Colorado Energy Research Institute

Western Research Institute

Western Resources Project

Produced Water Management and Beneficial Use

Award#: DE-FC26-05NT15549

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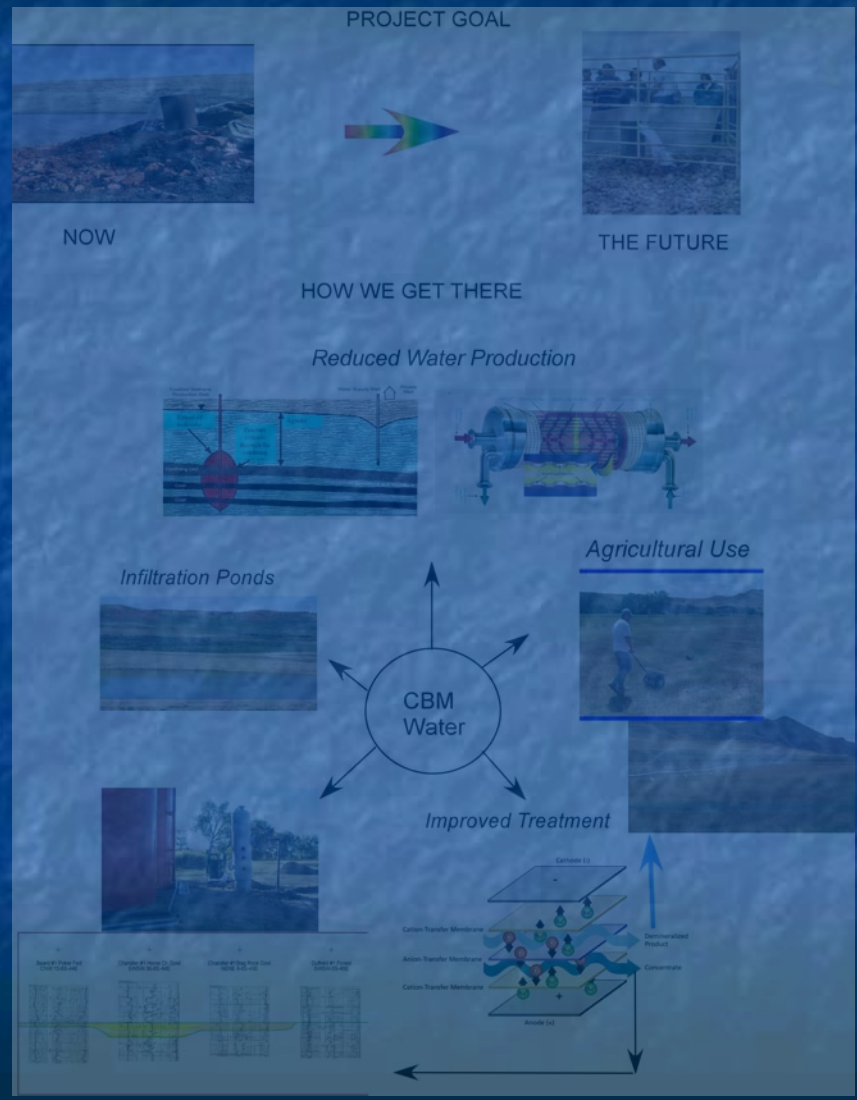
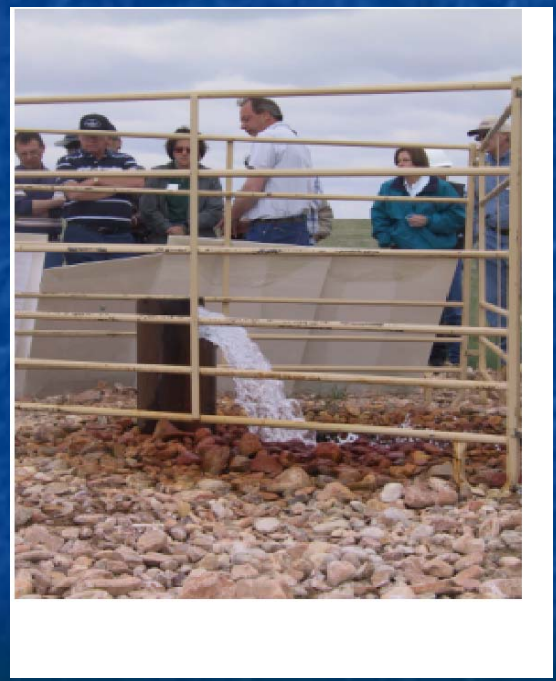


Produced Water Management and Beneficial Use



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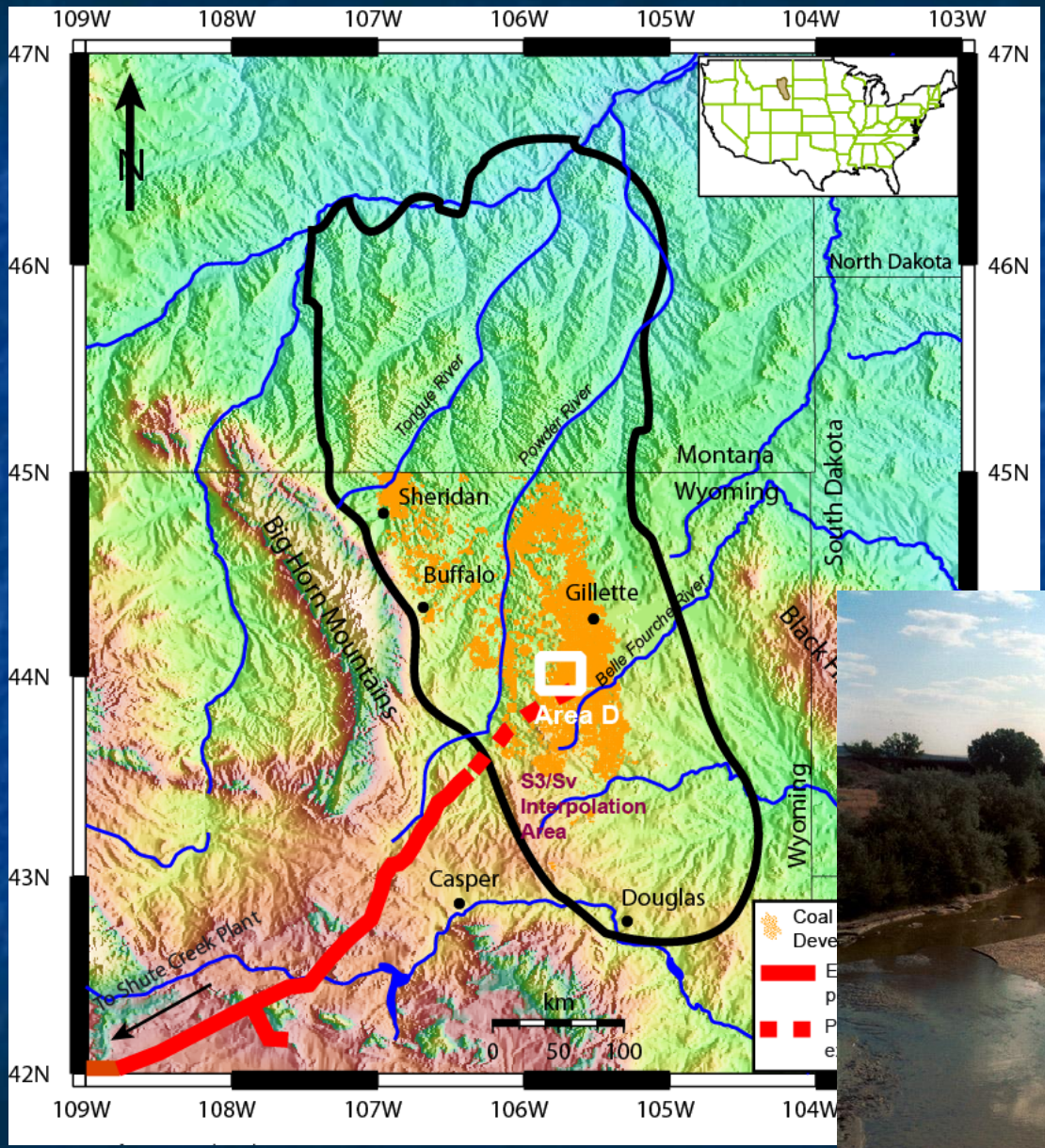
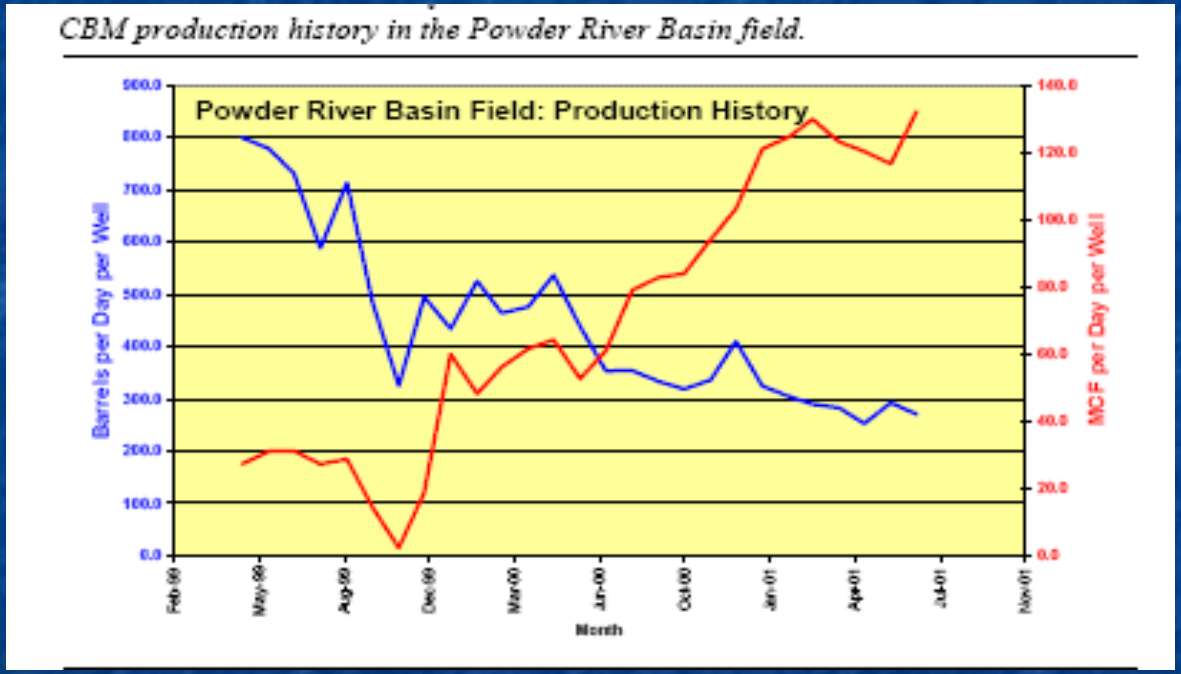
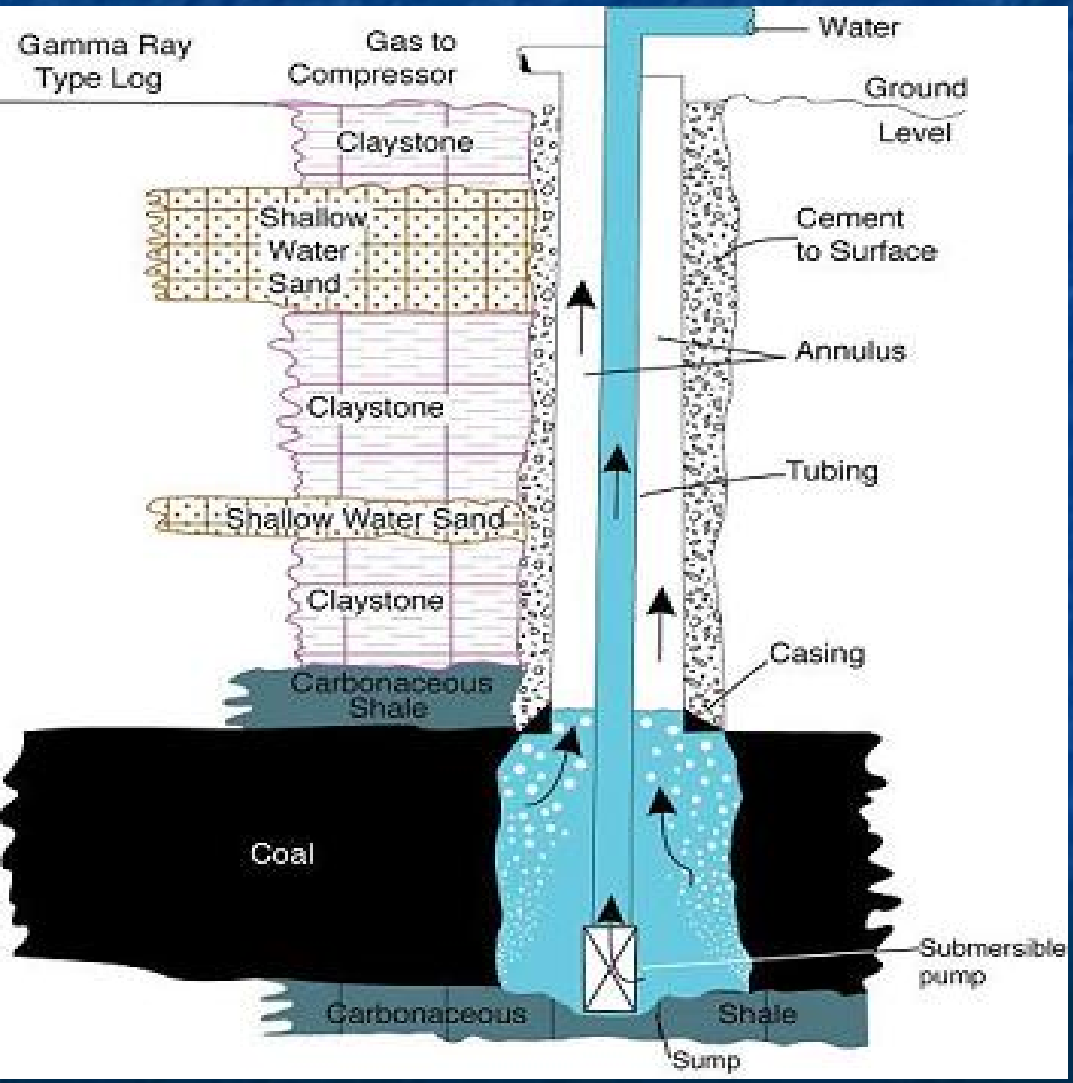


Overview of Problem

- Production of Coal Bed Methane produces water as by-product
- Variable volumes
- Water chemistry is generally dominated by Na-bicarbonate



Overview of Project



- The fundamental logic of this project is the recognition that no single treatment can be applied to all co-produced water from Coal Bed Methane (CBM) operations in the Powder River Basin of Wyoming. The project integrates the efforts of ten subcontractors from the Argonne National Laboratory, the Gas Technology Institute, University of Wyoming, Stanford University, Montana Tech, Pennsylvania State University and a private firm, PVES Inc. through the Colorado Energy Research Institute

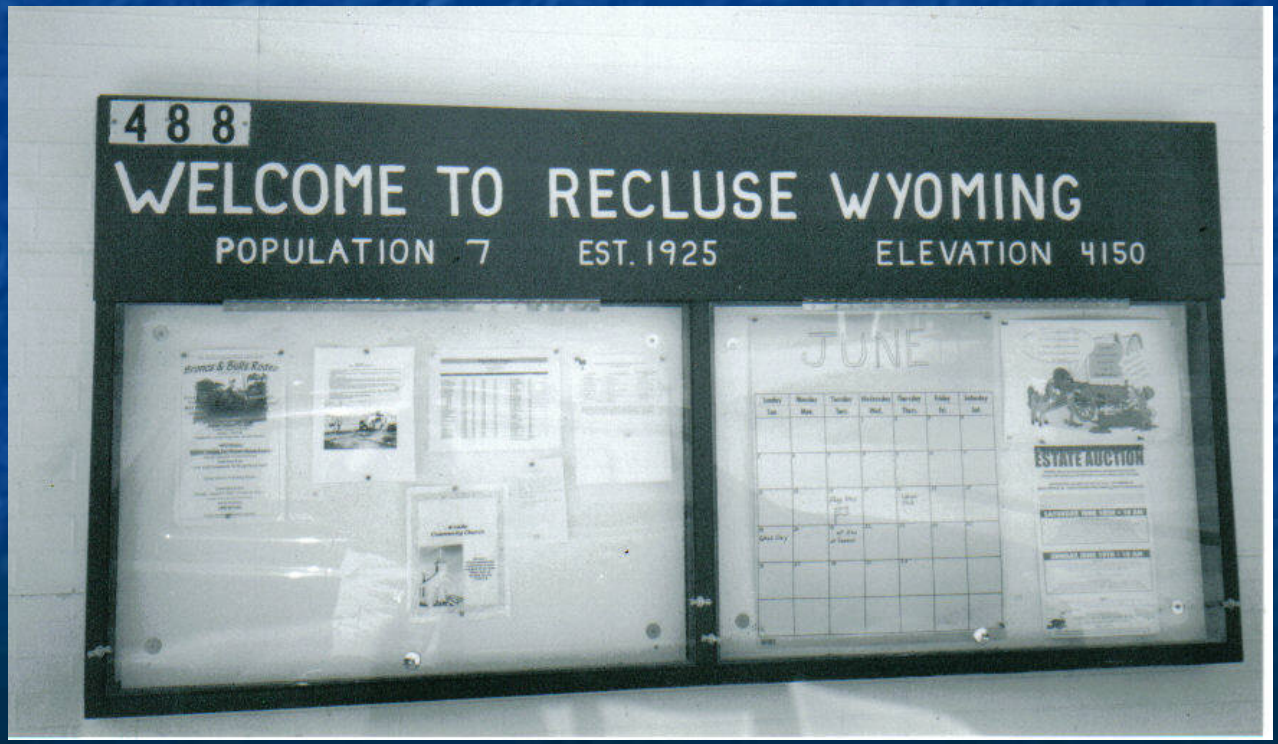
Temporal effects: Vegetation change

Lower stream, April 2003

Lower stream, June 2005

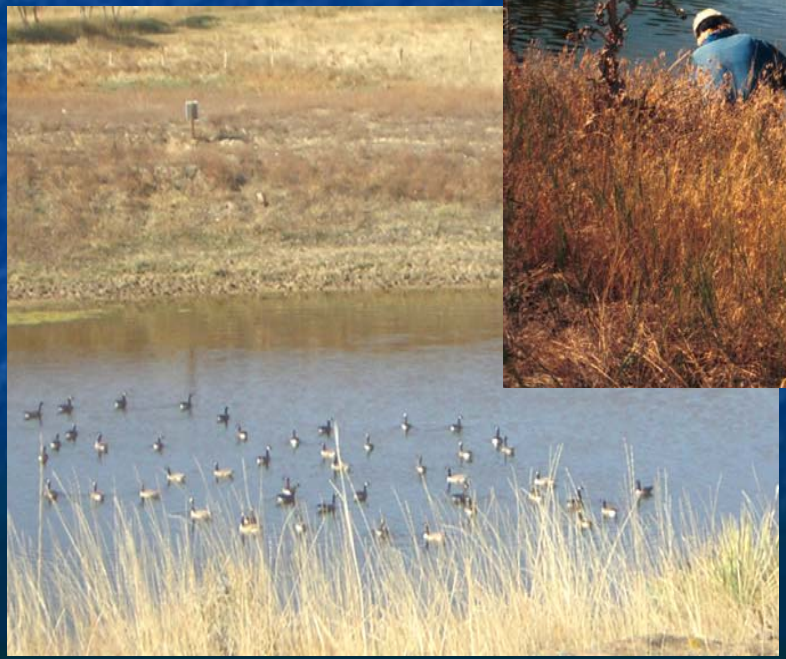
Overview of Problem

- Use the water for irrigation in high desert



Produced Water Management and Beneficial Use

Water Infiltration Impoundment



Project Funding

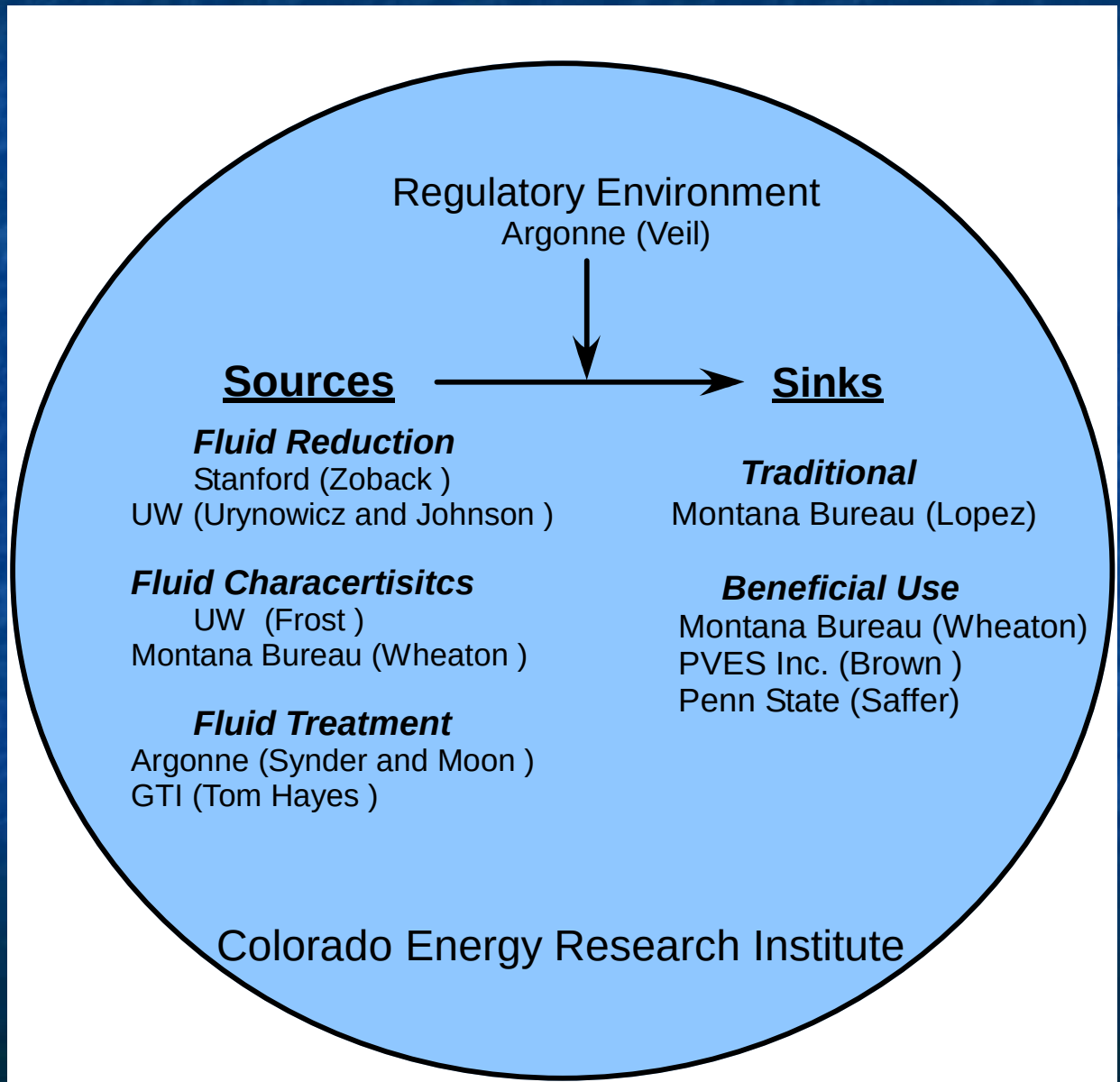
2 Year project

Total Project	$2,725,6000
Project Yr 1	Cofunding
$ 1,200,891	$ 274,335
Project Yr 2	Cofunding
$ 975,308	$ 275,067
Total	Cofunding Total
$ 2,176,198	$ 549,402

Progress to Date

- Start Date – April 29, 2005
- End Date – April 29, 2007
- All contracts in place by July 2005
- All projects underway

Project


Regulatory Environment
Argonne (Veil)
Sources
Sinks
Fluid Reduction
Stanford (Zoback)
UW (Urynowicz and Johnson)
Fluid Characertisitcs
UW (Frost)
Montana Bureau (Wheaton)
Fluid Treatment
Argonne (Synder and Moon)
GTI (Tom Hayes)
Traditional
Montana Bureau (Lopez)
Beneficial Use
Montana Bureau (Wheaton)
PVES Inc. (Brown)
Penn State (Saffer)
Colorado Energy Research Institute

Project Oversight

- **Colorado Energy Research Institute**
  - PI – Dag Nummedal
  - *Overall Management and Integration of Team Efforts*

- **Argonne National Laboratory**
  - PI – John Veil
  - *Ensuring that Technology Meshes with Regulatory Requirements*. This project provides team members with an overview on water regulatory topics and a resource to ensure that any technical results are feasible in the context of the regulatory environment..

Water Treatment

- **Gas Technology Institute and Argonne National Laboratory**
  - PI's – Seth Synder and Paula Moon
  - *Electrodialysis Treatment of CBM Produced Water for Beneficial* Use. The overall objective of this project is the development of electrodialysis processing for reliable, low-cost treatment of produced waters for product that is suitable for beneficial use.

Reduction of Source

- **University of Wyoming**
  - PI's – Michael Urynowicz and Andrew Johnson
  - *Membrane Enhanced CBM Treatment.* Project is exploring use of down-hole membranes to extract methane without water production.
- **Stanford University**
  - PI - Mark Zoback,
  - *Geomechanics and the effectiveness of wellbore completion methods in coalbed methane water in the Powder River Basin.* The goal of this study is to evaluate coalbed methane (CBM) wellbore completion methods to determine if there are ways to produce less water, while still achieving adequate coal depressurization for production.

Water Characterisitics

- **University of Wyoming**
  - Carol Frost, PI,
  - *Isotopic Tracing of Produced Coalbed Methane Water in the Powder River Basin*. Project will develop the use of Sr isotopic data to serve as single tracer to distinguish CBM water from background aquifers.
- **Montana Technical University**
  - PI – John Wheaton
  - *Perform Standardized Testing of CBM Water-Treatment Systems*. This project will develop a standardized trailer-mounted unit for water testing and analysis.

Beneficial Use

- **Montana Technical University**
  - PI – John Wheaton
  - *Regional siting criteria for CBM infiltration ponds*. This project will investigate the controls on infiltration of CBM water in ponds and develop siting criteria.
- **Pennsylvania State University**
  - PI – Demian Saffer
  - *Controls on the Fate of CBM Waters and Impacts to Shallow Aquifer Quality*. This project will provide the data for numerical modeling of infiltration and groundwater mounding in the Powder River Basin and develop predictive and transferable tools for water management.
- **PVES Inc.**
  - PI – Terry Brown
  - *Evaluating the Produced Water During CBM Extraction for Land Application in the PRB and Project management*. The project will test the effect of various soil amendments to enable the beneficial use of CBM water for irrigation.

Water Injection

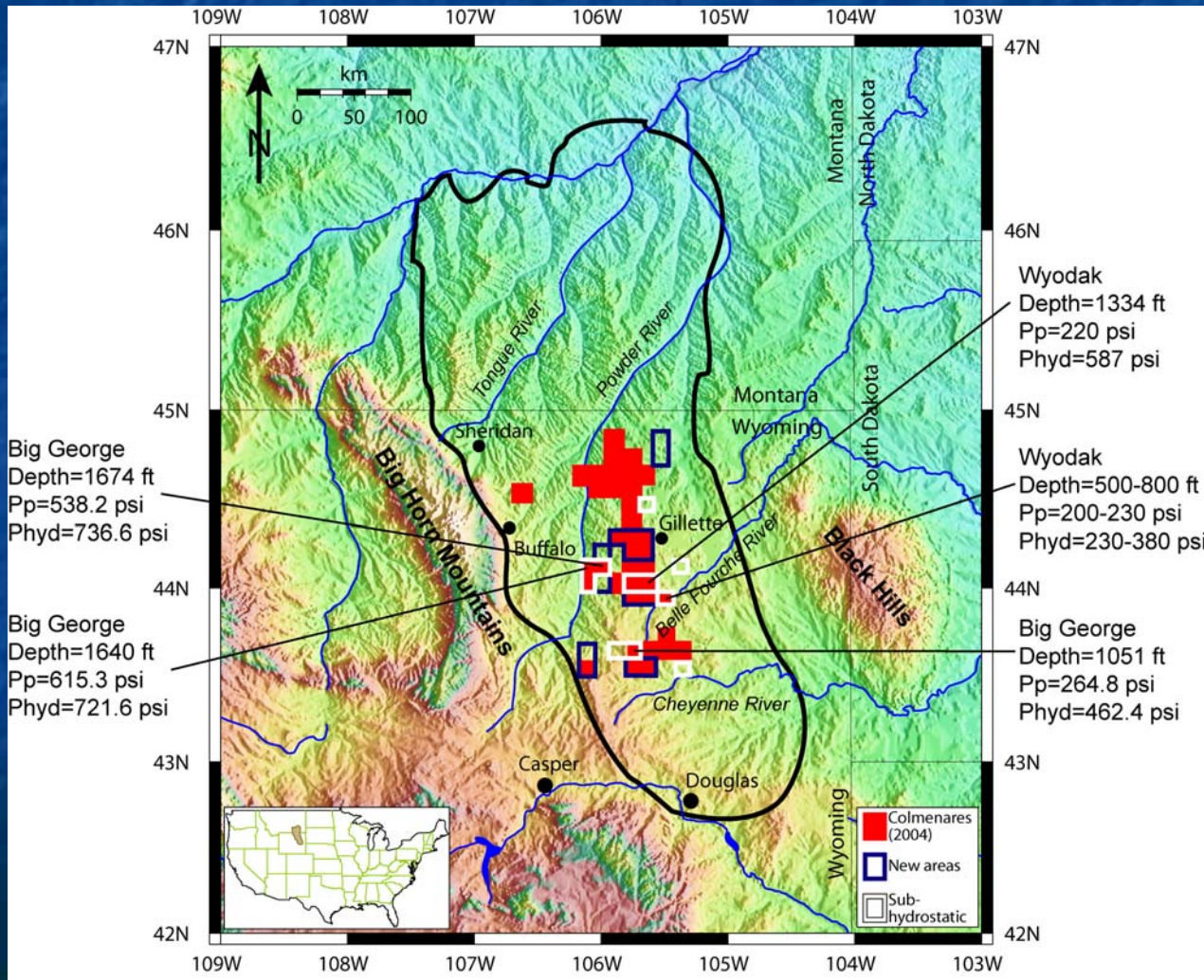
- **Montana Technical University**
  - PI – David Lopez
  - *Water Treatment by Injection*. This project will identify and test the feasibility of disposal of produced water by injection in shallow zones to preserve beneficial use by means of a pilot injection project. Specifically, the thick porous and permeable sands and non-producing coal beds in the Tongue River Member of the Fort Union Formation, which overlies the Lebo Shale Member will be mapped for potential test injection wells.

Project Benefits

- Chemical and Isotopic Methodology
  - Sr isotopic tracer
  - Mobile Chemistry Laboratory
- Evaluation of water volume reduction
  - Fracture orientation
  - Extraction by membrane
- Evaluation of traditional water disposal methods
  - Injection
  - Infiltration Ponds
- Evaluation of Beneficial Use
  - Irrigation
  - Water Treatment
- Tech transfer = publications and project website
  - AAPG Regional Meeting in Billings, 2006
  - RMAG/COGA 2006 meeting
  - AAPG Bulletin publication (Colmenares and Zoback)

First Problem

- Treatment to what standards?
  - Montana has new proposed standards
  - ED can meet standards but will generate saline solution
  - Underpressured zones are potential disposal sites



Pore pressure data from BLM wells in same township and range as our wells, and from same coalbeds