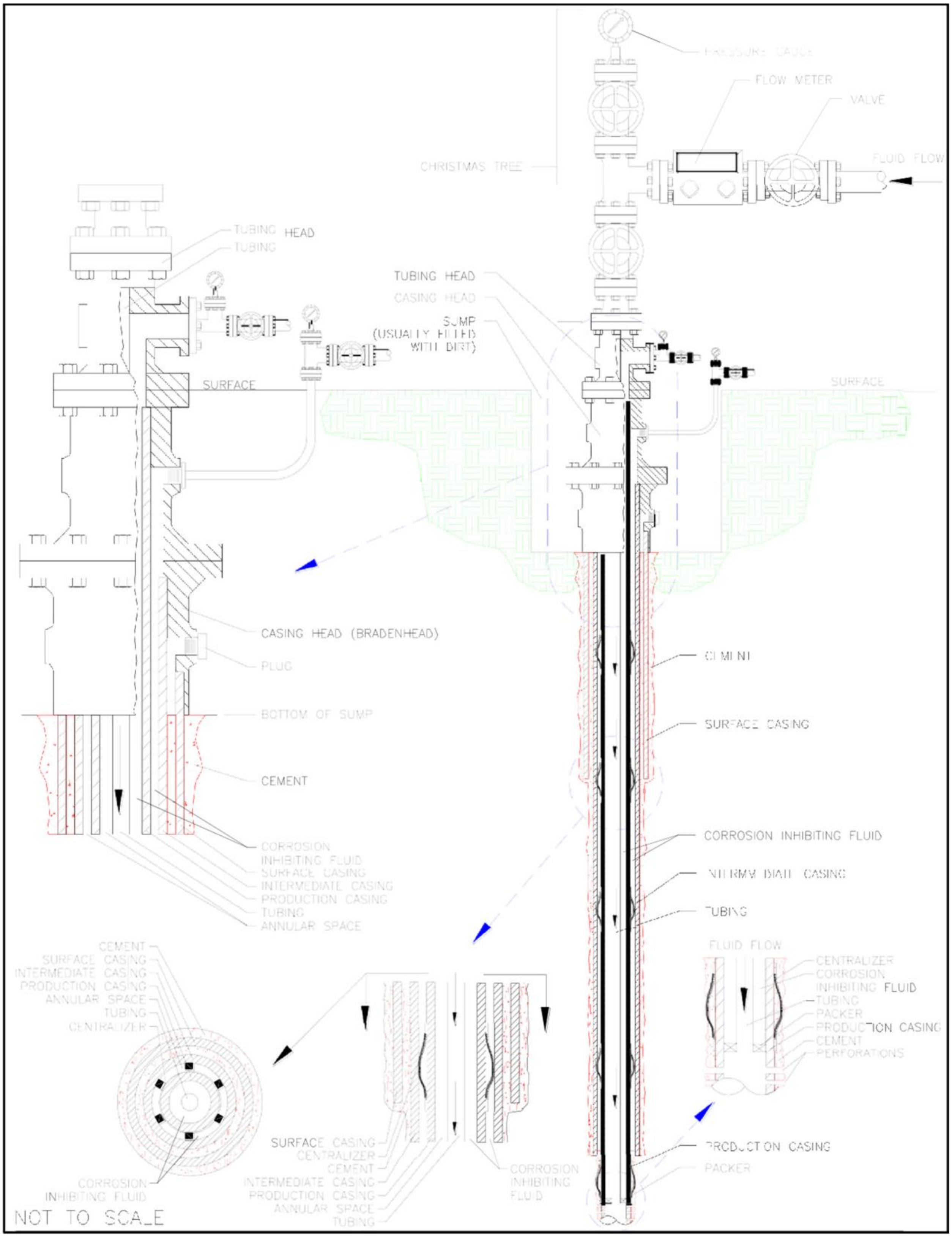

Figure 7. Typical Injection or SWD Well

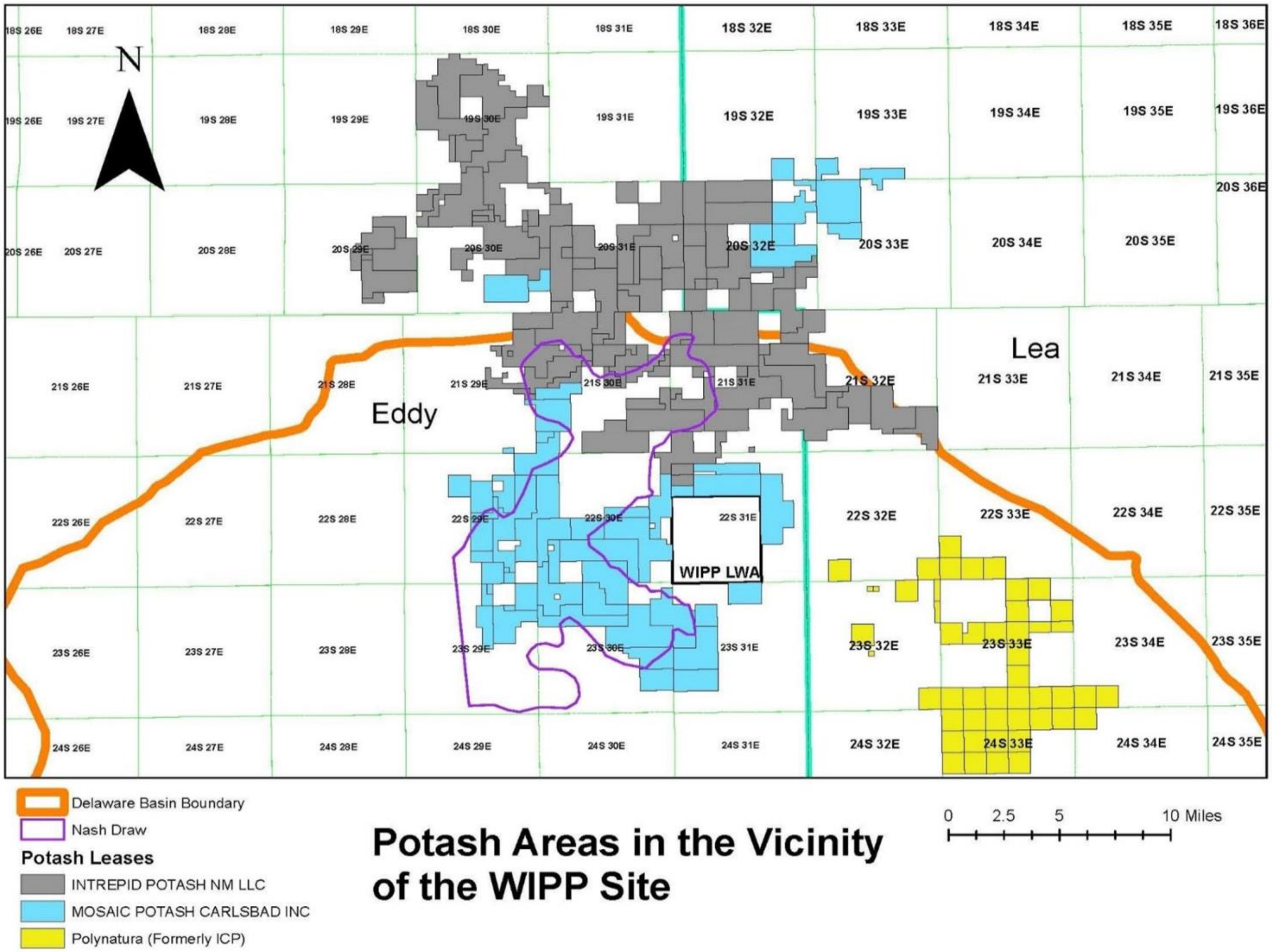

Figure 8. Potash Areas in the Vicinity of the WIPP site

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	28	0	0
11-3/4	0	0	0
10-3/4	1	0	0
9-5/8	0	21	0
8-5/8	0	1	0
7-5/8	0	7	0
7	0	0	0
5-1/2	0	0	29
4-1/2	0	0	0

NOTE: There were 29 wells completed in the nine-township area between September 1, 2022, and August 31, 2023.

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	28	0	0
16	0	0	0
14-3/4	1	0	0
12-3/4	0	0	0
12-1/4	0	21	0
11	0	0	0
10-5/8	0	0	0
9-7/8	0	8	0
8-3/4	0	0	6
8-1/2	0	0	0
7-7/8	0	0	1
7-3/4	0	0	0
7	0	0	0
6-3/4	0	0	22
6-1/8	0	0	0

NOTE: There were 29 wells completed in the nine-township area between September 1, 2022, and August 31, 2023.

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 New Mexico Portion of the Delaware Basin

№	API №[a]	Location[b]	Well Name & №	Spud Date	Status	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
Active Brine Well	4	3	7
Plugged Core Hole	30	2	32
Plugged Dry Hole	374	148	522
Active Gas Well	7	8	15
Active Injection Well	2	0	2
Junked and Abandoned Well	63	0	63
Active Oil Well	103	10	113
Plugged Brine Well	2	2	4
Plugged Gas Well	3	9	12
Plugged Oil Well	28	91	119
Plugged Salt Water Disposal Well	1	7	8
Plugged Stratigraphic Test Hole	0	18	18
Potash Core Hole	0	1,644	1,644
Active Salt Water Disposal Well	1	2	3
Active Service Well	11	0	11
Stratigraphic Test Hole	1,166	1	1,167
Sulfur Core Hole	496	61	557
Water Well	0	151	151
WIPP Well/Borehole	0	209	209
Other (Mine Shafts, Gnome Project Wells)	0	52	52
TOTALS	2,291	2,418	4,709

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	7	1	8
Core Hole	6	0	6
Drilling or Waiting on Paperwork[a]	931	109	1,040
Dry Hole	2,237	804	3,041
Gas Well	3,959	1,722	5,681
Injection Well	408	35	443
Junked and Abandoned Well	56	0	56
Oil Well	12,351	5,832	18,183
Plugged Brine Well	3	1	4
Plugged Gas Well	372	530	902
Plugged Injection Well	95	83	178
Plugged Oil Well	1,328	1,515	2,843
Plugged Salt Water Disposal Well	10	125	135
Plugged Service Well	7	1	8
Plugged Stratigraphic Test Hole	0	5	5
Potash Core Hole	0	274	274
Salt Water Disposal Well	485	241	726
Service Well	58	0	58
Stratigraphic Test Hole	48	7	55
Sulfur Core Hole	91	0	91
Water Well	0	0	0
WIPP Well/Borehole[b]	0	12	12
Other (Mine Shafts, Gnome Project Wells)[b]	0	8	8
TOTALS	22,452	11,305	33,757

a. The 1,040 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.

Table 6. Drilling Rates for the Delaware Basin

Reporting Period* 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	141.6

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

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	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

№	API №[a]	Location[b]	Well Name and Number	Spud Date	Status	Well Information
18	30-025-31800	22S-32E-15	Lechuza Federal #4	12/29/1992	Plugged Oil Well	N/A
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- 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. Plugged Well Summary by Plug Type

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%

Plug Type	Number of Wells											Current Frequency
	Pre-2015 totals	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total	
I	153	1	9	9	6	27	32	19	17	3	276	18.2%
II	121	11	20	41	11	50	75	34	35	1	399	26.4%
III	171	5	9	4	8	32	37	36	10	4	316	20.9%
IV	116	11	7	8	26	17	22	14	8	1	230	15.2%
V	14	0	11	3	0	1	0	0	0	0	29	1.9%
VI	25	13	11	21	3	47	62	41	22	17	262	17.3%
TOTALS	600	41	67	86	54	174	228	144	92	25	1,512	100%

Note: For the sake of simplicity, all years prior to 2015 were rolled into one column on this table. To view those years in detail, please see previous Delaware Basin Monitoring Annual Reports.

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	23,997	1,326	10/27/1992	6/29/2023	0.19	4.7
Eddy, NM	565	203	11/28/1975	6/28/2023	0.25	3.70
Jeff Davis, TX	26	2	9/16/2014	1/19/2023	0.84	2.63
Lea, NM	268	81	6/23/1993	6/19/2023	0.30	3
Loving, TX	409	28	2/4/1976	6/30/2023	0.66	2.9
Pecos, TX	442	13	1/30/1975	6/28/2023	0.70	3.00
Reeves, TX	6,233	825	10/13/2008	6/25/2023	0.41	5.4
Ward, TX	339	0	9/3/1976	2/15/2023	0.08	2.80
Winkler, TX	30	7	9/24/1971	3/29/2022	1.10	3.00
TOTAL	32,309	2,485				

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
5.0 to 5.9	Dislodges heavy objects; cracks walls
6.0 to 6.9	Considerable damage to buildings
7.0 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: A sharp increase in seismic activity in Culberson and Reeves County began in 2018 and continues to increase through the time of this report.

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-31E-33	30-015-29330	SWD	4,166-5,160	1998	June 2023	14,556,786
2	21S-31E-35	30-015-40890	SWD	4,355-6,320	2014	June 2023	4,473,529
3	21S-32E-08	30-025-31412	SWD	4,826-5,978	1991	May 2023	20,252,574
4	21S-32E-31	30-025-31443	SWD	4,618-6,012	1992	July 2023	10,269,439
5	21S-32E-35	30-025-44273	SWD	15,900-17,250	2018	July 2023	14,693,493
6	22S-30E-02	30-015-25758	Injection	7,200-7,264	1993	August 2022	29,015,534
7	22S-30E-02	30-015-26761	Injection	5,600-7,400	1991	August 2022	31,525,259
8	22S-30E-21	30-015-41074	SWD	15,291-16,801	2014	June 2023	30,032,498
9	22S-30E-25	30-015-33439	SWD	5,678-5,930	2010	June 2023	5,566,273
10	22S-30E-36	30-015-45691	SWD	15,610-16,730	2019	April 2023	7,228,092
11	22S-31E-02	30-015-32440	Injection	6,989-7,020	2003	October 2021	3,964,371
12	22S-31E-03	30-015-38254	SWD	5,355-6,137	2012	June 2023	7,520,018
13	22S-31E-24	30-015-26848	SWD	4,519-5,110	1991	June 2023	18,922,508
14	22S-31E-25	30-015-28281	SWD	5,634-5,987	1995	June 2023	16,274,896
15	22S-31E-35	30-015-26629	SWD	4,500-5,670	1991	August 2022	30,325,071
16	22S-31E-36	30-015-26171	SWD	4,500-5,700	1998	July 2022	12,080,313
17	22S-32E-05	30-025-27620	SWD	8,250-8,602	2004	August 2022	12,967,240
18	22S-32E-06	30-025-31227	SWD	4,626-5,730	2012	July 2023	7,124,712
19	22S-32E-06	30-025-43328	SWD	974-4,482	2018	July 2023	16,029,781
20	22S-32E-07	30-025-31076	SWD	4,676-5,814	1991	July 2023	15,289,069
21	22S-32E-14	30-025-08113	SWD	5,750-6,080	1994	June 2023	7,674,045
22	22S-32E-16	30-025-31644	SWD	5,582-6,380	2010	July 2023	3,127,238
23	22S-32E-16	30-025-31889	SWD	5,240-8,710	1995	July 2023	12,530,519
24	22S-32E-16	30-025-36006	SWD	5,850-6,450	2010	October 2021	3,166,992
25	22S-32E-17	30-025-31926	SWD	6,807-6,828	2007	June 2023	3,010,420
26	22S-32E-21	30-025-08109	SWD	4,755-5,110	1994	June 2023	5,069,615
27	22S-32E-27	30-025-32436	Injection	6,831-8,388	1994	June 2023	16,995,119
28	22S-32E-28	30-025-31754	SWD	4,674-5,672	1993	June 2023	8,582,124
29	22S-32E-30	30-025-44106	SWD	3,395-4,528	2017	July 2023	33,778,684
30	22S-32E-31	30-025-20423	SWD	4,734-5,590	1993	June 2023	9,271,886
31	22S-32E-31	30-025-32093	SWD	4,590-5,626	2004	December 2022	1,577,386

№	Location[a]	API №[b]	Type	Injection Zone	First Injection	Last Injection	Cumulative Barrels
32	22S-32E-32	30-025-36004	SWD	6,744-8,518	2010	November 2022	6,950,406
33	22S-32E-32	30-025-36135	SWD	5,850-6,450	2013	June 2023	4,414,083
34	22S-32E-32	30-025-37799	SWD	5,750-6,500	2010	July 2023	6,554,333
35	22S-32E-35	30-025-33149	SWD	4,950-6,252	1995	June 2023	13,361,947
36	23S-30E-16	30-015-20899	SWD	4,433-5,952	2003	June 2023	19,555,297
37	23S-30E-19	30-015-45072	SWD	3,032-3,283	2018	July 2023	24,307,201
38	23S-30E-20	30-015-29549	SWD	4,124-4,774	2006	June 2023	4,296,018
39	23S-30E-22	30-015-33637	SWD	4,510-5,780	2012	June 2023	3,946,680
40	23S-30E-29	30-015-28808	SWD	5,370-6,380	1996	June 2023	8,855,888
41	23S-31E-02	30-015-05840	SWD	4,500-5,700	1997	June 2023	10,943,301
42	23S-31E-06	30-015-46432	SWD	15,610-16,980	2020	June 2023	7,409,518
43	23S-31E-08	30-015-32619	SWD	7,900-7,933	2004	June 2023	6,238,726
44	23S-31E-09	30-015-33368	SWD	7,744-7,952	2005	June 2023	7,487,976
45	23S-31E-15	30-015-43805	SWD	1,180-3,300	2018	July 2023	27,356,439
46	23S-31E-20	30-015-30605	Injection	7,740-7,774	2001	June 2023	15,446,022
47	23S-31E-24	30-015-43806	SWD	16,390-17,500	2018	July 2023	33,242,507
48	23S-31E-25	30-015-28817	SWD	5,776-5,920	2008	January 2023	2,224,234
49	23S-31E-25	30-015-28859	SWD	5,236-5,498	2008	June 2023	1,189,625
50	23S-31E-26	30-015-20277	SWD	4,460-5,134	1992	May 2023	5,971,108
51	23S-31E-27	30-015-27106	SWD	4,750-5,720	1998	June 2023	7,485,894
52	23S-31E-28	30-015-26194	SWD	4,295-5,570	1993	June 2023	10,443,296
53	23S-31E-35	30-015-25640	SWD	4,484-5,780	1993	June 2023	11,930,563
54	23S-31E-36	30-015-20341	SWD	5,980-6,560	1994	June 2023	42,552,480
55	23S-32E-04	30-025-31650	SWD	4,884-5,886	2003	April 2023	6,476,309
56	23S-32E-07	30-025-33398	SWD	4,660-6,270	2009	June 2023	3,800,826
57	23S-32E-14	30-025-26844	SWD	5,496-6,014	1991	June 2023	2,792,199
58	23S-32E-15	30-025-35524	SWD	5,786-5,942	2008	June 2023	1,890,474
59	23S-32E-18	30-025-25017	SWD	16,700-18,000	1975	June 2023	6,236,628
60	23S-32E-21	30-025-45029	SWD	1,210-4,757	2019	July 2023	13,120,717
61	23S-32E-23	30-025-33653	SWD	5,950-6,065	2000	June 2023	3,297,804
62	23S-32E-24	30-025-33521	SWD	5,925-6,042	2001	June 2023	2,545,398
63	23S-32E-29	30-025-31515	SWD	4,844-6,160	1992	June 2023	19,381,433

№	Location[a]	API №[b]	Type	Injection Zone	First Injection	Last Injection	Cumulative Barrels
64	23S-32E-31	30-025-32868	SWD	5,150-5,700	1996	June 2023	6,219,067
65	23S-31E-02	30-015-29792	SWD	4,500-5,850	2000	June 2023	11,108,174
66	23S-31E-26	30-015-45235	SWD	16,513-17,894	2019	July 2023	30,897,366

Table 11. Brine Well Status/Type in 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	Active Brine Well
Eddy	22S-27E-23	30-015-28084	Dunaway #2	Permian Water Solutions, LLC	Active 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.