The importance of long-term monitoring around energy development:

Lessons learned about the value of water monitoring around coal and CBM development in southeastern Montana

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Long-term monitoring: Structure

• The impetus:
  • Local Concern
    • Coalbeds serve multiple purposes
    • Mixed reactions from landowners based on Wyoming’s experience with CBM development
  • CBM Environmental Impact Statement (EIS)
    • Co-written by the US BLM and MT Board of Oil and Gas
    • Stipulated monitoring through development and recovery by an agency like the MBMG
    • Monitoring modeled after the MBMG coal monitoring program
  • Controlled Groundwater Basin
    • PRB CGWA applies only to CBM wells
    • Established a Technical Advisory Council to monitor for impacts and MBMG supplies an annual report of monitoring
Long-term monitoring: Structure

• The impetus:

Coal Mine Bond Release: MT ARM 17.24.1116

• Phase I: backfilling, grading and drainage control.
• Phase II: soil replacement, two seasons of established vegetation, control of noxious weeds, farmland returned to a predetermined level of production.
• Phase III: Responsibility period has elapsed, vegetation is established, landscape is stable.
• Phase IV: Fish and wildlife habitats have been restored. Hydrologic balance disturbance has been minimized. Alternative water supplies to replace those that were adversely affected are functional. The reestablishment of essential hydrologic functions and agricultural productivity on alluvial valley floors has been achieved.

(Of the 34,484 disturbed acres, 50 acres have received MT Phase IV bond release – 0.1%, June 30, 2010)
Long-term monitoring: Structure

- **Partners:**
  - Resource agencies – BLM, DNRC, USFS
  - Landowners
  - Industry

- **The funding:**
  - Bureau of Land Management (long-term)
  - US Forest Service (long-term)
  - Montana State (project specific)
  - Local Conservation Districts (long-term & project specific)
  - US EPA (project specific)
  - US DOE (project specific)
Long-term monitoring: Structure

- Monthly monitoring of water levels
- Semi-annual alluvial water quality sampling
- Annual deep aquifer sampling
- Infiltration pond monitoring
- Installation of additional monitoring wells
- Annual reporting
Water levels in the Big Sky spoils aquifer quickly reached a new equilibrium.
Groundwater salinity in the Big Sky spoils aquifer stabilizes quickly but is spatially variable in the ultimate water quality.
Legend

- Wells sampled in the 1970's

Selenium concentrations
Legend

- **Wells sampled in the 1990's**

Selenium concentrations
methane to compressor station

water is managed for disposal

water pumped up through a central pipe

methane is collected in an outer pipe
What was known in 2001:
- CBM requires water-level drawdown to near the top of the coal
- Water quality will be slightly saline and highly sodium rich

What was unknown:
- Would the drawdown extend to other aquifers?
- What would be the impact to surface water and near-surface groundwater from produced water management?

<table>
<thead>
<tr>
<th></th>
<th>CBM Predicted</th>
<th>Mont. coal mines</th>
<th>Wyo. coal mines</th>
<th>Mont. computer model</th>
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</thead>
<tbody>
<tr>
<td><strong>Years</strong></td>
<td>early</td>
<td>20</td>
<td>20</td>
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<tr>
<td><strong>Drawdown (ft)</strong></td>
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<td>10</td>
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<tr>
<td><strong>Distance (miles)</strong></td>
<td>1 to 2</td>
<td>5 to 10</td>
<td>2 to 4</td>
<td>2 to 14</td>
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</tbody>
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<td><strong>Years</strong></td>
<td>5</td>
<td>10 to 15</td>
<td>3 to 4</td>
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<tr>
<td><strong>% Recovery</strong></td>
<td>90</td>
<td>70</td>
<td>90+</td>
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<tr>
<td><strong>Distance (miles)</strong></td>
<td>1+</td>
<td>0</td>
<td>0</td>
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</table>
Canyon Coal
20 foot drawdown

Dedicated Monitoring Wells & 48 hr Shut-in tests on CBM Wells
Impacts will occur for the life of production and during the years of recovery

- Recovery has been faster than anticipated but reflects on-going CBM production.

Less drawdown in overburden

- Overburden drawdown is rarely seen

About 10 feet of drawdown at 5 – 10 miles outside field

- About 20 feet of drawdown at 1 – 2 miles outside field, 0 drawdown at 5 miles.

Decrease flow of some springs

- Drawdown has not reached outcrop in any monitored location (springs)

Decrease water availability at wells

- Drawdown has decreased water availability in wells within the area of influence
How the information is used:

• Evaluating the adequacy of NEPA
  • The impacts described by the EIS and EAs have been shown to be reasonably accurate through on-going monitoring.
  • Improves confidence from outside.
  • Decreases risks of lawsuits.

• Evaluating impacts where data are scarce for future permitting
  • For example, pond permitting.
  • Transferability of environmental evaluations.
  • References for decision making.

• CBM Protection Act (Montana State program)
  • Landowners (Conservation Districts) tasked to determine financial impacts.
  • Look to government agencies and MBMG for data and assistance.

• Locally, Nationally, and Internationally
  • Used by landowners to identify drilling locations
  • Used at the Supreme Court level
  • Australian and Canadian monitoring modeled after PRB monitoring
Available Reports

COALBED-METHANE BASICS: Powder River Basin, Montana
by John Wheaton and Teresa Donato

Coalbed-Methane Basics
Ten Years of Lessons from the Powder River Basin, Montana

Elizabeth Meredith
John Wheaton
Shawn Kuzana

SPECIAL POINTS OF INTEREST:
- Introduction to coalbed methane
- The role of the Montana Bureau of Mines and Geology
- Current CBM production in Montana
- Coproduced water management
- Resources available to the public

Written for the general public.
Annual report of monitoring observations and interpretations

• Technical report written for stakeholders.
• 8 years of reporting beginning in 2003.

Long-term coal mine hydrology monitoring by the MBMG

• Summary report written for stakeholders, funding agencies, and scientists.
• Focuses on reclamation at Big Sky Mine.