Injection well safety — what happens if system failure occurs?

The Underground Injection Control (UIC) Class I injection regulatory and well design requirements include multiple safeguards to keep any injection fluid contained within a well in the event of a system failure, preventing the potential for migration into any below ground formation other than the desired injection zone located approximately 6,270 feet below ground surface. The entire purpose of a Class I well is to permanently and entirely remove salts, and other low concentration contaminants from the biosphere. The New Mexico Environment Department (NMED) and United States Environmental Protection Agency (US EPA) require we collect real data to verify that the siting and well construction are fit-for-purpose before they take any actions to possibly approve injection – hence the need for the test well data. Rare well failures are detected by the extensive continuous and periodic monitoring required and are addressed by making repairs to equipment long before fluids can impact any underground sources of drinking water.

Consideration of environmental and PFAS risks in project planning.

The environmental risks related to disposing of PFAS were considered during the Water Treatment Plant Alternatives Analysis. UIC Class I Injection wells are 1 of 3 approved methods for destruction and disposal of PFAS substances, per the USEPA. EPA's Interim Guidance on the Destruction and Disposal of PFAs

Food and livestock safety concerns surrounding PFAS.

Unlike other options, Class I wells actually remove PFAS from our biosphere and prevent the potential for exposure to the surface and useable groundwater.

Consideration of aquifers below the Ogallala.

As part of the permitting process for the UIC Class I injection well, site specific data must be collected showing that all Underground Sources of Drinking Water (USDW) cannot be impacted by the injection process. Multiple barriers are required for the design and construction of the injection well to prevent potential contamination of any USDW.

Capped early-1900s wells as potential PFAS migration pathways.

Based on State records, there is only one existing well in the 2.5-mile Area of Review (AOR). It was drilled to a depth similar to the proposed injection well. This well (Garrett No. 1) was evaluated as part of the permitting process. The Garrett No. 1 well (09-60003) was drilled to the Precambrian basement in October 1962 to a total depth of 7,537 feet. It provides helpful, but preliminary data to characterize the suitability of the local geology for the proposed injection wells. Well construction information for the Garrett No. 1 well was provided in the permit application. This well is located approximately 1.7 miles distant from the proposed IW-1 injection well. Based on well plugging records, there are four cement plugs installed below the

9⅝ inch casing shoe at a depth of 2,660 ft below ground level, as well as drilling mud remaining in the hole isolating the borehole between the cement plugs to prevent potential vertical migration of fluids to any overlying USDWs. The other two historical Oil & Gas wells present within the AOR are more distant and did not penetrate the confining zone, so they are not possible migration pathways. Existing and historical water wells in the area are far too shallow (typically too shallow by more than 5,700 feet to serve as potential migration pathways).

Contingency planning if PFAS migration occurs.

The UIC Class I injection well is designed with measures to contain injectate fluid with the injection well casing. In addition to multiple layers of steel pipe and cement, the annulus between the casing and the injection tubing is filled with pressurized water so that if the interior tubing ever leaks, this fresh water flow into the tubing and be carried down the tubing into the deep injection formation, and the injection brine will never even contact the first casing string. Furthermore, this pressurized annulus is continuously monitored so that the well will be immediately shut down if any concern is identified. Many operating conditions of each injection well will be continuously monitored and will alert the water treatment operations staff of any potential failures. Regardless, the injectate fluid will be contained in the well preventing any contamination of groundwater. There are many potential sources of PFAS contamination in groundwater aquifers, including by not limited to; firefighting foams, pesticides, herbicides, and several other "man-made" chemicals that get applied to the ground for various applications. Often, injection wells are being used to help clean-up water recovered from the surface or shallow groundwater.

Accident risk despite engineered safeguards.

Class I technology is by regulatory requirement a multi-barrier system that has many more engineered and geological safeguards than any alternative technology. It is also intended to reduce handling (which reduces risks), and the design isolates the brine from any endangering pathways in a form (low concentration brine as compared to a chemically altered and concentrated alternatives) and in a location (in a deep geologic repository that has isolated brines over millions of years as compared to less permanent surface impoundments) that provide more separation of the constituents of concern from the resources that are being protected. Although no technology can be honestly characterized as having no risk, Class I wells installed and operated to current standards have an exemplary record and are the lowest risk option for aqueous brine waste disposal.

Anticipated amounts of PFAS in waste brine.

The low levels of PFAS present in the source water at Ute Reservoir are currently below US EPA drinking water standards, therefore, the proposed ENMWUA Water Treatment Plant is not required to remove PFAS from the drinking water. However, the reverse osmosis treatment process proposed for removing Total Organic Carbon (TOC) and Total Dissolved Solids (TDS) consequently also removes PFAS from the source water, concentrating these constituents in an aqueous brine waste. The concentrations of PFAS present in this waste stream will be dependent

on the treatment process performance which could range between 10 and 17 times (29 to 55 nanograms per liter for PFOA) the concentration of PFAS in the source water.

For context, if the full allocation of water annually was treated and all of the PFOA present in the source water was removed through the treatment process, this would approximately equate to the mass of 2 - AA batteries per year.

Current PFAS levels in Ute Reservoir.

Based on the latest water quality testing the levels of PFOS and PFOA were 2.1 and 3.0 ng/L, respectively. These levels are below the current drinking water regulations maximum contaminant level of 4.0 ng/L.

Monitoring protocols and Jacobs' oversight responsibilities.

The injection wells will be equipped with online instrumentation to continuously monitor the injection wells. This information will be communicated back to the main control station at the water treatment plant, where an automated system will take pre-programmed actions such as precautionary well shut-in when appropriate and operators will be warned of any potential concerns. The continuous monitoring data are also used for automated command and control of operations, are used for regulatory reporting to ensure safe operation that complies with the rules, and are archived over the entire history of operations as a record of the site activity. In the experience and opinion of the injection well experts retained for this project, Class I continuous operating data exceeds most other environmental program monitoring requirements and is by far the most comprehensive monitoring of any disposal methods that are used for the management of saline brine and aqueous PFAS/PFOS water. Also note that ENMWUA will be responsible for oversight responsibilities, not Jacobs.

Protection of irrigation wells within the potential migration zone.

The UIC Class I injection well will not have an impact on existing irrigation wells. The entire purpose of Class I injection and the associated regulatory standards require that technical data be collected and analyzed for the specific site showing why and how the irrigation aquifers are protected from injection activity. There is already very poor-quality brine (worse than anything proposed for injection) in the proposed injection zone that is naturally isolated from the irrigation wells and aquifers. This isolation has existed naturally over geologic time. Injection is being proposed for 5,720 feet below the base of the geologic formation used as the source of irrigation well water.

Whether the permit is truly for a "test hole" or a planned injection well.

The current permit application is for a UIC Class I injection well. The permit is for a well built to Class I standards that will initially only be allowed to be used as a test well to collect data. Only if all the data collected proves to be sufficient can additional regulatory actions be taken to authorize the well to be used for injection. The regulators prefer open-ness and

transparency regarding the possible future use of the well, if standards can be met and the safety proven with data. Furthermore, it is the financially prudent way to proceed, rather than expending the majority of the budget on a well that cannot be used as an asset if data collection proves the concept. After test-well data is analyzed, decisions about the safety and viability of injection well technology use at the site can be finalized. If appropriate, further design and permitting would then be undertaken for additional wells that might be necessary to manage the required fluid volumes from the project.

Reason for applying for one well instead of four.

The current permit application includes one injection well that will initially be used as a test well to collect site specific data and that would need additional regulatory action from the regulators (other than just the initial permit approval) to authorize injection. There is limited available data on the subsurface geology in the proposed injection well location. The initial well will be used to gain additional information regarding the subsurface geology and potential injection rates. This information will help determine how many more injection wells will be required to properly dispose of the reverse osmosis concentrate. Until the test data is obtained, the injection well experts consulted for the project indicated that it was their professional opinion and recommendation that it was not appropriate to design or request additional wells until sufficient data is acquired to further evaluate the safety and potential. This is a technical, data driven process that requires site specific data for accurate project designs and regulatory submittals to justify injection authorization.

No Migration Petition — ENMWUA's willingness to exceed current standards prior to injection.

Preparation of a 10,000-year no-migration demonstration resulting in approval of an exemption petition is only required to allow a well to inject waste characterized as hazardous under the Resource Conservation and Recovery Act (RCRA) and banned from land disposal under the Hazardous and Solid Waste Amendments of 1984 (HSWA), unless such a petition is approved by US EPA. Since no RCRA regulated and banned hazardous waste is proposed for injection, no exemption is required for the proposed wells(s). Typically, data obtained from drilling, testing and completing an injection well are used as input for such documents when they are prepared. Although the characterization of the site to date has not found any data that would preclude the site from being able to satisfy technical petition standards, until a well is in place and until future determinations are made with regard to regulatory brine characterization and disposal limitations, it is premature to consider preparation of any petition related containment demonstration.

Feasibility of removing PFAS prior to injection of waste brine.

There are treatment options for removing PFAS prior to the reverse osmosis process, however, per drinking water regulations and the current PFAS concentrations in the Ute Reservoir, the treatment process is not required to remove any amount of PFAS. Therefore, treating for PFAS ahead of the reverse osmosis process would create an unnecessary cost increase to the

ENMWUA rate payers. It is also likely that the residuals from this pre-treatment process could require injection wells for waste management. At this time, the concentration levels of the PFAS related constituents that have been assessed meet drinking water standards and there is not a projected regulatory requirement to treat the water for that purpose. The primary purpose of the proposed reverse osmosis treatment process is for removing TOC and TDS from the water, removal of PFAS through this process is a side benefit.

Evaluation of alternative disposal methods (e.g., evaporation ponds).

There are other options for disposal of the reverse osmosis concentrate, however, UIC injection wells were determined to be the preferred method during the Water Treatment Plant Alternatives Analysis based on non-cost and cost factors. Solar evaporation ponds were evaluated as an alternative in the Water Treatment Plant Alternatives Analysis in the event the injection well was not viable after additional investigation and testing.

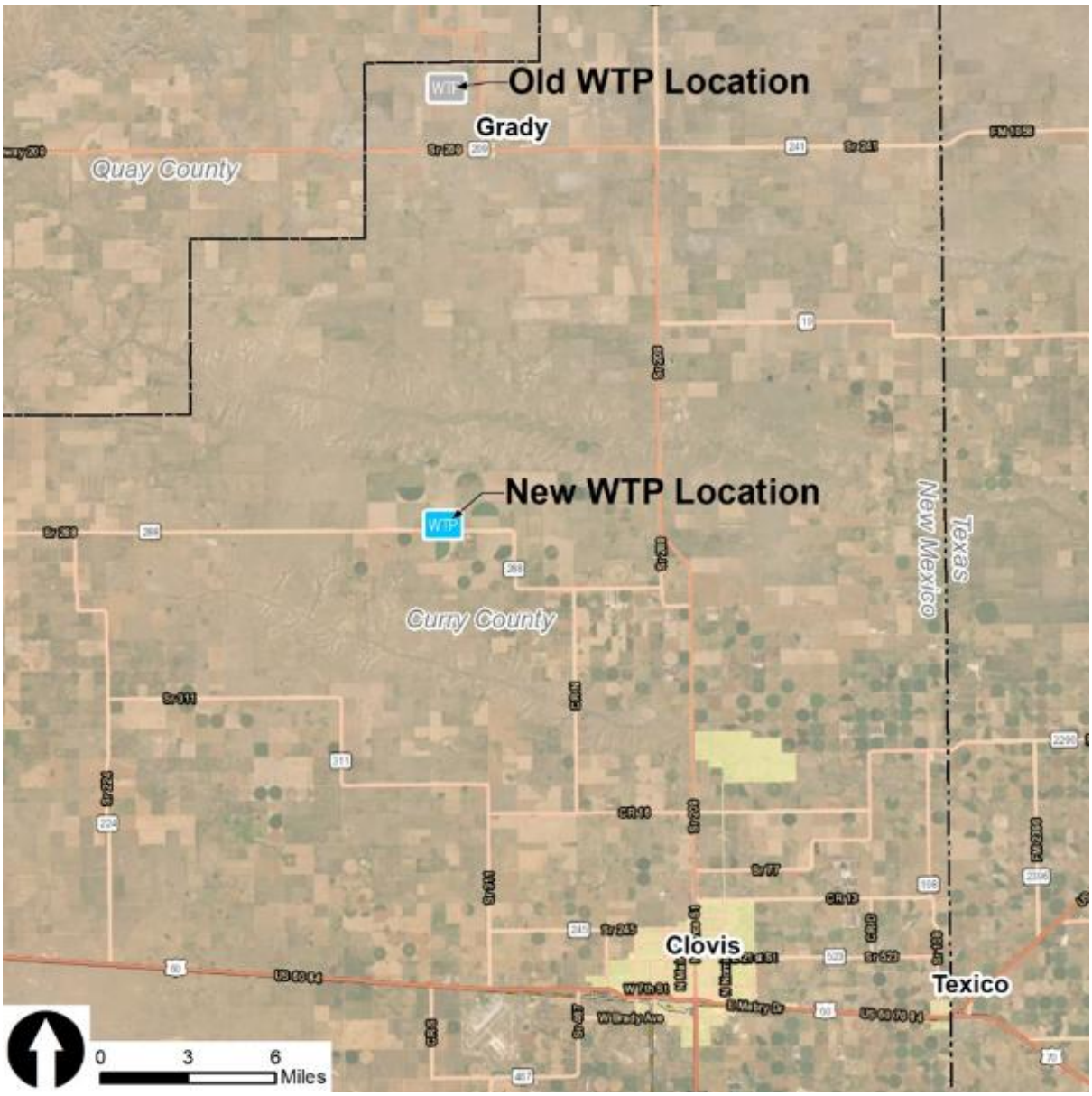
Site selection — alternative locations for injection wells or treatment facility placement closer to source or closer to the customer.

Several alternative sites for the water treatment facility have been evaluated over the years, and the current site location provides the greatest non-monetary and monetary benefits to the project, such as, operations, hydraulics, water age, and water quality.

ENMRWS Water Treatment Plant Location History

- *In 2006, a Preliminary Engineering Report (PER) was developed to address the water shortage issues. A formal decision support process was used to evaluate alternatives for a future water supply for ENMWUA members, including the following 6 alternatives:*
  - *Alternatives involving surface water from Ute Reservoir*
    - *Regional Water Treatment Plant (WTP) in Quay County*
    - *Regional WTP in Curry County*
    - *Aquifer Storage and Recovery (ASR) with Regional WTP in Curry County*
    - *Surface Impoundment with Regional WTP in Curry County*
  - *Alternatives involving groundwater*
    - *Brackish Groundwater in Curry County*
    - *Local "No Project" Alternative – communities would continue drilling wells to increase supply, current approach for communities until ENMRWS is online.*

- *In the 2006 PER, the Best Technical Alternative was determined to be the Regional WTP in Curry County (noted as Old WTP Location on the figure) based on cost and non-cost factors. The PER was reviewed by USBR Technical Services Center and the NMED - Construction Programs Bureau.*
- *In 2009, during Schematic Design, the WTP was sited on County Road 41 (CR 41) located in Curry County, New Mexico, approximately 2.3 miles north northwest of Grady, 1 mile west of New Mexico State Highway 469, and 2 miles north of New Mexico State Highway 209. The 2009 Schematic Design was reviewed by the USBR Technical Services Center and they provided a Design, Estimating, and Construction (DEC) Review Report December 2009. The conclusion of the DEC Review Report stated "The Team did not find any fatal technical flaws".*
- *In 2011, a Value Engineering (VE) evaluation was performed for the ENMRWS project in coordination with the USBR and ENMWUA. The VE evaluation identified cost savings and operational benefits that could be achieved by relocating the WTP site farther south in Curry County. Relocating the WTP eliminates the need for finished water pumping at the WTP and saves capital and annual operations and maintenance costs.*
- *The current WTP (noted as New WTP Location on the figure) site is located in Curry County, New Mexico, approximately 18.5 miles north northwest of Clovis on State Road 288 (SR 288) and 2.5 miles west of County Road P. The figure below shows an aerial map of the old and new WTP locations.*


Old WTP Location
WTP
Grady
Quay County
New WTP Location
WTP
Curry County
New Mexico
Texas
Clovis
Texico
0
3
6
Miles

Line flushing procedures — disposal of contaminated water during repairs.

There will not be contaminated water in the pipelines that are used to transport raw water from the reservoir to the treatment and distribution facility, the water will be either raw water from the reservoir or finished water following the treatment plant. The raw water from Ute Reservoir is not contaminated and meets safe drinking standards with regards to PFAS.