COAL-BED METHANE GAS DEVELOPMENT IN MONTANA, SOME BIOLOGICAL ISSUES

By

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A booming coal-bed methane (CBM) gas industry may soon have far-reaching, short- and long-term impacts on Montana land and waters, with potentially serious affects on irrigation, cropland, soils, sport fisheries and regional ecosystems. Inspired by potentially high profits and economic expansion, the industry in Wyoming has been upgrading and expanding its pipeline system; and Wyoming has relaxed its water quality standards to facilitate development.

There are now more than 3,000 CBM-producing wells concentrated in the Wyoming portion of Powder River Basin. Much of the ground water produced from these wells is being discharged into rivers that flow directly and into Southeastern Montana, notably the Powder, Little Powder, and Tongue Rivers and their tributaries. The Bureau of Land Management (BLM) in Wyoming is preparing to write an environmental impact statement (EIS) to examine the potential impact of as many 30,000 CBM wells in Wyoming – ten times as many as there are now.

This impressive number of wells in the region is not a far-fetched possibility for Montana. Recently, numerous CBM lease agreements and pipeline corridor rights-of-way agreements reportedly have been reached between various prospective CBM producers and private mineral holders in Montana. These agreements are reported to pertain to significant tracts of land stretching from Montana's Carbon County, eastward

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through Big Horn, Rosebud, Powder River, and Carter counties and into McCone and Richland counties to the north.

Coal-bed methane gas production is already underway in Montana and, given the success of CBM development in Wyoming, similar development in Montana appears likely. As of August, 2000, Montana's Board of Oil and Gas Conservation (BOGC) has issued about 290 permits to drill CBM related holes in Montana. Federal government agencies in Montana are considering CBM permit issuances on lands under their control. Montana's Department of Environmental Quality (DEQ) has evaluated one permit application to conduct activities that fall under its regulatory jurisdiction; more applications are anticipated in the near future. As of March 2000, there were about 120 producing wells on non-federal lands near Decker, Montana. All of the water produced by these wells flows toward or directly into the Tongue River and its tributaries. The Tongue River (average annual flow near the MT/WY state line of about 300 cfs [1]) and the Powder River (average annual flow near the MT/WY state line of about 150 cfs [1]) in Montana are two drainage areas that are of immediate interest in relation to CBM development in this state. Most of the probable near-term CBM developments within Montana, however, seem to be focused in the Tongue River drainage basin.

For compliance with the Montana Environmental Policy Act (MEPA), the BOGC has relied on a programmatic EIS published in 1989, a document that did not address CBM development. Governor Racicot recently directed Montana agencies to conduct a programmatic review of anticipated CBM activity while contemplating more specific development scenarios. Montana's Department of Environmental Quality (DEQ) is the lead agency in coordinating and carrying out this effort. Any environmental document produced by the review will delineate the CBM related responsibilities of each agency and the resources that CBM development affects.

Some short-term to long-term CBM development impacts will almost certainly include:

- dewatering of local and regional aquifers;
- decreased surface water availability in some areas;

- increased surface water flows in areas receiving CBM discharges in other areas;
- water quality effects of CBM development discharges on waters and biota receiving the CBM discharges; and
- creation of significant surface disturbances from CBM facility and service road construction.

Suggested herein are some of the possible and probable biological issues and concerns that seem important to consider in relation to CBM development in Montana. Most of the information presented focuses on the Tongue River. Biological issues and databases that might relate to CBM development in the Tongue River drainage are pretty numerous; this is a brief summary of some of those issues and related data. Information on some CBM development technology and hydrogeologic and regulatory issues associated with CBM are also provided in conjunction with this forum.

- **Waters generated from CBM developments may significantly drawdown local and regional aquifers and reduce important ground and surface water supplies.**

  Every minute, each well may produce about 15 gallons of water. As a result, springs, streams, domestic and stock water wells, and subirrigated acreages could be diminished or could dry up. For example, “linear” sources of water such as flowing reaches of streams may disappear or have to be replaced by "point source" wells due to aquifer drawdowns. Crop production may be diminished and carrying capacities and distribution patterns for livestock and wildlife could also be significantly and adversely affected. Loss or reduction of these water supplies could affect the ability to develop aquifers for domestic or agricultural usage. Springs and "water-gap" streams (e.g. perennial and/or intermittent flowing "reaches” of stream channels) are critical to stock-growers and to native flora and fauna in arid Southeastern Montana. Significant reduction in, or loss of, these waters can be devastating to the

aquatic and terrestrial biota and local/regional ecosystems and economies dependent on them.

- **Lower water tables near coal mines could adversely affect current coal mine permits, hinder reclamation potential, and interfere with the release of reclamation bonds.** This potential CBM effect is of significance to such coal mine reclamation mandates as:

  Coal mine reclamation plans have been carefully crafted, evaluated, and approved with regard to their ability to minimize "…disturbance of the hydrologic balance sufficiently to sustain approved postmine land uses…" of "…grazing land for livestock and wildlife, fish and wildlife habitat."[2] It may be impractical or impossible to carry out these mandates due to CBM impacts on local and regional hydrologic systems. Approved coal mining and reclamation plans that did not take into account temporary or long-term CBM-generated perennial flows into mine areas or across reclaimed lands may be adversely affected.

  It has been reported[3] that potential conflicts between coal mine permittees and CBM developers may result in litigation to resolve who has "first rights" to a resource. This could significantly and adversely affect approved coal mine plans and compromise the ability of coal permittees to reclaim in accordance with existing permits and law. It may also affect a coal companies ability to mine certain areas (some of which may already be permitted for mining) that might conflict with CBM development.

- **CBM discharges may cause substantial flows in normally dry watercourses such as ephemeral drainages, coulees, and gullies**. The average flow from an individual CBM well into the Tongue River would be about .033 cfs. As previously noted, the average annual flow of the Tongue River near at the MT/WY state line is about 300 cfs.[1] Thus, the estimated

from about 9000 CBM wells would approximately equal the average annual flow of the Tongue River (see Tables 1 and 2).

Table 1. Average water quality information for 100 CBM wells.[4]

Ca	3	mg/L
Mg	10	mg/L
Na	500	mg/L
TDS	1317	mg/L
EC	2107	umhos/cm
SAR	31.2	
estimated Q	0.033	cfs = 15 gpm

Table 2. Average water quality and quantity information for the Tongue River.[1, 4]

Ca	40	mg/L
Mg	23	mg/L
Na	19	mg/L
TDS	284	mg/L
EC	450	umhos/cm
SAR (calc)	0.6	
Flow	300	cfs

When water flows in drainages that may otherwise flow only part of a year is increased, vegetation in those stream channels may be destroyed. This could lead to various adverse environmental impacts. Increased channel erosion results in loss of soil, increased sediment loads, degraded water quality etc. These conditions adversely affect the algae, aquatic invertebrates, fish, amphibians, and other biological aspects of streams that receive these inputs. Increased deposition of sediment can adversely affect receiving streams and reservoirs.

- **Some of the CBM discharge waters could contain pollutants such as arsenic, ammonia, boron, iron, manganese, radium, and fluoride. Increases in salinity, sodium concentration and other soluble pollutants are likely to occur in streams receiving water discharged from CBM**

development. CBM-produced water may have substantial adverse chemical impacts on irrigated lands and crops, livestock, wildlife and fish populations.

Crops can tolerate salinity up to certain levels without a measurable loss in yield. At salinity levels greater than that "threshold" level, crop yield decreases linearly as soil salinity increases.[5] Figure 1 indicates soil salinity levels and relative declines in production of five common Montana crops. While salinity of irrigation water alone is likely to affect crops as noted, it is important to point out that soil salinity levels may exceed that of the irrigation water given repeated irrigation and resultant salt accumulation. A detailed analysis of the effects of CBM-generated water on crop soil is a complex issue and is beyond the scope of this paper. It is notable, however, that CBM-induced changes in irrigation water chemistry may affect soil fertility, plant available water, soil structure, crop yields, cropping flexibility, etc.

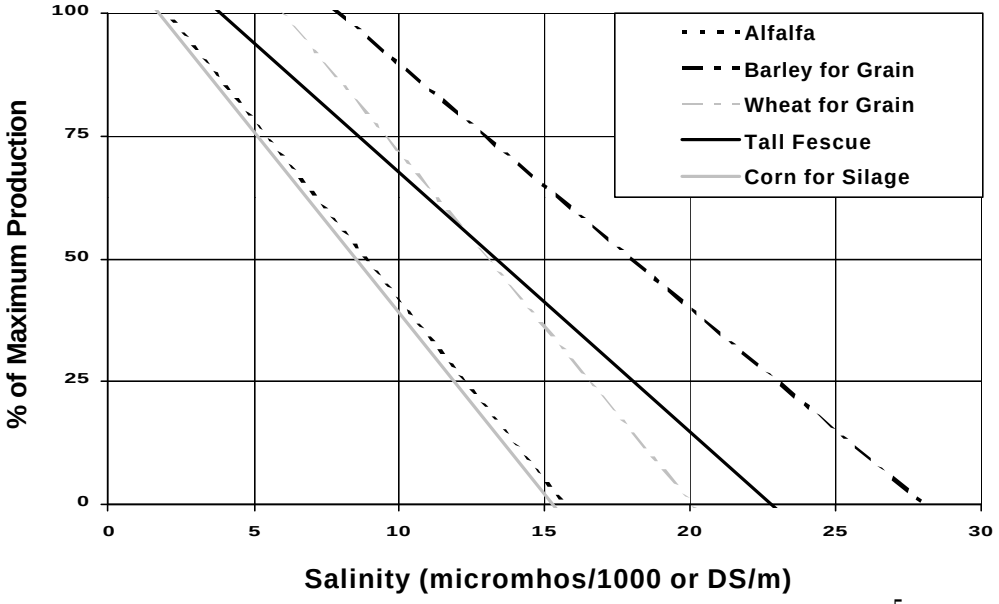

Figure 1. The influence of soil salinity on production of 5 common Montana crops. [5]

Chemical parameters of the Tongue River water differ from those of CBM discharge water (e.g. salinity [measured as electrical conductivity -EC] sodium absorption ratio [SAR], total dissolved solids [TDS], see Tables 1 and 2). As the CBM effluent mixes with the river water, the levels are increased

or decreased by a factor relative to volume and concentration. More wells mean more effluent, which in turn impacts river water quality and ecology to increasing degrees. The degree of influence each new well has on water quality and ecology will decrease as the limit of degradation is approached (Table 3, Figure 2). Therefore, cumulative effects of numerous wells may not exceed threshold limits until a very large number of wells discharge. Gradual degradation of water quality at levels below threshold, however, will likely create numerous unforeseen and adverse shifts in ecosystems and economics.

Table 3. The potential effects of CBM water on the quality of the Tongue River water quality for an increasing number of wells. [4]

	CBM WELLS			RIVER w/ CBM		
#	Q (cfs)	TDS (mg/L)	EC (umhos/cm)	Q (cfs)	TDS (mg/L)	EC (umhos/cm)
0	--	--	--	300	284	450
100	3.3	1317	2107	303	295	468
1000	33	1317	2107	333	388	616
2000	67	1317	2107	367	472	752
3000	100	1317	2107	400	543	865
4000	134	1317	2107	434	602	961
5566	186	1317	2107	486	679	1084
10000	334	1317	2107	634	828	1323
30000	1003	1317	2107	1303	1079	1725

*Calculated using data from Chris Levine, Water Quality Database Summary

These water chemistry influences may also have significant impacts on aquatic biota. Klarich and Regele[1] studied relationships between aquatic ecologic parameters and salinity of Southeastern Montana waters, including the Tongue River and many of its tributaries. They found that salinity levels of in-situ waters should not be increased above 1,200 micromhos if their excellent biological health characteristics are to be preserved. As indicated on Figure 2 and in Table 3, this limit may be reached when effluent from about 7500 wells (Q = 250cfs) with water chemistry, as noted in Table 1, enters the Tongue River (Q = 300cfs).

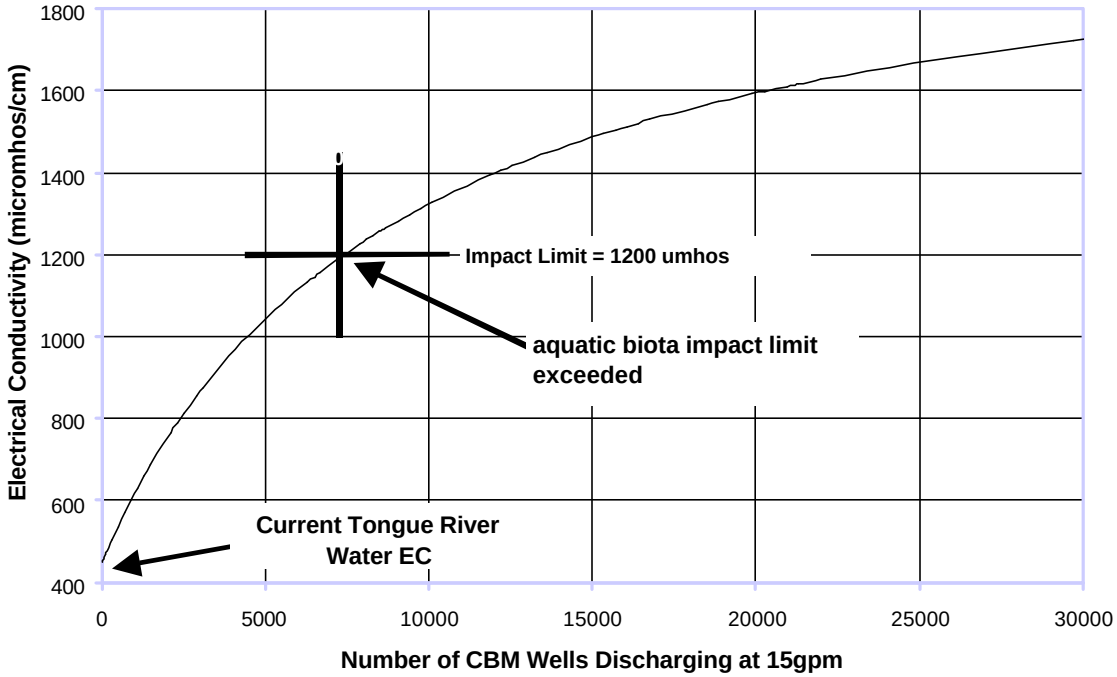

Figure 2. The potential relationship between the salinity of the Tongue River and CBM discharge. The aquatic Biota impact limit is shown. [1]

Additionally, fisheries may be adversely affected by CBM-induced hydrologic influences. The probability, or degrees, of such effects on fisheries are largely unknown. In the Montana portion of the Tongue River, thirty-three species of fish have been noted by MT Fish Wildlife and Parks (MFWP).[6] Of these, eight are restricted to the area of confluence with the Yellowstone River; two of these are of special interest (Shovelnose sturgeon and Paddlefish). About twenty-five of the fish species are found more or less throughout the Tongue River; sixteen of these may be classified as game fish.[7] As noted by MFWP, "Considering the limited habitat available to the various fish species in Southeastern Montana, extreme care must be taken where there is a potential for the degradation of aquatic resources."[6]

Numerous perennial and intermittent streams feed into rivers such as the Tongue River in Montana. In one of these, Squirrel Creek, MFWP has found thirteen species of fish,[6] ten of which are native.[7] MFWP has stated that "…these perennial and intermittent prairie streams play an important part in

the life history of native fishes and often provide spawning and rearing habitat for main stem fish species."[8]

Montana CBM development could be limited via the exceeding of Montana water quality standards resulting from Wyoming CBM-affected waters entering the state. This factor should also be evaluated in relation to potential effects on hydrologic and biologic resources and related land uses in Montana.

- **Creation of a widespread network of new trails and roads, increased use and impact on existing trails and roads, and significant surface disturbances resulting from compressor stations, holding ponds, and pipeline construction can significantly affect natural resources and land uses.** One stretch of road or trail ten feet wide crossing a section of land (one mile) equates to a little over an acre (1.2 ac). Surface disturbances around compressor stations, pipelines, etc., add additional disturbance acreage to a section of land influenced by CBM development activities. These surface disturbances can lead to significant erosion and noxious weed concentrations if they are not properly managed and maintained. They reduce the forage base and take significant acreage out of use by livestock and wildlife. Human activities associated with these facilities can adversely affect such wildlife resources as feeding, nesting and breeding grounds for various species (e.g. sage grouse, prairie dogs, etc.).

  CBM holding ponds may provide some short-term benefit as water sources for livestock and wetland habitat for wildlife species. They may also become "salt lakes", and saline seeps could develop down-gradient of them. This may result in varying degrees of adverse effects on vegetation, consumers of that vegetation, the soil resource, and water quality of any streams receiving salts from such areas. The optimistic life expectancy of a given CBM development site is projected to be about twenty years. If water is no longer supplied to these ponds, waterfowl and other wildlife species that had become dependent

on them may be displaced. Livestock operations that have incorporated the water source into management plans could be adversely affected and the dry pond sites could become infested with noxious weeds and/or otherwise become sites of diminished value.

- **Humans, of course, are also a "biological" issue.** Some will reap a significant economic gain from CBM development and some will benefit from the use of CBM. Others in the “CBM neighborhoods” feel that they will be significantly and adversely affected by construction and development associated with CBM activity. In addition to environmental and economic concerns, many are apprehensive about development after hearing stories and seeing first-hand the effects similar developments have had on the sociological attributes of other localities.

State and federal agencies in Montana, as well as other interested and concerned individuals and groups, have been working more or less independently to address CBM related issues and concerns. As a result of Governor Racicot's recent directive that Montana agencies conduct a programmatic review of anticipated CBM activity and specific development scenarios, these independent efforts will hopefully coalesce. This effort will almost certainly provide a much clearer picture of possible and probable impacts of CBM development in Montana and the Powder River Basin, and of regulatory and impact mitigation measures that may need to be implemented.

REFERENCES

1) Klarich, D.A., S.M. Regele. (1980). Structure, General Characteristics, and Salinity Relationships of Benthic Macroinvertebrate Associations in Streams Draining the Southern Fort Union Coalfield Region of Southeastern Montana. USGS Grant No. 14-08-0001-G-503 final report, Water Quality Bureau, Montana Department of Health and Environmental Sciences, Billings. 148 pp.

   Klarich, D.A., S.M. Regele and L.L. Bahls. (1980). Data Report for the Benthic Macroinvertebrate and Periphyton Community Inventory of Streams Draining the Southern Fort Union Coalfield Region of Southeastern Montana. USGS Grant No. 14-08-0001-G-503 final report, Water Quality Bureau, Montana Department of Health and Environmental Sciences, Billings. 268 pp.

2) Administrative Rules of Montana, 17.24.314(1) and 17.24.762. 2000.

3) Kegley, Morris W. 1999. Coalbed Methane and Western Coal Development. Presentations at the 1999 Mining Lawyers Conference, and The Montana Coal Council.

4) Levine, Chris. 2000. Montana Department of Environmental Quality, Resource Protection Planning Bureau. Unpublished data.

5) Hoffman, Glenn J. 1997. Water Quality Criteria for Irrigation. EC782. University of Nebraska, Institute of Agriculture and Natural Resources.

6) Elser, Allen A., Mark W. Gorges, and Lani M. Morris. 1980. Distribution of Fishes in Southeastern Montana. Cooperatively compiled by Montana Department of Fish, Wildlife and Parks and U.S. Department of the Interior, Bureau of Land Management. 136 p.

7) Brown, C.J.D. Fishes of Montana. 1971. Big Sky Books. Bozeman, Montana. 207 p.

8) Riggs, Vic. March 8, 2000. Montana Department of Fish, Wildlife and Parks. Personal communication.

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Presented Sept. 1, 2000 at: "Interactive Forum on Surface Mining Reclamation Approaches to Bond Release: Cumulative Hydrologic Impacts Assessment (CHIA) and Hydrology Topics for the Arid and Semi-arid West. Coal-bed Methane Workshop". Sponsored by USDI Office of Surface Mining, Denver CO; the Montana Department of Environmental Quality, Helena MT; Montana Bureau of Mines and Geology, Butte, MT.