SUPPLEMENTAL MATERIALS REPORT

PREPARED IN RESPONSE TO REQUEST FOR FRACTURE PRESSURE DETERMINATION

Pinon Midstream, LLC (OGRID #330718)
NMOCD Case #24755

On behalf of Pinon Midstream, LLC (Piñon), we (Geolex, Inc.) have prepared and hereby submit the following additional supporting materials in response to an additional New Mexico Oil Conservation Division (NMOCD) request following the September 12, 2024, NMOCD hearing to consider the matter of Case #24755. Specifically, NMOCD personnel have requested additional information and analysis to empirically estimate the formation fracture pressure conditions for the Siluro-Devonian geologic depth interval, as well-testing activities (i.e., step-rate injection testing) exhibited strong correlations in rate and pressure relationships and did not clearly identify a formation breakdown pressure, despite reaching a maximum injection rate of approximately 13,762 barrels per day (bpd) and a maximum surface injection pressure of 5,612 psig. Request for these analyses is made to confirm the capability of the approved Siluro-Devonian injection reservoir to accommodate increased injection rates without producing injection-induced fractures or formation breakdown.

INTRODUCTION

In providing the results of this additional empirical determination, we confirm and demonstrate that Piñon's request to increase the maximum daily injection volume, shared between the Independence AGI #1 (API: 30-025-48081) and Independence AGI #2 (API: 30-025-49974), to up to 28.5 million standard cubic feet per day (MMSCFD) can be approved without any risk that injection at these rates would result in the fracturing or physical breakdown of the injection reservoir. This is supported by the results of step-rate injection testing (SRT) and the empirically derived fracture pressure characteristics.

Based on the results of our empirical analysis, we determine the average fracture pressure gradient of the Siluro-Devonian injection reservoir to be approximately 0.68 psi/ft, with only minor variation exhibited when fracture gradient curves are plotted stratigraphically. When the empirical fracture gradient curve is compared to the results of step-rate injection testing, which achieved a maximum injection rate of 13,762 bpd and observed bottom-hole pressure gradients of approximately 0.54 psi/ft, it is apparent that step-rate injection testing fell significantly short of reaching the predicted pressures necessary to induce fractures within the formation.

While disposal volumes up to 13,762 bpd were demonstrated during the initial SRT, it is important to note that the actual injection volume increase requested by Piñon (i.e., 28.5 MMSCFD) equates to a daily injection volume substantially lower than those achieved in well-testing operations. Specifically, the total injection volume requested by Piñon is equivalent to approximately 10,875 bpd at reservoir conditions. Furthermore, two AGI wells are operated at the Piñon Dark Horse Treating Facility, and thus, the total disposal volume is routinely partitioned between the two wells under normal operating conditions. As such, it would be extremely uncommon for only one well at the Dark Horse Treating Facility to be in operation, and even under those circumstances, injection would occur at only 79% of the maximum disposal volume demonstrated by the SRT, which did not appear to exceed conditions likely to initiate fracturing of the reservoir.

In the following sections, we describe the results of step-rate injection testing, including the maximum injection rates and pressure achieved and the down-hole pressures and pressure gradient applied to the Siluro-Devonian strata during testing, which serves as the basis for comparison to empirical fracture pressure estimations. Additionally, we describe our results and methodology in determining the Siluro-

Devonian fracture pressure characteristics, utilizing appropriate analytical methods and incorporating local site-specific geophysical log data (i.e., data collected while drilling the Independence AGI wells).

SUMMARY OF STEP-RATE INJECTION TEST OPERATIONS AND RESULTS

Upon the completion of drilling-phase activities for Independence AGI #1, step-rate injection testing was performed to evaluate and confirm the Siluro-Devonian injection reservoir's ability to accommodate acid gas disposal, as proposed by Piñon and within the operational limitations required by NMOCC Order R-21455. The well testing procedure consisted of eleven (11) injection steps ranging from approximately 0.9 barrel per minute (bpm) to 9.5 bpm. The maximum surface injection pressure achieved was approximately 5,612 psig at a rate of 9.5 bpm (or 13,762 bpd), which corresponds with a bottom-hole pressure of approximately 9,437 psig.

Results of step-rate injection testing are summarized in Figure 1 and Table 1 below.

Table 1. Summary of injection test results (Independence AGI #1)

Step #	Injection Rate (bpd)	Surface Pressure (psig)	Bottomhole pressure (psig)	Pressure Gradient (psi/ft.)
1	0.93	307	7873	0.448
2	1.42	391	7953	0.453
3	2.03	633	8064	0.459
4	2.97	1104	8252	0.470
5	3.90	1412	8414	0.479
6	5.00	2039	8616	0.491
7	6.07	2810	8838	0.503
8	7.06	3795	9060	0.516
9	8.03	4311	9210	0.525
10	8.90	5132	9331	0.531
11	9.55	5635	9437	0.538

As shown in Figure 1, the step-rate injection test was completed, up to a maximum injection rate of approximately 9.5 bpm (or 13,762 bpd) and under bottom-hole pressures conditions up to 9,437 psig, with no indication of formation breakdown. This defines the upper limit of injection without fracture, as demonstrated by Independence AGI well testing activities.

As shown in these results, step-rate injection testing activities at the maximum injection pressure achieved a pressure gradient of approximately 0.54 psi/ft. across the approved injection interval. While these observations clearly demonstrate that injection rates up to 13,762 bpd can be achieved and maintained, without breakdown, they are also critical points of comparison to empirically derived fracture gradient curves to understand what range of additional pressure is required to induce fracturing. In the next section, we present the results of our empirically derived fracture pressure curve and its relationship to injection test conditions.

EMPIRICAL DETERMINATION OF SILURO-DEVONIAN FRACTURE GRADIENT

As step-rate injection testing activities failed to identify the fracture pressure of the Siluro-Devonian reservoir, it is important to utilize available well data and alternative determination methods to estimate fracture gradients when considering Piñon's request for additional injection volume capacity, to understand how much additional pressure would be required to induce fracturing, or more simply, how close did prior SRT activities come to reaching fracture pressure.

In generating an empirically derived characterization of fracture pressure conditions for the Independence AGI wells, we utilize methods presented in Eaton, 1969 (*Eaton, B.A., 1969. Fracture gradient prediction and its application in oilfield operations*), which are commonly utilized to investigate fracture pressure conditions. From these methods, estimates of fracture pressure conditions with depth can be made utilizing known or assumed conditions of overburden pressure, pore pressure, and Poisson's ratio utilizing the relationship shown below:

$$Fracture\ Gradient = (OBG - PPG)\ x\ \left(\frac{v}{1-v}\right) + PPG$$

Where:

OBG = Overburden Stress Gradient (assumed as 1.05 psi/ft.)
PPG = Pore Pressure Gradient (assumed as 0.45 psi/ft.)
v = Poisson's Ratio (determined from collected AGI data)

This method is not restricted to shale-dominated sections, as is required in other alternative methods, and instead utilizes Poisson's Ratio to model required stress to initiate formation fracture. For the Independence AGI wells, this (i.e., Poisson's Ratio) can be directly calculated as data collection activities included the recording of compressional and shear velocity logs. In characterizing Poisson's Ratio (v), the following relationship was utilized leveraging site-specific geophysical log data:

$$v = [\left(\frac{v_p}{v_s}\right)^2 - 2]/(2 * [\left(\frac{v_p}{v_s}\right)^2 - 1]$$

Where:

v_p = Compressional velocity (1,000,000/DTC)
DTC = Compressional sonic log
v_s = Shear velocity (1,000,000/DTS)
DTS = Shear sonic log

By utilizing this method, the desired empirically derived fracture gradient curve product can be generated from location-specific geophysical data, which provides a more accurate characterization of fracture pressure conditions.

Figure 2 illustrates the resultant fracture gradient curve concurrently with additional geophysical log data collected at the Independence AGI #1 well, including gamma, neutron porosity, bulk density, and sonic data characterizing the approved Siluro-Devonian injection zone.

As is shown in these results, the empirically derived average fracture pressure gradient ranges from approximately 0.66 psi/ft. to 0.69 psi/ft. (Average = 0.68 psi/ft.) with only minor variability observed and generally relating to the transition from limestone-dominated intervals within the Devonian and Wristen formations, to the dolomitic-limestone dominated intervals within the Fusselman Formation. Through comparison of these results to other independent assessments of Siluro-Devonian fracture conditions, which have been previously reviewed and accepted by NMOCD technical personnel, the results of this analysis are in full agreement.

COMPARISON OF RESERVOIR TESTING OPERATIONS AND THE EMPIRICAL FRACTURE GRADIENT DETERMINATIONS

As previously described, injection reservoir testing activities clearly demonstrate that under pressure conditions up to 0.54 psi/ft., and at a maximum injection rate of 13,762 bpd, fracturing of the Siluro-Devonian reservoir, at any depth, does not occur. As Piñon's request to increase the allowable daily injection volume to 28.5 MMSCFD (i.e., 10,875 bpd) is well within the limits of this demonstrated volume, no risk for fracturing of the disposal interval is anticipated at these maximum rates.

The determination that the proposed 28.5 MMSCFD daily injection volume is a reasonable and approvable request is further supported by independent empirical determinations of the Siluro-Devonian fracture gradient, which show an approximate average fracture pressure gradient of 0.68 psi/ft. and ranges within Siluro-Devonian strata from approximately 0.66 to 0.69 psi/ft. These results indicate that the SRT-demonstrated injection rate (i.e., 13,762 bpd), produced significantly lower pressure conditions than would be necessary to induce fracturing within the formation. Specifically, at the requested rate of 28.5 MMSCFD (10,875 bpd), corresponding step rate injection test data indicate a resultant pressure gradient of approximately 0.54 psi/ft, approximately 79% of the fracture pressure gradient predicted by our empirical determination, a more than adequate safety factor for approval of Piñon's request.

SUMMARY AND PIÑON'S REQUEST OF THE NMOCD

In response to the NMOCD's request, we have provided an empirical fracture pressure gradient determination appropriate for assessing the approved Siluro-Devonian injection reservoir utilized by the Independence AGI wells at Piñon's Dark Horse Treating Facility. The results of this assessment are in full agreement with other analogue evaluations characterizing the Siluro-Devonian injection reservoir, which have been presented, evaluated, and accepted by NMOCD technical staff. As the results of these evaluations, injection at the proposed rate up to 28.5 MMSCFD can be accommodated without risk of induced fracturing. As such, Piñon requests approval of the proposed increase, as described in the previously submitted C-108 amendment application.

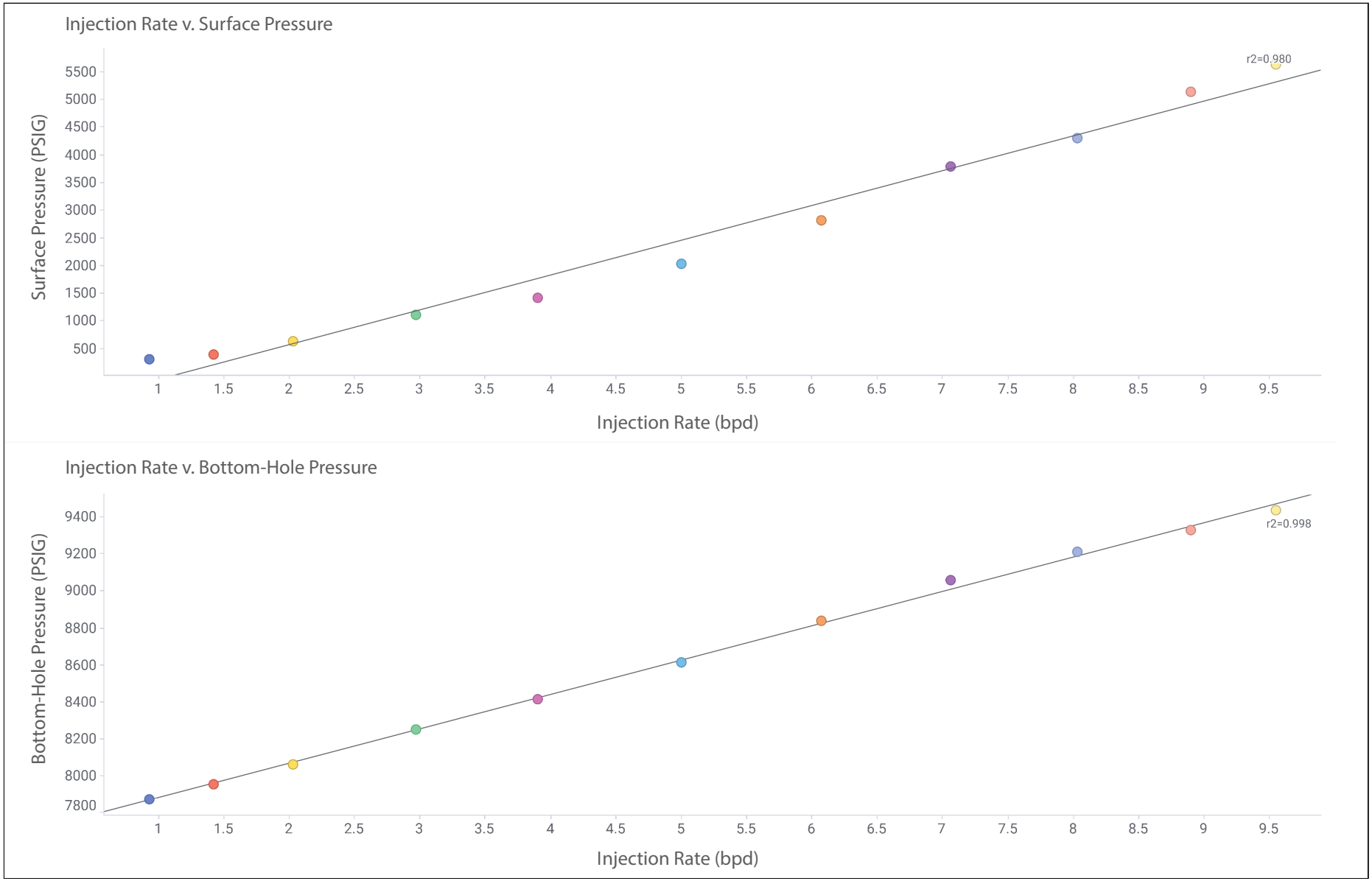

Figure 1. Summary of Independence AGI #1injection test results illustrating the relationship between injection rate and pressure

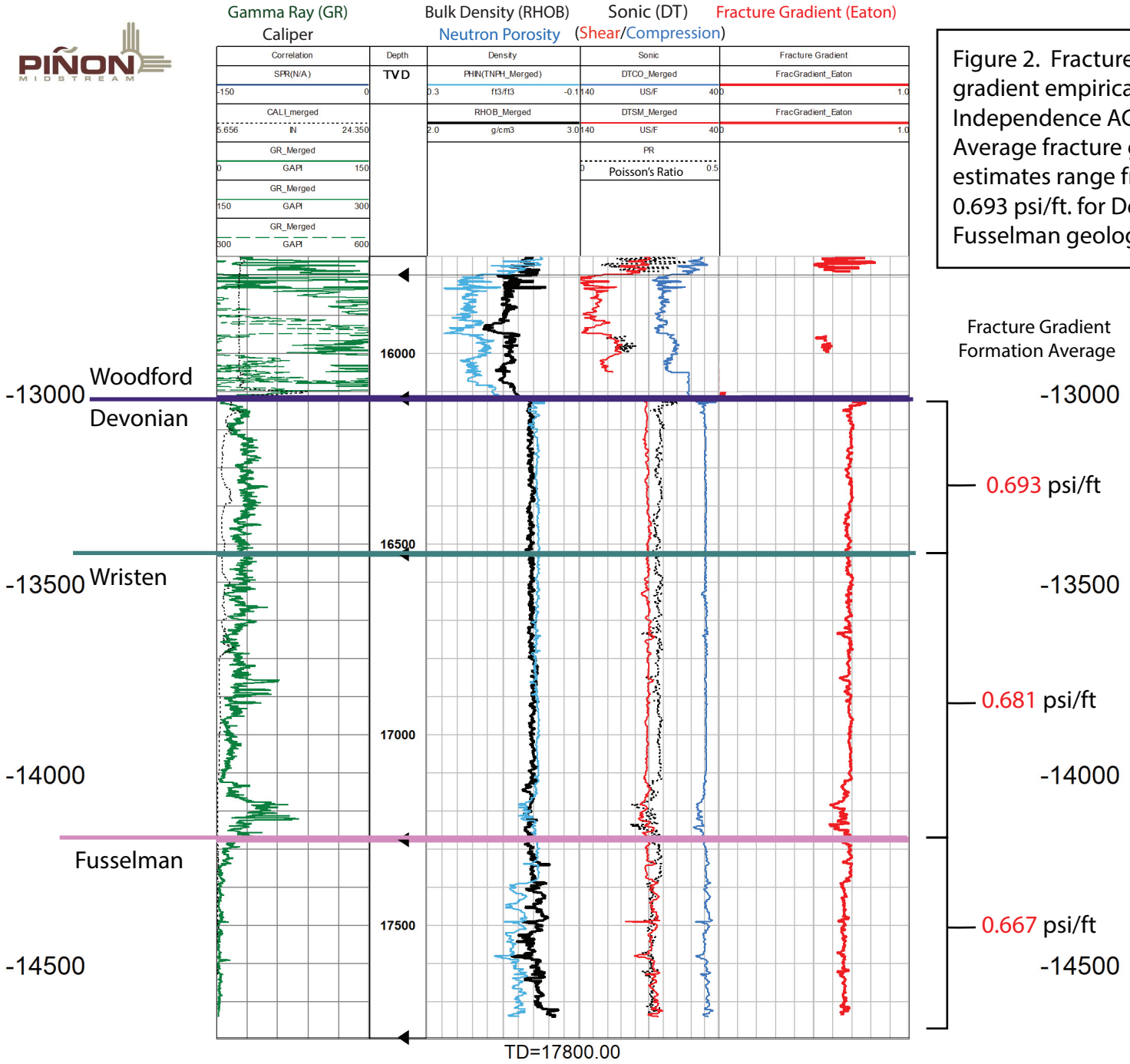

Figure 2. Fracture pressure gradient empirically derved for Independence AGI #1 (red trace). Average fracture gradient estimates range from 0.667 to 0.693 psi/ft. for Devonian through Fusselman geologic strata.