DIRECT TESTIMONY OF JIM GRISWOLD

My name is Jim Griswold, and I am the Special Projects Manager for the Oil Conservation Division ("OCD"). I previously served for several years as Chief of the OCD's Environmental Bureau and prior to that as a Senior Hydrologist. As Special Projects Manager, I manage the Carlsbad brine well project. My curriculum vitae is attached as Griswold Exhibit 1.

I. BACKGROUND

A brine well is a facility for the solution mining of salt wherein water that is low in dissolved solids is injected into underground salt formations, thereby dissolving the salt to produce brine (i.e., salt-saturated water) which is then extracted. The dissolution of salt results in a subsurface cavern the size of which is dependent upon the amount of brine produced.

The geologic formations in southeast New Mexico which contain oil and gas are situated beneath thick layers of salt deposited as an inland sea receded into what is now the Gulf of Mexico. Drilling fluids need to be pre-saturated with salt when advancing through those overlying layers in order to maintain the integrity of the boring. Due to its high density, brine is also used in workover operations on active wells to mitigate downhole pressures and increase safety. The large volumes of brine needed by the industry lends itself to the development of caverns rather than surface storage or mixing of dry salt with water at well sites. There are forty-two brine wells historically permitted in New Mexico, all in Lea or Eddy counties, thirteen of which are active.

The stability of an underground cavern is a function of its depth and size, and the strength of the rocks which form the cavern roof. In July and November of 2008, two brine caverns in Eddy County catastrophically failed resulting in significant sinkholes at the surface. In both instances, the depth to the salt formation was relatively shallow (<500 feet) and the width of each cavern was broad (>300 feet).

Jim's Water Service (7/2008)

Loco Hills Water Disposal (11/2008)

In response to these collapses, the OCD was tasked with providing a better understanding of the causes, identifying other potentially problematic caverns, and recommending regulatory changes. During this process, the OCD identified the brine well situated beneath a portion of southern Carlsbad as sharing similar characteristics to the two failed brine wells: shallow depth and a significant volume of brine production.

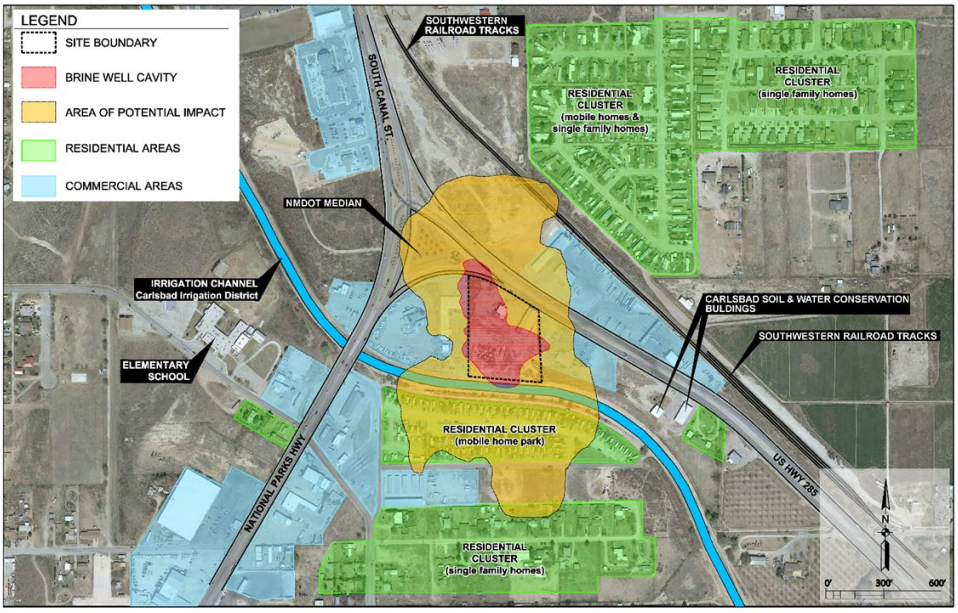
II. THE CARLSBAD BRINE WELL CAVITY

The brine well in southern Carlsbad opened in August of 1978 under the operation of Permian Brine Sales & Service of Odessa, Texas. A single well, Eugenie #1, was used for both water injection and brine production. The depth to top-of-salt is approximately 456 feet beneath surface. Because the well initially experienced low brine production, a second well, Eugenie #2, situated about 325 feet north of Eugenie #1was brought into service in November of 1979. Eugenie #2 was hydraulically fractured to establish fluid communication with Eugenie #1.

New Mexico was granted primacy over the UIC program in 1982, and the OCD issued its first permit to the brine well in December of that year. In July of 1983, B&E, Inc. of Hobbs, which owned the land, took over operations, and Permian Brine Sales became a minority partner. In July of 1995, I&W, Inc. of Artesia purchased and operated the brine well.

From November of 1979 until January of 2000, water from the Carlsbad municipal main was injected into Eugenie #2 and brine produced from Eugenie #1. In January of 2000, after failing a mechanical integrity test, Eugenie #2 was plugged, and I&W began to use Eugenie #1 for both water injection and brine production. In October of 2008, after the Jim's Water Service's brine well collapsed, I&W plugged Eugenie #1. Based upon incomplete historic brine production records, EMNRD calculated that the Carlsbad brine well produced more than six million barrels of brine and removed more than 220,000 cubic yards of salt.

The Carlsbad brine well is situated within an area of substantial development. To the north lies US 285, two commercial operations (one involving underground fuel storage tanks), and a railroad. To the east is situated a church. To the south is the Carlsbad Irrigation District's main canal and a mobile home park. To the west is situated a feedstore and US 62/180. The intersection of US 285 and 62/180 is, according to the New Mexico Department of Transportation, one of the busiest in the state with more than 100,000 vehicles traveling through daily and is the principal route for economic activity in the region. The irrigation canal is the primary source of water for an estimated $100 million of annual agriculture. The railway transports freight, potash, crude oil, and a large percentage of the frac sand used in the state. Groundwater in the area resides at a depth of only 40 feet beneath the surface.



Area Map

After the Loco Hills Water Disposal brine well collapsed in November of 2008, the Cabinet Secretary of the Energy, Minerals, & Natural Resources Department (EMNRD) issued a six-month moratorium on any new brine wells in geologically sensitive areas, and directed the OCD to work with the U.S. Environmental Protection Agency (EPA), other states, technical experts, and the oil and gas industry to examine the causes of the collapses and to develop a report with findings and recommendations. As part of this process, EMNRD requested that I&W cease operations at the brine well and submit a contingency plan, but I&W retained legal counsel and refused. After EMNRD filed a legal action to compel cessation of operations, I&W filed for bankruptcy.

Beginning in 2009, EMNRD took significant efforts to characterize and monitor the Carlsbad brine cavern, including basic conditions (cavern and barometric pressures, groundwater and canal levels, and air and soil temperatures), geophysical conditions (seismic and sonar imaging, resistivity, gravity, and magnetotelluric surveys, and direct coring), and ground movement (borehole tiltmeters, horizontal in-place inclinometers, subsurface microseismic monitors, and interferometric synthetic aperture radar). Monitoring devices are integrated into a

computer-controlled system with preset alarm levels. If an alarm condition is observed, automated notifications are sent to state, county, and city officials and emergency responders. Finally, local agencies prepared a cavern collapse response into their contingent plans, including evacuation, road closure, canal diversion, and utility shutdown.

In 2013, EMNRD initiated a detailed evaluation of alternatives to remedy the Carlsbad brine cavern. After deliberation, in-situ backfilling was considered most feasible, and in April of 2018, the state, through EMNRD, retained AMEC Environment & Infrastructure, Inc. (now Wood Environment & Infrastructure Solutions, Inc. (Wood) to undertake the design/build effort. Additionally, EMNRD negotiated access to six adjacent properties in order to implement the remedy.

In September of 2019, Wood initiated the in-situ backfilling of the Carlsbad brine cavern by drilling wells into the southern portions of the cavern and pressure-injecting grout while simultaneously extracting brine. Two drilling rigs were simultaneously operated for 24 hours per day, 7 days per week. This approach proved to be successful, eliminating the immediate risk to the canal, trailer park, and church. However, as Wood extended the drilling program into the northern portions of the cavern, it discovered a large void. Sonar logging and analysis indicated that the void, which exceeded 98,000 cubic yards and extended beneath US 285, was the result of undetected roof failures during the preceding twenty years or longer. Because injecting grout into such a large void would not be cost-effective, sand was substituted as the backfill material which would still provide the needed structural stability.

After backfilling a portion of the void with more than 100,000 cubic yards of sand, EMNRD determined that a significant amount of injected sand had infiltrated into cracks within the rubble pile at the bottom of the cavern, and that completing the backfill would require at least

an additional 60,000 cubic yards, including a significant portion of the void under the highway. Because this amount of backfilling exceeded the available resources, EMNRD paused the project. The drilling and injection subcontractors were demobilized and the master valves on all wells were secured. The monitoring systems, utility hookups, perimeter fencing, and traffic controls on US 285 remain in place, and Wood continues to routinely inspect the site. If the cavern pressure were to decline substantially, brine would be transported to the site and injected into the cavern.

During August of 2020, EMNRD requested that Wood evaluate the potential risk of the partially filled northern void and propose future actions. Wood advised that the actions completed to date are sufficient to prevent subsurface collapse from propagating to the surface as a large sinkhole, but there could be sufficient subsidence at the surface to damage US 285 and groundwater located above the cavern. EMNRD also established an expert panel that recommended resuming the sand backfilling of the void. The panel estimated the volume of sand needed to complete the project to be 76,500 cubic yards. Wood estimates that this work will cost $25M. EMNRD intends to remobilize to the cavern to resume the backfilling project in the next couple months, with an anticipated completion date in the Spring of 2022. Upon completion, EMNRD expects total expenditures to stabilize the Carlsbad brine cavern to approach $85M.

III. THE SPACING UNIT

On August 6, 2019, SPC filed an application to pool all uncommitted interests in and produce hydrocarbons from the Wolfcamp formation underlying a spacing unit comprised of the W/2 and E/2 of Section 12, Township 22 South, Range 26 East, and the W/2 and E/2 of Section 7, Township 22 South, Range 27 East, NMPM, Eddy County, New Mexico ("Spacing Unit"). Griswold Exhibit 2. On February 12, 2020, OCD issued Order No. R-21096 granting SPC's application. Griswold Exhibit 3. On April 12, 2021, OCD issued Order No. R-21096-A, which

updated the form of order, granted an extension of time to commence drilling until February 12, 2022, pooled additional interest owners, and affirmed the material provisions of the original order. Griswold Exhibit 4. On May 17, 2021, OCD issued Order No. R-21096-B, which pooled additional interest owners and affirmed the material provisions of the original order. Griswold Exhibit 5.

IV. THE CAVEMAN 402H WELL

On November 5, 2020, the Division's district office approved SPC's application to drill a horizontal oil well named "Caveman 7 12 WCXY 2H". Griswold Exhibit 6. On March 12, 2021, the Division approved SPC's sundry renaming the well "Caveman 402H." Griswold Exhibit 7. The surface location and vertical borehole for the Caveman 402H well will be located approximately 7,000 feet from the Cavity. Griswold Exhibit 8. The lateral for the Caveman 402 well will extend westward from the vertical borehole for approximately 10,500 feet at 8,797 feet beneath the surface. *Id.*

On April 14, 2021, I discovered that several horizontal oil wells were planned or had been drilled in proximity to the Cavity. On June 17, 2021, SPC sent a letter to the Division stating its intent to commence drilling the Caveman 402H well in late June or early July 2021 and complete it in late September or early October 2021. Griswold Exhibit 9. On June 30, 2021, the Division requested that SPC temporarily suspend its plan to drill and complete the Caveman 402H well for six months to allow EMNRD to complete the project to stabilize the Cavity. On July 1, 2021, SPC refused to temporarily suspend drilling the Caveman 402H well. On July 2, 2021, the Division's Director issued an emergency order suspending SPC's Application to Drill the Caveman 402H well and prohibiting SPC from taking any action to drill or complete the Caveman 402 well in order to protect the Cavity and the stabilization project and to prevent collateral injury to life,

property, environment, public infrastructure, and neighboring properties. Griswold Exhibit 10. On July 16, 2021, the Division again requested that SPC temporarily suspend its plan to drill and complete the Caveman 402H well for six months to allow EMNRD to complete the project to stabilize the Cavity, and SPC again refused the request. On July 17, 2021, the emergency order expired by operation of law.

V. THE CAVEMAN 7 12 WCD #003H WELL

On November 17, 2020, the Division's district office in Artesia approved SPC's application to drill the Caveman 7 12 WCD #003H well (API 30-015-47689) on the Spacing Unit. Griswold Exhibit 11. The surface hole location and vertical borehole for the Caveman 7 12 WCD #003H well will be located approximately 6,800 feet from the Cavity. Griswold Exhibit 8. The lateral for the Caveman 7 12 WCD #003H well will extend westward from the vertical borehole for approximately 11,000 feet at a depth of 9,300 feet beneath the surface. *Id.* On August 6, 2021, the Division requested that SPC temporarily suspend its plan to drill and complete the Caveman 7 12 WCD #003H well for twelve (12) months to allow EMNRD to complete the project to stabilize the Cavity. On August 9, 2021, SPC refused to temporarily suspend drilling the Caveman 7 12 WCD #003H well.