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(03/11)
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U.S. Department of Energy
FEDERAL ASSISTANCE REPORTING CHECKLIST
AND INSTRUCTIONS FOR RD&D PROJECTS

1. Identification Number: **DE-FE0006821**	2. Program/Project Title: **Small Scale Field Test Demonstration CO2 Sequestration**

3. Recipient:
University of Kansas Center for Research, Inc.

4. Reporting Requirements:	Frequency	Addressees
A. MANAGEMENT REPORTING		
☒ Research Performance Progress Report (RPPR)	Q	FITS@NETL.DOE.GOV
☒ Special Status Report	A	FITS@NETL.DOE.GOV
B. SCIENTIFIC/TECHNICAL REPORTING		
(Reports/Products must be submitted with appropriate DOE F 241. The 241 forms are available at www.osti.gov/elink)		
Report/Product — Form		
☒ Final Scientific/Technical Report — DOE F 241.3	FG	http://www.osti.gov/elink-2413
☒ Conference papers/proceedings* — DOE F 241.3	A	http://www.osti.gov/elink-2413
☐ Software/Manual — DOE F 241.4		
☐ Other (see special instructions) — DOE F 241.3		
** Scientific and technical conferences only*		
C. FINANCIAL REPORTING		FITS@NETL.DOE.GOV
☒ SF-425 Federal Financial Report	Q, FG	
D. CLOSEOUT REPORTING		
☒ Patent Certification	FC	FITS@NETL.DOE.GOV
☒ SF-428 & 428B Final Property Report	FC	FITS@NETL.DOE.GOV
☐ Other		
E. OTHER REPORTING		
☒ Annual Indirect Cost Proposal	O	See block 5 below for instructions.
☐ Audit of For-Profit Recipients		
☒ SF-428 Tangible Personal Property Report Forms Family	A	FITS@NETL.DOE.GOV
☒ Other – see block 5 below	A	FITS@NETL.DOE.GOV

FREQUENCY CODES AND DUE DATES:

A - Within 5 calendar days after events or as specified.
FG- Final; 90 calendar days after the project period ends.
FC- Final; End of Effort.
Y - Yearly; 90 calendar days after the end of the reporting period.
S - Semiannually; within 30 calendar days after end of project year and project half-year.
Q - Quarterly; within 30 days after end of the reporting period.
Y180 – Yearly; 180 days after the end of the recipient's fiscal year
O - Other; See instructions for further details.

5. Special Instructions:

Annual Indirect Cost Proposal – If DOE is the Cognizant Federal Agency, then the proposal should be sent to FITS@NETL.DOE.GOV . Otherwise, it should be sent to the Cognizant Federal Agency.

Other – The Recipient shall provide all deliverables as contained in Section D of Attachment 2 Statement of Project Objectives.

QUARTERLY PROGRESS REPORT

To

DOE-NETL
Brian Dressel, Program Manager
Award Number: DE-FE0006821

SMALL SCALE FIELD TEST DEMONSTRATING CO_2 SEQUESTRATION IN ARBUCKLE SALINE AQUIFER AND BY CO_2-EOR AT WELLINGTON FIELD, SUMNER COUNTY, KANSAS

Project Director/Principal Investigator:
W. Lynn Watney
Senior Scientific Fellow
Kansas Geological Survey

Ph: 785-864-2184, Fax: 785-864-5317
lwatney@kgs.ku.edu

Joint Principal Investigator:
Jason Rush

Prepared by Lynn Watney
Date of Report: March 10, 2014 (revised)
DUNS Number: 076248616

Recipient: University of Kansas Center for Research &
Kansas Geological Survey
1930 Constant Avenue
Lawrence, KS 66047

Project/Grant Period: 10/1/2011 through 9/30/2015
Tenth Quarterly Report
Period Covered by the Report: January 1, 2014 through March 31, 2014

Signature of Submitting Official:

Willard Lynn Watney

Digitally signed by Willard Lynn Watney
DN: cn=Willard Lynn Watney, o=The University of Kansas, ou=Kansas Geological Survey, email=lwatney@kgs.ku.edu, c=US
Date: 2014.05.07 22:45:24 -05'00'

EXECUTIVE SUMMARY

Project Objectives

The objectives of this project are to understand the processes that occur when a maximum of 70,000 metric tonnes of CO_2 are injected into two different formations to evaluate the response in different lithofacies and depositional environments. The evaluation will be accomplished through the use of both *in situ* and indirect MVA (monitoring, verification, and accounting) technologies. The project will optimize for carbon storage accounting for 99% of the CO_2 using lab and field testing and comprehensive characterization and modeling techniques.

CO_2 will be injected under supercritical conditions to demonstrate state-of-the-art MVA tools and techniques to monitor and visualize the injected CO_2 plume and to refine geomodels developed using nearly continuous core, exhaustive wireline logs, and well tests and a multi-component 3D seismic survey. Reservoir simulation studies will map the injected CO_2 plume and estimate tonnage of CO_2 stored in solution, as residual gas, and by mineralization and integrate MVA results and reservoir models shall be used to evaluate CO_2 leakage. A rapid-response mitigation plan will be developed to minimize CO_2 leakage and provide comprehensive risk management strategy. A documentation of best practice methodologies for MVA and application for closure of the carbon storage test will complete the project. The CO_2 shall be supplied from a reliable facility and have an adequate delivery and quality of CO_2. The project shall install compression, chilling, and transport facilities at the ethanol plant for truck transport to the injection site.

Scope of Work

Budget Period 1 includes updating reservoirs models at Wellington Field and filing Class II and Class VI injection permit applications. Static 3D geocellular models of the Mississippian and Arbuckle shall integrate petrophysical information from core, wireline logs, and well tests with spatial and attribute information from their respective 3D seismic volumes. Dynamic models (composition simulations) of these reservoirs shall incorporate this information with laboratory data obtained from rock and fluid analyses to predict the properties of the CO2 plume through time. The results will be used as the basis to establish the MVA and as a basis to compare with actual CO2 injection. The small scale field test shall evaluate the accuracy of the models as a means to refine them in order to improve the predictions of the behavior and fate of CO2 and optimizing carbon storage.

Budget Period 2 includes drilling and equipping a new borehole into the Mississippian reservoir for use in the first phase of CO2 injection; establishing MVA infrastructure and acquiring baseline data; establishing source of CO2 and transportation to the injection site; building injection facilities in the oil field; and injecting CO2 into the Mississippian-age spiculitic cherty dolomitic open marine carbonate reservoir as part of the small scale carbon storage project.

In Budget Period 3, contingent on securing a Class VI injection permit, the drilling and completion of an observation well will be done to monitor injection of CO2 under supercritical conditions into the Lower Ordovician Arbuckle shallow (peritidal) marine dolomitic reservoir. Monitoring during pre-injection, during injection, and post injection will be accomplished with

MVA tools and techniques to visualize CO2 plume movement and will be used to reconcile simulation results. Necessary documentation will be submitted for closure of the small scale carbon storage project.

Project Goals

The proposed small scale injection will advance the science and practice of carbon sequestration in the Midcontinent by refining characterization and modeling, evaluating best practices for MVA tailored to the geologic setting, optimize methods for remediation and risk management, and provide technical information and training to enable additional projects and facilitate discussions on issues of liability and risk management for operators, regulators, and policy makers.

The data gathered as part of this research effort and pilot study will be shared with the Southwest Sequestration Partnership (SWP) and integrated into the National Carbon Sequestration Database and Geographic Information System (NATCARB) and the 6th Edition of the Carbon Sequestration Atlas of the United States and Canada.

Project Deliverables by Task

1.5 Well Drilling and Installation Plan (Can be Appendix to PMP or Quarterly Report)
1.6 MVA Plan (Can be Appendix to PMP or Quarterly Report)
1.7 Public Outreach Plan (Can be Appendix to PMP)
1.8 Arbuckle Injection Permit Application Review go/no go Memo
1.9 Mississippian Injection Permit Application Review go/no go Memo
1.10 Site Development, Operations, and Closure Plan (Can be Appendix to PMP)
2.0 Suitable geology for Injection Arbuckle go/no go Memo
3.0 Suitable geology for Injection Mississippian go/no go Memo
11.2 Capture and Compression Design and Cost Evaluation go/no go Memo
19 Updated Site Characterization/Conceptual Models (Appendix to Quarterly Report)
21 Commercialization Plan (Can be Appendix to Quarterly Report).
30 Best Practices Plan (Can be Appendix to Quarterly or Final Report)

ACCOMPLISHMENTS

1. **Continued progress of Milestone 2 (Task 3) - Site characterization of Mississippian Reservoir for CO2 EOR – Wellington Field**
   Adjustments to Mississippian and existing Arbuckle Injection models with reduced CO2 volumes were performed to establish that size of plume has changed minimally to ensure that scientific information derived from the investigation will be maximized.
2. **Subtask 1.6. MVA Infrastructure–** Designs are nearly complete to deploy a temporary network of 15 seismometer stations donated on behalf of IRIS. These stations will record passive seismic data in close proximity to the Mississippian and Arbuckle injector

locations. Five 3-component broadband accelerometers purchased by the KGS will supplement the existing MVA design.

3. **Subtask 1.8 Arbuckle Injection Permit Application –** The completed permit application has 14 chapters (sections) and includes revisions with refined technical information and the most up to date model simulation results. Edits have been incorporated in the document and submitted to Berexco for final review. Once Berexco has signed the document, the Arbuckle Injection Permit and the Mississippian Permit Application will be submitted to EPA and state regulators, respectively (Subtask 1.9).
4. **Task 5.2 CO2 Capture and Compression Design and Cost Evaluation –** Due to schedule concerns, ongoing negotiations with the primary replacement supplier have been terminated. Alternatively, two industrial suppliers have been confirmed and will combine resources to maximize efficiency and volume of CO2 delivered. (Subtask 5.2) A final cost report has been submitted to DOE which includes all feasible supply costs broken down by volume delivered, overall quantity injected, vendor, injection duration, etc. The DOE is reviewing these materials and will determine if the project may proceed.
5. **Task 26. Updated Site Characterization/Conceptual Models –** Modifications to the Arbuckle injection simulation have been run using a reduced volume of CO2. The model confirmed that the new extent and behavior of the plume will still easily be depicted with existing MVA design.
6. **Task 28. Commercialization Plan –** Ongoing discussions have arranged for a CCUS conference to be held in the upcoming year. Support for the conference has been granted by various suppliers, Kansas operators, and other members of industry.
7. **Task 3. Site Characterization of Mississippian Reservoir for CO2 EOR –** Drilling location for Mississippian injector well KGS 2-32 has been reviewed and confirmed by Berexco and KGS personnel. The agreed upon site location is shown in **Figure 1**. Preliminary sensitivity analyses have been performed as part of the iterative simulations necessary to construct the full scale model.

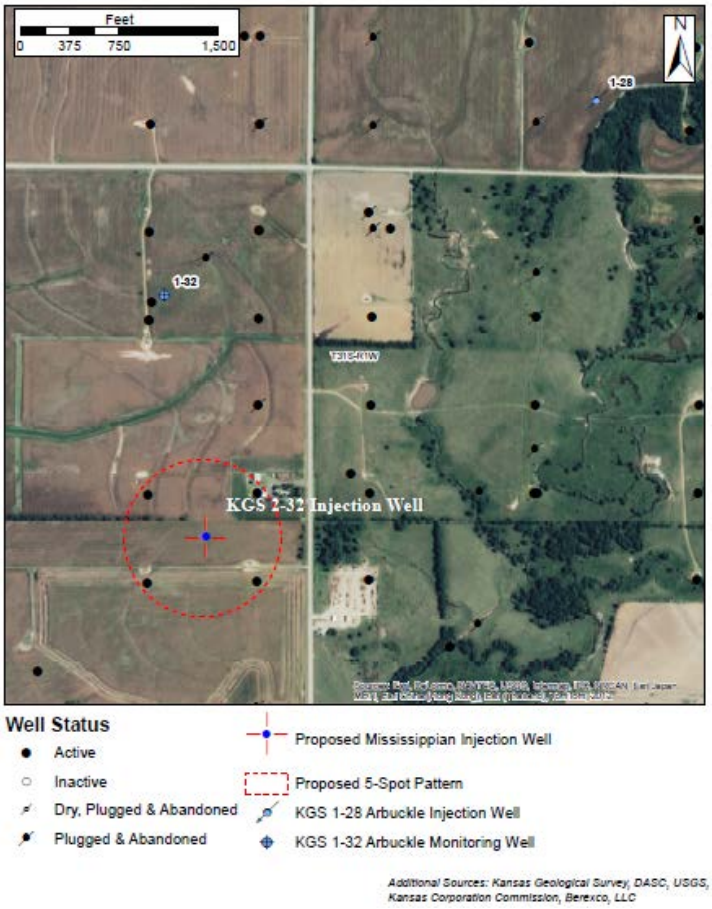


Figure 1. Drilling location for Mississippian injector well KGS 2-32.

MILESTONE STATUS REPORT

Task	Budget Period	Number	Milestone Description
Task 2.	1	1	Site Characterization of Arbuckle Saline Aquifer System - Wellington Field
Task 3.	1	2	Site characterization of Mississippian Reservoir for CO2 EOR - Wellington Field
Task 10.	2	3	Pre-injection MVA - establish background (baseline) readings
Task 13.	2	4	Retrofit Arbuckle Injection Well (#1-28) for MVA Tool Installation
Task 18.	3-yr1	5	Compare Simulation Results with MVA Data and Analysis and Submit Update of Site Characterization, Modeling, and Monitoring Plan
Task 22.	3-yr1	6	Recondition Mississippian Boreholes Around Mississippian CO2-EOR injector
Task 27.	3-yr2	7	Evaluate CO2 Sequestration Potential of CO2-EOR Pilot
Task 28.	3-yr2	8	Evaluate Potential of Incremental Oil Recovery and CO2 Sequestration by CO2-EOR - Wellington field

PROJECT SCHEDULE

CCUS Commercialization –

(1/21/2014) Lynn Watney and Rex Buchanan (the KGS interim director) held a meeting with Governor Sam Brownback on implementing CO2 utilization and storage in Kansas. Governor Brownback, along with the Kansas State Department of Commerce, expressed support for a CCUS conference to encourage the development of these opportunities among industry, regulators, and stakeholders. Pending a successful EOR test at Wellington Field (as

recommended by the Dept. of Commerce), these parties will set a schedule and hold a meeting in the upcoming year.

(2/4/14) A meeting was held with the Department of Commerce on the economic implications of CCUS. Department of Commerce officials have agreed to meet in the interim with key oil and gas operators and CO2 suppliers to discuss the issues and opportunities to use anthropogenic CO2 for CO2-EOR.

CO2 Supply –

(1/21/14) As of late January, no feedback or updates from meetings were provided from the lead alternative CO2 supplier. Due to major concerns regarding schedule, reliability, and economic viability, negotiations with the primary supplier were suspended, and other industrial sources were pursued as a backup plan.

(1/25/14) Discussion with three industrial suppliers was reestablished as complications developed with the primary supplier. Costs have been revisited based on daily supply restrictions and attempts have been made to reduce expenses by combining sources. Ongoing negotiations have included meetings, conference calls, and general correspondence with suppliers to obtain a finalized quote with an additional 8-10% under the already discounted price.

(1/30/14) One of the two alternative suppliers confirmed their reduced pricing for the Wellington injection.

(2/18/14) An official memo was submitted to DOE to outline the available options regarding CO2 suppliers. Due to supply restrictions in the vicinity of the proposed injection site, it was determined that the original anticipated volume of CO2 must be reduced to remain within budget.

(2/20/14) After much deliberation, two experienced and motivated suppliers were confirmed to optimally supply and deliver a maximum volume of CO2 to the injection site. Both parties have been closely involved in the study, and are eager to begin injection in hopes of establishing a future CCUS market in Kansas. This cost evaluation has been submitted to DOE for approval.

(2/27/14) A conference call was held with DOE to provide project updates, review work status, and comment on anticipated submission of Class VI application.

(3/15/14) Extensive evaluation has been performed to ensure that the reduced volume of CO2 can still be adequately detected and modeled in the subsurface. Results indicate that the reduced volume will have no negative impact on the science gained from the experiment. This decision has been technically based using the planned high-level MVA techniques that will be performed in BP2, such as the seismic resolution and simulated plume extent.

Class VI Injection application –

(1/17/2014) **-** Capillary Pressure calculations included into Arbuckle reservoir assumptions (see appendix for "Drainage Capillary Pressure Curves" report).

(1/25/14) – A morning-long meeting was held with Dana Wreath from Berexco to record his final comments pertaining to the Class VI application submitted in October. These revisions were included in the final draft and returned the following month.

(2/16/14) – Email correspondence with Kurt Hildebrandt from EPA confirmed that they are prepared to move forward with the Class VI application review as expeditiously as possible.

(2/19/14) – Final Arbuckle simulation figures included into Class VI document.

(2/28/14) – The final draft of the Class VI application was mailed to Dana Wreath for approval.

Class II CO2-EOR injection –

(2/26/14) -- 15 Seismometer stations arrived at the KGS from IRIS-PASSCAL to be deployed as a temporary seismic array near Wellington Field during Mississippian and Arbuckle injections.

(3/3/14) -- Final production estimates for the Mississippian reservoir model completed.

(3/15/14) -- Lead reservoir engineer, Eugene Holubnyak, completed a class on the latest geomechanical modeling tools to enhance the Wellington simulation. Topics included measuring the extent and amount of ground deformation. A newly appointed Ph.D. structural geologist with experience in Petrel is aiding these efforts to build on the geomechanical interpretation.

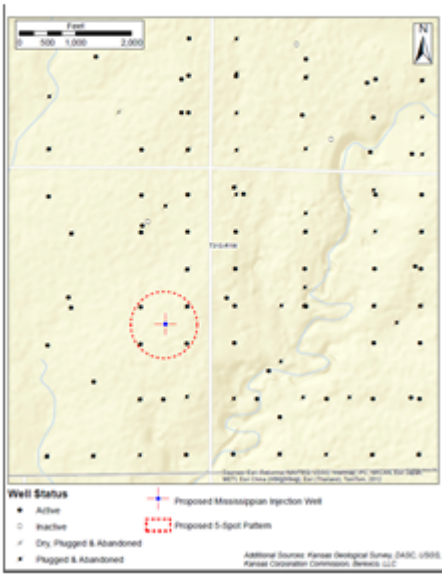
(3-15-14 to 3-30-14) The first stages of the CMG iteration modeling leading to the construction of the full field scale Mississippian oil field model have been completed. The methodology used in the EOR simulation included the following details:

- Simple 5-spot "layered-cake" model
- IMAX black-oil water-flood model with historical water flood based on current field conditions
- Sensitivity analysis with CMOST for water-flood model
- Preliminary PVT analysis without sensitivity analysis for CO2 EOR model
- Base case reservoir conditions assumed an initial water injection rate at 250 bbls/day followed by a CO2 injection at 110 tons/day, with infinite Carter-Tracy boundary

conditions and no leakage into the aquifer. Estimates from these calculations are outlined below (Mina Fazelalavi):

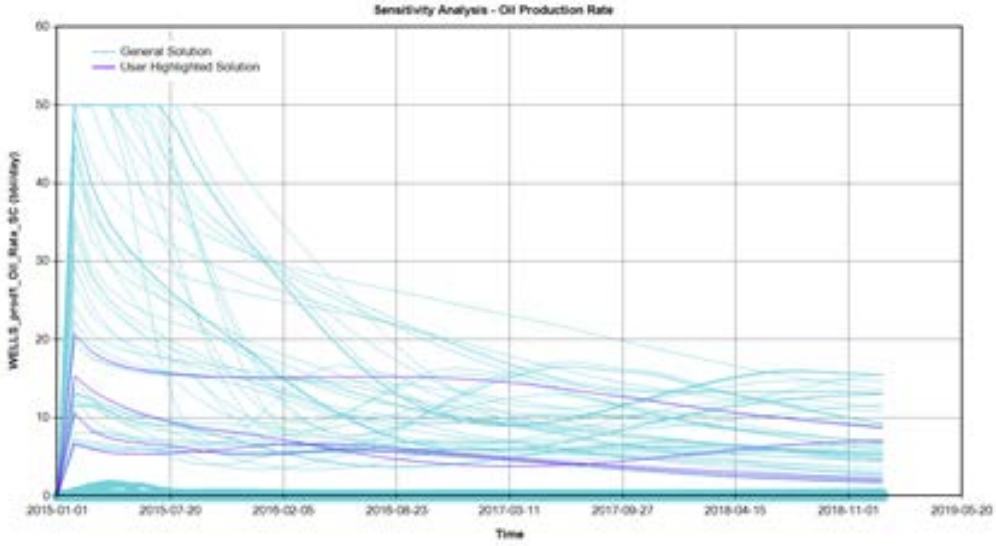
Estimation of Initial Oil in Place and Remaining Oil in Place

Description	Unit	Values
Area	ft 2	6.08E+05
Porosity cut off	%	5
Average thickness after porosity cut off	ft	40
Bulk volume	ft3	2.43E+07
Water saturation cut-off	%	67.00
Net bulk volume after sw cut off	ft3	1.78E+07
Average porosity	%	15.00
Net pore volume	ft3	2.68E+06
Average swi	v/v	0.33
Hydrocarbon pore volume	ft3	1.78E+06
Formation volume factor	bbl/STB	1.15
Initial Oil in place	STB	2.76E+05
Cumulative oil production for polygon:	BO	7.18E+04
Recovery factor	%	26
Remaining oil in place	STB	2.04E+05

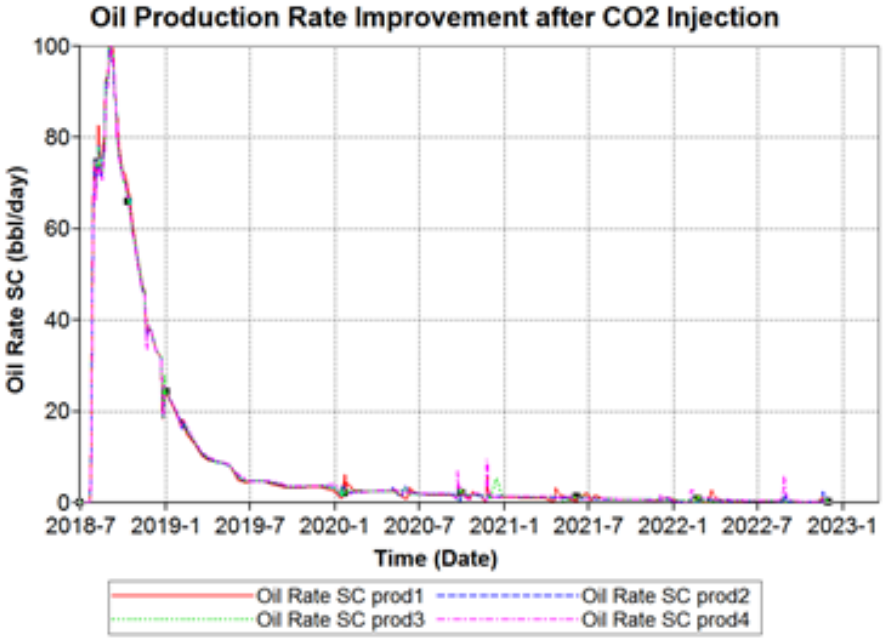


Water-Flood sensitivity analysis was run to obtain production estimates for a water-flood compared to results for the planned CO2 injection. Preliminary sensitivity analysis showed a substantial increase in oil production in response to CO2 injection, followed by a decline curve that is typical of similar wells. An increase in oil production was also observed after water injection, but higher volumes were required to achieve the desired results. These results are promising for the expected economic benefits of CO2 utilization in EOR activities throughout the state.

Water-Flood CMOST Sensitivity Analysis



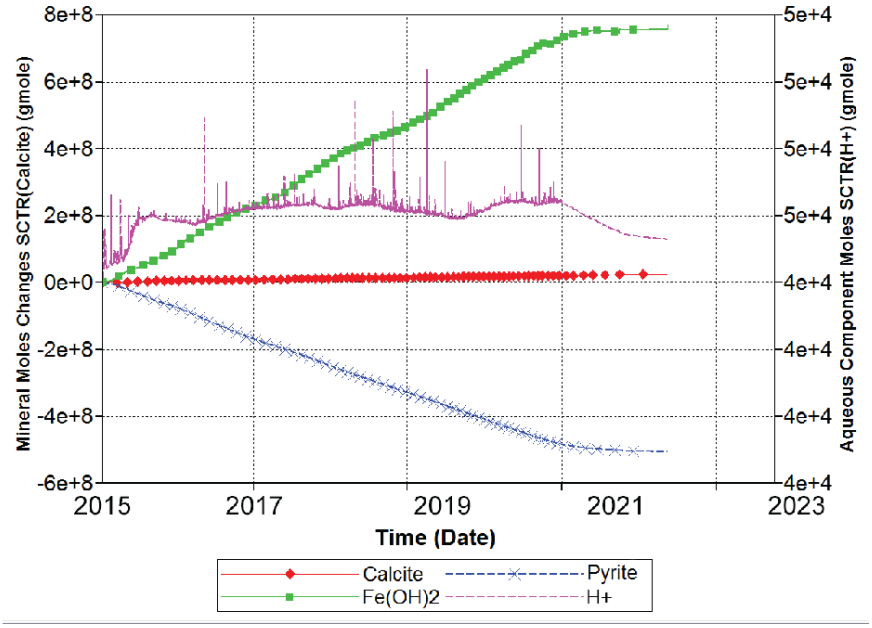
Expected Production Improvement After CO2 Injection

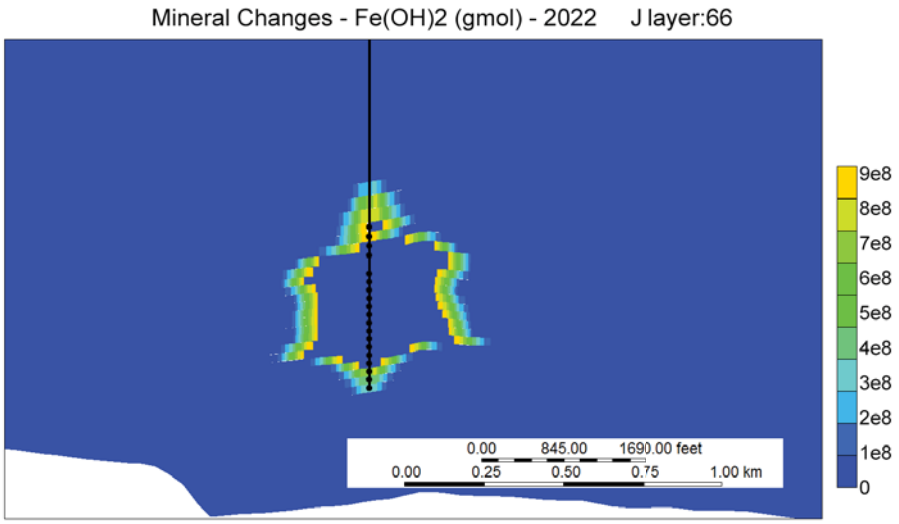


Mineral changes in Arbuckle model --

(Eugene 3/30/14) "CO2-brine-mineral reactions will be between minerals dolomite, calcite, chert, pyrite, anhydrite and argillaceous clay material. Small and large scale heterogeneity of mineral occurrences is observed throughout the formation which will create complex mineral-brine-CO2 interactions. Heterogeneous mineralogy occurs predominantly at the chert/carbonate interface where previous fractures and flow paths have been in filled with argillaceous and pyritic materials. These zones will be highly reactive upon the injection of CO2 and will release cations from non carbonate minerals, increasing the possibility of mineral trapping mechanisms in the long run. Fluctuations in brine chemistry observed during supercritical flow experiment showed the effect of heterogeneity on geochemical reactions. Complex reactions will develop in the aquifer with different kinetic rates as CO2 migrates through heterogeneous material."

Preliminary Numerical Modeling Results:





Several changes were made for the final Class VI Arbuckle model --

An updated vertical permeability model was prepared and applied to geocellular model, which provided a better estimation of vertical CO2 movement in the reservoir. Currently, dynamic simulations of CO2 injection in Lower Arbuckle reservoir predict that CO2 will stay contained within lower portion of the Arbuckle Fm and will not continue to move up towards the primary cap-rock. These modeling predictions are in agreement with geochemical fluid analysis (especially Br/Cl isotope analysis) which indicates that fluids of upper Arbuckle Fm are not mixing with fluids of lower Arbuckle Formation.

The scale ratio of vertical vs. horizontal model extent for the report was updated to match an aerial model views.

Revision of SOPO –

SOPO has been temporarily revised to account for schedule changes due to newly acquired CO2 source. The SOPO maintains the deployment of the Mississippian injection to be implemented first, commencing by 10/1/2014. Changes to budgetary items include removal of second seismic survey and removal of one of the proposed deep surface monitoring wells to bolster funds in other MVA technologies.

Some of the excerpts from a memo regarding the uniqueness and scientific value of the planned activities are listed below. Topics include the 1) Proactive response to seismicity in the area surrounding the injection site, 2) level of confidence to detect the CO2 plume/scientific importance of the Mississippian injection, 3) Readiness of the CO2 suppliers and EPA for a Class VI well.

1) Seismicity and Enhanced Monitoring

- The KGS has taken receipt of 15 IRIS-PASCAL seismometers for passive monitoring of the Mississippian and Arbuckle injections and to provide a networked site for earthquake monitoring in southern Kansas. KGS personnel will receive field and data handling training from PASSCAL in late April and are scheduled to scheduled deploy the stations in May to establish baseline observations,
- As of 3/7/14 – KGS will privately purchase 5 active accelerometers to install at Wellington Field alongside the IRIS seismometers. The KU Department of Geology plans to purchase additional accelerometers and is seeking necessary campus co-funding to also participate in this collaborative investigation at Wellington Field. The active, 24-bit, 3 component state-of-the art accelerometers will be placed with the seismometer array to 1) increase the bandwidth/frequency range of the events that will be monitored, 2) increase the sensitivity of the passive seismic monitoring to detect events as small a as -2.0 magnitude or less, and 3) and record 3-components of movement.

2) Uniqueness of the CO2-EOR test at Wellington Field

1. Extensive technical information available for this oil field that is and will continue to be all public domain including -
    a. 12 mi^2 multicomponent seismic that is uniquely available for ongoing and continued research
        i. Demonstrated mapping of phi-k mapping aided by seismic
        ii. Well suited for integrating geomechanical analysis, discrete fracture network
    b. 2D shear and p-wave seismic calibration lines adding to uniqueness and rigor of the seismic program,
    c. 1600 ft of continuous core providing unique view of entire caprock, strata comprising reservoir, and context stratigraphic data for continued analysis
    d. Two newly drilled basement wells, 3000 ft apart, with well testing, extensive whole core C/A including geomechanical analysis, geochemical analyses, petrophysical analysis
        i. Established unique petrophysical analysis techniques (including one with patent applied for) to predict capillary pressure, relative permeability, and kv and kh using extensive dataset

2. Highly constrained integrated Petrel model and CMG simulations and a skilled research team (KGS and beyond) with expertise in geology, engineering , and geophysics working with high quality data
    a. Well suited to conducted experiments directed toward next generation CO2-EOR in smaller (<50 million bbls) carbonate reservoirs common to the upper Midcontinent.
    b. Utilization of very high resolution seismic from KGS vibroseis to image the smaller quantities of CO2
    c. Will deploy in May the latest in passive seismic monitoring for dual purpose --
        i. installing five 3-component accelerometers purchased with KGS funds (decided on six 4/2/14) to aid in detecting CO2 and provide unique potential to adjust the CO2 flood in real-time
        ii. Plans for additional accelerometers to examine effects of suspected small fault the possibly would affect fluid flow; use monitoring to run experiment under pre-CO2 waterflood to define whether conductive or barrier to flow; incorporate a unique approach in seismic diffraction modeling by LLBL personnel to characterize faults based on another field test using near surface analog in SE Kansas with faulted Mississippian strata that will be seismically imaged and cored via slant hole.
        iii. Use of 15 IRIS seismometers along with accelerometers to understand the recent increase in earthquake activity in the area, integrate data with the existing seismic network coordinating with USGS, state agencies, and Oklahoma Geological Survey
3. Unique integration of Wellington Field with the Kansas CO2 Initiative engaging the entire community – petroleum industry, CO2 suppliers, lawmakers and regulators – over the course of next year with Wellington Field serving as the focal point
    a. Use of Wellington Field as a calibration site and field demonstration to engage petroleum industry in overcoming need and requirements in use of anthropogenic sources of CO2
    b. Test best practice, cost-effective monitoring to aid in applying next-generation CO2-EOR methods, refine model predictions, and to permit CO2 use to be optimized for CO2 sequestration
    c. Uniquely couple the oil field and the underlying saline aquifer to increase the CO2 sequestration capacity using Wellington to help calibration with Cutter field, 8 other sites in Kansas being completed in DE-FE0002056.

3) Readiness of the CO2 suppliers and EPA for a Class VI well.

CO2 Suppliers --

- Aggressive pursuit of CO2 sources and notable price discounts -- Following continued shutdown of the Abengoa plant in Colwich, KS, announced late July 2013, alternate sources of CO_2 were sought and two of the most favorable suppliers were secured.
- Industrial supplier's margin is breakeven, rates and amounts of CO2 meet project needs.
- Suppliers are leaders in CO2 capture and supply, an excellent partner for this project

EPA Class VI Review --

EPA decision is model-based and model is rigorous and clear about the safety of the test -- The simulation results summarized in the Executive Summary of the Class VI application indicate that the plume will stabilize within a few months of cessation of injection, and pressures will also drop to ambient conditions very rapidly. Therefore, KGS remains confident that the EPA will approve the permit in within a year or less. Also,

a. Overlying underpressured oil field and its caprocks minimize potential for leak of CO2
b. Exemplary database demonstrates distinct hydrostratigraphic units that comprise the Arbuckle – two basement tests, multicomponent seismic, exhaustive logs, core (1600 ft), seismic, lab tests, pulse test, geochemically and microbially distinction of units in Arbuckle demonstrating their hydraulic isolation.
c. Arbuckle core plugs also being analyzed by Susan Carroll at LLNL and coordination with us to help upscale their work on reactive transport models and reaction kinetics.
d. Our view is that industry partner, data used, and team assembled to analyze the information used to create the geomodels and simulations of the Mississippian and Arbuckle are top notch and prepared to take on the challenges of the small scale tests.

The EPA Region 7 Director has personally expressed interest in this project and has provided commitments to expedite the approval process.

ACTIVITIES OF LAWRENCE BERKELEY NATIONAL LAB

Plans have been scheduled with Susan Carroll at Lawrence Livermore National Laboratory to perform supercritical CO2 flow through experiments using seven total core plugs taken on behalf of DE-FE0002056. LLNL is operating from a separate contract with DOE-NETL through Traci Rodosta. Three core plugs taken from the Upper Arbuckle of the Wellington core will be analyzed starting June 23rd, and will be sent for pre-experimental flow through analysis and imaging. The following table lists the details of the Wellington core samples to be analyzed:

March '14 Wellington Thin Section Order			
Order No.	**Sample No.**	**Formation Name**	**Depth**
23	13-41	Upper Arbuckle	4225.7'
24	13-46	Upper Arbuckle	4230.3'
25	14-4	Upper Arbuckle	4247'

ONGOING ACTIVITIES

1) Complete Class VI review by Berexco and submit application to EPA.
2) Complete modeling of Mississippian injection and submit Class II permit to State.
3) Complete DOE cost evaluation review of alternative CO2 suppliers.
4) Complete DOE review of documentation of the uniqueness of the CO2-EOR test to be performed at Wellington Field.
5) Receipt and planning for installation of 15 seismometer stations from IRIS PASSCAL. Field training scheduled in April for KGS staff to provide networked site for earthquake monitoring in southern Kansas.
6) KGS plans to independently purchase five 3-component accelerometers to aid in detection of fluid movement and seismic events to adjust the CO2 flood in real time.
7) Collaboration with LLBL to arrange in situ micro CT imaging of CO2 with plans to examine oil reservoir, obtain reaction kinetics suited for improving injection simulations with discussions of upscaling results to geomodel using NMR technology.
8) Additional refinement of the dynamic Mississippian model and inclusion of CO2-mineral-brine interaction.

TASK 1. PROJECT MANAGEMENT AND REPORTING

Subtask 1.5 Well Drilling and Installation Plan – To be adapted from materials submitted in the Class VI application, and upon DOE approval of proposed changes.

Subtask 1.6 MVA - Updated monitoring plan adapted from Section 11 of Class VI application.

Subtask 1.7. Public Outreach Plan - To be adapted from material submitted in the Class VI application.

KEY FINDINGS

1. Two industrial suppliers have been confirmed to jointly deliver CO2 to the injection site.
2. A decreased volume of CO2 injected into the Arbuckle Saline Aquifer will still be successfully monitored with current MVA technology
3. Installation of a temporary seismometer array in conjunction with continuous recording from five multicomponent broadband accelerometers should provide precise delineation of injected fluid movement to refine reservoir scale modeling and assist in steering the injectate and optimize contact with the reservoir.

Plans for First Quarter 2014

1. Receive final Class VI comments from Berexco, and submit to EPA.
2. Submit Class II Injection application upon approval from DOE.
3. Procure and enter a contractual agreement with CO2 suppliers.
4. Deploy MVA technology to establish pre-injection baseline readings.
5. Install 15 IRIS-PASCAL seismometers and receive training to deploy at Wellington for passive monitoring of Mississippian and Arbuckle injections and provide a networked site for earthquake monitoring in southern Kansas.
6. Drill Mississippian Injection Well and commence field preparation for injection activities.

PRODUCTS

Publications, conference papers, and presentations

Fazelalavi, Mohsen., Fazelalavi, Mina., Fazelalavi, Maryam., Determination of Reservoir Permeability Based on Irreducible Water Saturation and Porosity from Log Data and FZI (Flow Zone Indicator) from Core Data. Paper number: 17429-IPTC to the 7th International Petroleum Technology Conference (IPTC) (patent pending)

Watney, Lynn, Rush, Jason, Raney, Jennifer, “Carbon Storage and Utilization in Kansas – Are We Ready?” Presentation to the University of Kansas Department of Geology Colloquium Series (January 2014)

Holubnyak, Yeven, "Pilot-Scale CO2 Geological Storage Project and CO2 EOR at Wellington Field in Southern Kansas." Presentation to the University of Kansas Department of Geology Colloquium Series (March 2014)

PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

A project organization chart follows. The work authorized in this budget period includes office tasks related to preparation of reports and application for a Class VI permit to inject CO2 into the Arbuckle saline aquifer. Tasks associated with reservoir characterization and modeling are funded in contract DE-FE0002056.

ORGANIZATION CHART

Name	Project Job Title	Primary Responsibility
	Kansas Geological Survey	
Lynn Watney	Project Leader, Joint Principal Investigator	Geology, information synthesis, point of contact
Yevhen Holubnyak	Petroleum Engineer	Reservoir engineer, dynamic modeling, synthesis
Jason Rush	Joint Principal Investigator	Geology, static modeling, data integration, synthesis
John Doveton	Co-Principal Investigator	Log petrophysics, geostatistics
Dave Newell	Co-Principal Investigator	Fluid geochemistry
Rick Miller	Geophysicist	2D seismic acquire & interpretation
		LiDAR/InSAR support, water well drilling/completion
TBN	Geology Technician	Assemble and analyze data, report writing
Tiraz Birdie	President, TBirdie Consulting, Inc.	Hydrogeologic modeling, permitting, MVA, integration
	KU Department of Geology	
Michael Taylor	Co-Principal Investigator	Structural Geology, analysis of InSAR, LiDAR, seismometer array
TBN	Graduate Research Assistant	Structural Geology, analysis of InSAR and LiDAR, seismometer array
	Kansas State University	
Saugata Datta	Principal Investigator	
TBN	Graduate Research Assistant	Aqueous geochemistry
TBN	3- Undergraduate Research Assistants	
	Lawrence Berkeley National Laboratory	
Tom Daley	Co-Principal Investigator	Geophysicist, analysis of crosshole and CASSM data
		Hydrogeology, analysis of soil gas measurements
Barry Freifeld	Co-Principal Investigator	Mechanical Engineer, analysis of U-Tube sampler
	Sandia Technologies, Houston	
Dan Collins	Geologist	Manage CASSM and U-Tube operation
David Freeman	Field Engineer	Manage field install of CASSM and U-Tube
	Berexco, LLC	
Dana Wreath	VP Berexco, LLC	Engineering, Manager of Wellington Field
Randy Koudele	Reservoir engineer	Engineering
Staff of Wellington Field		Field operations
Beredco Drilling team		Mississippian and Arbuckle drilling operations
	Abengoa Bioenergy Corp.	
Christopher Standlee, Danny Alllison		CO2 supply Colwich Ethanol Facility

IMPACT

Key personnel have been actively engaged with industry, regulatory agencies, and stakeholders to address the significance of this kind of demonstration project in Kansas. Both high-level elected officials and top oil and gas operators have expressed support to expand the carbon market throughout the state. These groups are anxiously awaiting a successful trial of the field experiment to justify future investment into the infrastructure

required for commercial level CCUS. Furthermore, some of the country's largest CO2 providers have confirmed their participation in the project, and are confident that the engagement will grant their business a leading edge on a burgeoning industry. Awareness and support for the Wellington CO2 project is growing stronger and more widespread. Successful field activities will provide evidence necessary to move CCUS even closer to commercialization.

CHANGES/PROBLEMS

Two industrial suppliers will now jointly deliver a reduced volume of CO2 to the injection site. Transport limitations have prevented the available funds from being sufficient to procure the original volume of CO2 to be injected. Adjustments to the injection simulations have been run to account for this decreased volume. The KGS is awaiting approval from DOE of the cost evaluation report, and to approve the documentation that the science of the tasks to be performed will not be impacted by the decrease in CO2.

Enhancements to the original MVA plan include the installation of 15 seismometer stations, and five broadband accelerometers to monitor fluid movement and detect any seismic events in the vicinity of the study area.

BUDGETARY INFORMATION

Cost Status Report

See figure on the following page for the cost status for quarters 1-10.

COST PLAN/STATUS

BP1 Starts: 10/1/11

Baseline Reporting Quarter		10/1/11-12/31/11 Q1	1/1/12-3/31/12 Q2	4/1/12-6/30/12 Q3	7/1/12-9/30/12 Q4	10/1 /12- 12/31/12 Q5	1/1/13 - 3/31/13 Q6	4/1/13 - 6/30/13 Q7	7/1/13-9/30/13 Q8
Baseline Cost Plan (from SF-424A)		(from 424A, Sec. D)							
Federal Share		$326.84	$17,208.52	$17,282.92	$31,693.50	$23,000.00	$23,000.00	$23,000.00	$23,000.00
Non-Federal Share		$365,421.00	$365,421.00	$365,421.00	$365,421.00	$0.00	$0.00	$0.00	$0.00
Total Planned (Federal and Non-Federal)		$365,747.84	$382,629.52	$382,703.92	$397,114.50	$23,000.00	$23,000.00	$23,000.00	$23,000.00
Cumulative Baseline Cost		$365,747.84	$748,377.36	$1,131,081.28	$1,528,195.78	$1,551,195.78	$1,574,195.78	$1,597,195.78	$1,620,195.78
Actual Incurred Costs									
Federal Share		$326.84	$17,208.52	$17,282.92	$31,693.50	$31,572.56	$25,465.07	$13,078.68	$52,993.14
Non-Federal Share		$0.00	$6,475.85	$43,028.94	$9,058.04	$15,226.34	$0.00	$0.00	$0.00
Total Incurred Costs-Quarterly (Federal and Non-Federal)		$326.84	$17,208.52	$60,311.86	$40,751.54	$46,798.90	$25,465.07	$13,078.68	$52,993.14
Cumulative Incurred Costs		$326.84	$17,535.36	$77,847.22	$118,598.76	$165,397.66	$190,862.73	$203,941.41	$256,934.55
Variance									
Federal Share		$0.00	$0.00	$0.00	$0.00	-$8,572.56	-$2,465.07	$9,921.32	-$29,993.14
Non-Federal Share		$365,421.00	$358,945.15	$322,392.06	$356,362.96	-$15,226.34	$0.00	$0.00	$0.00
Total Variance-Quarterly Federal and Non-Federal)		$365,421.00	$358,945.15	$322,392.06	$356,362.96	-$23,798.90	-$2,465.07	$9,921.32	-$29,993.14
Cumulative Variance		**$365,421.00**	**$724,366.15**	**$1,046,758.21**	**$1,403,121.17**	**$1,379,322.27**	**$1,376,857.20**	**$1,386,778.52**	**$1,356,785.38**