USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Development of a GIS for Analyzing and Mapping Ground-Water Elements Related to Coal-Bed Methane Production

Focus Categories: GW, SW, WU

Keywords: Resource protection, Energy development, Coal, Coal-bed methane, Hydrologic impacts, Water management, Land use, Water rights, Water use monitoring, Springs, Streams, Resource planning, Resource development, Regulatory permits, Ground-water hydrology, Ground-water management, Geomorphology, Geographic Information System, Data analysis

Duration: 12 Months: April 1, 2000 through March 31, 2001

Federal Funds Requested: $10,429

Non-Federal(matching) Funds Requested: $22,532

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Congressional District: First, Montana (entire state)

Statement of Critical Regional or State Water Problem

The U.S. Bureau of Land Management has declared a moratorium on further gas development on federal lands in Wyoming because of the thousands of wells being drilled and associated hydrologic concerns relating to coal-bed methane development. Currently in southeastern Montana, commercial methane production from regional coal-bed aquifers has begun and is rapidly expanding. The public, government agencies and other interested parties cannot readily access information describing the areas of present and future development, related aquifer dewatering, and water discharge points. In semi-arid southeastern Montana the coal beds are the regional aquifers for the agricultural

community. Development of this energy resource will have significant impacts on the regional hydrologic resources. A means must be established to disseminate information so the levels and extents of impacts to the regional hydrogeology can be assessed.

Methane production is accomplished through the process of drilling wells and pumping ground water from coal beds to decrease hydrostatic pressures. Methane gas then desorbs from the coal and is captured in the well, and co-produced with water discharged at ground surface. A large percentage of the Powder River Basin in Montana (including Big Horn, Rosebud and Powder River counties) has been leased for coal-bed methane exploration. Many wells have already been drilled and permits for hundreds more are being processed. Water co-produced with the methane can exceed tens of thousands of gallons of water per day from each well, and from the thousands of wells that may be drilled could exceed millions of gallons per day. The production of coal-bed methane, the associated declining static water levels and surface discharges of sodic ground water are expected to last for decades.

Statement of Benefits

The Montana Hydrogeologic Coal-Bed Methane Map will be produced under this project. The map and associated database will be a critical foundation for all future research on coal-bed methane development and impacts. The GIS will relate regional hydrologic features to the production of coal-bed methane. Coverages planned for the GIS include: planimetric features; hydrography; water wells; springs; MBMG monitoring wells; industry monitoring wells; traditional oil and gas wells; coal-bed methane wells; coal outcrops; clinker areas; coal mine permits; and pipeline data available in digital format.

The final products of this proposal will be used to address environmental concerns by landowners, coal and gas producers, local, state, and federal organizations. The project will yield visual tools and a searchable database in the form of a map and GIS database to allow ready access for spatial analysis of data associated with coal-bed methane development. This database will be the building block for future research, and will be available to the public.

Nature, Scope and Objectives of the Research

Coal-bed methane development is rapidly growing as an energy source in southeastern Montana. Methane is produced from coal seams in the Fort Union Formation of the Powder River Basin, and transmitted to pipelines for delivery to commercial markets. Current transmission from Montana is to Wyoming. Methane wells are closely spaced in arrangements called pods, that may contain as many as 20 wells, completed in as many as 4 coal seams, within about an 800 acre area. Numerous pods are planned for each well field. Within a pod, wells are connected to gas pipelines and to water discharge pipelines. The gas lines are consolidated, the gas dehydrated and pressurized for transmission.

Discharge water is piped either to holding ponds or to points where it can be released to surface waters such as the Tongue River.

Individual wells are expected to produce water at an average rate of 10 to 20 gallons per minute (gpm). This water is considered a waste product of the gas development process. The water is removed from the aquifer as a means of reducing hydrostatic pressure in the aquifer, thereby allowing methane gas to desorb from micropores, and from cleat and fracture faces in the coal. Each pod will nearly dewater the coal seams over an area of approximately 1.5 square miles, creating a cone of depression that will cover many square miles. The extent of significant drawdown from individual pods is expected to reach at least 10 miles from the pod. Each well field will create an area of water-level drawdown that will exceed those created by large-scale coal mining. Springs and private stock and domestic wells are expected to be impacted by coal-bed methane development.

Wells are expected to produce methane (and maintain a depressed water level) for up to 15 years. As development expands throughout the Powder River Basin, long-term impacts to water supplies may occur. Water discharged from gas wells may impact stream-channel stability, and will be high in sodium, which may impact surface water quality and soils. Responsible development of methane, and protection of water resources will require a thorough understanding of the drawdown and recovery of the coal-seam aquifers. Impacts of discharged water from gas wells on soils and surface water systems will also be an important issue. Research focused on developing a better understanding of these impacts will be based on spatial analyses of private wells and springs, gas-well locations, pumping rates and water-level data.

Landowners have voiced concerns over all the above issues. To understand where concerns are warranted, landowners need access to maps showing potential and actual coal-bed methane development, well status, and other hydrologic features.

The Geographic Information System (GIS) developed in this study will provide the basis for addressing the above concerns and will serve four main purposes.

1.) To provide a basis for spatial analyses in future research projects related to ground-water withdrawal and methane production.

2.) To produce an easily updated map product on a planimetric base at a 1:100,000 scale.

3.) The map will also be producible at different scales: for example at 1:126,720 to match Wyoming's Coal-Bed Methane Map; and at 1:24,000 to provide more detailed evaluation in areas of high interest.

4.) To provide the public with the above information.

Key GIS data for research and map production will include the following: coal-bed outcrops to show potential development areas; existing coal mines, as they also impact

the hydrogeology; coal-bed methane wells according to their status of permitted, spudded, producing and abandoned; ground-water observation wells currently available to monitor impacts; and all known springs, stock wells and domestic water wells within 3 miles of methane activities and currently recorded in the Ground Water Information Center (GWIC) database.

The study area will cover Montana's portion of the Powder River Basin from the Wyoming border northward to the Yellowstone River. This area coincides with that currently proposed by the Montana Department of Natural Resources and Conservation (DNRC) to become a Ground-Water Control Area for coal-bed methane development.

Once established under this grant, the GIS map and associated database can be easily updated in the future. Updates could include locations of newly permitted coal-bed methane wells, status of existing wells, and locations of new monitoring wells. This product would serve as a valuable research tool in allowing for the quantitative and spatially explicit evaluation of impacts of methane development on the fresh-water aquifers.

The duration of this project is 1 year and will consist of a bibliography and available data search (1 month); data assimilation (2 months); database creation and data entry (2 months); map layers assemblage (3 months); and, final product completion of the map and GIS data structure (4 months).

Methods, Procedures and Facilities

The GIS product will be developed using Environmental Systems Research Institute (ESRI) ARC/INFO and ArcView software. Hardware will include resources at the Montana Bureau of Mines and Geology's (MBMG) GIS Laboratory in Butte and at MBMG's Billings office. GIS data will be compiled from a number of sources. Coal, methane, geologic, and hydrologic data available at MBMG will be used to develop key GIS coverages. Well data on water use will be incorporated from MBMG's Ground Water Information Center's (GWIC) Sybase database. Gas well locations and status will be input from the Oil and Gas Conservation Division. MBMG monitoring well locations will be retrieved from GWIC, and coal-mine company monitoring well locations will be requested from mine companies. Gas lease information will be taken from records at county courthouses. Planimetric GIS data used to create the 1:100,000 basemap will be obtained from the Montana Natural Resource Information System (NRIS). Selected areas of high interest will be mapped at the 1:24,000 scale.

Related Research

The Montana Bureau of Mines and Geology plans to inventory private wells and springs in the active development area near Decker, Montana and to perform research on the

combined hydrologic impacts of coal-bed methane development and coal mining in this area. This private well and spring inventory will be limited to the area immediately adjacent to the Decker mines. The map developed from the Water Center funded research will serve as a base map for the site-specific hydrologic impact research. Because the Water Center funded map is regional, it can also help to identify other similar site-specific areas in the future.

The Department of Natural Resources and Conservation (DNRC) is proposing a Controlled Ground-Water Basin for the same area that this proposed Water Center project will cover. DNRC and Department of Environmental Quality (DEQ) will need spatially explicit data to monitor the basin.

The MBMG has performed research on coal mining impacts to hydrologic systems in the Powder River Basin for more than 25 years. The data from MBMG publications "Hydrogeologic responses: Twenty years of surface and coal mining in southeastern Montana, W. A. Van Voast and J. C. Reiten, 1988" and "Quality and reserves of shippable coal, selected deposits, southeastern Montana, R. E. Matson and J. W. Blumer, with Analytical data, L. A. Wegelin, 1973" will be incorporated into the proposed study. This proposal differs from these studies in addressing issues specific to coal-bed methane development.

The Wyoming Geological Survey has produced a similar map: Coalbed Methane Activity in the Eastern Powder River Basin, Coalbed Methane Map 98-1 (12/10/98), Campbell and Converse Counties, Wyoming, Wyoming State Geological Survey, 1998. The proposed research will make similar data available for Montana.

Coal-mine companies collect hydrologic data to meet permit requirements. These data are located at the Department of Environmental Quality. Coal-mine company data are not easily accessible, and do not include coal-bed methane wells or related hydrologic information.

The Ground-Water Information Center (GWIC) is located at the MBMG in Butte, Montana and is available for public access through the internet. The GWIC database maintains records of all known water wells in Montana. These data will be incorporated into the proposed study.