BASELINE MVA AT THE BELL CREEK COMBINED CO_2 ENHANCED OIL RECOVERY AND CO_2 STORAGE PROJECT

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ABSTRACT

The Plains CO_2 Reduction (PCOR) Partnership, led by the Energy & Environmental Research Center (EERC), is working with Denbury Onshore LLC (Denbury) to determine the effect of large-scale injection of carbon dioxide (CO_2) into a deep clastic reservoir for the purpose of simultaneous CO_2 enhanced oil recovery (EOR) and the incidental CO_2 storage associated with injection at the Bell Creek oil field, which is operated by Denbury. The CO_2 will be transported to the field via the 232-mile-long Greencore Pipeline and injected into an oil-bearing sandstone reservoir in the Lower Cretaceous Muddy Formation at a depth of approximately 4500 feet (Hamling and others, 2012).

The Muddy Formation within the boundaries of the Bell Creek oil field is characterized by high permeability (150–1175 mD) and high porosity (25%–35%), with reservoir pressures and temperatures that will maintain injected CO_2 in a supercritical state and are near conditions required for miscibility of CO_2 in the oil. The overlying Upper Cretaceous Mowry Formation shale will provide the primary seal, preventing fluid migration to overlying aquifers and to the surface. Additionally, several thousand feet of low-permeability shale formations overlie the Mowry Formation, providing redundant layers of fieldwide reservoir seals.

The activities at Bell Creek will inject an estimated 1.1 million tons of CO_2 annually, much of which will be permanently stored in association with the EOR operation. The Bell Creek demonstration project is a unique opportunity to develop a set of cost-effective monitoring, verification, and accounting (MVA) protocols for large-scale (>1 million tons per year) CO_2 EOR and to study incidental CO_2 storage in a clastic formation. Developing cost-effective approaches to predict and determine the fate of injected CO_2 is an important aspect of implementing large-scale carbon capture and storage (CCS) technology.

The goal of the MVA program is to provide critical data to verify site security, evaluate reservoir behavior during the injection program, determine the ultimate fate of injected CO_2, and investigate mechanisms that affect CO_2 storage efficiency within the EOR process all while operating in an integrated and compatible manner alongside the commercial CO_2 EOR operation. The MVA program utilizes targeted time-lapse data acquisitions as part of a surface-, near-surface-, and deep subsurface-monitoring program guided by key subsurface technical risk, geologic characterization, and predictive simulation results. In addition to developing a robust,

site-specific MVA data set, the MVA program will also provide complementary data to the commercial operator because of the natural overlaps that exist between MVA and EOR data sets.

There is growing recognition that EOR operations utilizing CO_2 as the injectant can have additional value for the public and the environment by taking advantage of the normal situation that commonly takes place in any EOR operation utilizing an outside substance to increase oil production from a reservoir. The fluid being injected, including saltwater when utilized in a secondary recovery project, ultimately occupies some of the pore space vacated by the produced oil. At the time of depletion and the closure of the enhanced recovery project, the injectant remains stored. This project is directed at taking advantage of the opportunity to monitor and account for this incidental storage of CO_2 that occurs during normal oil field operations.

No single technology exists that is capable of effectively monitoring the lateral and vertical extent of CO_2 throughout the stratigraphic column in both the near-wellbore and interwellbore environment for all storage sites. For this reason, the PCOR Partnership has designed a monitoring program specific to the needs of the Bell Creek Field that monitors a variety of physical phenomena within the field utilizing several commercially viable technologies and techniques. These technologies include geophysical surveys, a variety of wireline-deployed technologies, EOR operations data, and traditional groundwater- and soil gas-monitoring techniques.

The specific technologies selected are also designed to operate in a complementary manner where an anomalous signal from one monitoring technique can be investigated and characterized through the use of one or more of the remaining techniques. Additionally, the PCOR Partnership is also evaluating each of these monitoring technologies in order to understand the benefits, limitations, and challenges (including those unique to EOR) of each technology when deployed in a combined CO_2 EOR CCS operation from both an operational and technical standpoint.

REFERENCES

Hamling, J.A., Gorecki, C.D., Klapperich, R.J., Saini, D., and Steadman, E.N., 2012, Overview of the Bell Creek combined CO_2 storage and CO_2 enhanced oil recovery project: Paper Presented at the 11th International Conference on Greenhouse Gas Control Technologies (GHGT-11), Kyoto, Japan, November 18–22, 2012.