EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) established the Regional Carbon Sequestration Partnership (RCSP) Program to conduct comprehensive evaluations of the opportunities for carbon dioxide (CO₂) capture and storage in North America. One of the options for storage is the injection of CO₂ into unminable coal seams. To evaluate this storage option, the Plains CO₂ Reduction (PCOR) Partnership, which is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota, conducted laboratory- and field-based investigations of an unminable lignite coal seam located in Burke County in northwestern North Dakota. The purpose of the study was to assess the feasibility of storing anthropogenic CO₂ in lignite seams while simultaneously producing coalbed methane (CBM). More specifically, the goals of the study were as follows:

- To demonstrate that CO₂ can be safely injected and trapped in lignite by means of adsorption.
- To assess the feasibility of CO₂-enhanced methane production from lignite.
- To evaluate a variety of carbon storage operational conditions to determine their applicability to similar coal seams within the region or beyond.
In order to culminate all that was learned during the 4 years of the validation test, a Regional Technology Implementation Plan (RTIP) has been developed. The purpose of the RTIP is to provide direction on site selection and development; permitting; well drilling, casing, completion, and development; and CO₂ injection and monitoring. The RTIP expounds upon the experiences gained at the lignite test site to offer critical evaluations of decisions that were made and valuable insight into lessons that were learned.

The selection of the demonstration test site was driven by a number of technical and nontechnical factors. The former included the review of geophysical logs from the database of the North Dakota Industrial Commission Oil and Gas Division, which identified multiple coal seams. Following this reconnaissance effort, water well logs and other available data sets, e.g., gamma ray logs, were examined to identify the water quality, coal characteristics, and baseline geologic settings in these candidate coal seams. At the same time, the availability of mineral rights was also an important screening factor. This review led to the identification of an area in Burke County in northwestern North Dakota as the general location of the demonstration test site.

The injection well and the four monitoring wells were drilled as part of a single mobilization. A core was collected during the drilling of the injection well to provide samples for the conduct of selected laboratory tests.

Development of the wells was conducted by applying different stimulation techniques, in stages, with the intent of avoiding the use of more aggressive techniques that had the potential to negatively influence the injection zone and complicate the interpretation of postinjection monitoring. The techniques employed during the demonstration, in order of application, included swabbing, sonic hammer, nitrogen N-fit test (i.e., minifrac), and acid treatment. The results of the N-fit tests indicated that the coal formation was significantly underpressured, with an actual reservoir pressure of about 345 psia versus an expected formation pressure of approximately 470 psia. This underpressured situation was not anticipated, and as a result, well drilling, completion, and development activities were greatly affected.

Approximately 90 tons of CO₂ was injected over a roughly 2-week period into a 10–12-ft-thick coal seam at a depth of approximately 1100 feet. Monitoring, verification, and accounting (MVA) techniques were selected based on the characteristics of the site, and a number of techniques were utilized. Of these techniques, reservoir saturation tool logs and time-lapse crosswell seismic tomography provided the most valuable information. These techniques demonstrated that the CO₂ did not significantly move away from the wellbore and was contained within the coal seam for the duration of the approximately 3-month monitoring period. Evaluation of CO₂ fate beyond this time period would require an extended monitoring period which is beyond the scope of this demonstration.

Despite the atypical properties of the reservoir at the demonstration test site, which dramatically changed the dynamics of the test, the primary goal of the test, which was to demonstrate that CO₂ could be injected and stored in an unminable lignite seam, was achieved. This conclusion opens the door for the conduct of other similar CO₂ injection tests but at a larger scale and longer duration that can be used to confirm an optimal injection regime, investigate the
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