Kickoff Meeting

Innovative Water Management Technology to Reduce Environmental Impacts of Produced Water

DE-NT0005682

January 15, 2009
Pittsburgh, PA
Project participants

- U.S. Department of Energy
- National Energy Technology Laboratory
- Clemson University
- Chevron
Presentation outline

- Background
- Objective
- Scope of work – tasks
- Milestones and schedule
- Decision points, success criteria, outcomes
- Risk management
- Deliverables and briefings
- Budget summary
- Personnel
Produced water issues

- Most produced water is managed by re-injection or transport and treatment
- Regulations for injection and discharge are becoming more stringent
- Volumes of produced water are expected to increase
- Produced water issues will limit energy extraction and increase energy cost
- Effective, lower cost treatment is needed
Constructed wetland treatment systems

- Typically cost 50 to 90% less than conventional treatment systems
  - Low construction cost
  - Low operating expense (O&M)
- Provide effective “wastewater” treatment (achieve NPDES requirements)
- Support of regulatory community
- Water conservation and reuse
Applications of constructed wetlands: point sources

- Municipal wastewater
- Contaminated groundwater
- Industrial wastewater
- Pulp and paper
Applications of constructed wetlands: non-point sources

- Acid mine drainage
- Golf course runoff
- Stormwater runoff
- Agricultural runoff
Systems carefully designed to “treat” (transfer or transform) constituents in impaired water in order to decrease the environmental risks these constituents may pose in receiving systems.
Features of constructed wetland treatment systems

- Largely self-maintaining
- Treat multiple constituents; wide range of concentrations
- Design for seasonal variations
  - e.g., annual plant dieback renews sediment binding surfaces
- Permitted as “wastewater” treatment systems
Key concepts

- **Goal**: remove targeted constituents from aqueous phase and partition to sediments in non-bioavailable forms

- **Method**: replicate natural systems - biogeochemical processes in sediments

- **Evaluation of performance**: measure decrease in aqueous concentrations and perform toxicity tests
Approach

- Identify chemical, physical, and risk characteristics
- Determine reuse and discharge criteria
- Develop treatment performance goals
- Identify biogeochemical treatment processes (pathways) and conditions to achieve these processes
- Design and construct system
- Measure treatment performance
Treatment processes

- Transfers
  - Sorption
  - Volatilization
  - Precipitation/settling/sedimentation
  - Bioconcentration

- Transformations
  - Hydrolysis
  - Photolysis
  - Oxidation/reduction/speciation
  - Biotransformation/biodegradation

Rodgers and Castle (*Environmental Geosciences*, 2008)
Reducing pathway

- \( \text{Eh} \leq -150 \text{ mV} \)
- Organic-rich sediment
- Removal of metals via reductive pathways

*Schoenoplectus californicus* C.A. Meyer
Oxidizing pathway

- Eh > -50 mV
- Sandy sediment
- Removal of water soluble organics via oxidative pathways

Typha latifolia L.
Project objective

Develop constructed wetland systems for treatment and beneficial use of produced water, and conduct scientific studies to address ecological, environmental, and regulatory concerns that limit options for managing produced water, including surface discharge.
Scope of work

- Phase I: Assess environmental factors associated with produced waters
- Phase II: Design, construct, and monitor pilot-scale wetland treatment system
- Phase III: Construct a demonstration-scale wetland treatment system and measure performance
Phase I

- Task 1: Project management plan
- Task 2: Identify chemical, physical, and risk characteristics of produced waters
- Task 3: Determine reuse and discharge criteria and develop treatment performance goals
Task 1

- Project management plan
  - completed
Task 2

- Identify and compile chemical, physical, and risk characteristics of produced waters
  - Include conventional and unconventional resources, particularly natural gas
  - Analyze samples of actual produced waters to confirm targeted constituents
Task 3

- Determine reuse and discharge criteria
  - Reuse criteria – agriculture
    Seed germination and seedling growth
  - Reuse criteria – industry
    Scaling and biofouling
  - Discharge criteria
    Toxicity testing to measure risk
- Identify constituents of concern
- Develop treatment performance goals
Risk mitigation strategy (Tasks 2 & 3)

- Constituents in produced water
- Water use or reuse criteria

Constituents of concern

Treatment criteria

Risk mitigation strategy
- Treatment needs
- Performance criteria
Phase II

- Task 4: Design and construct pilot-scale constructed wetland treatment systems
- Task 5: Measure treatment performance of pilot-scale constructed wetland systems
- Task 6: Assess pilot-scale performance
Design components

Vegetation

Hydroperiod

Hydrosoil
Monitoring

- Does it work? (performance)
- How does it work? (function)
  - Mass balances
  - Reaction rates
  - HRT/MRT
  - Loading rates
  - Seasonal influences (temperature, rainfall)
Phase III

- Task 7: Design and construct demonstration-scale constructed wetland treatment system
- Task 8: Measure treatment performance of demonstration-scale constructed wetland system
- Task 9: Apply results to water management and technology replication
- Task 10: Technology transfer
- Task 11: Final report
## Milestones

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<tr>
<th>Completion of:</th>
<th>Milestone Description</th>
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<tr>
<td>Task 2</td>
<td>Data for identifying constituents for treatment, which will be used for designing systems that provide treatment for water discharge or reuse and that mitigate risks</td>
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<tr>
<td>Task 3</td>
<td>Target levels for treatment and risk mitigation (treatment goals)</td>
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<tr>
<td>Task 4</td>
<td>Pilot-scale systems needed for monitoring and evaluating treatment</td>
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<td>Task 6</td>
<td>Results needed for design and construction of the demonstration system (Task 7) and success criteria for moving ahead to the next phase of the project</td>
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<tr>
<td>Task 7</td>
<td>Demonstration-scale system needed for monitoring and evaluating onsite treatment at a field location</td>
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<td>Task 9</td>
<td>A basis for constructing wetland treatment systems at other sites of conventional and unconventional oil and gas production</td>
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## Schedule

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<tr>
<th>Task</th>
<th>Project Milestone Description</th>
<th>Project Duration - Start: Nov. 3, 2008</th>
<th>End: Nov. 2, 2011</th>
<th>Planned Start Date</th>
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## Decision points, success criteria, outcomes

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<th>Decision Point</th>
<th>Success Criteria</th>
<th>Outcome</th>
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<tr>
<td>End of Phase I</td>
<td>Determination of produced water characteristics, identification of reuse and discharge criteria, and assessment of constructed wetland systems for treating produced water</td>
<td>Project will move ahead to Phase II if it is determined that constructed wetland systems offer a feasible approach for treating produced water</td>
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<td>End of Phase II</td>
<td>Treatment performance of the pilot-scale constructed wetland system in treating produced water, including ability to meet criteria for water reuse and discharge</td>
<td>Project will move ahead to Phase III upon achieving performance of the pilot-scale constructed wetland system in treating produced water</td>
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<td>End of Phase III</td>
<td>Treatment performance of the onsite demonstration wetland treatment system</td>
<td>The technology will be ready to apply to other sites for full-scale treatment of produced waters</td>
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Risk management

- Reasonable project schedule
- Experienced personnel
- Compliance with environmental health and safety
  - Training
  - Chemical use protocols
- Other – e.g. weather
Deliverables

- Project management plan (Task 1)
- Topical report with details from Phase 1
- Topical report with details from Phase 2
- Final report (Task 11)
- Other reports in accordance with the Federal Assistance Reporting Checklist
Briefings/technical presentations

- Project kick off meeting
- Technical papers at DOE/NETL Annual Contractors Review Meeting
- Annual detailed briefings to DOE Project Officer
## Budget summary

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<th>Phase I (Tasks 1-3)</th>
<th>Phase II (Tasks 4-6)</th>
<th>Phase III (Tasks 7-11)</th>
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(End of budget summary table)
Personnel

- Clemson University
  - Jim Castle, PI
  - John Rodgers, PI
  - Graduate students: Alex Beebe, Bethany Alley

- Chevron
  - Jim Myers
  - Cindy Murray Gulde

- DOE-NETL
  - Sandy McSurdy, Project Manager
Questions and discussion