“Optimization, Scale-up, and Design of Coal-Dependent Methanogenesis in Preparation for *in situ* Field Demonstration

DE-FE0026155

Matthew Fields
Lee Spangler, Al Cunningham, Adie Phillips

Energy Research Institute at Montana State University

December 8, 2015 Kickoff Meeting
Arun Bose, Project Officer
National Energy Technology Laboratory
Office of Fossil Energy

Presentation Outline

- **Project Concept and Background**
- Project objectives
- Project team roles and responsibilities
- Tasks/subtasks
- Key milestones
- Success criteria at key decision points
- Deliverables

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"Sustainable" CBM Production

- Once initial methane production is completed the opportunity exists to enhance production of additional methane by stimulating indigenous microbial populations.

- Research aimed at developing sustainable microbial methane production from coal beds.
  - H_20 recycle
  - Nutrient recycle
  - CO_2 recycle

MECBM Research Team @ MSU

Dr. Al Cunningham
Dr. Robin Gerlach
Dr. Lee Spangler
Dr. Adie Phillips

Randy Hiebert, MET
Dr. Elliott Barnhart (USGS)

Hannah Schweitzer
Katie Davis
Logan Hodgskiss

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USGS science for a changing world

Dr. Bill Orem et al.
Reston, VA
Denver, CO

MSU CBM Project History

- NSF, Cold Geobiology, Collaborative Research: Hydrodynamic controls on microbial community dynamics and carbon cycling in coalbeds (PI: J. McIntosh, University of Arizona; co-PIs: M.W. Fields, A.B. Cunningham, MSU)
- Montana Board of Research and Commercialization Technology, Sustainable Coal Bed Methane (CBM) and Biofuel Production (MSU and Montana Emergent Technologies)
- DOE-NETL, Increasing the Rate and Extent of Microbial Coal to Methane Conversion through Optimization of Microbial Activity, Thermodynamics, and Reactive Transport (PI: M.W. Fields, co-PIs: L. Spangler, A. Cunningham, R. Gerlach, R. Hiebert)
- On-going collaborations with U.S. Geological Survey (W. Orem, Reston, VA; A. Clark, Denver, CO)

Approach: Multi-disciplinary work that combines microbiology, ecology, engineering, geochemistry, and hydrology to determine constraints on in situ CBM

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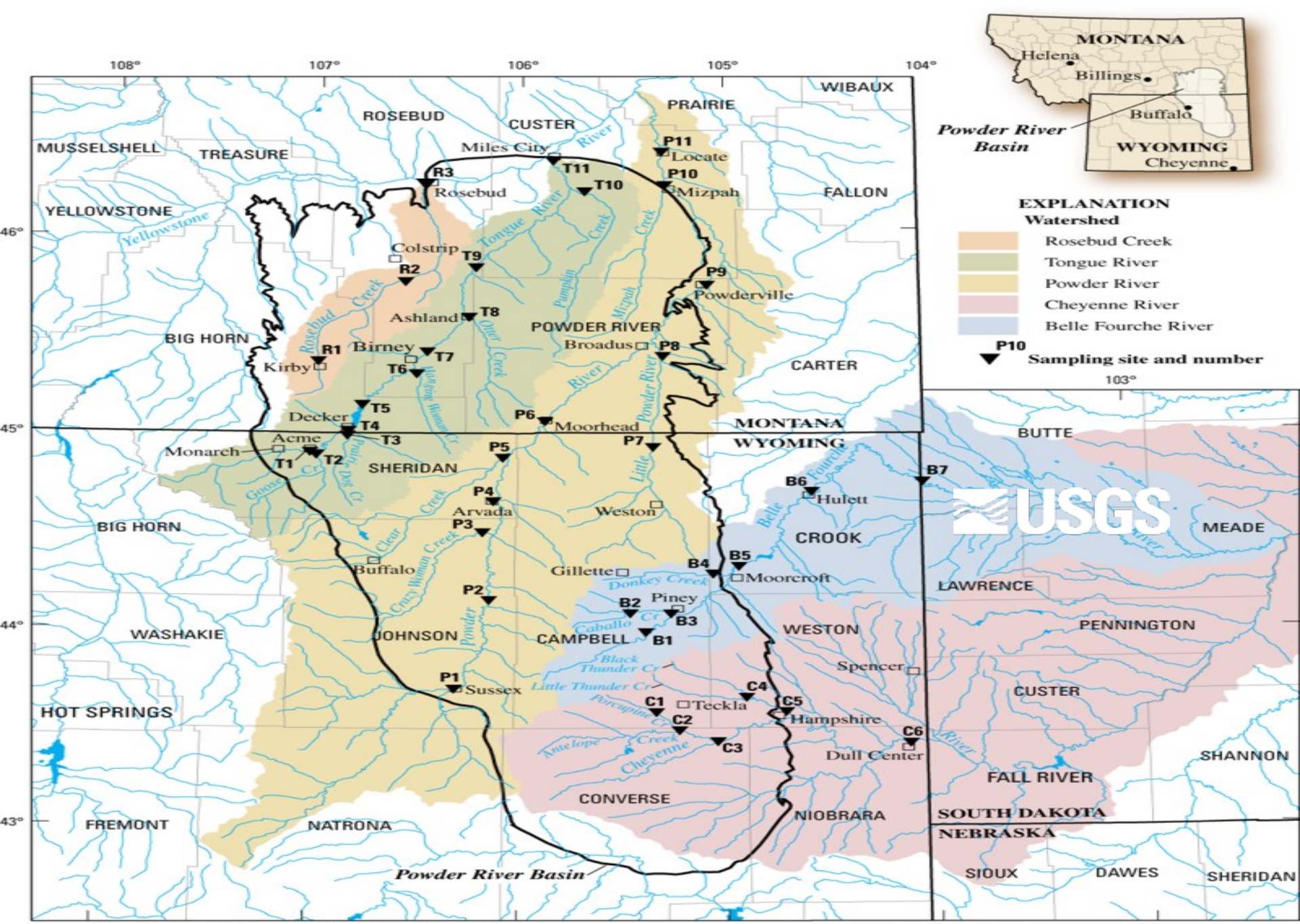

Base modified from Digital Chart of the World digital data, 2003
Drainage basins modified from USGS Hydrologic Unit Boundaries, 1999
Albers Equal-Area projection, standard parallels 20° and 60°,
central meridian -105°30′

0 25 50 100 MILES
0 25 50 100 KILOMETERS

Batch-Scale Coal-Dependent Methanogenesis

Approximately 75 enrichment cultures under varied, stimulating conditions from 5 different coal seams

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Summary of Current MSU Work for DE-FE0026155

- **Coal acquisition**
- **CBM production water collection**
- **Coal processing for reactors**
- **CBM production water processing**
- **Inoculum preparation**
- **Amendment preparation**
- **Construct and set-up small, pressure reactors**

Future Plans

- Test coal-dependent methanogenesis in small, pressure reactors
- Run large, pressure reactors
- Prepare field plan

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Objectives

The parameters that constrain microbial coal conversion to natural gas include many physical, chemical, and biological variables. The project will investigate and determine the impact of surface area, pH, nutrients, and transport on overall methanogenesis. The three main objectives of the project are to:

•**Objective 1**. *Evaluate time-delay to methane production post-stimulation during meso-scale push-pull injections.*

•**Objective 2.** *Complete site characterization.* Site characterization will be completed in terms of geology, hydrogeology, geochemistry, and microbiology to establish baselines for field assessments prior to potential field demonstrations.

•**Objective 3**. *Evaluate and design potential field demonstration and economic analysis at the USGS Birney Test Site in the Powder River Basin.* A final report will be prepared that includes description of above-ground processes required to implement and support *in situ* bio-gasification as it would be applied during future MECBM field tests.

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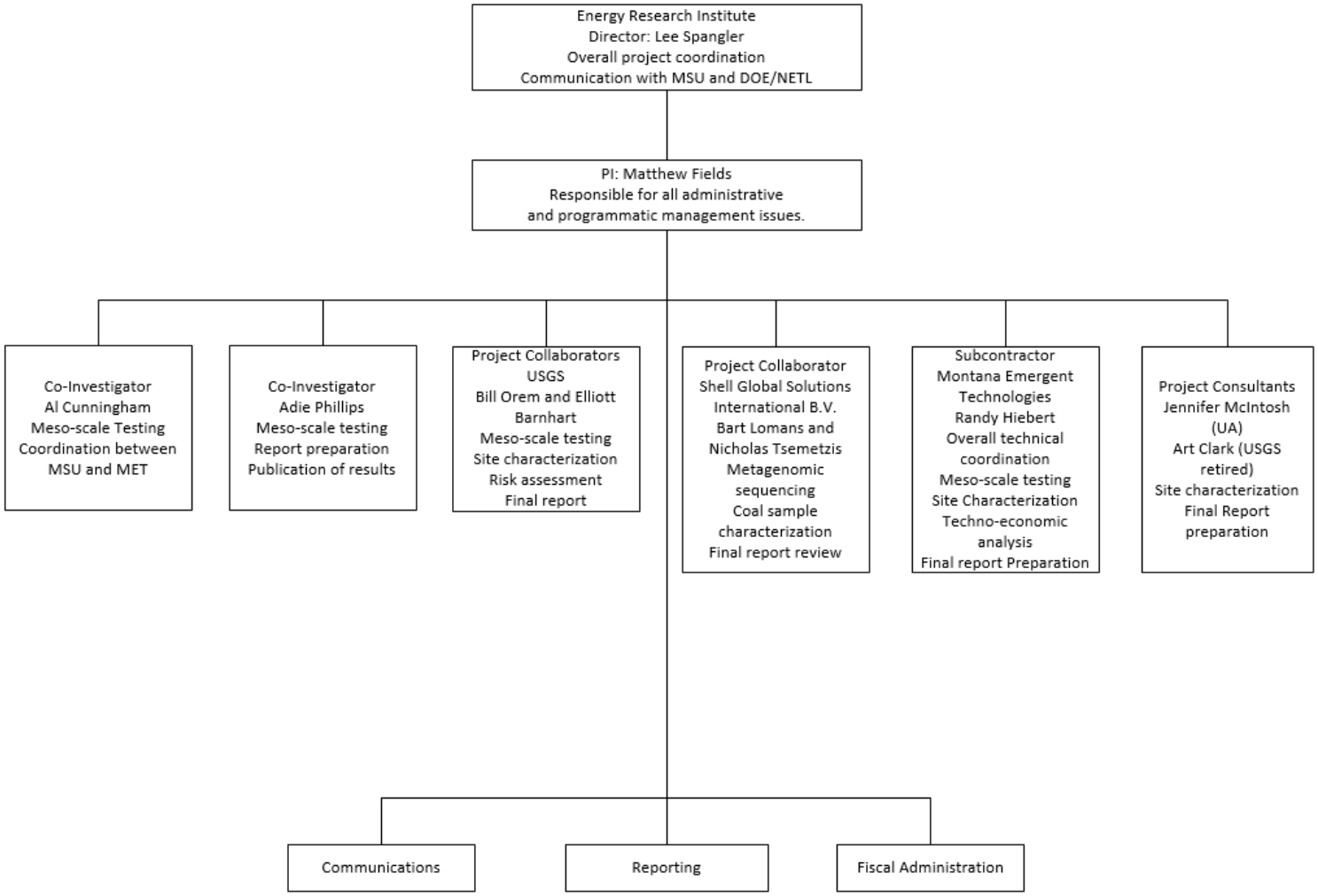
Team Roles & Responsibilities



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Task & Subtasks: Summary

Task 1.0 Project Management, Planning and Reporting: In accordance with the PMP

Task 2.0 Evaluate time-delay to methane production post-stimulation during a meso-scale push-pull injections.

Subtask 2-1 Evaluate time-delay to methane production post-stimulation during a meso-scale push-pull injection

Subtask 2.1 Push-pull injection into coal in MPV

Subtask 2.2 Push-pull injection into coal/sand in MPV

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Task & Subtasks: Summary

Task 3.0 Complete site characterization

Subtask 3.1 Compile existing field data into filed report and publication

Subtask 3.2 Analyze indigenous microbial communities in Flowers-Goodale coal seam and formation water

Task 4.0 Field test design and final report

Subtask 4.1 Subsurface sampling plan

Subtask 4.2 Preliminary risk management plan

Subtask 4.3 Surface infrastructure design

Subtask 4.4 Economic analysis

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Tasks & Subtasks

Subtask 2.1 Push-pull injection into coal in MPV

Subtask 2.2 Push-pull injection into coal/sand in MPV

Coal collection, water collection, coal processing, water processing

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Tasks & Subtasks

Subtask 2.1 Push-pull injection into coal in MPV

Subtask 2.2 Push-pull injection into coal/sand in MPV

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Tasks & Subtasks

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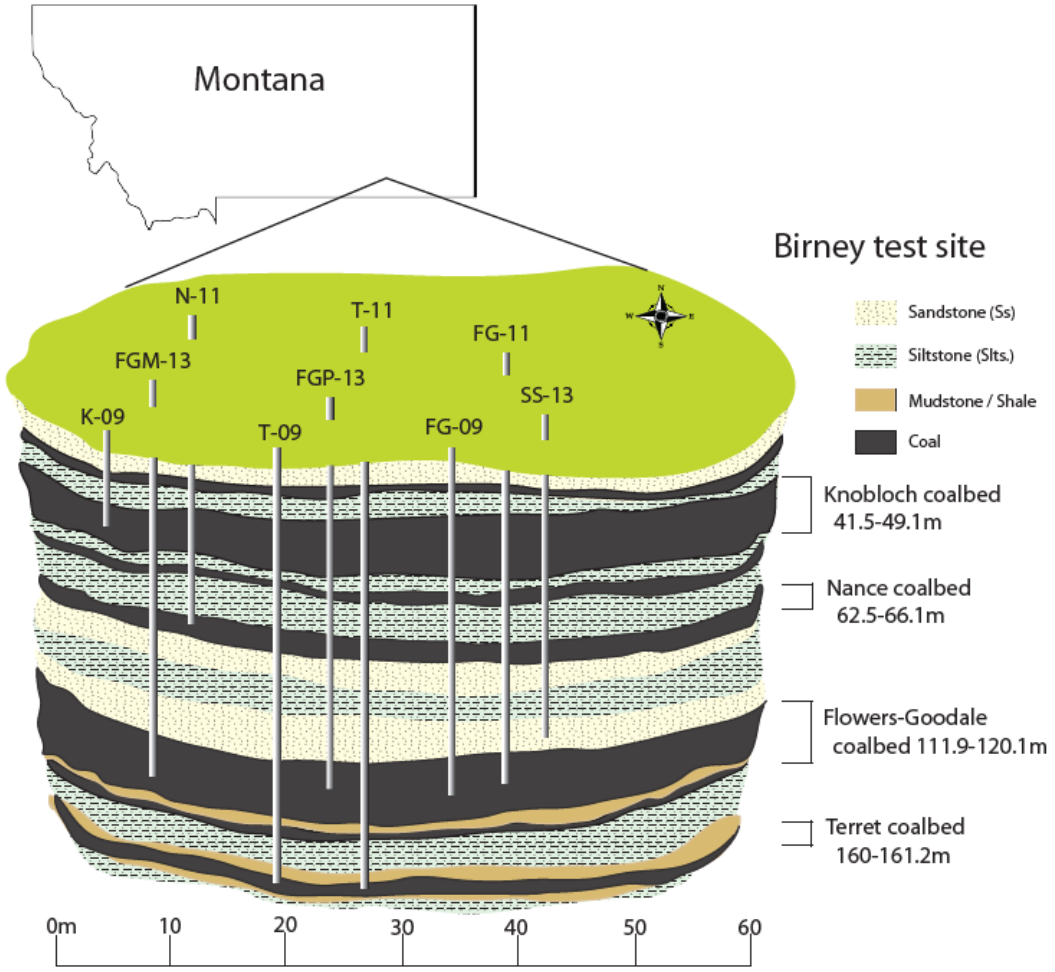
Birney test site consists of nine wells that access four major PRB coal seams (Knobloch (K), Nance (N), Flowers-Goodale (FG), and Terret(T)). Water samples were collected for geochemistry analysis and cores were obtained from T-11 and FG-11 for further geochemistry and microbiology analysis.



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Tasks & Subtasks

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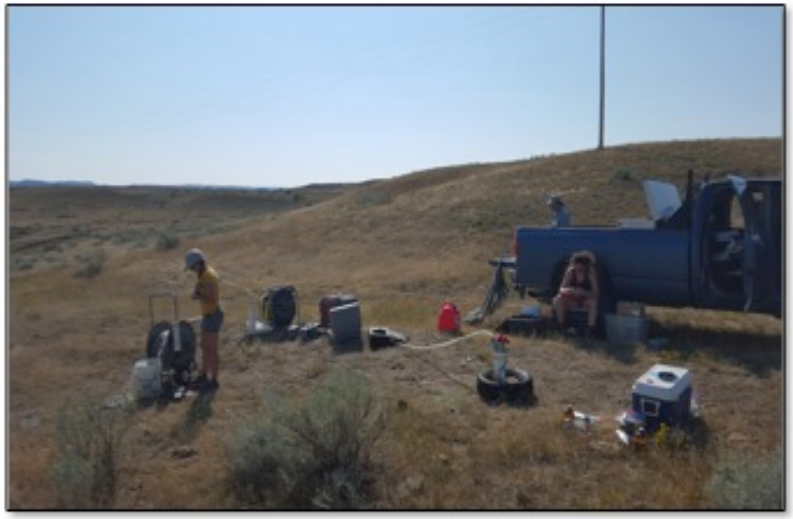

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Milestones

Table 1. Milestones

Milestone Number	Budget Period	Task	Fiscal Year & Quarter	Milestone Description	Planned Completion	Verification Method
1	1	1.0	FY2016 Q1	Updated Management Plan	11/30/2015	Project Management Plan file
2	1	1.0	FY2016 Q1	Kickoff meeting	12/31/2015	Presentation
3	1	2.1	FY2016 Q2	Complete assembly of meso-scale pressure vessel and begin push-pull experiments	01/31/2016	Progress Report
4	1	2.2	FY2016 Q3	Complete meso-scale push-pull experiment for Sub-task 2.2	08/31/2016	Progress report
5	1	4.0	FY2016 Q4	Complete Final Project report as per Task 4.0	09/30/2016	Progress report

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Deliverables

Task 2. Summary of observed time delays and rates for methane production after nutrient addition. This information will be included in the final report under task 4.0.

Task 3. A comprehensive site characterization report included as a chapter in the final project report. A report summarizing 16S and metagenomic sequencing data relevant to bio-gasification field testing at the Birney Test Site.

Task 4. Final report that includes of a plan for coordinating above-ground facility design for future field tests, a subsurface sampling plan, a preliminary risk management plan, a surface infrastructure design, and a techno-economic analysis.