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# Coalbed Methane Development in the Intermountain West: Primer

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# COALBED METHANE DEVELOPMENT IN THE INTERMOUNTAIN WEST:

## PRIMER

*Coalbed methane is one of the most important and valuable natural resources in the Western United States. The natural gas that results from CBM development is the cleanest burning fossil fuel, and the extensive domestic supply makes it a central element of the national goal of a secure supply of energy. Demand for natural gas will continue to grow and CBM will play an increasingly larger role in meeting that demand. CBM production has expanded tremendously over the past decade, and the rapidity with which development has expanded has resulted in stresses and tension in affected communities. Development of this important energy resource must be balanced with a number of other important goals of protecting water, land, and other resources in the West. The primary purposes of the report are to: provide an overview of where CBM resources are located and how they are extracted, provide some background for understanding the issues surrounding CBM development and the role that it plays in the nation's energy policy, review the public policies affecting the production of CBM, assess the major issues that have arisen in the West concerning CBM development and its impact on local communities and other natural resources, examine lessons that might be learned from different basins and that might be applied elsewhere, and suggest some basic principles and practical steps that might serve to address some of the conflicts that have arisen in CBM basins and that might be applied to shape future development in other basins.*

GARY BRYNER, *Natural Resources Law Center, University of Colorado School of Law*

## OVERVIEW

Coalbed methane (CBM) is a form of natural gas that is trapped within coal seams and held in place by hydraulic pressure. The gas is adsorbed to the internal surfaces of the coal; when wells are drilled that extract the water holding the gas in place, the methane eventually flows through fractures to the well and is captured for use. Coalbed methane extraction began as an effort to reduce the threat of methane explosions in coal mines, and has been produced in commercial quantities since 1981. CBM development in the United States has grown rapidly from a few dozen wells in the 1980s to some 14,000 wells in 2000. In 1989, the United States produced 91 billion cubic feet of coalbed methane; ten years later, the total produced had grown to nearly 1.3 trillion cubic feet, representing seven percent of the total natural gas production in the United States.<sup>1</sup>

Some 56 percent of the total CBM production in the United States has come from the Rocky Mountains. The San Juan basin in Southern Colorado/Northern New Mexico has been the major source of CBM. Development began in 1988 and rapidly expanded by the end of the 1990s. Production has now begun to decline and companies are trying to maintain output by more intensive

development. The Powder River Basin in Northeast Wyoming is the fastest growing CBM play. In 1997, the basin produced 54 million cubic feet of gas/day from 360 wells. Four years later, 5,854 wells were producing 656 million cubic feet/day. CBM resources are also being developed in the Uinta Basin in Eastern Utah, the Raton Basin in south-central Colorado, and the Piceance Basin in northwest Colorado, and major expansions of coalbed development are expected in Montana, the Green River basin in Wyoming, and perhaps other areas in the West. Colorado, New Mexico, Utah, and Wyoming may contain as much as 47 trillion cubic feet of coalbed methane, one third of the total estimated recoverable amount in the United States. According to the US Geological Survey, the United States may contain more than 700 trillion cubic feet (Tcf) of coalbed methane in place, with more than 100 Tcf economically recoverable with existing technology.<sup>2</sup>

The tremendous and rapid growth in coalbed methane development has posed daunting challenges for the communities in which it has occurred. The construction of new roads, pipelines, compressors, and other facilities have transformed landscapes. Air and noise pollu-



tion have become sources of conflict. Some land owners possess only surface rights; government agencies have leased the subsurface mineral rights to companies, and those rights clash with the interests of some ranchers, farmers, homeowners, and others who seek different kinds of land uses. Just as difficult as land use issues have been conflicts over the water produced from CBM development. CBM development may affect underground water quantity and contaminate aquifers, underground water supply may be diminished as dewatering occurs, groundwater may be contaminated by mineral-laden discharged water, and local ecosystems may be adversely affected by the surface release of large quantities of water. Produced water may also be a valuable source of fresh water in arid regions.

CBM development is a major issue facing federal land agencies, state governments, county commissions, energy companies, and citizens throughout the Intermountain West. Another major challenge is that of governance—how to coordinate the efforts of federal, tribal, state, and local governments that have varying interests and responsibilities for regulating CBM production.

This primer seeks to contribute to public discussion and policy making for CBM development by providing a non-technical, accessible, reference tool that explains what CBM is, examines and compares the experience of CBM development throughout the mountain West, explores options for resolving conflicts and improving policies that govern CBM development, and identifies lessons that can be learned from different areas that might help other regions better deal with the challenges posed by development. The sections of the primer focus on four major questions.

First, what is CBM, where is it located, and how is it developed? This section provides background and context for framing the issues surrounding CBM development, including the nature of CBM, its role in meeting national energy needs; the location of major CBM resources in the Interior West, including the relationship of reserves to private and public lands, including split estates and sensitive public lands, such as wilderness study areas, National Forest roadless areas, and national monuments; and the role of CBM in national energy policy.

Second, what are the problems, conflicts, and challenges associated with CBM development? Section two examines the environmental and other impacts associated

with CBM development, particularly the impacts of production and distribution of CBM on local landscapes and residents and the conflicts between competing land uses and users, and the impact of CBM extraction on water quality and quantity.

Third, how is CBM development regulated? This section examines current public policies governing CBM development, including Federal clean water, natural gas, and other laws and regulations; Federal tax incentives and its implications for CBM development; state regulatory programs; and local land use, zoning, and other regulatory programs in the Intermountain states where CBM development is occurring.

Fourth, how can conflicts surrounding CBM development be reduced? This section focuses on suggestions that have been made to minimize the environmental and other impacts of CBM extraction and actions that communities, governments, and companies might take to reduce conflicts over land use and water impacts from development.

## I. WHAT IS CBM, WHERE IS IT LOCATED, AND HOW IS IT DEVELOPED?

### WHAT IS COALBED METHANE?

Coalbed methane is a form of natural gas that is trapped within coal seams. Coalbed gas is primarily made up of methane (typically 95 percent), with varying amounts of heavier fractions and, in some cases, traces of carbon dioxide. Coals have a tremendous amount of surface area and can hold massive quantities of methane. Since coalbeds have large internal surfaces, they can store six to seven times more gas than the equivalent volume of rock in a conventional gas reservoir.<sup>3</sup> Coal varies considerably in terms of its chemical composition, its permeability, and other characteristics. Some kinds of organic matter are more suited to produce CBM than are others. Permeability is a key characteristic, since the coalbed must allow the gas to move once the water pressure is reduced. The gas in higher rank coals is produced as heat and pressure transform organic material in the coal; gas in low rank coals results from the decomposition of organic matter by bacteria. Figure 1 provides a simplified view of how CBM is formed.

Coalbeds are both the source of the gas that is generated and the storage reservoir once it is produced.<sup>4</sup> Gas



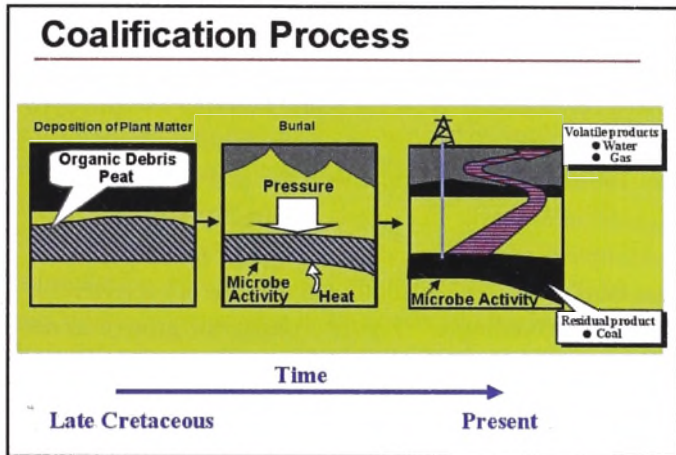


FIGURE 1 Source: William T. Brown, NRLC coalbed methane conference, April 4-5, 2002.

molecules adhere to the surface of the coal. Most of the coalbed methane is stored within the molecular structure of the coal; some is stored in the fractures or cleats of the coal or dissolved in the water trapped in the fractures. Coals can generally generate more gas than they can absorb and store. Basins that contain 500-600 standard cubic feet (SCF) of methane per ton are considered to be "very favorable for commercial coalbed gas production," as long as there is sufficient reservoir permeability and rate of desorption. Some coals have generated more than 8,000 SCF of methane per ton of coal.<sup>5</sup> The most pro-

ductive coalbeds are highly permeable, saturated with gas, and fractured.<sup>6</sup>

Coalbed methane is produced either through chemical reactions or bacterial action. Chemical action occurs over time as heat and pressure are applied to coal in a sedimentary basin. Bacteria that obtain nutrition from coal produce methane as a by-product.<sup>7</sup> Methane attaches to the surface areas of coal and throughout fractures, and is held in place by water pressure. When the water is released, the gas flows through the fractures into a well bore or migrates to the surface. Figure 2 illustrates the different kinds of coal, the production of coalbed methane, and the kinds of coal found in the major CBM basins in the West.

Most coals contain methane, but it cannot be economically extracted unless there are open fractures that provide the pathway for the desorbed gas to flow to the well. Methane remains in a coalbed as long as the water table is higher than the coal.<sup>8</sup> These cleats and fractures are typically saturated with water, and the coal must be dewatered (usually pumped out) before the gas will flow.<sup>9</sup> Some coals never produce methane if they cannot be dewatered economically. Some coal beds may produce gas but be too deep to feasibility drill to release the gas. CBM wells are typically no more than 5000' in depth, although some deeper wells have been drilled to extract the gas.

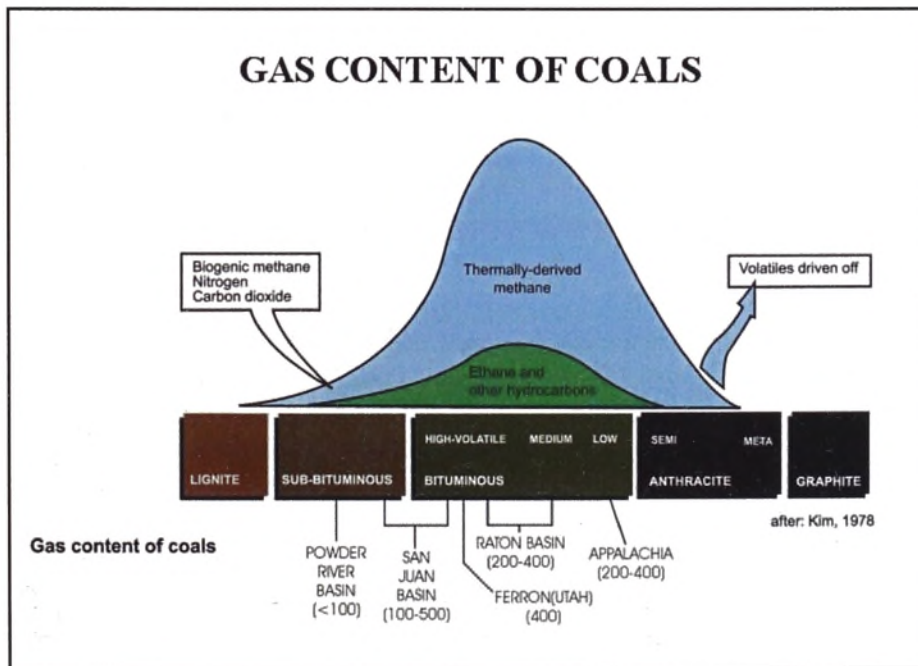


FIGURE 2 Source: William T. Brown, NRLC coalbed methane conference, April 4-5, 2002.

The deeper the coalbed, the less the volume of water in the fractures, but the more saline it becomes. The volume of gas typically increases with coal rank, how far underground the coalbed is located, and the reservoir pressure.<sup>10</sup>

As the fracture system produces water, the adsorptive capacity of the coals is exceeded, pressure falls, and the gas trapped in the coal matrix begins to desorb and move to the empty spaces in the fracture system. The gas remains stored in nearby non-coal reservoirs until it is extracted.<sup>11</sup> Drilling dewateres the coal and accelerates the desorption process. Drilling initially produces water primarily; gas production eventually increases and water



production declines. Some wells do not produce any water and begin producing gas immediately, depending on the nature of the fracture system. Once the gas is released, it is free of sulfur and usually of sufficient quality to be directly pumped into pipelines.<sup>12</sup>

#### WHAT ROLE DOES CBM PLAY IN U.S. ENERGY POLICY?

Oil and natural gas are the dominant fuels in the U.S. energy supply, providing 62 percent of the total energy supply.<sup>13</sup> Natural gas provides 24 percent of the energy used in the United States and 27 percent of total domestic production.<sup>14</sup> The United States produces 85% of the gas it uses and imports the rest from Canada. Natural gas is used to produce 16 percent of the electricity generated in the United States, and the fastest growing use of natural gas is to produce electricity.<sup>15</sup> It is also used for space and

water heating, cooking, fueling industrial processes, vehicle fuel, and other purposes. Natural gas prices have fluctuated considerably in recent years, affecting incentives to explore for new reserves. Prices were stable throughout the late 1980s and 1990s, and low prices in 1998 and 1999 resulted in cutbacks in exploration. In 2000, prices quadrupled, reaching an all-time high of \$9.98 per million Btus in December 2000, and exploratory activity expanded accordingly.<sup>16</sup> Figure 3 charts the growth in natural gas and other fuels in the United States.

The average household uses about 50,000 cubic feet of natural gas each year. One trillion (1,000,000,000,000) cubic feet of natural gas is enough to meet residential needs for about 75 days. The balance of the natural gas used each year fuels electricity production and industrial and commercial operations. Demand for natural gas is currently growing at about 1 Tcf per year.<sup>17</sup> The Bush administration's national energy policy projects that the United States will need about 50 percent more natural gas to meet demand in 2020 and that demand will eventually outstrip domestic supply, requiring increased imports of natural gas from Canada and elsewhere.<sup>18</sup> The U.S. Department of Energy (DOE) on which the national energy policy projections is based suggests that natural gas use will increase between 2000 and 2020 from 22.8 to 34.7 Trillion cubic feet (Tcf); another estimate suggested consumption will climb to 31 Tcf by 2015.<sup>19</sup> Others project an even more rapid increase in consumption. Many executives of natural gas companies believe that by 2007 the market for gas will reach 30 Tcf.<sup>20</sup>

Domestic production of natural gas is expected to increase from 19.3 Tcf in 2000 to 29.0 Tcf in 2020, resulting in increased natural gas imports. According to a DOE report,

*the most significant long-term challenge relating to natural gas is whether adequate supplies can be provided to meet sharply increased projected demand at reasonable prices. If supplies are not adequate, the high natural gas prices experienced over the past year could become a continuing problem, with consequent impacts on electricity prices, home heating bills, and the cost of industrial production. . . . To meet this long-term challenge, the United States not only needs to boost production, but also must ensure that the natural gas pipeline network is expanded to the extent necessary.<sup>21</sup>*

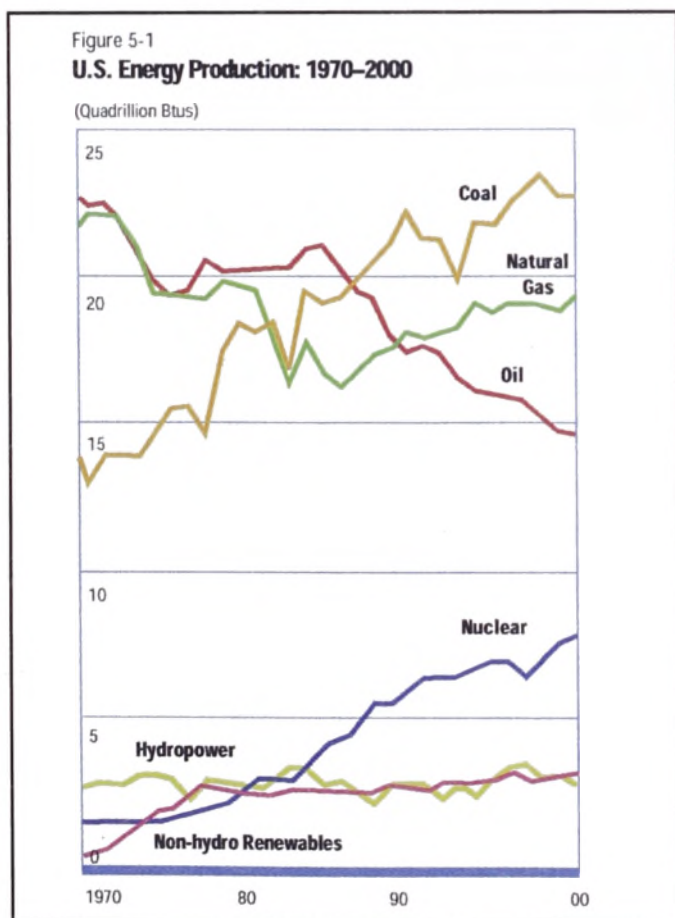


FIGURE 3 Source: National Energy Policy Development Group, *National Energy Policy*, 5-1.



Natural gas, including coalbed methane, and other domestically-produced energy sources play a major role in the Bush administration's energy policy. The administration's National Energy Policy and other policy statements all emphasize expanding U.S. sources of fossil fuels. The report includes 105 specific recommendations, including forty-two suggestions for policies to promote conservation, efficiency, and renewable energy sources and thirty-five that deal with expanding supplies of fossil fuels. The report, however, clearly emphasizes and gives priority to expanding the supply of traditional energy sources by opening new lands for exploration, streamlining the permitting process, easing regulatory requirements, and enlarging the nation's energy infrastructure. It summarizes the energy challenge this way:

*Even with improved efficiency, the United States will need more energy supply. . . . The shortfall between projected energy supply and demand in 2020 is nearly 50 percent. That shortfall can be made up in only three ways: import more energy; improve energy efficiency even more than expected; and increase domestic energy supply.<sup>22</sup>*

The Bush national energy plan argues that in the near term, increase in natural gas production will come from "unconventional sources" in the Rocky Mountain and other regions, and includes a number of recommendations that affect natural gas and CBM development. The plan:<sup>23</sup>

- Calls on federal agencies to promote enhanced recovery of oil and gas from existing wells, encourage oil and gas technology through public-private partnerships, reduce impediments to federal oil and gas leases, and reduce royalties and create other financial incentives to encourage environmentally sound offshore oil and gas development.
- Recommends additional oil and gas development in the National Petroleum Reserve in Alaska and the opening of an area (called section 1002) in the Arctic National Wildlife Refuge for exploration.
- Calls for streamlining the regulatory process, providing "greater regulatory certainty" for power plant operators, and reducing the time and cost involved in licensing hydroelectric power plants.
- Urges continued development of clean coal technology through a permanent extension of the research and

development tax credit and investing \$2 billion in research and development over ten years.

- Suggests the President issue an executive order to "rationalize permitting for energy production in an environmentally sound manner" and federal agencies "expedite permits and other federal actions necessary for energy-related project approvals."<sup>24</sup>
- Suggests the Interior Department reassess decisions it has made to withdraw certain lands from energy exploration and development, and to simplify its leasing policy so that more oil and natural gas are produced, including in the Outer Continental Shelf.
- Urges Congress to resolve the legal status of eleven million acres of BLM lands and 1.8 million acres managed by the Fish and Wildlife Service that have been designated by the agencies as wilderness study areas, and to determine which lands could be opened up to energy development.

The Bush administration's national energy policy, the energy legislation currently before Congress (passed by the House in 2001 and Senate in the spring of 2002), and the importance of energy in the American economy and the foreign policy consequences of our reliance on imported oil all raise important and difficult policy questions that have profound implications for the American West. Energy development clashes with other values of preservation of wild lands, protection of ecosystems and wildlife habitat, and recreational and aesthetic interests, and conflicts are inevitable as people throughout the West have greatly differing views about what should happen on public and private lands. Coalbed methane is no different from that of other natural resources, in that respect, but the rapid pace of development in areas has compressed and magnified these conflicts.

#### HOW IS CBM PRODUCED?

CBM was first noticed as a problem in coal mining, when fires or explosions of methane gas threatened miners. To reduce the risk of explosions, coalmine methane has been vented during mining operations. Some companies began capturing coalbed methane as a valuable resource and later, as attention came to be focused on methane as a potent greenhouse gas, coalmine methane production has been pursued as a way to help reduce the threat of climate change.



There have been some legal disputes over ownership of coalmine and coalbed methane. In *Amoco Production Company v Southern Ute Indian Tribe*, 526 U.S. 865 (1999), the Supreme Court ruled that CBM is not included in the meaning of coal; CBM is part of the gas estate not the coal estate. The Court indicated that coal companies can vent the gas while mining, but that the right to vent the gas does not imply ownership of it. The ruling is not binding on state law and private contracts. Oil and gas rights, including coalbed methane rights, are generally more senior than coal mining rights, and CBM companies may seek injunctions to ensure mining operations do not adversely affect methane extraction. In some cases, coal companies have bought out CBM leases so mining can continue unobstructed. In other cases, they complain that their operations are being held up unfairly by CBM owners who buy up gas rights and then sell them at above market prices.<sup>25</sup>

In 1980, Congress enacted a tax credit to encourage domestic production from unconventional sources, including CBM. Referred to as the Section 29 tax credit (section 29 of the 1980 Crude Oil Windfall Profit Tax Act), the provision has two limits: the gas must be sold to an unrelated party, and the credit only applies to wells placed in service before Dec 31, 1992. The tax credit, worth \$3 barrel of oil or Btu equivalent, expired on December 31, 2000 and the tax credit is modified and extended in both the House and Senate energy bills that the two chambers passed in 2001 and 2002, respectively, and are the subject of a conference committee convened in May 2002.

CBM has been produced in commercial quantities since 1981.<sup>26</sup> CBM development in the United States grew rapidly from a few dozen wells in the 1980s to nearly 6,000 wells producing 1.5 Bcf by 1992. Despite the tax credit no longer being available for new wells after that time, production skyrocketed; the Gas Research Technology Institute reported in 2000 that 14,000 wells produced 1.5 Tcf of gas, representing seven percent of the total gas production in the United States.<sup>27</sup> In 1989, the United States produced 91 Bcf of coalbed methane. Ten years later, the total produced had grown to nearly 1.3 Tcf.<sup>28</sup> Figures for CBM production in the state of Colorado illustrate the rapid growth of development in the state. In 1990, CBM wells in the state produced 27 Bcf of methane; by 1995, they produced 240 Bcf; and

their output steadily increased throughout the rest of the decade, reaching 417 Bcf in 2000.<sup>29</sup>

## HOW DOES CBM COMPARE WITH OTHER FORMS OF NATURAL GAS?

Methane is a major component of natural gas, and coalbed methane can be used in the same way as conventional gas. Conventional gas is formed in shale and limestone formations; pressure and temperature combine to transform organic matter into hydrocarbons. The gas migrates upward until trapped by a geologic fault or fold and rests in this reservoir rock until it is discovered, drilled, and extracted. The location and extent of conventional gas typically requires exploratory drilling since the location of reservoirs is not apparent from the surface.<sup>30</sup>

Coalbed methane is sometimes compared with another unconventional gas—"tight" gas—that is found at much deeper depths and in low permeability sandstone. Companies must use hydraulic fracturing, where they inject a fluid into a rock formation that causes cracking, in order to release gas from tight Cretaceous sands.<sup>31</sup> Fracturing is also used in some CBM plays to increase production, as explained below.

Coalbed methane differs from other gas reservoirs in several ways:<sup>32</sup>

- CBM is stored in an adsorbed state on the surface of the coal;
- Before CBM can be produced in significant quantities, the average reservoir pressure must be reduced; and
- Water is usually present in the reservoir and is normally co-produced with the CBM.<sup>33</sup>

The competitiveness of coalbed methane with conventional natural gas is a function of four primary variables: the rates of gas production, the production costs, markets, and economies of scale.<sup>34</sup>

- The rate and volume of gas production from CBM wells vary considerably. Low gas producers yield about 50 thousand cubic feet per day; high yield wells—"sweet spots" in basins produce 5 million cubic feet/day.
- Since coalbed methane wells are typically shallow (less than 4,000 feet) and on land, well costs are low to moderate in comparison with conventional natural gas.



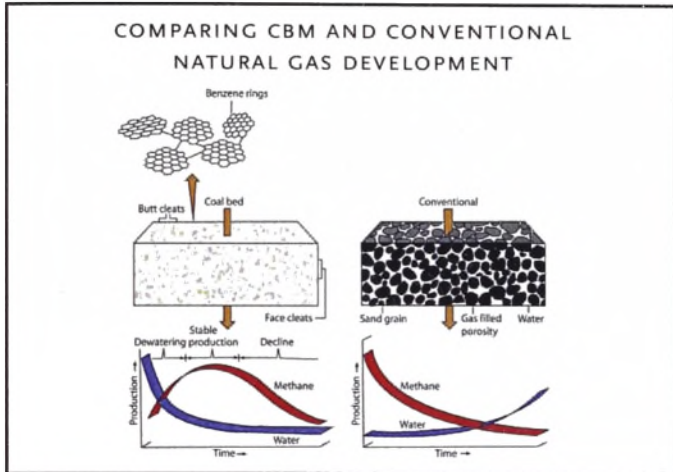


FIGURE 4 Source: William T. Brown, NRLC coalbed methane conference, April 4-5, 2002

- The distance between the producing wells and consumers also shapes the economics of CBM development. The market price, minus transportation and compression costs, equal the wellhead net back price. In some areas, the transportation costs may be as great as the wellhead net back price.
- CBM development needs to reach a critical volume of production in order to be economically viable. Costs include gas treatment, compression, transportation, geologic and engineering services, and field operations. The minimum threshold for a viable project varies depends on a variety of factors, but one estimate is that a new, remote basin requires at least 400 wells or 200 billion cubic feet of production to be viable.

In conventional wells, gas production peaks early and then declines over time, and water production eventually increases, the opposite of CBM extraction. The figure below depicts the stages in production of both kinds of wells. For CBM wells, large quantities of water are produced during the initial phase, then water volume declines as the pressure of the reservoir falls. The actual shape of the production curve is a function of production techniques (well spacing, reservoir permeability, reservoir pressure, and water saturation), and varies considerably by reservoir. In some basins, peak gas production occurs in three or more years. The length of time required to produce peak gas production increases in low permeability reservoirs and increased well density.<sup>35</sup> Since CBM wells generally

produce gas at lower rates than conventional gas wells, the cost of water disposal in CBM development is significant relative to that of conventional development. Further, CBM development cannot simply be shut off when prices fall, since the coal may refill with water: "you don't start and stop wells in response to short-term price swings."<sup>36</sup> Figure 4 compares CBM and conventional natural gas development and the differences in the volumes of water produced over time. One of the most important characteristics of CBM development is the relatively short span of time wells produce gas. Wells typically produce gas for 7-10 years, and basins may be relatively quickly pumped and then abandoned.

#### WHERE ARE CBM RESOURCES LOCATED?

Development of CBM resources has been concentrated in the West, South, and, to a lesser extent, the Midwest. Figure 5 is a map that identifies the major CBM plays in the United States.

Some 56 percent of the total CBM production in the United States has come from the Rocky Mountains. Colorado, New Mexico, Utah, and Wyoming may contain as much as 47 trillion cubic feet of coalbed methane, one third to one-half of the total estimated recoverable reserves in the United States. The San Juan basin in southern Colorado/northern New Mexico has been the major source of CBM. Development began in 1988 and rapidly expanded by the end of the 1990s. Production has now leveled off and companies are trying to maintain

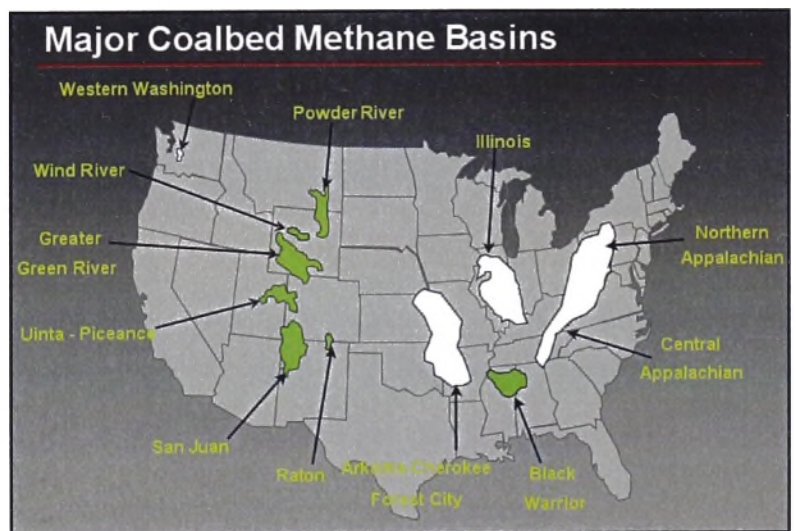


FIGURE 5 Source: Steve de Albuquerque, NRLC coalbed methane conference, April 4-5, 2002



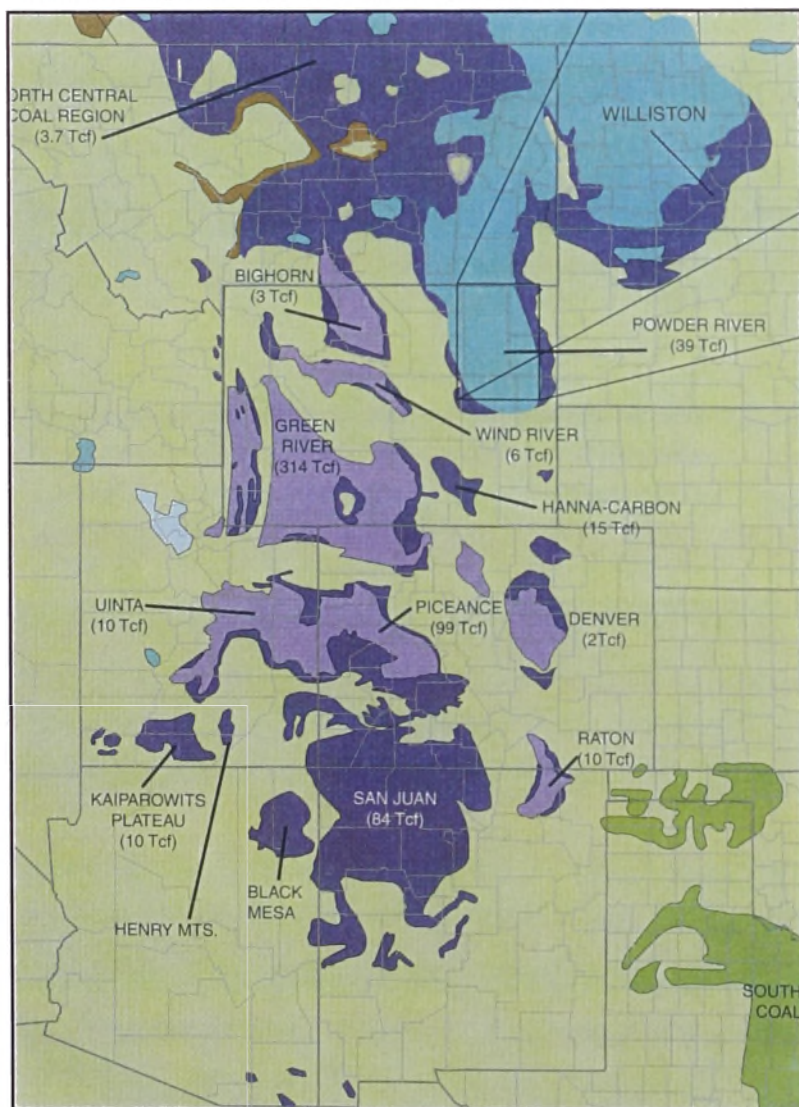
output by more intensive development. The Powder River Basin in northwest Wyoming is the area of CBM production that is growing the most rapidly. In 1997, the basin produced 54 million cubic feet of gas/day from 360 wells. Four years later, 5,854 wells were producing 656 million cubic feet/day. CBM resources are also being developed in the Uinta Basin in eastern Utah, the Raton Basin in south-central Colorado, and the Piceance Basin in northwest Colorado, and major expansions of coalbed development are expected in Montana, the Green River basin in Wyoming, and perhaps other areas in the West.

The Potential Gas Committee estimated in 1991 that the four states contained a "most likely recoverable resource" ("probable, possible, and speculative") of

coalbed methane of 47.2 Tcf. That amount represents about one-third of the estimated 145 Tcf in the United States.<sup>37</sup> In addition to those reserves, the Gas Research Institute estimates that between 87 and 110 Tcf may exist but is yet undiscovered. Another 1,000 Tcf of methane may also be located in Alaska.<sup>38</sup>

A more recent estimate looked at national reserves. The National Petroleum Council reported in 1999 that the United States' "natural resource base" in the lower 48 states was 1,466 trillion cubic feet; an additional 25 Tcf may be located in the Prudhoe Bay area in Alaska. According to Matt Silverman, CBM resources in the Rocky Mountain states are as follows: About 7 Tcf of CBM has been produced; 11 Tcf are the proved reserves that remain, and another 42 Tcf are economically recoverable reserves. Finally, the total resource base may be some 536 Tcf.<sup>39</sup> Estimates vary considerably, based on differing assumptions and differences between discovered resources and those that are economically or technically extractable.

Figure 6 is a map of the major coal-bearing regions of the Rocky Mountain states; figures for the estimated coalbed gas-in-place, in Tcf, are indicated in parentheses.



#### HOW DO CBM BASINS COMPARE?

The major CBM basins in the West include the following:

- Colorado/New Mexico:
  - San Juan Basin (most mature basin 80% of U.S. production)
  - Raton Basin (production for several years)
  - Piceance Basin (potential development)
- Colorado/Utah
  - Piceance (emerging area of development)
  - Uinta Basin (production for several years)
- Wyoming/Montana
  - Powder River Basin (fastest growing area)
- Colorado/Wyoming
  - Green River Basin (potential development)
- There is also potential CBM development in the Denver Basin, Colorado, and in Alaska.

FIGURE 6 Coalbed methane basins of the Rocky Mountains

Source: Matthew R. Silverman, NRLC CBM conference, April 4–5, 2002



Each coalbed methane basin is unique. Each poses a different set of exploration and development challenges and produces a distinctive set of impacts on surrounding communities and ecosystems. Some basins have reached their peak in production while others are in the early stages of development. In some areas, the water that is produced is of high quality and ready to be used for a variety of human, agricultural, ranching, and other purposes; in other areas, water quality is poor and must be treated or re-injected. According to an engineer with Schlumberger-Holditch Reservoir Technologies, "The one thing coalbed methane plays in the U.S. have in common is that they are all different. You have to consider the

complete package of coal characteristics, regional geology, and infrastructure . . . you can't get locked into one mindset."<sup>40</sup> The economics of each basin also varies: some basins may not look profitable at first, but innovative technologies are developed that make development feasible. The Powder River Basin, for example, was originally believed to be unsuited for CBM development, but companies experimented with various production and extraction techniques until development became feasible. Table 1 summarizes the main characteristics of CBM basins in the United States.

### COALBED METHANE PLAY CHARACTERISTICS

Table 1 comparison of coalbed methane plays

Basin	States	Producing Wells (1996)	Cummulative CBM Prod. in mmcf (1981–1996)	typical Net Coal Thickness (ft)	Typical Gas Content (scf/ton)	Typical Well Spacing (acres)	Avg. Prod. (mcf/well)	Est. Finding Cost (\$/mcf)
San Juan	CO, NM	3,036	3,857	70	430	320	2,000	0.11
Black Warrior	AL, MS	2,739	728	25	350	80	100	.25
Central Appalachian	WV, VA, KY, TN	814	121	16	na	80	120	na
Piceance	CO	123	36	80	768	40	140	1.23
Powder River	WY, MT	193	17	75	30	80	250	0.25
Uinta	UT	72	14	24	400	160	690	0.25
Raton	CO, NM	59	8	35	300	160	300	0.18

Source: Karl Hart, "Coalbed Methane Trends," Hart Energy Publications, *PTTC Network News*, 2<sup>nd</sup> quarter, 2000.

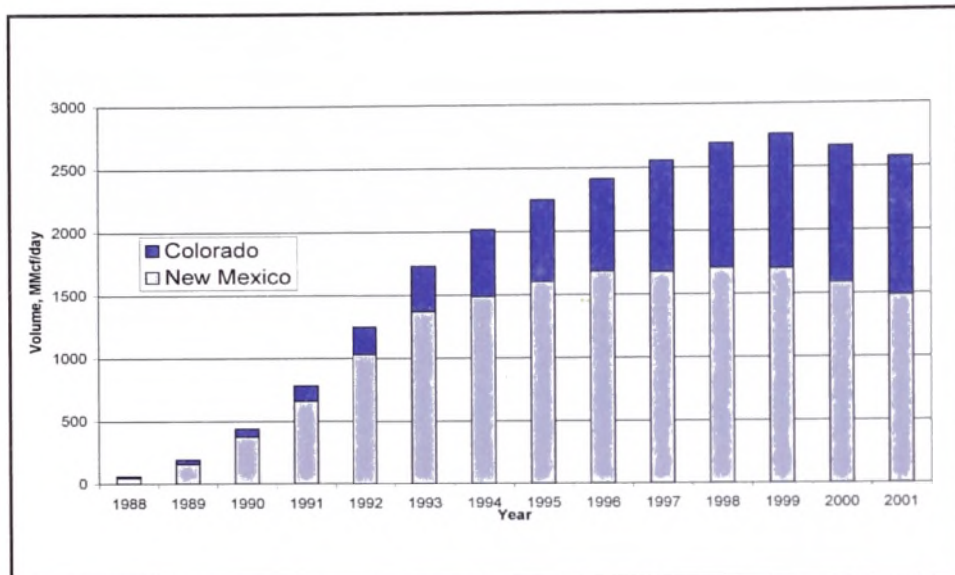


FIGURE 7, CBM production from the San Juan Basin

Source: Catherine Cullicott, Carolyn Dunmire, Jerry Brown, Chris Calwell, Ecos Consulting, *Coalbed Methane in the San Juan Basin of Colorado and New Mexico*.

#### THE SAN JUAN BASIN—COLORADO/NEW MEXICO

The San Juan basin has been the major source of CBM in the United States. The first recorded CBM well was drilled in 1951, but the first coalbed methane discovery well was drilled in 1976. Development began in 1988 and rapidly expanded to 2.7 Bcf/day by 1999. By 2002, there were some 4,50 active CBM wells in the basin. Production is no longer increasing and companies are trying to maintain output by focusing on enlarging gathering facilities, upgrading production equipment, installing pumping units and wellhead compression, recavitating producing wells, experimenting with secondary recovery efforts, and downspacing from 320-acre units. Typical wells in the San Juan Basin produce a total of from 7–12 Bcf, and many produce several million cubic feet each day.<sup>41</sup> In 2000, the San Juan Basin produced 0.78 Tcf of gas, 4% of total U.S. natural gas production and 80% of its CBM production, valued at \$2.5 billion.<sup>42</sup> The BLM projects that 12,500 new oil, gas, and CBM wells will be drilled in the San Juan Basin over the next 20 years. Infill drilling—drilling wells more densely, at every 160 acres rather than 320 acres—has already begun. Figure 7 depicts the evolution of CBM production in the San Juan Basin in Colorado and New Mexico.

Estimates of the total CBM resource available in the San Juan vary greatly. The US Geological Survey's 1995 estimate suggested some 7.53 Tcf while others project 50 Tcf

and higher.<sup>43</sup> According to Matt Silverman, there are 84 Tcf of CBM gas in place in the San Juan Basin and 8.5 Tcf of the 12 Tcf recoverable gas has already been extracted.<sup>44</sup>

The BLM and USFS are preparing an EIS in response to industry proposals to open new areas to drilling, and the draft EIS is expected to be released in the summer of 2002. The agencies are considering five options for expanded drilling: all five proposals call for increasing the density of drilling to one well per 160 acres, and all but one call for expanding drilling into the HD Mountains, a Forest Service roadless area.<sup>45</sup>

Coalbed methane development on the Southern Ute Indian Reservation has taken place for more than a decade and generated significant resources for the tribe. CBM development began in the early 1990s. In 1989, the Tribe's net worth was \$39,000,000; by 2002, it had grown to \$1,200,000,000.<sup>46</sup>

#### THE POWDER RIVER BASIN—WYOMING

The Powder River Basin is the fastest growing CBM play in the United States. The vast coal deposits of Wyoming contain massive quantities of methane gas and the Powder River Basin is one of the thickest accumulations of coal in the world.<sup>47</sup> In Wyoming, the first CBM wells were drilled in 1986. Companies drilled 10–55 wells/year through 1995, then 253 in 1996 to 4,502 in 2000 and 4,232 in 2001; 13,700 wells had been drilled by 2001. Production has climbed from about 1 Bcf in 1993 to 9 Bcf in 1996 to 251 Bcf in 2001.<sup>48</sup> In 1997, the basin produced 54 million cubic feet of gas/day from 360 wells. By 2001, 5,854 wells were producing 656 million cubic feet/day. Some 400 Bcf had been recovered since drilling began and the Wyoming Geological Survey estimates total recoverable resources at 25.1 Tcf (about the total U.S. demand for natural gas for one year) and a production level by 2010 of 3 Bcf/day.<sup>49</sup> Other estimates range from less than 10 to more than 20 Tcf.<sup>50</sup> Matt Silverman suggests that the total CBM resource in place in the basin



is 40 Tcf, with at least 10 Tcf and likely more that is recoverable.<sup>51</sup> Industry representatives estimate that the eight million acre basin will eventually have 50,000–100,000 producing wells.<sup>52</sup>

Coals in the Powder River Basin are very permeable, shallow, and thick, and the low gas content and low pressure were initially seen as barriers to development. The initial wells drilled and completed produced large quantities of water but little gas. As companies shifted to drilling more shallow wells, production increased significantly. The low drilling costs (as low as \$35,000 per well, and taking two to three days to drill and complete) and high water quality that allowed it to be discharged on the surface encouraged development. The Powder River basin has become so promising that it has attracted dozens and dozens of operators, both large and small. One industry official explained the popularity as a result of the certainty about development: “It’s a fantastic play, and the technical risk is very low. We know the resource is there, we know what the capital costs are going to be.”<sup>53</sup> The play is attractive to independent companies since “it has very low geologic risk, and the financial engineering opportunities that are created by that risk profile are not found anywhere else in the natural gas business.”<sup>54</sup>

Development costs are described as low: finding costs are in the range of 30 to 40 cents per thousand cubic feet, and the play is profitable even at prices of \$2/mcf.

But the wells are not huge money-makers: “the per-well recoveries are fairly low [and] high operating costs, mainly from pumping the well and managing the water once it reaches the surface, are ongoing challenges.”<sup>55</sup>

By 2000, some 40 companies were working in the area, including Pennaco Energy and Lance Oil and Gas, two of the largest producers of CBM in the basin. A group of oil and gas companies have proposed drilling some 39,400 new wells and accompanying roads, pipelines, and electrical utilities, and compressors in an 8,000,000 acre parcel of private and federal lands. As the CBM play moves west, more and more of the gas lies under lands owned by the Federal government.<sup>56</sup> Before new drilling can take place on these lands, the BLM must complete an environmental impact statement. The draft EIS was released in January 2002.<sup>57</sup> The Powder River EIS assesses the proposal to develop 51,444 new CBM and 3,200 conventional oil and gas wells in a 12,500 square mile area.

Powder River Basin coal ranges from 200 to 2,500 feet below the surface, and most CBM drilling is at the 200–1,200 foot range. Wells typically take from three to six days to complete. Wyoming law provides for 40-acre spacing, but rules issued in March 2001 for units in the northeast and southwest part of the Powder River Basin specified 80-acre units. The CBM wells are projected to produce 3.6 Bcf at maximum production.<sup>58</sup> Wyoming also includes the following other CBM basins:<sup>59</sup>

Washakie Basin: Coal is 5–20 feet thick, at 300–3,000 feet of depth, wells take 5–15 days to complete, hydraulic fracturing may be required, spacing is at 40–80 acres.

Hanna Basin: Coal is 20–50 feet thick, at 3,400–4,500 feet depth, wells take 15 days to complete.

Green River Basin: Wells are 2,500–3,000 feet deep, 80-acre spacing; water is reinjected at 6,700 feet.

Wind River: The basin’s CBM resources were estimated in 1995 to be 0.43 Tcf.

Figure 8 charts the dramatic increase in Wyoming CBM production:

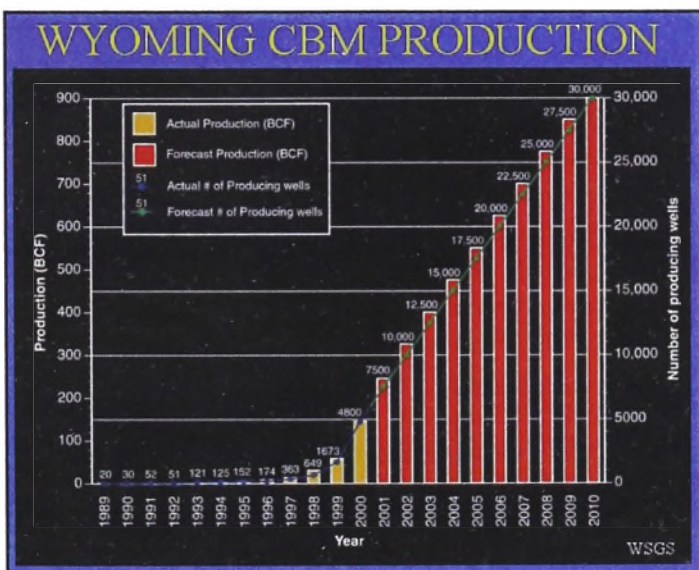


FIGURE 8, CBM production in Wyoming

Source: Matthew Silverman, NRLC CBM conference April 4–5, 2002.

#### POWDER RIVER BASIN—MONTANA

Montana has placed a moratorium on new drilling in its portion of the Powder River basin, and the BLM is



preparing an environmental review of the area.<sup>60</sup> Industry officials are optimistic about development in Montana: "In a year's time, after the EIS is complete, CBM could be quicker and easier in Montana than in Wyoming." The proposal being examined in the EIS calls for 20,000 wells, producing 1.5 Tcf per year.<sup>61</sup> One estimate suggests the Montana region of the PRB contains 4.5 Tcf of coalbed methane.<sup>62</sup> Another estimate suggests a total resource in place of 10 Tcf, with half of that recoverable.<sup>63</sup>

#### THE RATON BASIN—COLORADO/NEW MEXICO

The Raton basin straddles the Colorado-New Mexico border. The Gas Research Institute estimated its recoverable CBM resources at 3.7 Tcf. Others suggest the basin may contain 10 Tcf of resource and 3.5–4.0 Tcf of recoverable CBM.<sup>64</sup> By the end of 2000, some 100 Bcf had been produced. The basin's coal, in comparison with the Powder River Basin, is thin, relatively deep, not particularly permeable, and distributed throughout a wide sedimentary section.<sup>65</sup> Evergreen Resources, Inc., has been the leader in developing the play. By 2001 it had some 675 wells on 200,000 acres that produced about 120 Mcf/day, and planned to drill during that year another 1,000 wells. One third of the wells are expected to be increased density wells (adding a fifth well in a section); one third will be shallower wells; and one-third will extend the field. The average recoverable reserves of these three wells ranges from 1 to 1.6 Bcf per well. The average well costs \$400,000; 60 percent of that goes to drilling, completing, and equipping; gathering, gas collection, and compression make up the remaining 40 percent.<sup>66</sup>

The Raton contains two coal bearing formations: Evergreen Company's production has largely been from the Vermejo formation coals (between 450 and 3,500 feet), but it believes that the shallower Raton formation coal seams are also promising. Evergreen is a vertically integrated company. It has compressor stations, owns its own water trucks, has its own pipeline and hydraulic fracturing crews, and operates a low-pressure gathering system that extends for several hundred miles.<sup>67</sup> About half the water it produces goes into surface impoundments and percolates into the ground; 40 percent is discharged onto the surface or is given to local ranchers; and 10 percent is reinjected into formations 2,000 to 3,000 feet below the coals.<sup>68</sup> Devon Energy and El Paso Energy Corp. acquired PennzEnergy and Sonat Exploration and

may jointly develop CBM reserves in the Vermejo Ranch property in New Mexico.<sup>69</sup>

#### THE UINTA BASIN—UTAH/COLORADO

The Uinta Basin CBM play is located on the west side of the San Rafael Swell, at the Southwest edge of the Uinta basin. By the end of 2000, a total of 190 Bcf of gas had been produced and gas was flowing in 2001 at about 250 Mcf/day. Total recoverable reserves in the Ferron are more than 2 Tcf. The largest producing area is Drunkards Wash, where Phillips Petroleum has 350 wells spread over 170,000 acres that produce 210 Mcf/day. The company planned to drill 85 new wells in 2001 and 110 in 2002. Typical wells are drilled at a 160 acre spacing, 1,100 to 4,000 feet deep, and fracturing is used to free up the gas. The average well cost is \$330,000. Water is not potable, and some 65,000 barrels per day is reinjected into the Navajo sandstone. River Gas Corporation has some 200 producing wells and plans to develop 400 more. River Gas' operations are in a remote plateau. To save costs, the company installed an automated system that only requires a minimal staff in a remote station. The system includes a "radio system for communicating well data and remote control commands, electronic gas measurement to eliminate chart recorders, and a supervisory control and data acquisition (SCADA) system to manage the operation."<sup>70</sup> Texaco and Anadarko are also operating in the basin.<sup>71</sup>

#### DENVER BASIN

The Denver Basin in Eastern Colorado contains an estimated 2 Tcf of CBM. Development has been hindered by a lack of data on the extent of the resource and the nature of the gas reservoirs. The two major coal bearing formations are also surrounded by four Denver basin aquifers, raising questions about the extent to which the aquifers and coals are connected hydraulically and what the impacts of CBM development would be on the water.<sup>72</sup>

#### OTHER BASINS

The Black Warrior Basin, in Alabama, has been the most productive CBM basin outside the Rockies. According to one summary, "relatively limited commercial exploitation of CBM has taken place in other basins, but that is changing." Some production has occurred in the Appalachian basin in Pennsylvania (30 wells in 2000), West Virginia (36 wells), and southwestern Virginia



(1321 wells). Alaska contains nearly half of the total U.S. coal reserves, and studies have found that coals in Northern Alaska's Colville Basin, the Yukon Basin and the Chignik Basin of the Alaskan Peninsula have the highest CBM production potential. Some have suggested that CBM produced in Alaska will likely only be for used for local consumption, while others believe that a gas pipeline may be built from the Prudhoe Basin to the lower 48 states.<sup>73</sup>

## II. WHAT ARE THE CONFLICTS, PROBLEMS, AND CHALLENGES ASSOCIATED WITH CBM DEVELOPMENT?

There are three consequences of CBM development that are responsible for most of the conflicts: the large quantities of water produced during extraction, split estates and the impact of extraction on the owners of surface lands, and development of CBM resources on public lands that might also be reserved for other purposes. These three topics are discussed in detail below. Since methane is a greenhouse gas, CBM development also relates to the threat of climate change and that issue is briefly addressed at the end of this section.

### CBM DEVELOPMENT AND WATER

The amount of water produced during the CBM production process is staggering and represents a major challenge. In the Colorado portion of the San Juan Basin, approximately 1,200 wells have produced nearly 36 billion gallons of water to date.<sup>74</sup> In the Wyoming portion of the Powder River Basin, it is estimated that in the next 15 years, approximately 51,000 wells will have produced over 1.4 trillion gallons of water.<sup>75</sup>

The cleats and fractures in coal are typically saturated with water, and the coal must be dewatered (usually pumped out) before the gas will flow.<sup>76</sup> Some coals never produce methane if they cannot be dewatered economically. As the fracture system produces water, the adsorptive capacity of the coals is exceeded, pressure falls, and the gas trapped in the coal matrix begins to desorb and move to the empty spaces in the fracture system. The gas remains stored in nearby non-coal reservoirs until it is extracted.<sup>77</sup> Drilling dewateres the coal and accelerates the desorption process.

The deeper the coalbed, the less the volume of water in the fractures, but the more saline it becomes.<sup>78</sup> The volume of gas typically increases with coal rank, how far underground the coalbed is located, and the reservoir pressure.<sup>79</sup> Initially, drilling primarily produces water; gas production eventually increases and water production declines. Occasionally, wells do not produce any water and begin producing gas immediately, depending on the nature of the fracture system.<sup>80</sup>

When the CBM is extracted, the water must be separated, the gas is sent to pipes, and the water is dumped into ponds or injected back into the ground. In order to develop the resource, companies must first pump large quantities of water from the ground, about 12,000 gallons a day on average for each well, to release the methane. Discharged water that is of high quality, as is the case in many areas in the Powder River Basin, may be used by ranchers to water stock or to irrigate crops. Water that is not useable for irrigation or watering stock may be reinjected into underground regions.<sup>81</sup> Given the scarcity of water in the West, virtually any production of water that is not put to beneficial use or that might affect water quality or water supply and rights is controversial. The development of CBM sometime pits energy developers against ranchers and other water users. CBM development raises several issues surrounding its impacts on:

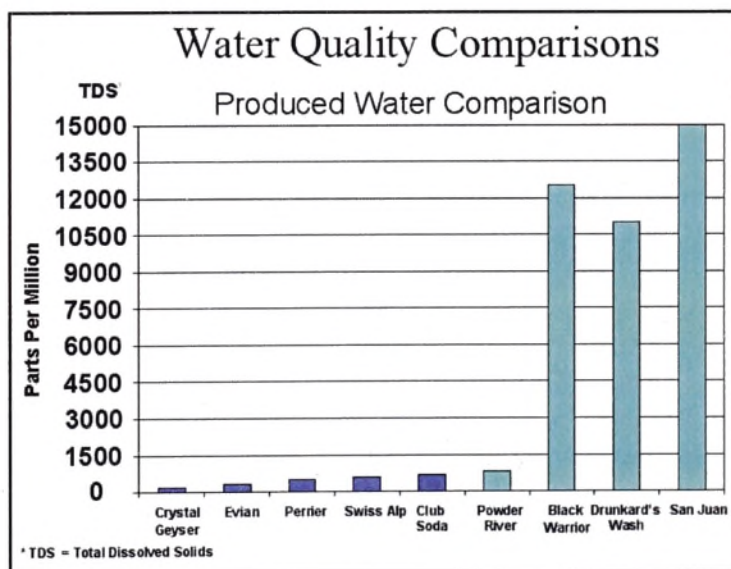


FIGURE 9 Source: Lance Cook, "Geology of CBM in Wyoming," NRLC CBM conference April 4-5, 2002.



- underground water quantity and the possibility that drilling or fracturing fluids contaminate aquifers with water of lower quality;
- water rights and underground water supplies that may be diminished as dewatering occurs;
- groundwater that may be contaminated by discharged water that is polluted; and
- aquatic areas, stream beds, and local ecosystems that are unaccustomed to receiving such large volumes of water.

Water quality indicators vary across and even within basins, depending on the depth of the methane, geology, and environment of the deposition. The major elements of CBM water quality include:

- total dissolved solids (salts)
- pH and temperature
- major cations (positively charged ions)—sodium, potassium, magnesium, calcium
- major anions (negatively charged ions)—chlorine, sulfate, hydrogen carbonate
- trace elements—iron, manganese, barium, chromium, arsenic, selenium, and mercury
- organics—hydrocarbons, additives.<sup>82</sup>

Water quality varies tremendously across basins, as figure 9 illustrates (note that the figure also compares CBM produced water with different brands of bottled water):

Because of differences in water quality, CBM-produced water is dealt with differently across the major basins:<sup>83</sup>

San Juan:	99.9% of produced water is injected
Uinta:	97% injected, 3% evaporation
Powder River:	99.9% surface discharge
Black Warrior:	100% surface discharge
Raton Basin:	
Colorado:	70% surface, 28% injected
New Mexico:	100% injected

Even if water quality is high, salts may concentrate during evaporation or may overwhelm the semi-arid environment, inundating vegetation and causing erosion.

The options for dealing with the large quantities of water released include the following (costs generally increase as one moves down the list):<sup>84</sup>

- Traditional surface discharge: water is allowed to travel downstream and be absorbed or evaporate as it moves;
- Irrigation: water released to agricultural areas;
- Treatment: water is treated to improve quality;
- Containment with reservoirs: water is piped to a surface impoundment where it is absorbed or evaporates, or may be used to water cattle;
- Atomization: water evaporates more quickly than normal through the use of misters placed in surface impoundments.
- Shallow injection or aquifer recharge: water is pumped into freshwater aquifers;
- Deep injection: salty water is typically reinjected deep into the ground.<sup>85</sup>

The volume of produced water in the major basins also varies considerably, as Table 2 illustrates:

BASIN	STATE	No. of WELLS	BBL/DAY/WELL	BBL/MCF
Black Warrior	Alabama	2,917	58	0.55
Powder River	Wyoming	4,454	275	2.17
Raton	Colorado	459	266	1.34
San Juan	CO/NM	3,089	25	0.031
Unita	Utah	393	215	0.42

SOURCE: C.A. Rice and T.T. Bartos, "Nature and Characteristics of Water Co-Produced with Coalbed Methane with Emphasis on the Powder River Basin" USGS CD.



## SAN JUAN BASIN

The average CBM well in the San Juan basin produces 25 barrels or 1,050 gallons of water a day, a ratio of 0.031 gallons of water/thousand cubic feet of gas. The 4,208 CBM wells produce on average 4.42 million gallons of water a day or 13.6 acre feet.<sup>86</sup> Because of poor quality, virtually all produced water in the San Juan is reinjected. The threat of water contamination is one of the major complaints of local residents surrounding CBM development:

Some residents report that in some areas, their drinking water has been contaminated by methane or by hydraulic fracturing;<sup>87</sup> BP Amoco purchased four homes and leveled them as part of the settlement of a lawsuit after owners charged the company with responsibility for methane in their basements and water wells.<sup>88</sup>

Residents have complained that drilling reduces the water levels of residents' and ranchers' wells as aquifer rock is fractured and water escapes.<sup>89</sup>

Some residents emphasize that while drilling is not directly responsible for the natural seepage of hydrogen sulfide into rivers, it may amplify the natural seepage, and point to signs along the Animas River, a popular kayaking and river running area, that warn of harmful levels of hydrogen sulfide seeping from the ground into the water.<sup>90</sup>

Water storage pits are another source of contention. Dehydrator/separator pits are required to be lined. Residents have complained that companies do not always comply with these requirements.<sup>91</sup>

Industry representatives disagree that CBM development significantly impacts water quality and quantity, although they acknowledge there have been occasional problems. According to one BP official, "different companies have different standards," but there has been improvement over the years in the impacts on water quality.<sup>92</sup> According to a BP official, CBM wells are 2–3,000 feet deep, while drinking water wells are only 200–400 feet deep. CBM well bores are encased in steel and cement 50 feet below the lowest water table to ensure no contamination of aquifers occurs. When BP began drilling at one well in each 160 acre plot, company officials tested water quality near the new wells before and after drilling commenced. Since biogenic-produced methane is found at shallower depths and thermogenic gas at deeper levels, companies can conduct isotopic

analyses that fingerprints the gas and allows analysts to trace its origins and learn whether the methane is a result of natural migration or a result of drilling. The Colorado Oil and Gas Commission requires additional testing if methane is found in domestic drinking water wells, and methane has been found in 12 percent of those wells.<sup>93</sup>

The impact of CBM drilling on local water supplies has been very contentious in other areas such as the Raton Basin. Residents of Cokedale, in Las Animas County, protested coalbed methane drilling of one hundred wells that produce twenty-four million gallons of waste water a month, because they feared the water will contaminate the shallow wells that residents depend on, and the dispute resulted in lawsuits and countersuits.<sup>94</sup> The issue of water contamination is critical. The EPA is expected to release a report in the summer of 2002 on CBM contamination of water. If the report concludes that contamination has occurred, it will be difficult for development to continue until more detailed studies are completed.<sup>95</sup>

## POWDER RIVER BASIN

The average flow of water from a CBM well in Wyoming is 12–15 gallons/minute.<sup>96</sup> In contrast to the San Juan basin, much of the produced water in Wyoming may be useable for a variety of purposes. A major challenge has been managing in a semiarid landscape the tremendous amount of produced water. CBM wells in Wyoming produce on average 150 barrels of water a day over a 7? year life-time.<sup>97</sup> The rate of water production during initial stages of development range from 400–800 barrels/day to 1,000–1,500 barrels/day in deeper wells.<sup>98</sup> More than 1.28 million barrels of water were produced each day from CBM extraction in 2000.<sup>99</sup> The average production rate of oil per well, after dewatering, is a much smaller amount than in the San Juan.<sup>100</sup>

Critics of CBM development argue that the amount of water withdrawn from CBM production will greatly lower the aquifer levels in Wyoming. They warn that by 2010, surface discharge of produced water will reach 1 billion gallons a day. Data from coal mine permits and plans suggest that it will take 800–1,500 years following reclamation to recharge the coal aquifer and argue that, despite the differences between coal mining and CBM extraction, CBM development poses the same kind of threat to the region's long-term water supply.<sup>101</sup>



The draft environmental impact statement (DEIS) for the next round of development in the Powder River Basin suggests that the drawdown of the Fort Union Coal Aquifer under all alternatives will be from 300–1,200 feet and 10–250 feet for the Deep Wasatch Sands. For the Shallow Wasatch Sands, drawdown projections range from 1–50 feet in areas of thin cover and –1 to –50 feet in areas of impoundments and creeks receiving produced water. Peak drawdown will likely occur between 2006 and 2009, and the aquifers will, according to the DEIS, recover to within 95 percent “over the next hundred years or so.”<sup>102</sup>

Just as controversial as impacts on the region’s aquifers have been the consequences of the produced water from CBM extraction. The quality of produced water varies across the Powder River Basin. In general, water quality is highest in the southeast, and diminishes to the West and North, where total dissolved solids increase.<sup>103</sup> A USGS study concluded that total dissolved solids (TDS) range from 370 to 1940 mg/L, with a mean of 840 mg/L; the national drinking water standard for potable water is 500 mg/L. TDS levels increase as sampling wells moved North and West.<sup>104</sup>

Discharges into the Tongue and Powder Rivers have been particularly contentious. The water there is generally of sufficiently high quality for drinking water and watering stock, but the produced water is not as good as in the Tongue River, so no discharge permits can be issued.<sup>105</sup> In other areas, the water can be discharged into the Belle Fouché and Cheyenne Rivers and Caballo Creek.<sup>106</sup> While the water is suitable for cattle, there are insufficient cattle to use the produced water. Surface disposal is a challenge as it may result in erosion when discharged into drainages or inundate vegetation. Even though water quality is good, salts may concentrate during evaporation and harm soils.<sup>107</sup>

Some local residents believe domestic and stock water wells are drying up or becoming contaminated, and that discharge of water is causing erosion and soil damage.<sup>108</sup> Others have reported that domestic well lids have been blown off by gas pressure, methane has been found in their water wells, and they have seen companies continue to discharge water after they have received notices of violations.<sup>109</sup> Stock reservoirs have been created, and while some ranchers have wanted the water source, others do not since that takes land out of production.<sup>110</sup> Ranchers

are faced with soils damaged by the salts and metals remaining after evaporation, less grass is available for cattle, clay soils become hard pan, and dead cottonwood trees, dead grass, and weeds result from the discharge of produced water that destroys native vegetation.<sup>111</sup>

Given the aridity of the West, the region’s water is at least as valuable as its natural gas. One of the most important challenges surrounding CBM development is finding beneficial uses for the produced water. One industry consulting hydrologist emphasized many beneficial uses for produced water—livestock, dust control, industrial, fish and wildlife, recreation, irrigation, and aquifer recharge. He summarized water management options in the Powder River in these terms:<sup>112</sup>

- Discharge to surface streams—acceptable on the Eastern part of the basin; erosion controls are needed but treatment is not; shallow groundwater recharge occurs, and there may be downstream impacts; iron and manganese may need to be removed;
- Impoundment—problems of limited locations, need for erosion controls; few isolated instances of this, the volume is often too low to cause problems;
- Injection—not economic or practical; no evidence of contamination of drinking water, it is often better quality; no toxins; it would reduce water quality of the Tongue River but not others.

#### CBM DEVELOPMENT AND CONFLICTS WITH OTHER LAND USES

Just as contentious as water has been conflicts between local residents and energy companies over land use. CBM development impacts rural lands in several ways. The construction of roads, drill pads, water disposal sites and related facilities and the operation of these facilities may conflict with livestock operations and farming. Noise from pumps, compressors, and traffic may disturb residents and wildlife. Air pollution problems include health effects of fine particles and reduced visibility. CBM development has disrupted areas that were previously isolated from development or valued for undisturbed vistas and solitude. In contrast, in other communities where conventional gas development or coal mining has already occurred, new CBM projects often produce relatively little incremental impact.



Many of the conflicts are rooted in laws that were enacted to promote the development of the West by opening lands to settlers but reserving mineral rights to the Federal government. Most of the land disposition statutes enacted by Congress in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries reserved the mineral estate to the United States. The Stockraising Homestead Act of 1916, for example, reserved to the United States "all the coal and other minerals" under the federal lands sold to settlers.<sup>113</sup> The Taylor Grazing Act of 1934 similarly reserved "all minerals to the United States" for federal lands that were exchanged for private lands in order to consolidate BLM grazing districts.<sup>114</sup>

Much CBM development is occurring on split estates—areas where those who own the surface rights of land are not the same as those who own the subsurface mineral rights. Some surface owners have been able to negotiate with energy companies payments for damage to their lands or even a share of the proceeds from development. But conflicts have occurred when residents have purchased surface rights to settle in quiet, undeveloped rural settings or in residential areas, and not realized that those who own the subsurface rights must be given access to the land to develop those rights. Landowners have been forced to allow drilling on lands they assume would be used for grazing or hunting. This is not a problem unique to CBM, but the rapid pace and magnitude of development appears to have intensified conflicts.

The socio-economic impacts of coalbed methane development are similar to those resulting from development of conventional gas. Development produces new jobs, new income, and new revenues for governments from taxes and royalties. It also increases demand for new public services and housing and increases traffic, air pollution (from construction as well as traffic and other sources once construction is completed), noise, and congestion. One difference between CBM and conventional gas that has exacerbated tension is that drilling and construction typically proceeds much more quickly for CBM than for conventional gas. CBM wells may only take a few days to drill and a few more to complete, whereas conventional wells may take 45–60 days to drill and complete. CBM development may rapidly transform a rural community into an energy production area with pipelines, compressors, and other facilities, while the transformation resulting from conventional gas development will likely

proceed more slowly. As a result, CBM projects may place more strain on communities than conventional projects because of the speed of development.<sup>115</sup>

#### THE SAN JUAN BASIN

While most of the San Juan basin is located in New Mexico, conflicts seem to be more pronounced in Colorado. Tax policy differences between the two states are one factor. In New Mexico, oil and gas taxes directly fund educational programs, and that connection helps strengthen support for drilling. In Colorado, oil and gas revenues are not so closely identified with funding for such programs.<sup>116</sup> Perhaps even more important are differences in land use between the San Juan basin in Southern Colorado and Northern New Mexico. The Durango area has become a recreational, residential, retirement community, in contrast with New Mexico, which is still largely an energy production region. Expansion of CBM development in La Plata County clashes with strongly held expectations for protection of roadless areas, vistas, and residential areas.<sup>117</sup> Many people moved into the area because of the solitude, quiet, vistas, and rural landscape, and believe CBM development threatens those characteristics of the land and diminishes their property values. Proposals to intensify drilling density have generated particular opposition in the affected communities.<sup>118</sup>

Other land use conflicts pit preservationists against developers. Some roads are closed for the winter to protect wildlife habitat, but if CBM development occurs in the area, companies get can get a waiver to use the road to get to their sites.<sup>119</sup> There are some roadless areas that include old growth Ponderosa pines that companies would like to open for drilling but are treasured areas for preservationists.<sup>120</sup> Ranches, retirement homes, and roadless areas do not easily coexist with extensive energy development infrastructure. Some residents feel that the long-term goals of sustainability and community are threatened by short-term energy development. The anger and frustration felt by some local residents is palpable, as they accuse companies of failing to comply with the law and arrogantly dismissing residents' complaints and lament the discounting by governments and by energy companies of the personal, anecdotal problems that local landowners report because they are not part of formal scientific studies.<sup>121</sup>



Jim Baca, former director of the BLM and former mayor of Albuquerque, said in a tour of western states sponsored by The Wilderness Society that CBM development in the San Juan Basin "has absolutely destroyed whole landscapes there and quality of life for people." Baca warned that the BLM lacks the resources or staff to deal with the greatly expanded workload due to CBM development, and that as a result, the agency is not inspecting wells in the San Juan area and water is not being properly contained and wells aren't properly maintained. He suggested the agency will need a massive infusion of funds in order to adequately manage CBM development.<sup>122</sup>

#### THE POWDER RIVER BASIN

As is true of other basins, CBM development brings many benefits to the Powder River Basin. It is less invasive than other forms of non-renewable energy development like coal mining, and it has brought tax revenues, business, employment, and other important economic benefits. Deputy Secretary of the Interior Steve Griles said in a March 2002 speech that energy development in Wyoming is a blueprint for the rest of the nation: "It is restoring the environment and it is allowing us to have both healthy, sound environment and the recovery of energy that fuels this great country and the economy we have." He rejected criticism of coal and CBM development in particular as damaging to the environment: "It's just not a fair representation . . . I looked at coalbed methane development here in and around Gillette. When it is done correct and right, the impact on the environment can be positive."<sup>123</sup>

Local residents, however, have complained about noise, particulate emissions from vehicles and traffic, wind-generated dust, emissions from compressors, reduced visibility, fragmentation of habitat by roads, noxious weeds, increased human damage to fragile ecosystems, loss of privacy, and diminished quality of life. Visibility on Native American reservations and protected federal is threatened, and CBM development appears to have contributed to the problem. Fine particles affect visibility and also pose the greatest threat to human health. Fine particles have increased by 50 percent and average concentrations in the area average 12 micrograms/cubic meter.<sup>124</sup> Larger particles, measured as PM10, are less deadly, but still a health threat for those

with asthma and other respiratory diseases. Noise levels provoked one resident to fire 17 shots at a compressor. Others complained of companies leaving garbage and the loss of scenery, solitude, and wildlife.<sup>125</sup>

Landowners argue that CBM development challenges their ability to manage their land in a sustainable fashion. They report that they were not given the option to not sign development agreements, not notified when subsurface minerals were leased, that surface use agreements were not required, that eminent domain was used to install pipelines, and that communications towers have been installed without their permission, that there is a lack of planning for infrastructure needs, a failure to deal with threatened and endangered species, no planning to protect air quality, that little information on development is given to land owners, and bonding is inadequate and some orphan wells have resulted. For these residents, such insults do not just represent damage to their lands and the wasting of scarce and precious water, but are rooted in a sense of powerlessness and a violation of property rights. They view some CBM companies as irresponsible, and complain of signed agreements that are not honored, such as violating royalty agreements by companies that subtract expenses before calculating payments. They feel powerless to protect their lands and ensure their sustainability.<sup>126</sup>

#### ISSUES IN REDUCING SURFACE IMPACTS

While split estates have been a major issue in the San Juan and Powder River basins, future CBM development may face a different set of challenges. Issues of overlapping governance will always be a concern as federal, state, and local government boundary conflicts permeate the West. The Bureau of Land Management will play a major role in determining the scope, speed, and impacts of CBM development on public lands and the process of updating resource management plans and preparing environmental impact statements for large scale leasing will be a major task of the agency. CBM development will bump up against other public values, such as protecting habitat and migration routes for wildlife and preserving biodiversity, and insulating recreational lands from the impacts of resource extraction. BLM's resource management plans are largely out of date and some 160 plans will need to be revised during the next ten years.<sup>127</sup>



As discussed below, the failure to have up to date and comprehensive management plans and environmental assessments may block CBM development affecting public lands and federal mineral resources.

For the existing CBM basins, the conflicts between surface and mineral owners are often intense. The BLM requires, under Secretarial Order No. 1, that mineral leaseholders provide evidence that they have entered into good faith negotiations with surface owners before they can receive an approval for a permit to develop.<sup>128</sup> Ranchers, farmers, and others complain that some gas companies fail to consult with them and explore ways to minimize surface impacts. BP officials have argued that reducing visual and noise impacts of drilling and recovery has not been a priority for companies, since their operations are typically not located in inhabited areas. They have begun to develop equipment and practices that reduce impacts. One option is to use a pneumatic pump that pumps without an engine, produces no noise, and is only about 10–15 feet tall (conventional pumps may be 30–40 feet tall). But pneumatic pumps may not work well when large volumes of water are extracted in the process; an alternative is the progressive cavity pump, smaller than traditional pumps (only about 7 feet tall) but requires an engine. Engines can be equipped with a muffler much as in a motor vehicle. Well pads are typically one acre in size, and must be sufficiently large to accommodate drilling equipment, but that size may be reduced as technology improves.<sup>129</sup>

Another option is to place sound barriers, formed with sound insulation, above and on the sides of engines. Noise, traffic, and dust from operators driving to monitor production can be reduced through automated monitoring systems. These systems can be solar powered. J.M. Huber officials have camouflaged wells from nearby residents by building a ridge of dirt and planting trees on the ridge. Companies have also replaced controllers on wells in order to reduce leaking methane and thereby reducing greenhouse gas emissions.<sup>130</sup> At least one company is developing a diagnostic device for assessing the concentration of CBM in a coal seam that uses a slender tube with sensors that produce immediate data on coal conditions. If reservoir assessments can be improved, that will decrease the likelihood that a company will pump out a large volume of groundwater and then discover that

there is insufficient recoverable methane to make the process worthwhile.<sup>131</sup>

The Northern Plains Resource Council was organized in 1971 by ranchers to fight coal strip-mining and the group played a key role in getting mining reclamation legislation enacted in Montana in 1973 that served as a model for the 1977 federal strip-mining law. It negotiated in 2000 a “good neighbor agreement” with the Stillwater Mining Company that included more strict water protection standards than provided by law and included other safeguards. In 2001, it published a booklet giving recommendations for how CBM development should take place in the state.<sup>132</sup> And it has launched lawsuits. One suit against the state board of oil and gas conservation board was settled when the agency agreed to conduct an environmental impact assessment of CBM before issuing permits. Another suit against the BLM is pending.<sup>133</sup> The council’s call for responsible CBM development includes six provisions:<sup>134</sup>

- Effective monitoring of coalbed methane development and active enforcement of existing laws to protect private property rights, Montana citizens, and Montana’s natural resources,
- Surface owner consent, surface use agreements, and reimbursement of attorney fees to help landowners better protect their property rights,
- Use of aquifer recharge, clustered development, mufflers for compressor stations, and other low-impact, best-available technologies to minimize impacts on underground water reserves, rivers and streams, and surface resources,
- Collection of thorough fish, wildlife, and plant inventories before development proceeds to protect habitat, followed by phased-in development to diffuse impacts over time,
- Meaningful public involvement in the decision-making process,
- Complete reclamation of all disturbed areas and bonding that protects Montana taxpayers from all cleanup liability costs.

These and other ideas for reducing conflicts surrounding CBM development are discussed in Section IV, below.



## CBM DEVELOPMENT AND PUBLIC LANDS

While the development of CBM on private lands has been very contentious in many areas, conflict surrounding CBM development on public lands has also been controversial. As indicated earlier, a major thrust of the Bush administration's national energy plan is to expand development of energy resources on public lands.

Congressional Republicans have also vowed to open public lands to energy development. Developing resources on public lands is a major theme of the House energy bill passed in 2001. House Resources Committee chair Jim Hansen (R-UT) said in introducing a March 2001 hearing, "[i]t's time for a course correction in the management of our public lands. It's ironic that we are faced with an energy crisis while we have abundant reserves of oil, coal, natural gas and hydro-electricity locked up in our public lands and waters."<sup>135</sup>

The Senate energy bill proceeded much more slowly, and much of the debate focused on energy development in the Arctic National Wildlife Refuge.<sup>136</sup> In April, 2002, the Senate defeated an amendment to the energy bill to open ANWR to drilling.<sup>137</sup> The House passed a similar provision and the House-Senate energy conference committee was slated to begin negotiating a compromise bill in June. The House bill favors incentives for expanding fossil fuel and nuclear power production, while the Senate version emphasizes conservation and alternative energy sources.<sup>138</sup>

While the national energy policy debate continues, the Bush administration is accelerating plans to develop oil and gas resources on federal lands in the West. Deputy Secretary of the Interior Steve Griles said in a March 2002 speech that energy development in Wyoming is serving as a blueprint for the rest of the country and that the objective of the president's plan is to "have a steady increase in the use of fossil fuel, and at the same time ratcheting down any type of environmental impact."<sup>139</sup> The BLM is reducing the time it takes companies to apply for drilling permits by one-third in order to increase development.<sup>140</sup> In March 2002, Peter Culp, BLM's assistant director for minerals and resource protection said that oil and gas companies can expect speedier drilling approvals, easier access to petroleum deposits, reduced royalty payments, and fewer environmental restrictions as part of the Bush administration's

national energy plan. He indicated that the BLM would also expedite reviews of oil and gas resources in the Powder River and San Juan basins.<sup>141</sup> The BLM is also conducting a new study of how much oil and gas might be available in BLM lands in the lower 48 states, expected to be completed in 2002; the study will be used by the BLM to find ways to expedite exploration and "evaluate potentially overly restrictive impediments to determine if alternative methods are available."<sup>142</sup>

State officials have been just as adamant in arguing for the development of energy on public lands. Montana Governor Judy Martz has complained that the Clinton administration had tried to "lock up the West" and prohibit the development of the region's resources, claiming that "we have seen our ability to responsibly develop those resources grind to a halt. . . ."<sup>143</sup> Wyoming Governor Jim Geringer claims that "Wyoming's energy potential could completely replace the entire OPEC production for the next forty-one years."<sup>144</sup>

Controversy swirls around a number of issues, including the methods used to assess resources. Environmental resource economists like Pete Morton have suggested only reserves that are economically viable be counted.<sup>145</sup> Wyoming Congresswoman Barbara Cubin counters that the economic viability test discourages exploratory development that might discover resources, such as the state's Jonah Gas field.<sup>146</sup>

There is little agreement concerning the role public lands have played in energy development. Representative Hansen, for example, argues that domestic natural gas production has steadily declined since 1973.<sup>147</sup> But natural gas production on public lands has increased, while production on private lands has fallen. A Natural Resources Defense Council report found that energy production on public lands steadily increased between 1988 and 1998. During those years, oil production on public lands grew by 39 percent, natural gas by 26 percent, and coal by more than 20 percent.<sup>148</sup> The Department of the Interior reported in January 2001 on the production of oil, gas, and coal from offshore and onshore Federal and Indian lands: the contribution of oil and gas production on federal lands grew from thirteen percent of total domestic production in 1992 to twenty-five percent in 1999.<sup>149</sup> Some industry officials, such as Ed Porter of the American Petroleum Institute, have acknowledged that natural gas production had increased,



but argue for expanded drilling on public lands to capture the remaining resources.<sup>150</sup>

Two key issues at the heart of these disagreements over energy development and public lands are the volume of natural gas resources available and their location. As indicated above, the National Petroleum Council reported in 1999 that the United States' "natural resource base" of natural gas (not just CBM) in the lower 48 states was 1,466 trillion cubic feet. While current consumption is about 22 Tcf/year, that is projected to increase to 31 Tcf by 2015.<sup>151</sup> The Council also concluded that some 105 Tcf of this resource base was off limits to development: 29 Tcf in the Rocky Mountain states and 76 Tcf because of restrictions on off-shore development. A representative of The Wilderness Society, in a hearing before the House Resources Committee, suggested that in addition to the 105 Tcf, an additional nine Tcf of gas would not be available as a result of the Forest Service's roadless protection initiative, making 115 Tcf unavailable. If that figure is subtracted from the resource base of 1,466 Tcf, the amount of resource available is 1,351 Tcf. At the projected consumption rate of 31 Tcf per year several years from now, the resource would last 40 years, assuming consumption did not grow. As a result, he argued, we need not feel pressure to move into these environmentally sensitive areas in order to expand natural gas production.<sup>152</sup>

The National Petroleum Council also estimated that some 108 Tcf of natural gas resource in the Rocky Mountain region are available with restrictions. Although these areas can be leased, these restrictions are aimed at protecting sensitive wildlife and habitat areas. The BLM imposes three different kinds of stipulations that affect CBM and other natural gas development:

Standard stipulations that place limits on operations, such as prohibiting development within 500 feet of surface water or riparian areas and are typically applied to all oil and gas leases;

Seasonal or other special stipulations that prohibit activities during specified time periods when suggested by the Fish and Wildlife Service or others to protect nesting, calving, and other seasonal habitat use;

No surface occupancy stipulations that prohibit operations directly over a leased area and require directional drilling to protect underground mining opera-

tions, archaeological sites, caves, steep slopes, campsites, or wildlife habitat.<sup>153</sup>

A Wilderness Society analysis of CBM and public land, using USGS data, concludes that there is between 500–943 Bcf of coalbed methane in the roadless areas of the Rocky Mountain States. If these Forest Service lands were opened for drilling, and the economically recoverable CBM were made available, that would increase America's natural gas reserves by only one-tenth of one percent. It cited a USGS report that concluded there is no economically recoverable CBM within any national monument. The analysis emphasized the importance of focusing on economically extractable reserves, rather than technically recoverable resources. If technically recoverable resources are used, this overestimates the value of resources that may be inaccessible due to public land protection policies and may contribute to pressure to open those lands to development when the economically recoverable resources are quite modest.<sup>154</sup>

There are numerous examples of conflicts between developing energy resources and preserving protected public lands that illustrate the challenges confronting CBM and other energy development in the West and will require careful planning, environmental assessments, and other analyses. A draft report from the Interior Department circulated in April 2001 recommended that millions of acres of lands that had been managed by the Clinton administration as protected areas be opened for energy development. The report urged Congress to decide which of the 17 million acres in 11 western states that have been protected as wilderness study areas (WSA) should be designated as wilderness and which should be opened to development. It also recommends that the Forest Service modify forest plans to allow for more energy development.<sup>155</sup> In 1997, in order to protect its jagged peaks and diverse wildlife, the Clinton administration Forest Service banned oil and gas drilling for ten to fifteen years in that portion of the Lewis and Clark National Forest that is part of the Overthrust Belt, a resource-rich mineral formation that primarily traverses Montana, Idaho, and Wyoming.<sup>156</sup> Interior Secretary Gale Norton said in early 2001 that the Overthrust Belt was one of the areas "that would be studied as part of an across-the-board look at energy resources."<sup>157</sup>

In Wyoming, 94 percent of the state's eighteen million acres of public lands are open to development.



Within the 6 percent of protected area is the 600,000-acre Jack Morrow Hills that is part of the Red Desert. Former Interior Secretary Babbitt toured the area in the late 1990s and would have suggested it for designation as a national monument, but the Wyoming congressional delegation in 1950 had pressed Congress to pass an amendment to the Antiquities Act prohibiting presidents from declaring national monuments in the state without congressional approval.<sup>158</sup> The BLM developed a plan to reopen some lands to oil and gas development, but in December 2000, Secretary Babbitt ordered the agency to come up with a new plan that gave top priority to conservation.<sup>159</sup> Similar disputes have arisen elsewhere in the state, such as in the Bridger-Teton National Forest in northwest Wyoming. In a December 2000 draft environmental impact statement, the forest supervisor announced that oil and gas drilling would not be allowed on some 370,000 acres near the Gros Ventre Wilderness Area southwest of Jackson Hole.<sup>160</sup>

Industry groups first proposed drilling in 1996, and the forest plan provided for drilling in the area. More than seven thousand people submitted comments on the proposal; 85 percent of the respondents opposed development, according to preservationists.<sup>161</sup> Environmentalists have successfully blocked development to protect wetlands and forage for elk, bear, coyotes, wolves, and other wildlife, several blue ribbon trout streams, and four rivers eligible for National Wild and Scenic River designation. In addition, migratory patterns of wildlife from Yellowstone National Park would be threatened by the development.<sup>162</sup> The EPA's position is that the area "is an important buffer between wilderness areas and developed private lands," and represents essential protection for endangered species habitat. Development groups charge the Forest Service with trying to create a *de facto* wilderness area.<sup>163</sup>

CBM and other energy development on public lands in the West pose daunting dilemmas for policy makers and for affected communities and companies. Some argue that the analysis, though difficult, involves an assessment of costs and benefits, while others reject any effort to quantify variables like solitude, open vistas, and habitat protection. In Wyoming, the BLM had argued that it was possible to balance oil and gas development with preservation of the desert elk herd in the area, and other proponents of drilling argued that the benefits of energy development far outweighed the environmental costs. Energy

company executives argued that "we respect the issue of preserving the value of place, but oil and gas drilling will have no impact whatsoever on that value . . ." <sup>164</sup>

Others argue that energy development on public lands often requires choices between preservation or extraction. The editors of the *Great Falls, Montana, Tribune* wrote, in response to the debate over energy development in ANWR, the Rocky Mountain Front, and the Missouri Breaks Monument; "We've long opposed drilling in those places, saying the benefits of doing so are far outweighed by the environmental and recreational benefits of not doing so." <sup>165</sup>

Conservationists argue that 90 percent of BLM lands are available for energy and other resource development, and the last ten percent, much of which has been proposed for wilderness designation, should be protected. "We don't need to drill the last ten percent," said former BLM director Jim Baca.<sup>166</sup>

Others agree that in some landscapes, the issue is a choice between one or the other, rather than a balancing of both: "It gets down to, do you want cheap oil and gas, or do you want Yellowstone?" <sup>167</sup> An official of Questar, a natural gas company operating in the area, focused the debate by saying " [y]ou can't have Wyoming be a pristine, untouched area and still be a major natural gas producer." <sup>168</sup> Richard Fineberg, an environmental consultant, argues that the concept of wilderness "is immutable. It is like perfection—there are no degrees to it. [Energy] development in a wilderness, no matter how sensitive, changes the very nature of it. It means it's no longer wilderness." <sup>169</sup> Said another, "It's almost like the original temptation. We have this incredibly beautiful place that we can either leave alone or go in and grab the apple." <sup>170</sup>

Public lands play a critical role supplying energy and other natural resources, but also in providing recreation, habitat, and ecosystem services such as improving air and water quality. As CBM development moves into new areas, the BLM faces the challenge of protecting habitat, migration routes for big game, and a host of other environmental goals that are part of the purposes of public lands. The Bush administration has emphasized the importance of increasing domestic production of energy sources, and much of that development will take place on public lands.<sup>171</sup> But principles of compromise, collaboration, communication, balance, and stewardship suggest that development needs to be carefully structured in



order to ensure that environmental protection and energy production goals are pursued together.

Environmental impact statements are a key vehicle for assessing the interaction of preservation and development goals. Controversy swirled around the BLM's draft EIS for the Powder River Basin in Montana and Wyoming that was released in February 2002 when EPA officials in Region 8 indicated they would give the study the lowest possible ranking it gives. EPA's concerns were primarily about water quality issues and the impacts of discharged water on the environment and irrigation.<sup>172</sup> The agency faulted the BLM for not examining options for preventing harm from the water, for differences between the Montana and Wyoming studies' analyses of the same water issues, for failing to resolve issues dividing the two states as well as the Northern Cheyenne and Crow tribes, and for inadequate assessment of the effect of development on air quality.<sup>173</sup>

The EPA also found the Montana EIS "environmentally objectionable due to the lack of specifically identified, economically and technically feasible water-management practices that are adequate to assure attainment of water quality standards under the Clean Water Act," and was even more critical of the Wyoming EIS, suggesting that while the Montana document could be remedied, the Wyoming study may need to be scrapped.<sup>174</sup> EPA and BLM officials began meeting to try to resolve the differences, and EPA's views might be altered as they are reviewed at agency headquarters. Interior Department Deputy Secretary J. Steven Griles protested to EPA Deputy Administrator Linda Fisher that the criticisms were misdirected, but then distanced himself from the issue because of his past involvement in the Powder River Basin representing gas companies.<sup>175</sup> In May, 2002, the EPA's Denver office released its assessment of the environmental impact statements, giving the lowest possible rating as had been proposed in the draft letter, and focusing particularly on the water quality issues in the Tongue and Belle Fourche Rivers, but also arguing that environmental safeguards could be devised so that the BLM could approve new development by the fall of 2002.<sup>176</sup>

#### CBM AND THE THREAT OF CLIMATE CHANGE

The development of CBM may contribute to reducing the threat of global climate change. Methane is one of

the most important greenhouse gases, more than 20 times as potent as the equivalent volume of carbon dioxide in trapping radiated energy and contributing to the threat of disruptive climate change. One-third of the methane released into the atmosphere is related to energy production and transportation. Fugitive methane emissions occur during the production of natural gas and emissions are expected to increase as natural gas production expands, even though the average rate of emissions per unit of production is declining. Coal-related methane emissions are expected to decline as technologies for the recovery of vented methane improve. Expanded CBM development could actually result in decreased methane releases if methane that would be otherwise vented through coal mining is captured through coalmine methane recovery, carefully transported to ensure minimal loss, and then used to produce energy.<sup>177</sup>

CBM production could also reduce greenhouse gas concentrations in the atmosphere by serving as a sink for carbon dioxide. The adsorption of carbon dioxide molecules by coal stimulates the desorption of methane and thus enhances its production. Carbon dioxide injected into coal seams for secondary recovery of methane drawn from power plant waste streams, for example, is as a consequence not released into the atmosphere where it otherwise would act as a greenhouse gas.<sup>178</sup>

While the United States has not ratified an international agreement that mandates reductions in greenhouse gases, some local governments and businesses have committed to reduce their greenhouse gas emissions. Part of the strategy developed by these companies is to achieve emission reduction goals through emissions trading programs. Divisions generate emission credits through instituting changes in materials or process, and by efficiency improvements that reduce emissions. The companies then allow the divisions to meet their goals by buying and selling these emission credits, and by purchasing carbon credits from agricultural sequestration, tree planting, and other activities. The revenue from marketing these credits might create additional incentives for injecting carbon dioxide into CBM formations.<sup>179</sup> The role that CO<sub>2</sub> injection might play in enhancing CBM production is not well documented and its promise is unclear but likely modes. Natural gas use produces CO<sub>2</sub> and contributes to the threat of climate change. But some com-



panies are collecting data from pilot projects on the role of CO<sub>2</sub> in enhancing CBM production.<sup>180</sup>

### III. HOW IS CBM DEVELOPMENT REGULATED?<sup>181</sup>

#### FEDERAL REGULATION

The Mineral Leasing Act of 1920 (MLA) provides the current framework for approval and management of CBM activity on federal lands. Federal agencies' policies regarding fluid minerals are adopted pursuant to MLA. Lands managed by the BLM, U.S. Forest Service and other lands owned by the United States are open to CBM production under MLA. BLM is the principal agency responsible for managing the mineral estate on all federal lands. The Federal Land Policy and Management Act (FLPMA) also governs BLM management of federal lands. The National Forest Management Act (NFMA) governs development in national forests. Multiple layers of decisions precede drilling on public lands, including land use plans, leasing decisions, and the Plan of Development (POD)/Application for Permit to Drill (APD).

#### LAND USE PLANS

CBM and other development on federal lands must conform with BLM Resource Management Plans and Forest Service Land and Resource Management Plans. BLM Land Use Plans or Resource Management Plans (RMPs) are developed in accordance with section 202 of FLPMA. Forest Service Land and Resource Management Plans (LRMPs) are issued pursuant to NFMA. Land Use Plans should include a discussion of anticipated land uses, including mineral extraction. Implementation of plans trigger the requirements provided in the National Environmental Policy Act (NEPA) and the agencies must conduct an environmental assessment that may require a formal environmental impact statement (EIS). In the EIS, the agency must predict "reasonably foreseeable" development that will result from opening lands to mineral development. Further, the land use plan should reflect the agency's determination as to where and how development will occur. Because CBM development has been so rapid and recent, most plans did not anticipate or discuss the impacts of this level of CBM development, if CBM development was discussed at all.

#### LEASING

The Federal Onshore Oil and Gas Leasing Reform Act (FOOGLRA) of 1987 requires competitive bids for leases on federal lands. Standard lease terms include application of federal environmental laws and additional measures to minimize adverse impacts, and can include special or supplemental stipulations. The National Environmental Policy Act (NEPA) applies to leasing decision, although there is some debate whether environmental assessments or full environmental impact statements are required and federal courts have issued inconsistent opinions on the issue. BLM may provide NEPA analysis for leasing decisions in RMPs, but most RMPs did not anticipate the levels of CBM development. The Forest Service engages in a two tier leasing analysis under FOOGLRA: analysis of all lands under its jurisdiction available for leasing, and leasing decision for specified lands. Standard Lease Terms (SLTs) give the lessee the right to use the leased land to explore, drill, extract, remove and dispose of oil and gas deposits under the land. Additional measures may be added to mitigate adverse impacts to the surface.<sup>182</sup>

Leasing disputes may play a major role in the Powder River Basin and perhaps other areas as well. In April 2002, the Interior Board of Land Appeals ruled, in response to a challenge by the Wyoming Outdoor and Powder River Basin Resource Councils of three CBM leases in the Powder River Basin issued by the BLM, that the agency had failed to perform adequate environmental reviews before issuing the leases.<sup>183</sup> The board found that two BLM studies on which the agency relied in making leasing decisions, a 1985 BLM resource management plan that did not consider CBM development impacts, and a draft environmental impact statement on CBM development, as "insufficient to provide the requisite pre-leasing NEPA analysis for the sale parcels in question." While the decisions only applied to three leases, they appear to be similar to many more and the decision could bring to a halt thousands of CBM leases until the BLM can revise its environmental assessments. In addition to stopping existing leases, the decision puts into question whether the analysis the BLM is doing in anticipation of approving thousands of new leases would meet the board's criteria. The IBLA opinion concluded that



*not only does the record amply demonstrate that the magnitude of water production from CBM extraction in the Powder River Basin creates unique problems and the CBM development and transportation present critical air quality issues not adequately addressed in the RMP/EIS, but BLM has also acknowledged the inadequacy of the RMP/EIS as far as the analysis of CBM issues is concerned.*<sup>184</sup>

As a result, the BLM could not rely on that document to satisfy its obligations under NEPA. The decision may have major impacts on CBM development, depending on whether the councils appeal more decisions, the Secretary of the Interior reverses the Board's finding, gas companies sue the board in federal court, or the BLM decides to place a moratorium on leases until environmental assessments can be completed.<sup>185</sup>

#### PLAN OF DEVELOPMENT/APPLICATION FOR PERMIT TO DRILL

The application for permit to drill (APD) includes a plan of operations that outlines the nature of surface impacts. The Forest Service emphasizes protection of resources and general reclamation principles. Onsite inspections may trigger revision of APD or conditions of approval. APDs are submitted directly to BLM, which then distributes the APD to any affected surface management agency. Under revised BLM and Forest Service regulations, both a "drilling plan" and a "surface use plan of operations" must be developed. Neither BLM nor FS rules contain specific terms and conditions governing surface reclamation, although FS does set out some general principles. Prior to approving the APD, the BLM must verify that the required performance bond is in place. In some cases, the APD review is preceded by an application for a plan of development (POD). PODs are required when a field of oil or gas is to be developed rather than one well. PODs give the BLM the opportunity to assess the cumulative impacts of development and to consider ways to reduce impacts such as requiring companies to consolidate their infrastructure.

BLM's surface use planning addresses an extensive set of issues, including existing roads, proposed roads, location of existing and proposed wells and facilities, location and type of water supply, construction materials to be used, methods for handling waste disposal, ancillary

facilities, wellsite layout, plans for surface reclamation, type of water discharge, discharge points, reservoirs/containment pits, road crossings, culverts, erosion control measures, discharge rate, downstream concerns, water management plans, and water quality maintenance and monitoring. An interdisciplinary team of geologists, engineers, biologists, archaeologists, hydrologists, and others review the plans, conduct on-site investigations, and conduct post-inspection monitoring.<sup>186</sup>

#### CLEAN WATER LAWS

Under the Federal Clean Water Act, as administered by states, CBM development is governed by water quality standards to protect designated uses of water. Standards include pollution limits, anti-degradation requirements beyond water quality standards, and total maximum daily loads—maximum daily pollutant discharges that are assigned to point and non point sources to ensure total pollution levels are not exceeded. Developers must receive a National Pollution Discharge Elimination System (NPDES) permit if they are discharging produced water into surface waters of the state. State Water Quality Standards and Effluent Limitations also apply to CBM, but there currently are no technology-based effluent standards for CBM discharges. Permits must still impose effluent limitations that will ensure that State Water Quality Standards are not violated. There is little agreement on what they should be. In Wyoming, for example, there are no numeric standards for sodium absorption ratio (SAR); state officials require that CBM-produced water does not degrade designated uses of surface water. Montana has numeric standards for some waters downstream, so Wyoming sources are required to comply, and the two states have negotiated an agreement.

Under Section 401 of the Clean Water Act, applicants must receive certification from the State where the discharge originates stating that their activities will comply with the Clean Water Act; state requirements become part of the federal permit and are enforceable by either BLM or Forest Service. Under Section 404, parties must get 404 permits for any activities that may result in the placement of fill into the waters of the United States

The Federal Safe Drinking Water Act (SDWA) governs re-injection of water produced from CBM extraction. No underground injection is allowed without a permit.



Part C of the SDWA is designed to protect underground resources of drinking water by issuing permits for any underground injections of fluids. There are five classes of injection wells under these regulations, which are classified by the type of fluid injected and the area where the fluid is injected. With CBM, most re-injection is done into Class II wells. Class II wells cover fluids that are either brought to the surface in connection with oil and gas development or are used to enhance the recovery of oil and gas. The EPA is studying the environmental risks associated with hydraulic fracturing used to facilitate methane recovery for underground sources of drinking water in response to complaints that CBM development has compromised water quality in some drinking wells.

Hydraulic fracturing or fracing has been the subject of significant litigation. In *Legal Environmental Assistance Foundation (LEAF) v. EPA*<sup>187</sup>, plaintiffs claimed that the nearby use of hydraulic fracturing to extract CBM polluted their well waters and should have been regulated under the SDWA. The court held that fracing fluids fell within the SDWA's definition of "underground injection," stating that "the process of hydraulic fracturing obviously falls within this definition, as it involves subsurface emplacement of fluids by forcing them into cracks in the ground through a well."<sup>188</sup> Accordingly, the court granted the petition for review and remanded the matter to EPA. In July of 2000, EPA published a notice in the *Federal Register* indicating that it is undertaking a nationwide study to evaluate the environmental risks of fracing to underground sources of drinking water.<sup>189</sup> A final report has not been completed. The LEAF decision may pose significant implications for CBM development in western states as well. For example, although the Wyoming Department of Environmental Quality (WDEQ) has an approved UIC program, WDEQ does not regulate the underground injection of hydraulic fracing fluids.

#### OTHER FEDERAL LAWS

CBM development on tribal lands is governed by the Omnibus Indian Mineral Leasing Act of 1938<sup>190</sup> and the Indian Mineral Development Act of 1982.<sup>191</sup> Energy development on tribal lands is subject to a dual legal system of federal and tribal law. These acts require the Bureau of Indian Affairs to authorize energy leases. NEPA review applies to these decisions. Under other laws, quali-

fying tribes can act as states in enforcing environmental laws, and tribes may regulate their lands more stringently than federal minimum standards and may regulate in areas not covered by federal laws or programs.

Other Federal laws are applicable to CBM development. The Endangered Species Act requires all federal agencies to insure that any action authorized, funded or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat of such species.<sup>192</sup> Agencies must consult with either the United States Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) when any activity they authorize, fund, or carry out could affect listed species.<sup>193</sup> The Surface Mining Control and Reclamation Act includes provisions to water from coal mining operations that might serve as a model for CBM regulation. Underground coal mining permits must include actions to "minimize the disturbances of the prevailing hydrologic balance at the minesite and in associated offsite areas and to the quantity of water in surface ground water systems." Using the "best technology current available," companies are required to "minimize disturbances and adverse impacts of the operation on fish, wildlife, and related environmental values, and achieve enhancement of such resources where practicable."<sup>194</sup> Federal officials are to monitor operations to ensure compliance and to require monitoring of aquifers.<sup>195</sup>

#### STATE REGULATION

State "conservation statutes" created oil and gas commissions and boards. They were originally authorized to establish drilling units and provide for the location of permitted wells. These laws were typically enacted for three purposes: (1) To protect the opportunity of all owners to share in oil and gas production, (2) To prevent waste of the resource, and (3) To avoid drilling unnecessary wells. Their responsibilities have expanded to include the regulating of drilling, casing, plugging and the abandonment of wells. In some states, the commissions or boards may be authorized to protect the rights of surface owners. Specific state statutory provisions differ in terms of the charge they give to oil and gas commissions:<sup>196</sup>

- Colorado: the Oil and Gas Conservation Commission is to encourage production and prevent and mitigate



adverse environmental impacts. Its original function was to foster, encourage, and promote the development, production and utilization of oil and gas. COGCC focused on increasing production by preventing waste;<sup>197</sup> in 1994, its mandate was expanded to prevent and mitigate significant adverse environmental impacts on any air, water, soil, or biological resource resulting from oil and gas operations<sup>198</sup> and to investigate, prevent, monitor, or mitigate conditions that threaten to cause, or that actually cause, a significant adverse environmental impact.<sup>199</sup>

- **Montana:** the Board of Oil and Gas Conservation (MBOGC) was established in 1953 with the passage of the Montana Oil and Gas Conservation Act. No oil or gas exploration, development, production, or disposal well may be drilled until MBOGC issues a drilling permit. MBOGC's mandate is (1) to prevent waste of oil and gas resources; (2) to encourage maximum efficient recovery of the resource; and (3) to protect the right of each owner to recover its fair share of the oil and gas underlying its lands.<sup>200</sup> MBOGC can also take measures to prevent contamination of or damage to surrounding land caused by drilling operations, such as regulating the disposal of produced salt water and the disposal of oil field wastes.<sup>201</sup> Montana also has a state environmental policy act requiring its state agencies to complete environmental analyses similar to those required under NEPA.<sup>202</sup>
- **New Mexico:** The Oil Conservation Commission and the Oil Conservation Division of the Energy, Minerals and Natural Resources Department regulate the conservation of oil and gas and the disposition of wastes resulting from oil and gas operations, including the protection of public health and the environment.<sup>203</sup>
- **Utah:** The Board of Oil, Gas and Mining<sup>204</sup> and its related technical and administrative agency, the Division of Oil, Gas and Mining<sup>205</sup> regulate drilling, testing, equipping, completing, operating, producing, and plugging wells; spacing and location of wells; and disposal of salt water and field wastes.<sup>206</sup> Board rules require operators to "take all reasonable precautions to avoid polluting lands, streams, reservoirs, natural drainage ways, and underground water."<sup>207</sup> Board rules encourage the development of surface use agreements with landowners but do not adopt statewide standards of reclamation.<sup>208</sup>

- **Wyoming:** The Oil and Gas Commission (WOGCC) has the authority to require drilling, casing, and plugging of wells in order to prevent escape of oil or gas, the furnishing of a reasonable bond limited to plugging each dry or abandoned well, and monitoring of well performance.<sup>209</sup> It can also regulate, for conservation purposes, the drilling, producing and plugging of wells, the shooting and chemical treatment of wells, well spacing, disposal of salt water and drilling fluids "uniquely associated" with gas exploration and development, and the contamination or waste of underground water.<sup>210</sup> The Commission has a duty to prevent the waste of natural gas and to keep it from polluting or damaging crops, vegetation, livestock, and wildlife.<sup>211</sup> WOGCC rules provide that, "[t]he owner or operator shall not pollute streams, underground water, or unreasonably damage or occupy the surface of the leased premises or other lands."<sup>212</sup>

#### LOCAL REGULATION

County regulation of CBM development has been accepted in some areas and been contentious in others. County regulations may place limits on operations; require special use, building, and road permits; and require companies to paint production tanks and keep sites weed-free. Colorado's La Plata and Las Animas Counties have enacted regulations that require consideration of noise levels, impacts on air and water quality, vibration and odor levels, fire protection, access requirements, visual impacts, impacts to wildlife and public safety. Conflicts have occurred between the county and developers and between the county and state officials.

La Plata County was the first to regulate CBM development and its regulations were challenged by gas companies as pre-empted by state or federal laws. The county first adopted regulations affecting CBM development in 1991. Industry challenged the regulations in court and the county's authority was upheld. It issued new regulations in 1995 providing that surface owners be able to determine, within a window specified by the OGCC, the specific areas on their land where drilling could take place. It was again sued, and this time the court struck down the regulations. County officials have emphasized that their goal is to address the impacts of development on communities and not to block CBM production.<sup>213</sup>



Of particular importance to county officials is the objective of equating the surface and mineral estates so landowners can help shape the location and nature of extractive activities that affect their lands, and these officials have proposed that companies be required to negotiate surface use agreements before drilling begins. Industry representatives argue that they already provide those agreements before drilling, while others claim that such requirements are too onerous and will drive industry out of the state.<sup>214</sup> The county challenged an Oil and Gas Conservation Commission rule that strengthened the Commission's power over county regulation of oil and gas development.<sup>215</sup>

In February 2002, J.M. Huber filed a lawsuit against La Plata County Commissioners, charging they had exceeded their jurisdiction and abused their discretion when they denied Huber's request for a reconsideration of a drilling permit condition. The company also asked for and was granted a hearing before the Colorado Oil and Gas Conservation Commission. The condition required the company to install a low-profile or alternative pump and use an electric motor at its Bellflower gas well east of Durango. The company argued the decision was outside the jurisdiction of the county and was within the purview of the state OGCC, and that complying with the county's directive "will cause waste as prohibited (by state regulations) since it will significantly inhibit or limit production from the well." County officials, local residents, and Huber representatives had met during the summer of 2001 to negotiate noise and visual mitigation steps the company would take in operating the well, but were unable to come to agreement.<sup>216</sup>

La Plata County regulations issued in 1998 require permits for drilling to be processed within seven days. The process typically begins with the company identifying a new site, visiting the site to discuss the proposal, and formulating an agreement with the land owner. If an agreement is reached, the company then submits an application for a drilling permit to the county and to the COGCC. The county and commission may attach conditions to the permit, and that process can take up to a month. Once the permit is approved, a pre-construction notice is sent to the surface owner from 1–14 days before construction begins. A permit is good for up to one year; if not used by the end of that period, a new permit is required. As much as two month's time may pass

between the time the surface agreement is negotiated and the construction and drilling are completed.<sup>217</sup>

On July 11, 2000, the COGCC approved infill well applications that provided for one well every 160 acres instead of the standard 320 acre spacing. It also issued an order imposing new requirements on companies drilling for CBM in La Plata County, in response to residents' concerns with noise, gas seepage, and impacts on the local landscape. By August 27<sup>th</sup>, BP had filed 10 applications to drill with the county and five had been approved. County planning officials reported that "for the most part, we're on the same page" with the state commission.<sup>218</sup> The state's general conditions require companies to take the following actions:<sup>219</sup>

- Request a COGCC hearing to apply for new drilling sites located within 1/2 mile of the Fruitland Outcrop,<sup>220</sup>
- Identify all plugged and abandoned wells near each new well site,
- Submit drilling plans to the COGCC.

Surface mitigation requirements include the following:

- Curtail drilling during wildlife "seasonal" times,
- Install electric motors "where practicable" to reduce noise levels,
- Water roads to control dust,
- Use plugged or abandoned well sites when possible to reduce new wells.

Companies are also required to ensure they don't contaminate drinking water by:

- taking periodic sampling of water from wells located within 1/2 mile of each new well, and
- testing the water wells before drilling occurs, one year after drilling is completed, and twice more within the next six years.<sup>221</sup>

If a proposed CBM well site is near a subdivision:

- the COGCC director or staff member must make an on-site inspection,
- an on-site inspection is required if an agreement with the surface owner is not reached.

An attorney for the San Juan Citizen's Alliance asserted that the state's requirements failed to address noise, visual impact, and other serious issues, and the COGCC



director observed that the regulations do not address other issues such as noise, decline in property values, compensation to land owners, and problems with private agreements between land owners and gas companies.<sup>222</sup>

Surface land owners have argued that their rights were not protected by the regulations. In July 2000, landowners in La Plata County filed a class action suit against 13 companies, claiming they were not minimizing surface impacts. If the plaintiffs prevail, companies will be required to use smaller well pads and pumping units whenever possible.<sup>223</sup> The litigation was based on a 1997 Colorado Supreme Court ruling that gas companies must minimize adverse, unnecessary impacts on surface lands.<sup>224</sup> That same year, J.M. Huber applied for a drilling permit in a housing development with lots of ten acres or less. After numerous hearings with county officials and 12 public meetings at the well site with residents, the company and county agreed on 13 conditions for drilling, including an electric pump rather than a more noisy gas-powered pump to run the pump jack within six months of when the well starting producing, burying power lines, and using a smaller pump jack. The company subsequently concluded that those conditions would cost tens or perhaps hundreds of thousands of dollars, and decided not to install the electric pump. The company concluded that the permit conditions made the company operate less efficiently and profitably, and asked the county to reconsider whether it had the authority to impose such conditions. The company's attorney suggested that the county was "regulating down-hole production and sound," contrary to court rulings that the state oil and gas conservation commission alone had that authority. Local residents countered with demands that the county hold the company to conditions it had agreed to.<sup>225</sup> In February, 2002, the company sued the county commissioners and petitioned the COGCC, charging that the county had "exceeded its jurisdiction and abused its discretion" when it denied the company's request in January 2002 to reconsider the drilling permit conditions.<sup>226</sup>

The Colorado Supreme Court's *Gerrity Oil & Gas Corp. v. Magness*<sup>227</sup> opinion has been widely discussed in the context of CBM development, and warrants a brief note here. The issues before the court dealt with a claim of trespass in a split estate. The court explained that,

*Severed mineral rights lack value unless they can be developed. For this reason, the owner of a severed mineral estate or lessee is privileged to access the surface and "use that portion of the surface estate that is reasonably necessary to develop the severed mineral interest." The right to use the surface as is reasonably necessary, known as the rule of reasonable surface use, does not include the right to destroy, interfere with or damage the surface owner's correlative rights to the surface.*

*In this sense, the right of access to the mineral estate is in the nature of an implied easement, since it entitles the holder to a limited right to use the land in order to reach and extract the minerals. As the owner of property subject to the easement, the surface owner "continues to enjoy all the rights and benefits of proprietorship consistent with the burden of the easement." "The surface owner thus continues to enjoy the right to use the entire surface of the land as long as such use does not preclude exercise of the lessee's privilege. [citations omitted]*

*Although we have referred to the mineral estate as the dominant estate and the surface estate as the servient estate, our cases have consistently emphasized that both estates must exercise their rights in a manner consistent with the other. Hence, in a practical sense, both estates are mutually dominant and mutually servient because each is burdened with the rights of the other. [citations omitted]*

*The fact that neither the surface owner nor the severed mineral rights holder has any absolute right to exclude the other from the surface may create tension between competing surface uses. "The broad principle by which these tensions are to be resolved is that each owner must have due regard for the rights of the other in making use of the estate in question." This "due regard" concept requires mineral rights holders to accommodate surface owners to the fullest extent possible consistent with their right to develop the mineral estate. How much accommodation is necessary will, of course, vary depending on surface uses and on the alternatives available to the mineral rights holder for exploitation of the underlying mineral estate. However, when the operations of a lessee or other holder of mineral rights would preclude or impair uses by the surface owner, and when reasonable alternatives are available to the lessee, the doctrine of reasonable surface use requires the lessee to adopt an alternative means. [citations omitted].*

Communities in other states may have general regulations that impact CBM development, but have not yet enacted regulations that directly address CBM. In Montana, local regulation is allowed if it ensures effective



utilization of resources. In New Mexico, it is likely to be upheld if it only deals with issues traditionally within the jurisdiction of county government. In Utah, counties are precluded from regulating in areas of state law, where the oil and gas board is given exclusive authority, but it is likely to be permissible for counties to regulate traffic, noise, and compatibility with surrounding activity.

In Wyoming, counties can regulate land use but can't prevent use necessary to the extraction or production of mineral resources. Wyoming counties have hired a coalbed methane coordinator to help resolve problems. A memorandum of understanding between the state, five county commissions, and two conservation districts is in place to help coordinate the efforts of the various agencies and to facilitate the flow of information. The coordinator has emphasized the need for consistency in regulation across the basin, the importance of impact funding early in development before tax revenues are received, mitigation funds contributed by all companies, more research and data on development and its impacts, and more amenities for communities affected by development.<sup>228</sup>

## STATE WATER LAW

Most of the discussion of CBM and water focuses on water quality, but there are many questions about how CBM development affects water rights. The Rocky Mountain states have all adopted the prior appropriation approach to water law. Under prior appropriation, ownership of land does not result in ownership of water, but water rights are created when water is diverted and used or appropriated for a beneficial purpose. The main provisions of prior appropriation include the following.<sup>229</sup>

First, appropriated waters need not be used on riparian lands; they may be used any place and need not remain in the originating watershed. The water right is the amount of water put to a beneficial use; there are no limits to the quantity used such as reasonable use, but state statutes typically require right-holders to show that all the water will be beneficially used and not wasted;

- Appropriators are typically required to use a reasonably efficient means of diversion,
- Seniors may not transfer their rights to another or change diversion, purpose of use, or place of use if that harms the rights of juniors,

—Since about half of the water diverted for agriculture typically returns to the hydrologic cycle, the return flow may be used by other right-holders, and senior right-holders may not adversely affect the return flow; junior right-holders are entitled to the stream conditions that existed at the time they received their appropriation.

Second, the date of the original appropriation established the water right priority date; the holder of the oldest or most senior priority right is entitled to delivery of the full right; junior right-holders are entitled to whatever water is available after senior rights-holders have withdrawn their water;

- All right-holders are ranked according to the dates of their appropriation and each is either junior or senior to all other right-holders,
- If downstream senior right-holders "call" their water, upstream juniors must allow sufficient water to flow past their diversion to meet the rights of seniors.

Third, rights are acquired by use and may be lost by non-use;

- Abandonment occurs when the right-holder intends to relinquish the water right,
  - the burden of proof lies with those who seek to demonstrate that the right holder has abandoned the water right,
  - a period of non-use creates a rebuttable presumption that the right has been abandoned, and the right-holder may then provide evidence of the intent to retain the right.
- Forfeiture does not require the intent to abandon, but may occur when there is non-use for the specified period of time or the diversion construction does not occur.

Fourth, water rights are "perfected" when an applicant receives a certificate or decree from the state water engineer or court recognizing that the water is being put to beneficial use and belongs to the applicant;

- Most states require rights-holders to apply for a permit,
  - All affected parties must be given notice and a hearing must be held to determine whether the criteria for establishing a right have been met,



- The construction of the diversion facilities must occur within a specified time period, and
- The water must be put to a beneficial use.
- Colorado does not issue permits, but, instead, uses a water court system to adjudicate rights; priority is established when the applicant
  - Decides to put the water to beneficial use, and
  - Makes an “open, overt physical demonstration of the intent” that gives notice to third parties.
- Colorado also allows for “conditional decrees” that reserve water for future use; the priority of the right is that of the date of the decree;
  - Applicants must demonstrate that there is a “substantial probability” that the water project “can and will” be completed within a reasonable time,
  - A court must determine whether there is sufficient water available for the proposed diversion.

Fifth, beneficial use generally includes domestic, municipal, industrial, commercial, agricultural, hydropower production, stockwatering, and mining; recreation, fish and wildlife maintenance, and preservation of environmental and aesthetic values have also been defined as beneficial use;

- If water use is deemed beneficial, it cannot be defeated by a more junior claim that water will be put to a more beneficial use,
- However, a right-holder may lose that right if the means of diversion or the use is found to be wasteful,
- The public trust doctrine also places some limits on uses of water to protect environment and recreational interests of the public.

Sixth, water rights are passed to new land owners when land is conveyed unless the grantor expressly reserves those rights, and water rights may be transferred separately from the land if allowed by state law;

Finally, the prior appropriation doctrine is primarily applicable to surface waters. Water that occurs as a result of human labor, such as transbasin diversions, is not subject to appropriation but belongs to those responsible for producing it.

In Colorado, Utah, New Mexico and Montana, water produced from coalbed methane operations is generally defined as byproduct water. Although Wyoming also exempts byproduct water from oil and gas operation from

its groundwater permitting system, coalbed methane water does not fall into the exemption, and operators must obtain a groundwater permit from the state engineer and put the byproduct water to a beneficial use.<sup>230</sup>

#### COLORADO WATER LAW

Under Colorado law, operators are not required to apply for a permit from the state engineer when withdrawing non-tributary water unless that water will be put to a beneficial use.<sup>231</sup> If the produced water is put to a beneficial use, the state engineer must ensure that it will not cause “material injury to the vested water rights of others.”<sup>232</sup> If injury will result, the permit must contain mitigation measure to avoid injury. In Colorado, a reduction of hydrostatic pressure level or water level is not considered a material injury.<sup>233</sup>

The Colorado Oil and Gas Conservation Commission (COGCC) has jurisdiction over produced water, which appears to fall under its definition of “exploration and production waste.”<sup>234</sup> COGCC Rule 907 covers the management of “E&P” waste, and it dictates how produced water shall be managed and disposed. Under the rule, if produced water is placed in a pit, it must first be treated to prevent crude oil and condensate from polluting the pit.<sup>235</sup> The rule also contains a number of disposal options including reinjection into a Class II well, evaporation or percolation in a permitted lined or unlined pit, disposal at commercial facilities or through road-spreading, or discharge into the waters of the state.<sup>236</sup> All of these provisions require the operator to receive the proper permits before undertaking any of these activities. The produced water may also be reused to aid in enhanced recovery, drilling or other uses as long as the use follows established water quality standards and water rights.<sup>237</sup> Finally, the rule allows for the water to be used by the surface owner as an alternative domestic water supply that cannot be traded or sold.<sup>238</sup> When water is used in such a manner, it is not considered an implicit admission by the operator that his or her activities are impacting existing water wells.

#### NEW MEXICO WATER LAW

New Mexico law classifies water used in the “prospecting, mining . . . or drilling operations designed to discover or develop the natural resources of the state” as a



beneficial use, and in certain instances, mine operators must obtain permits to withdraw water.<sup>239</sup> However the state engineer does not have authority over aquifers found at 2500 feet or further below the ground surface that contain nonpotable water.<sup>240</sup> In most instances, coalbed methane wells operating in New Mexico fall under this provision, and thus are not permitted by the state engineer. The Oil Conservation Division of the Energy, Minerals and Natural Resources Department has jurisdiction over "water produced or used in connection with the drilling for or production of oil and gas."<sup>241</sup> The division may regulate surface and subsurface disposal of the water in such a manner as to protect fresh water sources.<sup>242</sup> Particular methods include the use of lined pits and below grade tanks to store produced water,<sup>243</sup> and requirements calling for the prevention and abatement of water pollution so that "all ground water . . . which has a background concentration of 10,000mg/L or less of TDS" is either remediated or protected for beneficial uses.<sup>244</sup> The division also regulates the subsurface injection of produced water into reservoirs.<sup>245</sup>

New Mexico law also contains provisions crafted to protect existing water rights while at the same time promoting mineral development in the state.<sup>246</sup> Under the Mine Dewatering Act, any operator who wishes to appropriate water for a beneficial use or to dewater a mine is given the right to replace the appropriations of existing water rights which may be impacted.<sup>247</sup> The cost to replace the water is solely the responsibility of the operator, who must make an application with the state engineer to replace water.<sup>248</sup> Although an appropriation of water may be made under this act, simply dewatering a mine does not establish water rights for the applicant.<sup>249</sup> The state engineer may only approve an application under this statute if he is satisfied that the plan of replacement will prevent the impairment of affected waters.<sup>250</sup> In approving a plan of replacement, the state engineer must consider the characteristics of the aquifer, present withdrawals on the aquifer and their effects on water levels and water quality, the impact of the mine dewatering on the aquifer, and the "present and future discharge from, recharge to and storage of water in the aquifer."<sup>251</sup>

## UTAH WATER LAW

While Utah also has a groundwater appropriations system,<sup>252</sup> jurisdiction over byproduct water rests with the Utah Board and Division of Oil, Gas and Mining.<sup>253</sup> However, in certain circumstances, the state engineer may issue a temporary water right to put byproduct water resulting from mining development to a beneficial use, but only occurs once the water has been diverted from its underground source.<sup>254</sup> The Division has developed various rules that pertain to the disposal of "salt water and oil field wastes," which include coalbed methane water.<sup>255</sup> Operators may use lined pits,<sup>256</sup> or unlined pits if the disposed water does not have a TDS content higher than ground water that could be affected or other objectionable constituents such as chlorides, sulfates, pH, oil, grease, heavy metals or aromatic hydrocarbons.<sup>257</sup> Unlined pits may also be used when "all, or a substantial part of the produced water is being used for beneficial purposes such as irrigation, and livestock or wildlife watering" and an analysis of the water shows that it can be used for those purposes.<sup>258</sup> Finally, unlined pits may also be used when the amount of disposed water does not exceed five barrels per day.<sup>259</sup> Operators may also opt for subsurface disposal into Class II injection wells under the state UIC program.<sup>260</sup>

## MONTANA WATER LAW

Montana is the only Western state that addresses coalbed methane wells directly in its statutes. Under Montana law, groundwater may not be wasted, although in certain situations, including the management, discharge, or reinjection of coalbed methane water, the withdrawal and use of groundwater will not be considered waste.<sup>261</sup> Coalbed methane operators have three management options for the groundwater that is produced from their wells. They may (1) use the water for irrigation, stock water or other beneficial uses, (2) reinject the water into an "acceptable subsurface strata or aquifer" according to the applicable laws, or (3) discharge the water to surface waters or the surface upon obtaining an NPDES permit.<sup>262</sup> While Montana law mandates that no groundwater shall be wasted, the methods of disposal available for coalbed methane produced water are not considered "wasteful" under the law. However, even though the quality of



coalbed methane water in Montana is quite good, the sodium absorption ratio (SAR) of the water still may be too high to allow the water to be used for irrigation. Likewise, allowing the byproduct water to be lost down stream or possibly reinjected into aquifers containing a lower quality of water may result in the byproduct water being wasted in fact. Coalbed methane operators are required to notify any other appropriators whose rights may be harmed by the withdrawal of water from aquifers due to coalbed methane development.<sup>263</sup> Furthermore, the operators must offer mitigation agreements to those appropriators whose wells are within one mile of a coalbed methane well or within one half of a mile of any well adversely affected by a coalbed methane well.<sup>264</sup>

Montana law also allows for the designation of controlled groundwater areas. These are areas where groundwater withdrawals exceed the recharge rate of the aquifers within the designated area or are likely to exceed the recharge rate in the future.<sup>265</sup> In order to withdraw and appropriate water from designated groundwater areas, one must obtain a permit showing that the withdrawal will take water that is available, that existing uses will be protected, and that the water will be put to a beneficial use.<sup>266</sup> The Powder River Basin was designated a controlled groundwater area in 1999, meaning that coalbed methane operators are required to obtain permits to withdraw water from the basin. It is questionable whether operators can meet the permit requirements of controlled groundwater areas when the amount of water taken from coalbed methane operations is, to some extent, uncontrolled in an area where the amount of appropriations is already taxing the available resources.

## WYOMING WATER LAW

Although Wyoming water law contains provisions that deal with byproduct water appropriations, they do not apply to coalbed methane produced water.<sup>267</sup> Instead, the state engineer retains jurisdiction over produced water from coalbed methane wells, and as such, operators are required to obtain groundwater appropriation permits.<sup>268</sup> According to Wyoming water law, applications to appropriate groundwater "shall be granted as a matter of purpose, if the proposed use is beneficial and, if the state engineer finds that the proposed means of diversion and construction are adequate."<sup>269</sup> However, the state

engineer may also deny the application if he finds that it would not be in the public's water interest.<sup>270</sup> Beneficial uses of water are outlined in Wyoming water law, and are ranked according to preferences.<sup>271</sup>

The emphasis placed on putting appropriated groundwater to a beneficial use and preventing waste presented problems for initial coalbed methane applicants. On original "Application for Permit to Appropriate Ground Water" forms, appropriators were required to specify the use to which the water would be put. Operators often checked the "miscellaneous" box and stated that the water was used to produce coalbed methane. Present forms now have an individual box for coalbed methane operators to check.<sup>272</sup> Apparently, the state engineer now considers the production of water in connection to coalbed methane development alone a beneficial use of ground water.

While coalbed methane produced water varies in quality across the region, it does not generally approach the poor quality of conventional oil and gas byproduct water, which can reach TDS levels five to ten times that of the worst coalbed methane water, and in some cases is of relatively high quality. Regulating coalbed methane-produced water under the traditional oil and gas regulations runs the risk of wasting a potentially important source of water. Given the value of the water which many believe is at least as valuable as the gas, if not more so, state legislatures may decide to fashion provisions expressly aimed at defining who owns CBM produced water and what should happen to it.

A variety of theories have been suggested for governing the withdrawal and use of groundwater in CBM development. (1) States could declare the owner of surface lands the owner of all the water under it as part of the soil; most states have rejected this approach since it provides no recourse when land owners deplete or contaminate groundwater. (2) States may allow landowners to withdraw reasonable amounts of water as long as that use is connected to the beneficial enjoyment of the land. (3) California provides for withdrawals from a common aquifer equal to the proportion of ownership of the land above the aquifer, in recognition that withdrawals by one land owner affect the water available to other land owners. (4) States may employ tort law to hold liable those whose withdrawal of water harms neighboring land own-



ers, is beyond a reasonable share of water use, or affects surface water in ways adverse to right-holders of that water. (5) States may apply prior appropriations principles, but since senior right-holders might drain an aquifer, states may limit the protection provided for seniors through principles such as "unreasonable interference," where the "lowering of the water table is not per se an unreasonable impairment of senior rights."<sup>273</sup>

States may require permits for water withdrawal to protect water rights and water quality. Permits may specify that withdrawals do not exceed recharge rates or adversely affect groundwater rights. Permits may regulate withdrawals of groundwater in areas where surface and groundwater are interconnected in order to protect the senior water rights from junior well owners whose pumping may diminish surface water. In Colorado, juniors may pump underground sources if they augment surface right-holders with supplemental water to offset any loss in surface water from groundwater removal. To protect water quality, states may require that wells do not draw contaminants into an aquifer. If such contamination occurs, landowners may pursue tort claims against those who have contaminated their groundwater. If they have no water appropriation rights, landowners may still pursue nuisance claims if contamination unreasonably interferes with their use and enjoyment of the land above the aquifer.<sup>274</sup>

#### CBM DEVELOPMENT AND PENDING NATIONAL LEGISLATION IN 2002

Both Houses of Congress have passed major energy bills and concerns about energy prices, energy imports and national security, and other energy issues are likely to lead to legislation in 2002.<sup>275</sup> While the national debate has focused on other issues, such as opening the Arctic National Wildlife Refuge and increasing fuel efficiency requirements, some proposals address coalbed methane development, and the future of these CBM-related provisions are linked to the prospects for passage of the broader bills. The following proposals for legislation affecting CBM development are currently before Congress:<sup>276</sup>

Conflicts between coal and CBM development: In response to conflicts between coal and coalbed methane companies, members of Congress introduced H.R. 2952/S. 675, the Powder River Basin Resource Development

Act, which sets up a process to resolve conflicts between coal and CBM development; coal companies are complaining that coal development is a more valuable lease and they are being held up by CBM development, in response to the *Amoco v. Southern Ute* ruling. The proposal would establish a dispute resolution process; if negotiations fail, the parties file a petition in court and the court will decide which resource is of the greater value and give development rights to it. The less valuable lease will be suspended, typically the CBM lease, and damages awarded to the CBM company. The coal company will get a royalty credit to reimburse them for the payment they make to the CBM company, and as a result the federal government would lose royalty payments and will also reimburse the state for any loss of its CBM royalties.

Environmental impacts of CBM development: Section 607 of the Senate's energy bill, S 617, orders a National Academy of Sciences study of the effects of CBM development on surface and water resources (in the May 2002 Senate energy bill). The NAS would have 18 months to study issues such as water disposal, impacts on groundwater supplies, surface impacts, and possible mitigation associated with CBM production. The Secretary of Interior would then be required to respond to the study and make recommendations for legal or policy changes she feels are required as a result of the study.

Tax credits: Both the House and Senate energy bills would extend and modify the section 29 tax credit for nonconventional fuels. The current tax credit ends January 1, 2003; the House bill would extend it through January 1, 2007; the Senate version would only extend it for three years. The bills also authorize increased spending for permitting processing and inspections and enforcement.

Hydraulic fracturing: As indicated above, the EPA is expected to release sometime in 2002 a draft report on the impacts of hydraulic fracturing during CBM production on underground drinking water sources. If the EPA reports little or no harm the study will end; if harm is shown, there will be multiyear field studies. A provision in the Senate energy bill requires the EPA to complete a study on fracturing within 24 months of enactment, and the National Academy of Science to review the study within nine months.

While there has been some discussion of legislation to address surface use agreements, no bills are currently being considered. The oil and gas industry is strongly



opposed to the requirement, and ranchers and other land owners are adamantly in favor of legislation, and members of Congress have been unable to broker an agreement so far. There may be some possibility for administrative changes, such as BLM encouragement of more surface agreements, and possible incentives for companies and surface owners to negotiate agreements.

#### IV. HOW CAN CONFLICTS SURROUNDING CBM DEVELOPMENT BE REDUCED?

##### FINDINGS AND CONCLUSIONS

From the perspective of many landowners, government officials, and energy companies, coalbed methane development is a great success. It is a source of jobs, income, corporate profits, tax revenues, royalty payments, and other benefits. Many companies are trying to work with local residents to minimize impacts and reduce conflicts. Some company officials argued that there are no real problems with CBM development, and it may be that the majority of companies and community members are satisfied with the way development has unfolded and the public policies that are in place. The strong statements of concern offered at the NRLC conference in April, as well as those that have regularly appeared in other meetings and in media stories, are, however, compelling evidence that some problems have occurred.

Given the great number of companies developing CBM resources, it is likely that some companies are better than others in working out problems and conflicts. It is not surprising that the rapidity of CBM development has resulted in unwanted impacts on and polarization and division across communities and local residents. Nor is it surprising that land owners, ranchers, and recreationists clash with energy companies who all envision very different uses of the same land or that conservationists and developers do not see eye-to-eye over whether roadless areas and wild lands should remain untouched by roads, pumps, pipelines, and power lines. Nevertheless, a review of the issues discussed in this report suggests the following conclusions about CBM development and associated problems.

1. Coalbed methane is an important and valuable resource in meeting the nation's energy demand. CBM is a growing component of the natural gas that is pro-

- duced in the United States each year, and demand for natural gas to generate electricity is expanding rapidly because it is a secure, domestic source of energy and is the cleanest burning fossil fuel. CBM is a particularly valuable resource in the Western United States and is an important source of income and jobs to westerners and revenue to local, state, and national governments.
2. A unique challenge posed by CBM development is the speed in which change is occurring. Parties are forced to deal with issues of produced water, conflicts between landowners and those who lease mineral rights, impacts of development on communities, demands for governmental and regulatory services, and other issues in a very compact time frame.
  3. As is true with other forms of energy production, there have been numerous conflicts between local land owners and energy companies over the impacts of development on other uses of land, noise, and property values. These are a result of split estates and division of ownership of the land and underlying resources; the lack in some cases of the formulation, implementation, and enforcement of adequate surface use agreements; impacts from development on lands owned by one landowner that spill over to adjacent landowners that are not addressed by agreements; disputes over the calculation of royalties; and other differences. Some companies have developed better relations with surface land owners than others.
  4. Like other forms of economic activity, CBM development poses challenges for local communities that must absorb increased traffic, noise, air pollution, demands on housing and public services, and other consequences of growth. Impact fees, property taxes, royalties, and other financial resources can help communities cope with growth, but the consequences of growth may come much faster than the eventual flow of funds. Local governments bear the brunt of dealing with the consequences of growth but may lack the resources and authority to address them effectively. Depending on state law, local governments may or may not benefit directly from royalties or severance taxes derived from development.
  5. Governance in the United States is fragmented, overlapping, and complex. Natural resources, watersheds, and ecosystems implicated in energy development ignore state and other governmental boundaries.



Governance is particularly complicated in the West by large parcels of public lands and reservations that add additional layers of sovereignty and governmental authority. Federal, state, and local governments all have some regulatory authority over CBM development and a major challenge for energy companies, landowners, and other concerned citizens is negotiating this complex structure of jurisdictions whose policy making efforts are often uncoordinated and inconsistent. Most agencies lack the finances and staff to meet all the demands on them for expeditious processing of applications, timely and comprehensive assessment of environmental impacts, monitoring and enforcement of agreements, and long-term planning.

6. Given the aridity of the West, dealing with the impact of CBM development on water is a tremendous challenge. While there is considerable uncertainty concerning the impact of CBM development on water quality, some residents are convinced that development at least exacerbates the natural seepage of methane into drinking water sources if not directly contaminating aquifers. Produced water can inundate desert ecosystems and damage fragile soils, cause erosion, and pollute cleaner bodies of water. Perhaps most importantly, water is so valuable and scarce that any activity that seems to waste it is problematic.
7. Despite some progress in bringing energy companies and land owners together to resolve differences, considerable efforts at public education and communication, and experience all parties are gaining in understanding and addressing the impacts of CBM development, conflicts and pressures will likely continue as the density of development increases and new lands are opened to development. In some areas, parties may be able to strike a balance between energy extraction and grazing, between economic incentives for development and impact fees and taxes, between government regulation and market forces, and between water used for energy production and for other purposes. In other areas, such as wilderness study and roadless areas, development may be precluded by commitments to preservationist values. Major challenges include identifying lands that should not be leased or developed, examining how we can promote domestic energy and provide for other land uses, and devising analytic tools

and frameworks for helping decision makers to clarify and make appropriate choices.

8. As of the writing of this report, in May 2002, the future of CBM development is uncertain. Because of its plentiful supply and clean-burning characteristics, demand for natural gas will continue to grow. But legal challenges may slow development. As explained above, the Department of Interior's Board of Land Appeals decision in April 2002 that the BLM did not perform adequate environmental reviews before issuing three leases in Wyoming may be reversed by the Secretary of the Interior, expanded to vacate thousands of leases in the basin, and/or be challenged through lengthy litigation. Current production in some areas may be halted until the BLM prepares additional environmental analyses and new resource management plans. Disputes over the BLM's environmental impact statements for CBM in Montana and Wyoming may delay the completion of the analyses that are required before a new round of leases can be approved and CBM development expands.

#### PRINCIPLES FOR ASSESSING OPTIONS FOR CBM DEVELOPMENT

As is true for other natural resource issues in the West, there is no consensus over the problems surrounding coal-bed methane development. Ranchers, farmers, wilderness advocates, county commissioners, company executives, air and water quality regulators, oil and gas commissioners, governors, federal agency officials, and others differ in their diagnoses of the causes of the controversies that have swirled around CBM development and possible remedies. There is, however, strong support throughout the West for bringing together parties to increase communication, generate innovative alternatives for solving problems, and build support for implementing solutions. A variety of rationales, assumptions, and ideas have contributed to these efforts to find new ways to resolve natural resource conflicts, and include the following underlying principles:

**SUSTAINABILITY.** The idea of sustainability provides a useful lens for assessing the rapidity of CBM development and for examining possible responses. Sustainability emphasizes the interaction of ecological,



economic, social, cultural, and other values, so that no one set of values, such as environmental or economic factors, can alone determine policy. The methodology of sustainability builds on the idea of ecosystem services, but goes beyond to include several other additional criteria for assessing policy choices, including pollution prevention rather than treating emissions, sustainable yield of renewable resources, the precautionary principle and preservation of ecological values in the face of uncertainty, true-cost pricing that internalizes environmental costs in market exchanges, the development of economic indicators and measures that reflect depletion of natural resources, considerations of equity and distribution, and preservation of ecological conditions and options for future generations. Sustainability focuses on comprehensive solutions that reflect the interconnections of ecology. It respects the maxim, "everything is connected to everything else," that is at the heart of ecology.

An important feature of sustainability is its integration of ecological protection and economic activity with social equity and political empowerment. Political participation is a key ingredient in ensuring that decisions affecting economic and environmental conditions be made more inclusive. Sustainability is not an ecological concept alone, but also one of social justice, inclusion, fairness, community well being, and political engagement. These social and political values are important and valued in their own right as well as because they contribute to ecological protection. It requires fairness in the distribution of benefits and burdens, a perpetual resource base and ecological services, and a social system that secures the interests of all persons. Sustainability is bound up with notions of strong democracy, participation, community, and those social characteristics are fostered through a scale of personal interaction. So too is a commitment to a land ethic. As Aldo Leopold defined the land ethic, sounding much like a proponent of sustainable communities, "An ethic, ecologically, is a limitation on freedom of action in the struggle for existence. . . . All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. . . . The land ethic simply enlarges the boundaries of the community to include soils, water, plants, and animals, or collectively: the land."<sup>277</sup>

There is ongoing debate over how to define and implement the goal of sustainability and apply it in contexts such as developing fossil fuels and other nonrenewable resources. For some, sustainability means that development and growth continue with some balancing of economic and environmental values, while others give primacy to ecological health and place severe constraints on economic activity.<sup>278</sup> Despite global agreements that appeal to sustainability, the concept is inextricably intertwined with the idea of community, and the most thriving examples of sustainability seem to be in that context. Dale Jamieson, for example, argues that, at the local level, sustainable works in the negative: we can agree when local land practices are not sustainable:

*In many specific contexts the language of sustainability can be made more useful by focusing on what is unsustainable rather than on a positive definition of sustainability. Often people who would initially disagree about what sustainability is can agree about when something is unsustainable. Ranchers and environmentalists (for example) may agree that eroded, denuded land is unsustainable, even if they disagree about what it would be like for the land to be sustainable.<sup>279</sup>*

The idea of sustainability suggests a number of principles that might illuminate the choices surrounding CBM and other forms of energy development:

- Ensure sustainable yield of resources
- Integrate ecological, economic, and community values
- Secure inter- and intra-generational equity and fairness
- Prevent problems rather than treat their impacts
- Conserve ecosystem services in the face of uncertainty
- Promote community, local empowerment/responsibility
- Develop true-cost prices that internalize all costs

**COLLABORATIVE DECISION MAKING.** The idea of sustainability is intertwined with community-based, collaborative decision making as a process for making sustainable policies. Collaboration seeks to avoid the conflict, litigation, and other problems that have plagued other planning processes, and provide a forum for government officials from different levels of government and overlapping jurisdictions to work together. Various forms of collaborative processes are likely to be used by communities as they develop plans and policies for making CBM development more sustainable. Proponents argue that successful



collaborative processes involve the interests or stakeholders who are most affected by decisions, empower local environmental protection groups to advocate for broad environmental values in local decisions, ensure that all interests have adequate resources to represent their views and participate effectively, allow agencies to facilitate participation among stakeholders and develop plans responsive to their concerns, within the constraints of national laws and policies, reduce conflict among stakeholders, generate opportunities to find innovative, and low cost solutions, and promote partnerships between agencies and stakeholders that promote implementation and foster problem solving and learning by experience.<sup>280</sup>

One critical issue here is determining the goal of collaboration: is it to produce actual decisions and plans that governmental authorities simply adopt, or to assist decision makers in discharging their responsibilities? The more collaborative groups are seen as advisory, the less of a concern there is about displacing agency authority. But the more decision-making power collaborative groups have, the more opportunities there are to capture the advantages of collaboration. Collaborative groups have arisen in response to the inadequacies of traditional, agency-based decision making, so there are strong incentives to find new processes and structures.<sup>281</sup>

There are significant challenges involved in devising effective collaborative efforts. The processes may exclude national stakeholders' views and weaken national environmental commitments. They fragment decision making and reduce the power of national planning efforts. Critics warn they inevitably benefit industry interests that are typically better funded than conservation groups and they fail to encourage agencies to make the often difficult decisions mandated by environmental laws. Collaborative efforts must respond to the concern that the efforts de-legitimize the conflict that is sometimes required to move away from unsustainable use of resources and toward their preservation and co-opt the strength of environmentalism as a force rooted in broad public support. Such efforts may increase the costs and time required to make decisions, and win-win solutions will not always be possible as natural resources become increasingly scarce and preservation values fundamentally collide with commodity interests.<sup>282</sup> Part of the evolution of natural resource policy making will be the development of new ways of bringing members of a communi-

ty together to devise plans that will meet sustainability goals and will generate strong commitments to comply with the difficult choices to be made. While each landscape is different, lessons from one area can be shared with others. Open and inclusive processes that encourage broad participation, initiatives that capitalize on a sense of place and landscape, and agreements that clearly meet or exceed the protections required in natural resource laws are some of the keys to constructive collaboration.<sup>283</sup>

CBM development in the West will inevitably expand as demand for natural gas continues to grow. Companies will continue to operate in areas where resources are already being developed and conflicts may diminish in some areas as combatants become weary or irresponsible companies go out of business. Future CBM plays may pose new conflicts over protecting sensitive lands. The challenge is to manage development in ways that promote ecological, economic, and community sustainability. The interest expressed by many companies in building community and protecting local environments can combine with everyone's interest in reducing conflict. CBM development can be the basis of collaborative efforts that reduce conflicts, resolve problems, and ensure that energy production continues in a more sustainable fashion. Consensus-based decision making suggests the following general principles that can guide CBM decisions:

- Recognize the importance of place-based decision making and a land ethic
- Ensure the participation of all affected interests
- Integrate overlapping government jurisdictions
- Develop partnerships for designing and implementing solutions
- Learn from experience and engage in intelligent trial-and-error
- Employ adaptive management techniques and approaches.

Sustainability and collaboration are reinforced by the Western Governors Association and others who have embraced principles of balance and stewardship in environmental policy making that is reflected in a concept labeled "enlibra." Enlibra, a hybrid term from Latin words, is a set of principles aimed at promoting solutions to natural resource conflicts that avoid litigation, torn communities, and natural resource wars.<sup>284</sup> The governors endorsed the idea as governing principles in 1997



and have held two summits in the West in order to encourage use of *enlibra* in addressing problems of population growth, developing natural resources, providing for economic growth in new service industries, adjusting to the globalization of markets and competitiveness, controlling more diverse and diffused sources of pollution, changing land use patterns, and new technologies.<sup>285</sup>

*Enlibra* builds on collaborative efforts the governors developed in the 1990s that are reflected in the Park City Principles for Water Management, the High Plains Partnership, the Grand Canyon Visibility Transport Commission, the Oregon Plan for Salmon and Watersheds, the Texas Regional Water Supply Planning Process, Trails and Recreational Access for Alaska, and the Wyoming Open Lands Initiative. These efforts reflect “strong commitment from state and local government, vested local support, and federal collaboration.”<sup>286</sup>

*Enlibra* embraces the following eight principles:

- National standards, neighborhood solutions—assign responsibilities at the right level, give flexibility to non-federal governments, and provide accountability
- Collaboration, not polarization—use collaborative processes to break down barriers and find solutions
- Reward results, not programs—move to a performance-based system that encourages problem solving, not just compliance with programs
- Science for facts, process for priorities—separate subjective choices from objective data gathering and seek agreement on facts and uncertainties before framing choices
- Markets before mandates—pursue market-based approaches and economic incentives whenever appropriate
- Change a heart, change a nation—support environmental understanding and education about stewardship
- Recognition of benefits and costs—make sure all decisions affecting infrastructure, development, and environment are fully informed by life-cycle costs and economic externalities
- Solutions transcend political boundaries—use appropriate geographic boundaries to identify the full range of affected interests and facilitate solutions to environmental problems.<sup>287</sup>

The Bush administration has embraced the principles of *enlibra*. The White House Council on Environmental

Quality co-hosted the Western Governors’ Association’s *enlibra* summit, and EPA administrator Christie Whitman and Interior Secretary Gale Norton both endorsed its principles in speeches given at the meeting. Administrator Whitman’s National Environmental Performance Partnership System emphasizes collaboration between federal and state governments in setting priorities and defining roles. Secretary Norton’s “4 Cs”—“communication, cooperation, and consultation in the service of conservation”—is another reflection of these principles.<sup>288</sup> They are rooted in a decades-long effort to redefine federalism and refine the relationship between federal, state, and local governments in natural resources and other policy making arenas that have been given labels like cooperative federalism, new federalism, and policy devolution.<sup>289</sup>

Proponents of these principles of collaboration and conservation will need to be responsive to the fears of environmentalists that devolution to state and local policy making will weaken compliance with national environmental standards and require battles for conservation that were won at the national level be re-fought in each state. An important strength of the environmental movement lies in its ability to tap into broad public interest in protecting the environment and in the aggressive use of the courts to ensure national laws are implemented faithfully, and that they are disadvantaged in other forums. The participation of environmentalists in policy making efforts sponsored by the administration, western governors, and others will likely require a strong commitment to the principles of balance and fairness.

#### RECOMMENDATIONS FOR THE GOVERNANCE OF CBM DEVELOPMENT

While there are some differences between these prescriptions for policy making, they share a common core of ideas:

- solutions to problems need to engage a wide range of affected interests in their design and implementation,
- national environmental standards need to be pursued in light of local conditions,
- fragmented governmental jurisdictions need to coordinate their efforts,
- policy makers need to balance competing interests and values such as preservation and resource extraction, and



- the interests of future generations need to be reflected in decision making.

The widespread commitment to these principles for managing the West's natural resources and preserving its unique environment is, of course, not a reflection of a consensus over how to deal with CBM development and a host of other issues. Not everyone embraces the principles and some are quite skeptical of their utility in bringing Westerners together in ways that adequately protect national values and environmental quality. If one begins, for example, with the view that the most pressing public purpose is extracting energy resources as quickly as possible to help reduce vulnerability to imported sources of energy, these principles will likely be viewed as a diversion. But they reflect the common view, at least at the level of basic commitments, of a wide range of interests. Applying them to the problems and challenges surrounding CBM may help illuminate possible solutions as well as some of the strengths and weaknesses of these principles of sustainability, collaboration, enlibra, and cooperation in guiding energy policy in the West.

#### WORKSHOPS IN EXISTING CBM BASINS

The active support of and participation in problem solving forums requires sacrifices of time and resources on the part of all parties. Environmental and community group volunteers will need to find time to participate in proceedings, as will industry executives and government officials. While those investments may be costly in the short-run, they may prevent and reduce conflict in the long-run. Environmental groups do not give up their ability to seek remedies in court, but may defer such efforts until more collaborative forums are supported first. Energy companies will be required to take more time initially to meet with land owners and others and lay the foundation for obtaining drilling and water discharge permits, but that investment can result in fewer conflicts, problems, and delays in the future.

Since the problems and conflicts surrounding CBM development differ considerably by basin, it makes sense that people in each basin work together to design and implement solutions. A series of workshops could provide a forum for those interested in CBM development in each basin to produce recommendations and guidelines

to governments, companies, and residents concerning many of the most contentious issues surrounding CBM development. Such collaborative efforts seem to be most promising when they are characterized by clear and discrete tasks to be accomplished within a limited time frame, strong leadership and commitment by affected interests, and adequate resources to support the analyses required and ensure the participation of all interests. These workshops could draw upon the expansive materials already available, including environmental impact statements, reports, and studies as well as commission additional research that may be needed. Participants might include representatives from the BLM and other federal agencies, state oil and gas commissions and boards, state air and water quality agencies, county commissions and planning boards, other governmental bodies, as well as citizen and industry representatives.

The first forum could be convened as a pilot project to work out the details of who would participate, how commissioned research would be funded, what kinds of recommendations and guidelines might be produced, and how the forum would be structured. The agenda for these workshops could include the following questions set out below. A separate workshop could be convened for each issue, or a workshop could take on two or three issues.

#### 1. HOW CAN THE RIGHTS AND INTERESTS OF SURFACE AND MINERAL OWNERS BE BALANCED?

Stewardship, sustainability, and collaboration all require that those who own and live on the land play a major role in determining how development occurs. If landowners cannot help shape the surface impacts of CBM development then they will simply not be viable partners in ensuring the sustainability of the western landscape. Their participation in determining the location of pumps, compressors, pipelines, and roads need not be a threat to the ability of companies to extract the gas profitably, and there needs to be a balance between the needs of companies and land owners. Established mineral law generally emphasizes the rights of those who hold leases to extract minerals, and companies could stand firm on this superiority issue. But harmonizing surface and mineral owner rights is an essential element of reducing the conflict surrounding CBM development



and balancing resource extraction with other uses of the land. The Supreme Court of Colorado ruled in 1997 that the rights of mineral and surface owners must be exercised in a manner consistent with each other: "Both estates are mutually dominant and mutually servient because each is burdened with the rights of the other."<sup>290</sup> Other states could choose to embrace a similar view. Some suggestions for ways of improving cooperation and reducing conflict between surface owners and companies that could be discussed in CBM workshops include:

- Require consultation and encourage surface owner agreements on split estate lands before issuing drilling permits and effectively enforce this requirement and monitor compliance
  - Some companies report that they already require such agreements before drilling begins;
  - Companies can give land owners options for different ways to locate development and allow them to choose the option that minimizes conflict with other uses of their land;
- Provide an ombudsperson or expedited dispute resolution process to address problems with surface owner agreements;
- Create incentives for companies to work closely with landowners through royalty credits, awards and recognition, and other efforts;
- Assess the need for legislative changes in oil and gas laws to better reflect the balance between land owner and mineral development rights.

## 2. HOW CAN THE TRUE COSTS OF RESOURCE DEVELOPMENT BE PROVIDED FOR?

The costs of leases, royalty or severance taxes, exploration, extraction, and transportation are reflected in the price at which gas is sold. But other costs of development, including the surface land owner's financial, opportunity, aesthetic, and other costs of the development of CBM resources are often not represented in those prices. Competitive pressures between CBM and other sources of natural gas plays, and between natural gas and other energy sources, create powerful incentives to externalize costs, and the commitments of companies to ensure that prices include more of the real cost of production is essential. CBM workshops might explore sev-

eral options for better internalizing the costs and benefits of CBM development, including the following:

- Compensate split estate landowners for surface access, mitigation of impacts, damages, and loss of property values resulting from gas development with mineral lease revenues and royalties;
- Require adequate reclamation bonding or create an escrow fund from lease and royalty revenues to ensure the implementation of reclamation agreements.

## 3. HOW CAN THE PROCESS OF ISSUING PERMITS AND ENFORCING PERMITS AND OTHER LEGAL REQUIREMENTS BE IMPROVED?

Enforcement of permit stipulations, relevant laws, and other legal requirements is important in recognizing the efforts of responsible companies and in creating clear incentives for compliance. Both industry and community representatives emphasize the need for effective enforcement. Effective enforcement helps ensure that all companies are required to incorporate the costs of balanced and environmentally sensitive development in the prices they charge and some firms are not able to undercut their competition by reducing environmental protections. Effective enforcement is a regular refrain of community groups who want to ensure that standards are applied consistently and fairly. Ideas for improving permitting and enforcement efforts of federal and state agencies include the following:

- Secure additional funding for processing, issuing, and enforcing permits, through permit fees on applications as occurs in other environmental permitting (Clean Air Act operating permits, for example), royalty payments, and other sources;
- Ensure companies that are not acting responsibly are identified and sanctioned for noncompliance with relevant laws and regulations;
- Create incentives for companies to comply with permit requirements through self-audits and other innovations that allow conscientious companies to demonstrate compliance and government agencies to focus enforcement resources on problem companies.



#### 4. HOW CAN THE INTERESTS OF COUNTIES TO REGULATE THE IMPACTS OF CBM DEVELOPMENT BE BETTER INTEGRATED WITH STATE AND FEDERAL AGENCY REGULATION OF CBM DEVELOPMENT?

Counties are at the front lines of efforts to deal with the impacts of CBM development and they need the legal and financial resources to address those impacts and to be able to coordinate energy and other forms of economic development with zoning and other land use planning efforts. State laws give responsibility to oil and gas commissions to regulate resource extraction and typically emphasize efficient production of resources and minimization of waste, and may not provide much guidance for how the impacts of extractive activities should be addressed. In some areas, county and state officials appear to be working together with minimal problems, while in a few areas, conflicts between state and county officials are a major issue. State agencies should work with counties to develop clear statements of authority concerning the governance of CBM. Workshops could seek to devise guidelines for coordinating the efforts of county, state, and federal agencies that could address the following questions:

- How can state oil and gas commissions and environmental quality agencies and counties harmonize their regulatory concerns and cooperate in regulatory activities?
- How can companies work with counties in coordinating the development of CBM infrastructure among themselves to reduce the number and extent of facilities? Contractual obligations, technological differences, and other factors place limits on sharing infrastructure, but some reduction in impacts is likely.
- What state-county relationships have worked in particular areas and how can successful models be adapted elsewhere?

#### 5. HOW CAN ECOSYSTEM- OR WATERSHED-LEVEL PLANNING AND COORDINATION FOR CBM DEVELOPMENT TAKE PLACE?

Each CBM basin poses a unique set of challenges in governing development, but one commonality is the complex, overlapping, and fragmented framework of gover-

nance. Specific regulatory authority is given to a variety of government agencies and those jurisdictions do not reflect the landscape, watersheds, and other factors shaped by development. A workshop involving all relevant agencies and citizen and industry representatives could bring participants together to produce guidelines to:

- Create ecosystem or watershed planning efforts and regional air quality planning processes to ensure that CBM-related decisions are integrated with other land use and development decisions;
- Create forums to coordinate CBM permitting and other regulatory decisions to streamline the time required to make decisions, facilitate public participation in regulatory decisions, and increase communication among decision makers.

#### 6. HOW CAN WATER QUALITY AND SUPPLY BE BEST PROTECTED?

There is clear consensus that water quality must be protected during CBM development, and no consensus over how serious a problem this is. As indicated above, governments can assuage concerns by more effective enforcement of permitting requirements for drilling and for disposal of water. A workshop could bring parties together to:

- Formulate plans to produce accurate baselines for water quality and quantity;
- Review compliance with testing and monitoring requirements and regularly assess those requirements to see if they should be strengthened.

#### 7. HOW CAN BENEFICIAL USE OF PRODUCED WATER BE FOSTERED?

Water is such a valuable commodity that all parties involved in CBM development should renew their efforts to find ways to ensure that produced water is used beneficially. Suggestions for workshops include the following:

- Clarify legal ownership of produced water
- Develop guidelines and processes to ensure that surface owners are involved in decisions concerning the discharge of water onto their lands;



- Develop a research program to carefully trace what happens to produced water and what its impacts are on surface ecosystems and groundwater.

## 8. HOW CAN EFFECTIVE RECLAMATION BE SECURED IN PERMITTING AND BONDING?

Reclamation is not currently the most pressing CBM development-related issue, but the fear of inadequate future reclamation is undoubtedly a concern of those who seek to slow down CBM development. Given the relatively short life-span of CBM wells, the adequacy of reclamation policies will soon be tested as fields mature. Some of the recommendations discussed above address reclamation, but because of the importance of ensuring that reclamation contributes to the sustainability and stewardship of lands in the West, a workshop could develop specific recommendations on how to:

- Ensure surface owners are involved in reclamation planning through surface use agreements;
- Ensure adequate reclamation requirements are included in permits and adequate reclamation bonds are posted as part of the permitting process.

## 9. WHERE SHOULD CBM DEVELOPMENT BE PROHIBITED?

In most areas, CBM development and other land uses can be balanced. In a few areas, the choice is either to protect them as undeveloped or to allow some development. The vast majority of public lands are available for resource extraction, and lands where no development has yet occurred contain only a small fraction of total CBM reserves. Wilderness study areas, roadless areas, and other protected lands may contain valid leases and the rights and interests of leaseholders need to be preserved. One of the most difficult challenges for a CBM workshop would be to develop recommendations for placing limits on development, compensating leaseholders fairly if they are not able to exercise their leases, and minimizing impacts of development affecting protected areas. A workshop could address the following questions:

- In what places where there are CBM reserves, such as a roadless areas, wilderness study areas, and national

monuments and wildlife reserves, should development not take place? How should such decisions be made?

- How can CBM development take place with a minimum of environmental impact in or near these ecologically sensitive areas?
- How can lease holder rights be protected in areas where it is determined that development should not occur?
- How can the broad commitment to collaboration, communication, and conservation ensure that development of new CBM resources is more carefully and systematic planned and adverse impacts minimized?
- How can the BLM apply principles of adaptive management to planning and leasing actions affecting CBM so that development is balanced with protection of habitat, wildlife corridors, and other environmental values?

## 10. HOW CAN WE PROMOTE CONSERVATION AND EFFICIENT USE OF NATURAL GAS?

Demand for natural gas is increasing and will continue to do so. Satisfying that demand exclusively through increased production will make it very difficult to balance extraction with other values affected by development. The more efficient the use of natural gas and more effective efforts to conserve its use are, the less pressure there will be on increasing well density and developing new areas. In addition to conservation and efficiency in the use of natural gas, collecting methane that would otherwise escape in the process of mining prevents the waste of an important resource and reduces emissions of a very potent greenhouse gas. While conservation and efficiency efforts are not directly part of CBM development, and may not be in the short-term interest of gas companies, all parties should be interested in the sustainability of natural gas as a transition fuel until even cleaner, renewable energy sources are more widely developed. A workshop might address the following questions:

- How can the amount of methane vented in coal mining and conventional gas operations be reduced?
- How can methane extraction be balanced with conservation and efficiency efforts and the promotion of renewable resources in order to reduce pressures for development on sensitive lands, ranching and agriculture, and other values?



## LESSONS FOR EMERGING BASINS

The Powder River Basin in Montana, the Green River Basin in Wyoming, and other areas are poised to begin major development of CBM resources. Federal, state, and local government officials, energy companies, and local residents could join in a CBM summit before development occurs to examine the lessons learned in areas where CBM development has already occurred. The results of the workshops suggested above could also be valuable not only to the basins with large-scale existing development, but also to these potential sites. These lessons, indicated by the NRLC April CBM conference, suggest the following agenda for such summits:

- A comprehensive inventory of the location of likely CBM wells and base line data on underground and surface water quality, wildlife and soils, and other important resources likely to be affected;
- A framework of governance to clarify governing authority and ensure the permitting and other regulatory decisions are coordinated;
- A set of guidelines for best operating and management practices for companies from cradle-to-grave CBM operations, landowner/gas company relations, and other issues;
- A plan to ensure adequate funding of the impacts of development on communities, funding of the issuance and monitoring of permits, funding of reclamation, and other costs of development;
- A plan to ensure protection of water quality and beneficial use of produced water.

## NOTES

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23. The provisions that follow are listed in National Energy Policy Development Group, Appendix One, Summary of Recommendations, Chapter Five, Energy for a New Century: Increasing Domestic Energy Supplies, unless otherwise noted.

24. National Energy Policy Development Group, Chapter Three, Protecting America's Environment: Sustaining the Nation's Health and Environment, *supra* note 13.



25. John Watts, keynote address, NRLC CBM conference, April 4–5, 2002.

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32. The composition of CBM and natural gas in the Powder River Basin differs:

	CBM	Natural Gas
Carbon dioxide	1.1%	1.8%
Nitrogen	0.1	2.1
Ethane	0.1	12.4
Methane	98.6	73.9

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66. *Id.* at 43. Another company operating in the basin, Devon Energy, reported typical costs for wells of 1,200 to 2,800 in depth of \$350,000. Reserves average 1.25 to 1.75 Bcf per well, and finding and development costs are in the range of 35–40 centers per Mcf. *Id.*, at 44.

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209. WYO. STAT. ' 30-5-103(a), 30-5-104(d)(i). Bonding requirements cover only plugging. They do not address reclamation.
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211. *Id.* ' 30-5-121.
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mits and Commission standards, the Commission standards are to be binding, but the new regulation makes that provision more explicit and more definitive than counties believe is legal under state law. Interview, Adam Keller, Planning Office, La Plata County, February 28, 2002.

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240. N.M. STAT. ANN. § 72-12-25.

241. N.M. STAT. ANN. § 70-2-12.

242. *Id.*; See also N.M. Reg. § 19.15.1.13.

243. N.M. Reg. § 19.15.1.18.

244. N.M. Reg. § 19.15.1.19.

245. N.M. Reg. § 19.15.9.701.

246. N.M. STAT. ANN. § 72-12A-2.

247. N.M. STAT. ANN. § 72-12A-4.

248. *Id.*

249. N.M. STAT. ANN. § 72-12A-5A.

250. N.M. STAT. ANN. § 72-12A-7C.

251. N.M. STAT. ANN. § 72-12A-8.

252. See UTAH CODE ANN. § 73-3-1 et seq.

253. UTAH CODE ANN. § 40-6-5(3)(d).

254. UTAH CODE ANN. § 73-3-8(2).

255. UTAH ADMIN. CODE R649-9-1.1.

256. UTAH ADMIN. CODE R649-9-3.1 to 3.2.

257. UTAH ADMIN. CODE R649-9-4.2.

258. UTAH ADMIN. CODE R649-9-4.3.

259. UTAH ADMIN. CODE R649-9-4.4.

260. UTAH ADMIN. CODE R649-5-2.

261. MONT. CODE ANN. § 85-2-505(e).

262. MONT. CODE ANN. § 85-2-521.

263. *Id.* at § 85-2-521(e).

264. *Id.*

265. MONT. CODE ANN. § 85-2-506.

266. MONT. CODE ANN. § 85-2-508

267. WYO. STAT. §§ 41-3-903, 41-3-904.

268. WYO. STAT. § 41-3-905.

269. WYO. STAT. § 41-3-931.

270. *Id.*

271. WYO. STAT. § 41-3-102(b), by application of WYO. STAT. 41-3-906. The statute itself states:

(b) Preferred water uses shall have preference rights in the following order:

(i) Water for drinking purposes for both man and beast;

(ii) Water for municipal purposes;

(iii) Water for the use of steam engines and for general railway use, water for culinary, laundry, bathing, refrigerating, . . . for steam and hot water heating plants, and steam power plants; and

(iv) Industrial purposes.

272. Wyoming State Engineer's Office, Form U.W. 5 (revised as of March 1995).

273. Laitos, *supra* note 229, at 407–09.

274. *Id.*, at 410–11.



275. H.R. 4 was passed on August 20, 2001; S 517 (H.R. 4, amended) on April 25, 2002; members of the conference committee were named on April 25, 2002. See Rebecca Adams, "Daschle Must Make Fast Shuffle To Get ANWR Opponents on Panel, *CQ Weekly* (May 4, 2002): 1133.

276. This section is based on John Watts, NRLC CBM conference, April 4–5, 2002.

277. Aldo Leopold, *A Sand County Almanac* (New York: Ballantyne Books, 1966): 238–39.

278. For a thoughtful critique and defense of sustainability, see Thomas Prough, Robert Costanza, and Herman Daly, *The Local Politics of Global Sustainability* (Washington, DC: Island Press, 2000).

279. Dale Jamieson, "Sustainability and Beyond," NRLC Public Land Policy Discussion Paper Series (PL02) (Boulder CO: Natural Resources Law Center, 1996): 12.

280. For a helpful overview and assessment of the functioning of consensus-based groups, see Douglas S. Kenney, "Arguing About Consensus: Examining the Case Against Western Watershed Initiatives and Other Collaborative Groups Active in Natural Resource Management" (Boulder CO: Natural Resources Law Center, University of Colorado School of Law, 2000).

281. *Id.*

282. For a discussion of the challenges facing collaborative efforts and how they might be addressed, see Julia M. Wondolleck and Steven L. Yaffee, *Making Collaboration Work: Lessons from Innovation in Natural Resource Management* (Washington, DC: Island Press, 2000).

283. Barb Cestero, *Beyond the Hundredth Meeting: A Field Guide to Collaborative Conservation on the West's Public Lands* (Tucson, AZ: Sonoran Institute, 1999).

284. Richard Halvey and Karen Deike, "Unleashing Enlibra," *Environmental Forum* (September-October 2002): 21–31.

285. Western Governors' Association and the White House Council on Environmental Quality, "Environmental Summit on the West II" Salt Lake City, April 24–26, 2002. [www.westgov.org/wga](http://www.westgov.org/wga).

286. Western Governors' Association, "Enlibra," [www.westgov.org/wga/initiatives/enlibra/default.htm](http://www.westgov.org/wga/initiatives/enlibra/default.htm)

287. Western Governors' Association, Policy Resolution 99-013, "Principles for Environmental Management in the West" (June 15, 1999) [www.westgov.org/wga/policy/99/990113.htm](http://www.westgov.org/wga/policy/99/990113.htm).

288. Western Governors' Association, *supra* note 259; see also Rebecca Watson, NRLC CBM conference April 4–5, 2002.

289. See Denise Scheberle, *Federalism and Environmental Policy: Trust and the Politics of Implementation* (Washington, DC: Georgetown University Press, 1997).

290. *Gerrity Oil and Gas Corp. v. Magness*, 946 P.2d 913 (Colorado 1997).