

**STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
SUPERVISOR OF WELLS**

IN THE MATTER OF

THE PETITION OF RIVERSIDE ENERGY)
MICHIGAN, LLC FOR AN ORDER FROM THE)
SUPERVISOR OF WELLS APPROVING AN)
ENHANCED GAS RECOVERY OPERATION BY)
INJECTION OF CARBON DIOXIDE, AND SUCH) ORDER NO. 08-2022
OTHER APPROPRIATE SUBSTANCES AS MAY BE)
APPROVED, INTO THE ANTRIM FORMATION)
WITHIN THE CUSTER 35 UNIFORM SPACING)
PLAN, IN PARTS OF CUSTER TOWNSHIP,)
ANTRIM COUNTY, AND RAPID RIVER TOWNSHIP,)
KALKASKA COUNTY, MICHIGAN.)

OPINION AND ORDER

This case involves the Petition of Riverside Energy Michigan, LLC (Petitioner) requesting the approval of a secondary or enhanced recovery operation by injection of carbon dioxide (CO₂) in the Custer 35 Uniform Spacing Plan (USP) in order to maximize the recovery of gas pursuant to Section 61506(i) Part 615, Supervisor of Wells, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended (NREPA), and R 324.612 of the rules promulgated pursuant to Part 615. The USP consists of approximately 2,160 acres and is described as:

Township 29 North, Range 7 West, Custer Township, Antrim County

Section 25: S/2, S/2 NE/4, W/2 NW/4

Section 26: All except S/2 SW/4

Section 35: All

Section 36: W/2, W/2 NE/4

Township 28 North, Range 7 West, Rapid River Township, Kalkaska County

Section 2: N/2, NE/4

JURISDICTION

The development of oil and gas in this state is regulated under Part 615, Supervisor of Wells, of the NREPA, MCL 324.61501, *et seq.* The purpose of Part 615 is to ensure the orderly development and production of the oil and gas resources of this state, with a view to the ultimate recovery of the maximum production of these natural resources. MCL 324.61502. To the end of maximizing recovery, the Supervisor of Wells (Supervisor) regulates recovery methods of oil and gas, including the introduction of substances into producing formations, for purposes of enhancing production. MCL 324.61506(i). A person proposing secondary recovery by injection of water, gas, or other fluid into a producing formation must file a petition for public evidentiary hearing. 1996 AACRS, R 324.612. Evidentiary hearings in these matters are governed by the applicable provisions of the Administrative Procedures Act, 1969 PA 306, as amended, MCL 24.201, *et seq.* See 1996 AACRS, R 324.1203. The evidentiary hearing in this matter was scheduled for November 29, 2022.

FINDINGS OF FACT

The Petitioner specifically requests that the Supervisor issue an Order allowing the Petitioner to inject CO₂ and other approved substances into the Antrim Formation, more specifically identified as all formations lying between the top of the Lachine and the base of the Norwood, for purposes of secondary and enhanced gas recovery.

The Supervisor determined that the Notice of Hearing was properly served and published. No answers were timely received. The Supervisor designated the hearing to be an uncontested evidentiary hearing pursuant to R 324.1205(1)(b) and directed evidence be presented in the form of verified statements pursuant to R 324.1205(2).

In support of its case, the Petitioner offered the testimony by verified statement of the following witness: Mr. Phillip Koro, Engineering and Oilfield consultant for the petitioner.

I. Unit Area

The spacing of wells targeting the Antrim Formation is governed by Order No. 14-9-94, as amended. This Order allows for wells to be developed on a project basis through Uniform Spacing Plans (USPs) formed by combining blocks of governmental surveyed

quarter-quarter sections of land, so long as the underlying leases allow for such pooling. On September 8, 2022, the Petitioner filed a request to form the Custer 35 USP. Mr. Koro testified that the USP is subject to a Unitization Agreement executed or ratified by all owners within the USP and that the Plan of Unitization allocates production to the various tracts on a mineral acre basis (a ratio of the mineral acres owned by a respective party, in proportion to the total number of mineral acres in the unit). The Custer 35 USP, comprising 2,160 acres, was approved administratively by the Oil, Gas, and Minerals Division on September 22, 2022. The proposed injection of CO₂ will occur within the USP and will initially utilize existing wells.

Mr. Koro's Exhibit A depicts the Custer 35 USP and the location of wells in the area. Mr. Koro's verified statement indicates that the initial well was drilled by O.I.L./Lee Petroleum to the Antrim in 1998 as a test well. Initial production started in 1998 as the Custer 35 Project. Full development commenced in 2001 thru 2003 when 16 wells were drilled for Antrim production within the Custer 35 USP. Three additional wells were added in the Custer 35 USP in 2008.

Mr. Koro indicates that production in this area is monitored on a project-level basis and provided Exhibit B, which details the primary production data associated with this project. Production commenced in the Custer 35 Unit towards the end of 1998, reaching peak production in 2005 of 566 thousand cubic feet per day (MCFD). Production remained relatively flat thru 2012 and has declined at a rate of about 4 percent over the last 10 years. Water production peaked in 2001 at 690 barrels of water per day (BWPD) and has declined sharply as the field has dewatered. CO₂ percentage in the gas has increased, starting around 4 percent to 5 percent and increasing to 12 percent today. Current production is 346 MCFD and 38 BWPD.

To highlight the geology of the area, Mr. Koro submitted Exhibit F which shows two geologic cross sections transecting the USP and depicts the thickness and depths of the Glacial Drift, the Ellsworth Shale, and the Antrim Shale. Exhibit G, submitted by Mr. Koro, is a geologic structure map of the Antrim Shale. Mr. Koro testified that the Antrim Shale has very low structural relief dipping to the southeast and that structure does not play a significant role in influencing Antrim natural gas production. Mr. Koro further testified that the Petitioner operates several Antrim wells that offset the USP, and that CO₂ injection

is not expected to impact wells in the surrounding units.

I find the boundary of the Custer 35 USP is an appropriate Unit Area for enhanced recovery operations.

II. Secondary Recovery

It is Mr. Koro's opinion that in order to maximize the ultimate recovery from the Custer 35 USP, further development of the USP should occur by injecting CO₂ into the Antrim formation. In forming his opinion regarding the benefits of injecting CO₂, Mr. Koro relied, in part, upon two publications marked as Exhibits C and D to his verified statement and that there are similarities between the Antrim formation and Coal Bed Methane (CBM) and CO₂ Injection.

Exhibit C is a paper titled "A Field Study on Simulation of CO₂ Injection and ECBM Production and Prediction of CO₂ Storage Capacity in Un-mineable Coal Seam". In this study, CO₂ was injected into a coal seam in West Virginia. Almost 260 tons (an average of 38.7 MCFD) of CO₂ was injected over three years and increased methane recovery by 6.7 MCFD. The Petitioner plans to inject about 650 MCFD of CO₂ per day into the USP.

Exhibit D is a paper titled "The Allison Unit CO₂-ECBM Pilot – A Reservoir and Economic Analysis". The study estimated that CO₂ injection would result in incremental methane recovery over primary recovery of approximately a proportion of one volume of methane for every three volumes of CO₂ injected.

Mr. Koro testified that a review of the process of adsorption of CO₂ and the desorption of methane in this Unit is necessary to understand the benefits of injecting CO₂. To further elaborate, Mr. Koro stated that his study of the Antrim Shale indicates that the Antrim Shale stores methane gas through adsorption. The methane gas was created biogenically by microbes instead of the more conventional thermogenic process. The microbes generated both methane gas and CO₂ and the majority of these gases are adsorbed to the rock matrix. As formation pressure is lowered, the rock releases both methane and CO₂. The methane gas desorbs from the rock at a higher rate than the CO₂ as the shale matrix preferentially desorbs methane gas and retains CO₂. Mr. Koro indicates that the Petitioner knows from gas samples that as the Antrim produced, the gas content is much higher in methane verses CO₂ initially. As gas reserves are produced over time, the CO₂ content slowly increases. By injecting CO₂, the partial

pressure of CO₂ is increased, which creates a driving force for the adsorption of CO₂ and desorption of additional methane gas to the fracture system and ultimately to the wellbore. In summary, the Antrim Shale will adsorb the CO₂ and release additional methane gas in its place.

Mr. Koro testified that injection of CO₂ in the USP would result in incremental gas recovery of 2,393 to 5,959 MMCF (Exhibit I). Mr. Koro states that the Petitioner owns a CO₂ processing plant located within the boundary of the USP. The primary reason why this USP was selected for CO₂ injection is because the Petitioner has a secure source of CO₂ at its plant. The plant presently strips CO₂ from Antrim shale gas in order to make the gas marketable. The CO₂ is vented to the atmosphere. Exhibit E, attached to the verified statement, is a schematic of the wells and infield gathering system. Gas and water are separated, with water disposed of in a brine disposal well (BDW). Gas is compressed, dehydrated, and sent to the CO₂ plant. At the plant, CO₂ is removed and vented to the atmosphere, while methane gas is sold into the transmission system. The Petitioner plans to add infrastructure to capture the CO₂ instead of venting it, compress and dehydrate the CO₂ and send it back to the injection wells. Mr. Koro's enhanced gas recovery forecast and estimated economics indicate the project will be profitable and add additional gross revenue of about \$5.439 million (Exhibit J).

Based on the Petitioner's analysis, there is evidence of a significant amount of gas remaining in the reservoir that will not be recovered by further primary production but may be recovered by enhanced recovery operations through the injection of carbon dioxide in the reservoir. I find the estimated cost of injection operations will not exceed the value of the additional hydrocarbons recovered. I further find that the injection of carbon dioxide proposed by the Petitioner is feasible, prevents waste, and presents a reasonable opportunity to recover gas from the USP which will not be recovered by conventional primary production techniques.

CONCLUSIONS OF LAW

Based on the findings of fact, I conclude, as a matter of law:

1. The Supervisor may regulate the secondary recovery methods of oil and gas, including the introduction of gas, air, water, and other substances into the producing

formations. MCL 324.61506(i).

2. A person desiring to inject water, gas, or other fluid into a producing formation or use other technology for the purpose of increasing the ultimate recovery of hydrocarbons from a reservoir shall file a petition for hearing. 1996 AACCS, R 324.612(1).

3. The operator of a secondary recovery project shall keep accurate records of all oil, gas, and brine produced; volumes of fluids injected; and injection pressures. The operator shall file reports of the data, and other data as may be required, with the Supervisor at regular intervals, as specified. 1996 AACCS, R 324.612(2).

4. The Supervisor has jurisdiction over the subject matter and the persons interested therein.

5. Due notice of time, place, and purpose of the hearing was given as required by law, and all interested persons were afforded an opportunity to be heard, with respect to the determination made herein. 2015 AACCS, R 324.1204. Based on the findings of fact, I conclude, as a matter of law:

DETERMINATION AND ORDER

Based on the Findings of Fact and Conclusions of Law, the Supervisor determines that the secondary recovery operations will prevent waste and maximize the ultimate recovery of hydrocarbons from the proposed Unit Area.

NOW, THEREFORE, IT IS ORDERED:

1. The Petition of Riverside Energy Michigan, LLC, is granted, and the proposed Unit Area (Custer 35 CO2 USP) is approved in accordance with and subject to this Order.

2. Riverside Energy Michigan, LLC is appointed Unit Operator.

3. The Unitized Formation is described as: Antrim Formation, more specifically identified as all formations lying between the top of the Lachine and the base of the Norwood.

4. Riverside Energy Michigan, LLC, shall make reports to the Supervisor; and when requested, meet with Supervisor's staff to review, and evaluate the current data. Specifically, Riverside Energy Michigan, LLC, shall report to or consult with the

Supervisor's staff as follows:

a. An Engineering Committee for the Custer 35 CO₂ USP Unit Area shall be formed. The Engineering Committee shall consist of a minimum of two representatives of Riverside Energy Michigan, LLC, and a minimum of two representatives of the Department of Environment, Great Lakes, and Energy (EGLE), Oil, Gas, and Minerals Division (OGMD). Riverside Energy Michigan, LLC shall notify the Supervisor's staff within 60 days of the effective date of this order what representatives they are nominating for the Engineering Committee.

b. The Engineering Committee shall meet from time to time as the Supervisor's representatives shall determine. However, the Engineering Committee shall meet on at least one occasion prior to the commencement of injection of CO₂ into the Unitized Formation.

c. Prior to injection, Riverside Energy Michigan, LLC shall prepare and submit a plan to monitor the freshwater aquifer, reservoir pressures, and CO₂ concentrations and migration within the Unit Area. The Petitioner shall obtain the Supervisor's approval of the plan prior to the commencement of injection of CO₂ into the Unitized Formation.

5. Riverside Energy Michigan, LLC shall notify the Supervisor between 30 and 60 days prior to the commencement of injection operations, and between 30 and 60 days prior to the anticipated date of permanent cessation of injection operations. The Petitioner shall comply with the filing requirements of R 324.610, R 324.612, and R 324.810 of the administrative rules of Part 615 of the NREPA and shall obtain such approvals as are necessary from the EGLE, OGMD.

6. Operation of the Custer 35 CO₂ USP Unit Area shall be conducted exclusive of and as an exception to all applicable spacing orders and rules, provided that the well density is no less than 80-acres per well, the distance between bottom hole locations of wells is no less than 1,320 feet, and that no well may be completed in the Unitized Formation at a location closer than 330 feet from the outside boundaries the USP.

7. The enhanced recovery operations shall initially be accomplished by the injection of carbon dioxide. Other substances may only be injected with written approval from the Supervisor.

8. The Supervisor retains continuing jurisdiction over the Unit Area in order that the Supervisor may exercise such administrative control as is consistent with the powers and duties of the Supervisor, as established by Part 615 of the NREPA.

9. This Order is effective immediately.

Dated: January 27, 2023



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