BELL CREEK TEST SITE WELLBORE LEAKAGE DATA COLLECTION COMPLETED

Plains CO_2 Reduction (PCOR) Partnership Phase III
Task 4 – Milestone M10

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BACKGROUND

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 CO_2 storage at the Bell Creek oil field, which is owned and operated by Denbury. The CO_2 will be obtained from the ConocoPhillips Lost Cabin gas-processing plant in Fremont County, Wyoming, which currently generates approximately 50 million cubic feet of CO_2 a day. The CO_2 will be transported to the site and injected into an oil-bearing sandstone reservoir in the Lower Cretaceous Muddy (Newcastle) Formation at a depth of approximately 4500 feet (1372 meters). The Muddy Formation within the boundaries of the Bell Creek oil field are characterized by high permeability (425–1175 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 activities at Bell Creek will inject an estimated 1.1 million tons of CO_2 annually, much of which will be permanently stored.

Denbury will carry out the injection and production operations in a phased approach initiating in the Phase 1 area (Figure 1), while the EERC will provide support for the site characterization, modeling and simulation, and risk assessment and will aid in the development of the monitoring, verification, and accounting (MVA) plan to address CO_2 migration risks and mitigation strategies. The PCOR Partnership has developed an approach that integrates site characterization, modeling and simulation, risk assessment, and MVA into an iterative process to produce meaningful results for large-scale CO_2 storage projects.

A technical team that includes Denbury, the EERC, and others is currently conducting a variety of activities to determine the baseline geological characteristics of the subsurface environment and to assess the potential for out-of-zone fluid migrations, both through geologic strata and existing wellbores in the vicinity of the injection site. With respect to wellbore integrity, there are hundreds of existing wellbores in the Bell Creek oil field and many others in close proximity. Identification and examination of data related to drilling, completion, operation and, where applicable, plugging of these existing wellbores are necessary to determine the potential risk of out-of-zone fluid migration via wellbore and to guide monitoring and mitigation plans to identify and eliminate or minimize associated risks. To accomplish this goal, wellbore

data were compiled for the Bell Creek oil field and surrounding areas, available from both public databases and from nonpublic data provided by Denbury.

Wellbore Integrity Data Collection Completed

Collection of relevant wellbore data to aid in evaluating the potential for out-of-zone fluid migration via wellbores in the Bell Creek oil field and surrounding area was completed in December of 2011. These activities included the following:

- Collected and scanned historical wellbore data files for the Bell Creek oil field and surrounding areas via Denbury archives and the Montana Board of Oil and Gas in Billings, Montana. Data summary consisted of the following:
  - 601 total wellbore files available from Denbury archives
  - 120 total wellbore files scanned at the Montana Board of Oil and Gas

The acquired data are currently being utilized to evaluate the range of completions (casing types, cement types, perforated zones, top of cement, etc.) present throughout the Bell Creek oil field and surrounding areas. Initial work will be focused on Phase 1 and the surrounding areas where injection is first planned to occur, initiating in the first quarter of 2013. These data will be utilized to assess a well integrity risk, which will in turn guide the MVA strategy throughout the field. Ongoing efforts include the following:

- Data integration into a geographical information system (GIS) database for all available injector (86 wells), producer (86 wells), and plugged and abandoned (P&A) wells (28 wells) in the Phase 1, 2, 3, and 7 (partially) areas (Figure 1).

- Data integration from the Phase 4, 5, 6, and 7 areas into the GIS database.

- Data integration of wells outside of the field boundary.

In addition to collecting and analyzing wellbore data available through Denbury archives and the Montana Board of Oil and Gas, soil gas samples were collected in Q4 of 2011 throughout the field, with a focus on the Phase 1 development area. These samples were chemically analyzed to provide a baseline data set of soil gas chemistry in the vicinity of wellbores within the injection area. The sampling efforts will continue quarterly over the course of 2012 and will provide a statistical year-round average of soil gas composition near wellbores throughout the field as part of the monitoring effort. The soil gas chemical composition data are anticipated to provide a valuable correlation to the risk assessment and wellbore integrity analysis. A summary of the types of soil gas samples collected as part of the first quarter sampling effort are summarized below and displayed in Figure 2:

- Soil gas samples were collected near the following:
  - 93 injection and production wells
  - 44 P&A wells
  - 11 interspaced samples between a production and an injection well

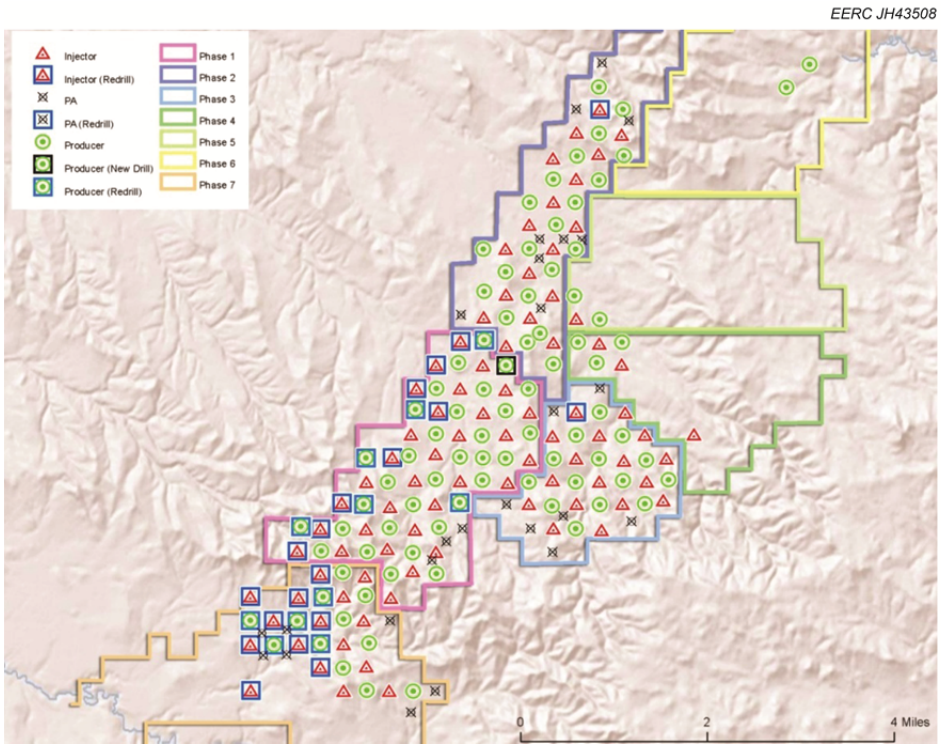

Figure 1. Map illustrating wellbore data files from the Phase 1, 2, 3, and surrounding areas currently integrated into the GIS database.

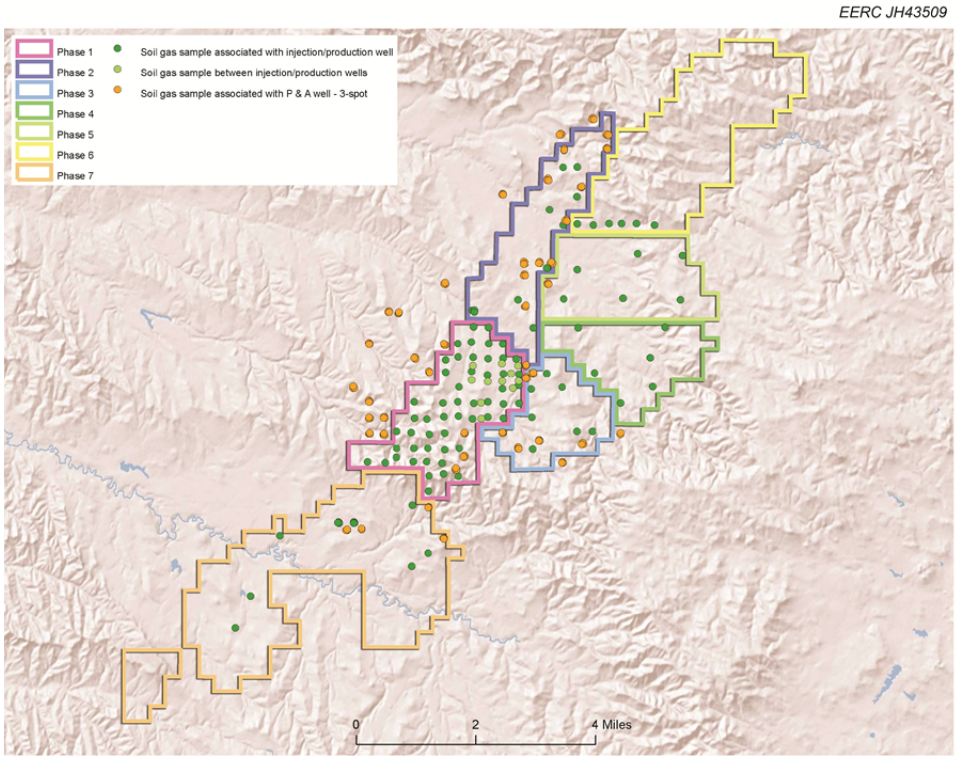

Figure 2. Map illustrating soil gas samples collected throughout the Bell Creek oil field.