U.S. Department of the Interior
Bureau of Land Management

Buffalo Field Office **October 1999**

Wyodak Coal Bed Methane Project Final Environmental Impact Statement

MISSION STATEMENT

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

BLM/WY/PL-00/013+1310

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CHAPTER 1
PURPOSE OF, AND NEED FOR, THE PROPOSED ACTION

This chapter has been reprinted in its entirety and includes changes in response to comments.

This document has been prepared as an abbreviated final environmental impact statement (FEIS). It must be used in concert with the draft environmental impact statement (DEIS) to understand the analysis, which includes the response to comments received. The FEIS is organized by chapters, the same as the DEIS, but only changes (errata), new information or analysis are included. The FEIS is responsive to public comments and also to updated regulatory framework, including the recent U.S. Supreme Court decision determining federal CBM resources to be an oil and gas right, new federal regulations on regional haze, and ongoing State of Wyoming reviews of its permitting procedures and monitoring requirements for CBM development. The largest section of the document is Chapter 4, which contains a revised groundwater section. Chapter 5 - Consultation and Coordination includes an update on coordination that has taken place since the DEIS was issued and a response to the comments received. All comments were taken into consideration in the preparation of this FEIS and are included in **Appendix E**. Substantive issues were compiled into resource-based issue statements; in response, separate statements addressing specific issues were prepared. Those comments containing only opinions or preferences did not receive a formal response.

INTRODUCTION

Barrett Resources Corporation and Lance Oil and Gas Company representing themselves and a number of additional coal bed methane (CBM) developers (hereafter referred to as the Companies) have notified the USDI Bureau of Land Management (BLM), Buffalo Field Office, of their intent to expand CBM development on lands in the Powder River Basin (PRB). This expansion would include federal lands and federal minerals administered by the BLM and USDA Forest Service (FS), and is known as the Wyodak CBM Project. Initial development scenarios of 3,000 and 5,000 new productive wells were analyzed in combination with 640 productive wells previously addressed in the Gillette South CBM Project Environmental Impact Statement (EIS) and 250 productive wells previously analyzed in the Gillette North CBM Project Environmental Assessment (EA). In total, this EIS documents the analysis of the cumulative effects of 3,890 productive wells (Proposed Action), 5,890 productive wells (Alternative 1), 2,890 productive wells (No Action Alternative), and associated facilities, including roads, pipelines, and CBM compressors (**Map 1-1**).

Shortly after the Record of Decision (ROD) for the Gillette South CBM Project EIS was signed in October 1997, a meeting was held by the BLM to discuss the implications of this ROD regarding mitigation measures, monitoring requirements, and the potential and direction of additional development. Information provided subsequently by industry in 1998 regarding development plans indicated an additional 2,250 CBM wells could be drilled and operated in the PRB south of Gillette, Wyoming. Continued interest by industry added the potential for 750 wells north of Gillette. Continuing industry interest during the analysis process for this EIS indicates that three or four times the number of proposed CBM wells analyzed here in this initial development scenario may now be contemplated for the PRB. This Wyodak CBM Project EIS uses information developed in the analyses for previous CBM EAs in the area, including the Gillette North, Lighthouse, and Marquiss

EAs, and it considers the effects of changes in environmental conditions and development procedures that have occurred since the Gillette South CBM Project EIS was completed.

Drilling CBM wells on lands where mineral rights are owned and controlled by the federal government must be conducted under an approved application for permit to drill (APD) issued by the BLM. In considering whether to approve APDs, the BLM must consider the possible project-specific and cumulative environmental impacts to ensure compliance with the National Environmental Policy Act of 1969 (NEPA). This draft EIS was prepared to meet that requirement. An additional analysis, which will look at the site-specific impacts of the drilling location and its relationship to the range of impacts documented in this analysis, will be completed in response to the filing of an APD and prior to approval by BLM.

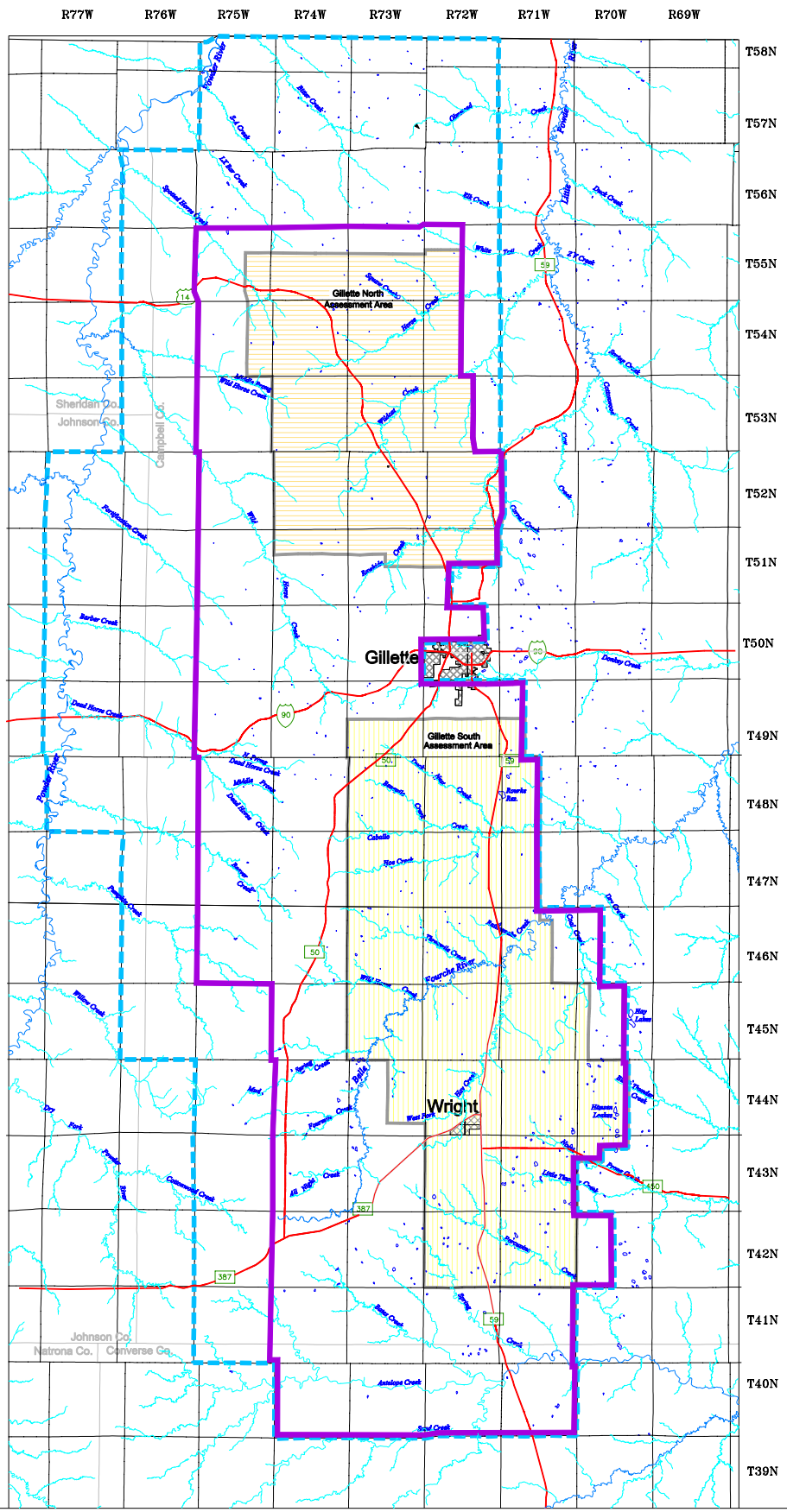
The BLM's authority and decisions related to CBM development in the eastern PRB are limited to the agency's stewardship, resource conservation, and surface protection responsibilities for federal lands and minerals. As conservator of the federal surface and mineral estate, the BLM has responsibility for ensuring that the federal mineral resource is conserved (not wasted) and is developed in a safe and environmentally sound manner. However, the BLM does not authorize or control any of the following:

- CBM development involving only fee or state-owned lands and minerals;
- the appropriation (withdrawal) or subsequent beneficial use of groundwater;
- water quality;
- the discharge of CBM produced water to surface waters;
- surface water diversions, stream channel modifications, construction of new reservoirs, reservoir supply, or dam modifications to existing reservoirs;
- oil and gas well spacing; or
- air quality, including siting, permitting, emissions, and monitoring for stationary or mobile sources of air pollution and regional haze.

Regulatory areas where the BLM has shared responsibilities with other federal or state agencies include the following:

- oil and gas drilling;
- activities that would impact waters of the U.S.;
- special status species of plants or animals; and
- cultural, historical, or paleontological resources.

When actual locations and operational requirements for gas compression facilities (CBM development) are determined, permit applications would be submitted to the Air Quality Division (AQD) of the Wyoming Department of Environmental Quality (WDEQ). At that time, additional site specific air quality analyses, such as a Best Available Control Technology (BACT) analysis



LEGEND

- Proposed Action Project Boundary
- Alternative 1 Project Boundary
- Gillette North Assessment Area
- Gillette South Assessment Area
- Perennial Stream
- Ephemeral Stream

N

0 8.5 17

Scale (mi)

MAP 1-1
Project Location
Wyodak CBM Project

or Prevention of Significant Deterioration (PSD) increment analysis, may be performed. The analysis contained in this draft EIS is not intended as an air quality regulatory determination. PSD increments are used here only to evaluate air quality impacts.

PURPOSE AND NEED

The purpose of, and need for, the proposed CBM development is to allow for the orderly development of the resource to meet the energy needs of the nation. Development of federally-owned CBM also would reduce the possibility of drainage from the federal mineral estate and loss of royalties to the U.S. Treasury and the State of Wyoming. The leaseholders will be able to exercise their rights within the project area to drill for, extract, remove, and market CBM within conditions stipulated in the lease. Also included in these lease rights is the right to build and maintain necessary improvements. These rights continue throughout the lease term and any extensions or renewals granted by the appropriate authority.

The purpose of the Proposed Action is to analyze the impact of additional development of federal CBM properties within the Wyodak project area that were not analyzed in the Gillette South EIS and the Gillette North EA. This project area includes new developments within the Gillette South EIS and Gillette North EA areas and locations now being developed exclusively on state and private oil and gas leases outside these original assessment areas. An estimated 890 productive CBM wells were in place within the Wyodak project area by the end of 1998. Production statistics for 420 productive CBM wells were available for February 1998 (PI/Dwight's, 1998). Production statistics for 638 productive CBM wells were available for November 1998 (PI/Dwight's, 1999).

For the purpose of this analysis, the BLM estimates the following conditions: 1) up to one-half of all new CBM wells that would be drilled within the project area would be located on lands where these mineral rights are owned privately or by the State of Wyoming; and 2) up to one-half of all the new CBM wells that would be drilled within the project area would be located on lands where CBM mineral rights are federally owned. Drilling wells under an approved APD is the only way to determine the potential for CBM production on federal lands. The private- and state-owned gas will be developed regardless of the outcome of this decision, but under the Proposed Action the project would include development of private, state, and federal CBM properties.

The operators propose to develop CBM within the project area by increasing the total number of wells and ancillary facilities where economically feasible. This proposal would enhance recovery of methane from the project area by increasing the availability of gas supplies, thus allowing operators to provide more gas to companies distributing and supplying methane to consumers.

LOCATION OF THE PROPOSED ACTION

The proposed CBM projects are located in central Campbell and northern Converse Counties, Wyoming, within the eastern portion of the PRB. The proposals include additional development within the Gillette South EIS assessment area and the Gillette North EA assessment area, and in surrounding areas (**Map 1-1**). The wells would be located within a project boundary extending from approximately 33 miles north of Gillette, Wyoming to 24 miles south of Wright, Wyoming. Wells

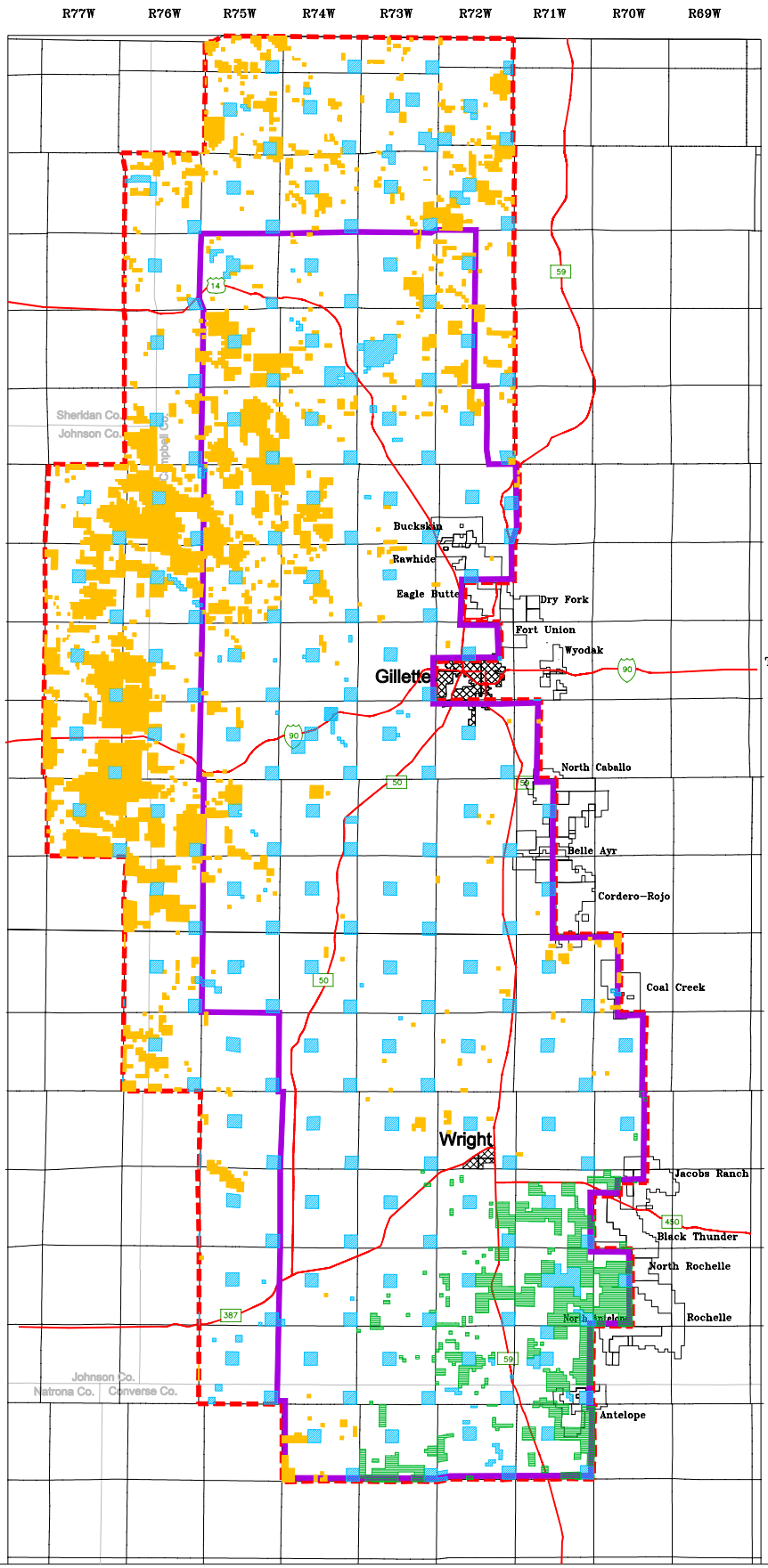
would be located on lands adjacent to the coal mines along the eastern project boundary, and would extend to a western boundary located about 18 to 36 miles to the west. For reference, this roughly rectangular area has been named the Wyodak CBM project area. The project area includes portions of the Thunder Basin National Grassland (TBNG), which is under surface administration of the FS; drilling activity currently is proposed on FS-administered federal lands. The project boundary was delineated by industry interest. There is no legal requirement for the Companies to confine drilling to this area other than their federal leases. It is significant to note that although approximately 8.1 percent of the project area is federal surface (4.5 percent BLM-administered federal lands and 3.6 percent FS-administered federal lands) (**Map 1-2**), federal ownership of oil and gas rights constitutes about 50 percent of the project area (**Map 1-3**). Federal ownership of coal rights totals about 88 percent of the project area (**Map 1-4**) (USDI BLM, 1998f).

AUTHORIZING ACTIONS

The BLM's Buffalo Field Office (BFO) administers oil and gas leases for all federally-owned minerals within the project area. CBM development is regulated in accordance with federal oil and gas regulations and onshore oil and gas orders. The U.S. Supreme Court recently decided the ownership of CBM in Southern Ute Indian Tribe vs. Amoco Production Company et al., a case involving CBM development in Colorado. CBM is disposable under the oil and gas leasing provisions of the 1920 Mineral Leasing Act.

Leasing of federal lands and federal minerals administered by the BLM is subject to the limitations imposed by the *Buffalo Resource Management Plan/Record of Decision* (RMP) (USDI BLM, 1985); current policy; and local, state, and federal laws. The FS's Douglas Ranger District of the Medicine Bow-Routt National Forest administers oil and gas leasing and development activities within the TBNG. Leasing and development activities on FS-administered federal lands are subject to the limitations imposed by the *Land and Resource Management Plan for the Medicine Bow National Forest and Thunder Basin National Grassland* (LRMP) (USDA FS, 1985 as amended) and the EIS for *Oil and Gas Leasing on the TBNG* (USDA FS, 1994).

Before any surface disturbance can occur on federal lands and/or federal minerals administered by the BLM, a company must have an APD approved by the BLM Field Manager for on-lease drilling. A right-of-way must be approved by the BLM for off-lease disturbance of federal surface.
Securing necessary legal access to and/or across any state- or privately-owned lands also is part of the APD approval process. The Wyoming Office of State Lands and Investments is responsible for easements and temporary uses of state lands that are required for off-lease activities. Before any surface disturbance can occur on FS-administered federal lands, a company must have a surface use plan approved by the FS District Ranger for on-lease activities, which is part of the APD that must be approved by the BLM Field Manager. A special-use permit is issued by the FS to manage off-lease activities on FS-administered federal lands. On-lease production facilities on federal lands and/or federal minerals are authorized by Sundry Notices.



LEGEND

- Proposed Action Project Boundary
- Alternative 1 Project Boundary
- Bureau of Land Management
- Forest Service
- State
- Private

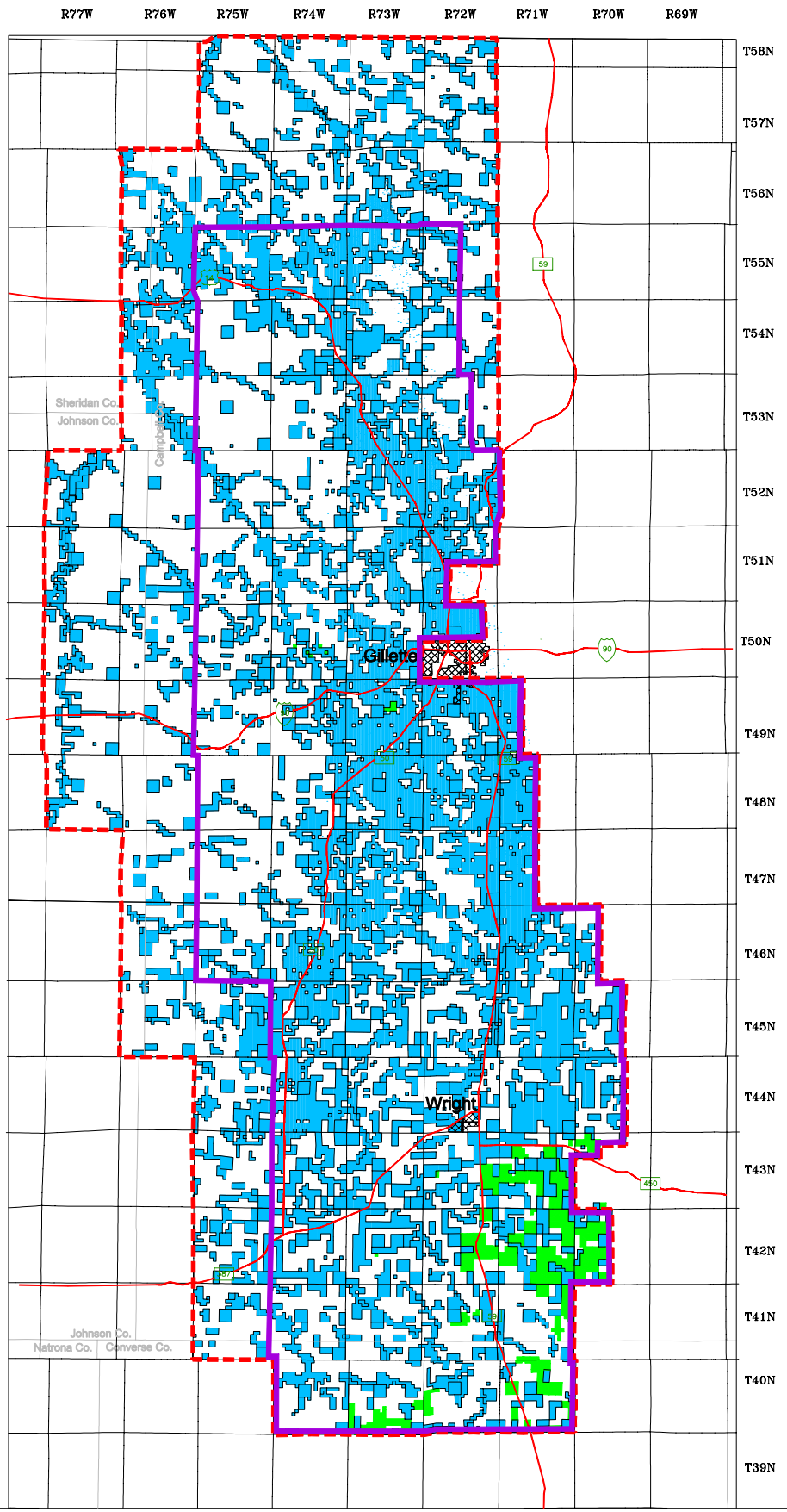
	Proposed Action	Alternative 1
Bureau of Land Management	4.5%	9.3%
Forest Service	3.6%	2.4%
State	6.3%	6.2%
Private	85.7%	82.1%

N

0 8.5 17

Scale (mi)

MAP 1-2
Surface Ownership
Wyodak CBM Project



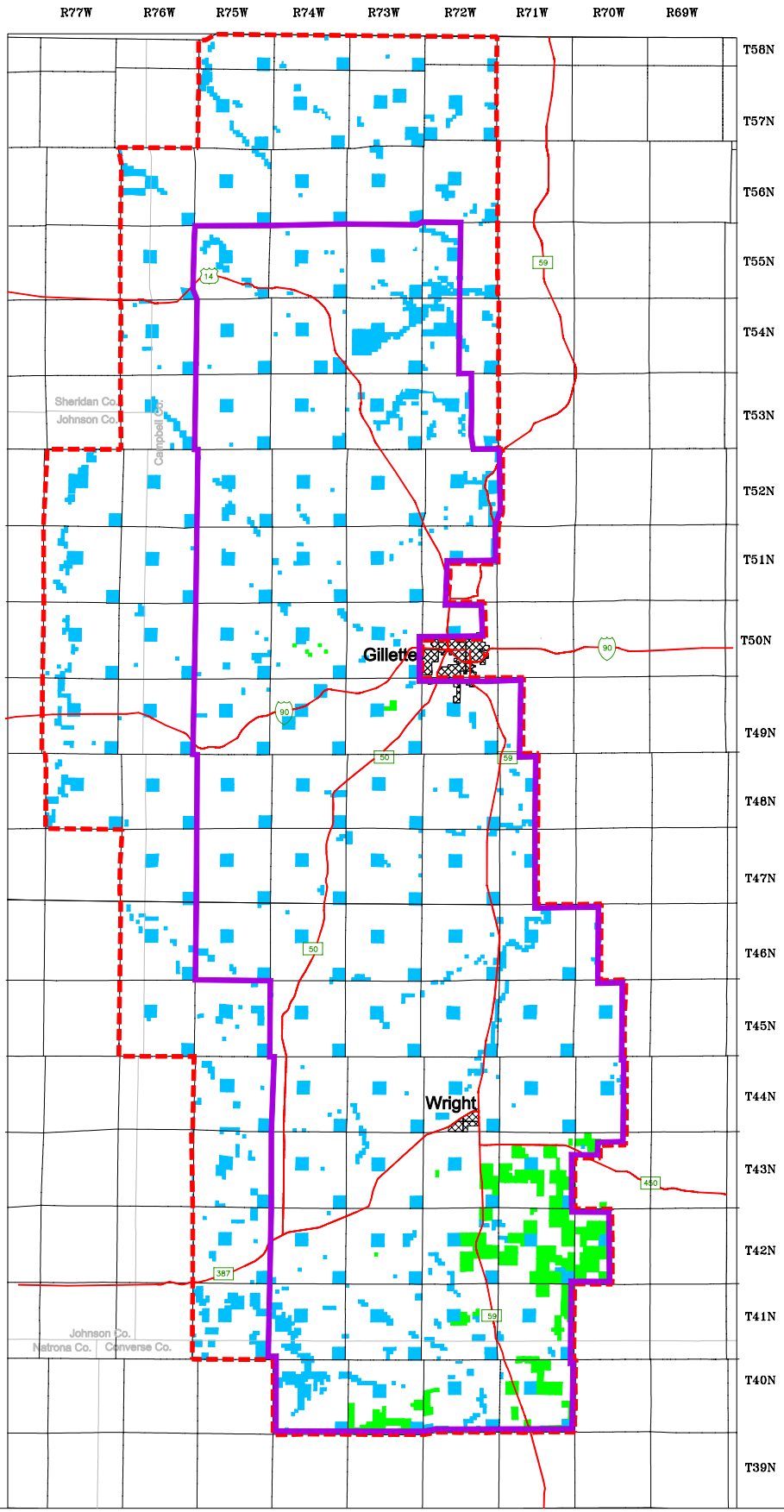
LEGEND

- Proposed Action Boundary
- Alternative 1 Project Boundary
- Complex Mineral Ownership *
- Federal
- State and Private

*May Include Multiple Owners or Fractional Interests; Surface Administered by U.S. Forest Service

0 8.5 17
Scale (mi)

MAP 1-3
Oil and Gas Ownership
Wyodak CBM Project



LEGEND

- Proposed Action Boundary
- Alternative 1 Project Boundary
- Complex Mineral Ownership *
- Federal
- State and Private

*May Include Multiple Owners or Fractional Interests; Surface Administered by U.S. Forest Service

N

0 8.5 17

Scale (mi)

MAP 1-4
Coal Ownership
Wyodak CBM Project

The Wyoming Oil and Gas Conservation Commission (WOGCC) regulates drilling and well spacing, and requires an approved APD for all oil and gas wells drilled in the state, including federal wells. The WOGCC also regulates reserve pits and water encountered (surface flows) or produced during drilling operations.

Under current State of Wyoming laws, CBM operators are allowed to produce water with a stock/miscellaneous use WSEO permit and discharge that water with an NPDES permit from WDEQ. Producers operating with these permits are within the requirements of state laws.

The State of Wyoming considers water produced in conjunction with CBM development to be a beneficial use of groundwater and requires an approved permit from the Wyoming State Engineer's Office (WSEO) prior to the drilling of a CBM well. This WSEO permit authorizes the appropriation of groundwater from subsurface aquifers and its subsequent beneficial use at specific locations. Surface water diversion, stream channel modification, reservoir supply, construction of new reservoirs, and/or dam modification on existing reservoirs also require permits from the WSEO. Engineering designs are required, as appropriate, as part of the approval process.

The Water Quality Division (WQD) of the WDEQ regulates increasing sedimentation, erosion, and other issues affecting the quality of water. WQD also is responsible for granting a National Pollution Discharge Elimination System (NPDES) permit for surface discharge of produced waters from CBM wells. The WDEQ's NPDES permitting process, effluent limitations, and monitoring requirements for CBM produced water currently are being reevaluated. Specific requirements for discharge of CBM produced waters are being evaluated on a case-by-case basis.

The WQD also issues NPDES permits for pipeline construction activities that disturb five or more acres or involve temporary discharge to "Waters of the State" during hydrostatic testing. Beginning no later than 5/31/2002, construction projects that clear one acre or more will be required to obtain stormwater permit coverage. Types of oil and gas activities that may be covered include well pad construction, road construction, pipeline installation, and any other activity that results in clearing, grubbing, or grading of the land surface.

The WQD also administers a voluntary State Wetland Bank where landowners can temporarily "bank" newly-created wetlands as a wetlands credit. The existence of a non-wetland use is recorded to facilitate reversal of the decision creating the banked wetlands (if desired, as long as the wetland credit was not used as mitigation for another wetland impact). Where the U.S. Army Corps of Engineers (COE) exerts federal jurisdiction over banked wetlands, the outcome of decisions involving these wetlands will be in accordance with the federal regulations administered by the COE.

Federal agencies are directed to take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial value of wetlands by Executive Order (EO) 11990, May 24, 1977, (Protection of Wetlands). A BLM instructional memorandum summarizing the operating procedures used to implement this federal policy for all Wyoming wetlands administered by the BLM is included in Appendix A of the DEIS.

The COE authorizes activities that would impact navigable waters and waters of the U.S. through individual permits or nationwide permits for categories of activities, and also receives pre-construction notification of activities. "Waters of the U.S." is a collective term for all areas subject to regulation by the COE under Section 404 of the Clean Water Act. COE will require a permit when dredge or fill activities are planned in waters of the United States. The COE currently is in the process of developing a Programmatic General Permit (PGP) for oil and gas exploration and development activities in Wyoming having minor environmental impacts. A February 19, 1998 letter describing COE jurisdictional areas, regulated activities, and permitting requirements in relation to CBM production activities in northeastern Wyoming is included in Appendix A of the DEIS.

The AQD of the WDEQ enforces U.S. and Wyoming Air Quality Standards and Regulations, and authorizes the construction and operation of stationary compression facilities. A Section 21 permit application is required prior to the construction, modification, or operation of any site, equipment, source, facility, or process that may cause or increase the emissions of an air contaminant into the atmosphere. Emissions from all stationary sources and monitoring activities for these sources are regulated by the WDEQ. The WDEQ has the authority to set permit limits, mitigating measures, monitoring requirements, and BACT for stationary sources.

The EPA has the authority to set permit limits, mitigating measures, monitoring requirements, and maximum allowable emission rates for mobile sources (including coal trains). New federal regulations on regional haze require reductions in haze over time.

Construction within the City of Gillette, use of existing rights-of-way and easements dedicated or owned by the City, or discharge of water within the city limits into the City's storm drainage system would require permits. Additionally, the City of Gillette has noise ordinances that could affect drilling or construction within the jurisdiction. Similar permits likely would be required for the proposed project from the affected counties or the City of Wright.

As part of the APD approval process for oil and gas drilling on federal lands and/or federal minerals it administers, the BLM reviews the surface use and drilling plans submitted by a company. For CBM development, BLM is asking operators to submit a Project Plan of Development (POD), which includes a master drilling plan, a master surface use plan for all wells, and a water management plan. Each POD includes up to 32 wells.

After the BLM receives a Notice of Staking (NOS) or an APD/POD and before approval, an onsite inspection is made of the proposed drilling locations, access roads, water management, and potentially-disturbed areas. BLM personnel, company representatives, and the surface owner(s) usually attend the inspection to determine site-specific conditions for approving the APD/POD. As part of the APD/POD approval process, BLM requires standard and, in some cases, special site-specific protective measures for design and operation of the proposed project and may require establishment of additional monitoring wells.

Before construction, the Companies would be required to follow current BLM land management guidance and decisions, and comply with existing laws for threatened and endangered species; cultural, historical, and paleontological resources; and federally-protected raptor nests. The actions proposed must be in conformance with the BLM's Buffalo RMP (USDI BLM, 1985 as amended or maintained) and the BLM's oil and gas maintenance action (10/11/1990). The BLM would apply any appropriate conditions of approval to protect site-specific resources. A plan for monitoring and mitigating potential adverse impacts to groundwater and surface water would be detailed as part of this project design (Chapter 2). Standard *Conditions of Approval* for APDs used by BLM's Buffalo Field Office as the starting point for a mitigation plan are contained in **Appendix B**. Mitigating measures that would be considered in project design under all action alternatives are compiled in **Chapter 2**.

As part of the APD approval process for FS-administered federal lands, the FS reviews the surface use plan and BLM reviews the drilling plan submitted by a company. After the FS and BLM receive the NOS or APD and before approval, an onsite inspection is made of the proposed drilling locations, access roads, and other potentially-disturbed areas. Agency personnel and company representatives attend the inspection to determine site-specific conditions for approving the APD. As part of the APD approval process, the FS and BLM require standard and, in some cases, special site-specific protective measures for design and operation of the proposed project, and the FS may require additional baseline information on water resources or the establishment of additional monitoring wells.

Before construction, the Companies would be required to follow FS land management guidance and comply with existing laws. The actions proposed within the project area must be in conformance with the management goals within the FS LRMP (USDA FS, 1985 as amended). The management goal for the TBNG is to demonstrate grassland management and utilization of resources and values that are in harmony with nature's requirements and behavior, and to foster long-term economic stability and productivity of the land base and quality of life for the people and communities in the area. The TBNG is managed to provide for multiple land uses, including oil and gas development; a broad spectrum of dispersed recreation opportunities; characteristic landscapes that satisfy the adopted visual quality objectives; increased public access; wildlife and fish habitats that maintain viable populations; and water quality and increased water quantity where possible (USDA FS, 1985).

All of the TBNG is available for oil and gas leasing. Many leasing restrictions were developed by the FS in 1994 for use within the TBNG. Any restrictions applicable to drilling or production activities may be included as conditions of approval for activities on post-1994 leases. These restrictions can be reviewed to provide insight regarding conditions of approval that may be applied to future APDs within the TBNG (USDA FS, 1994). The FS would apply any appropriate conditions of approval to APDs that are needed to protect site-specific resources or conditions.

PUBLIC PARTICIPATION

Scoping Process

The Council on Environmental Quality (CEQ) regulations require an "early and open process for determining the scope of issues to be addressed and for identifying significant issues related to a Proposed Action" (40 CFR 1501.7). Scoping was conducted through a direct mail process and a public meeting. The mailing list included landowners, business groups, environmental groups, and other interested members of the public.

The Notice of Intent (NOI) for this EIS was published in the *Federal Register* on January 29, 1998, and a public meeting was held on February 5, 1998 at the Holiday Inn in Gillette. All substantive comments the BLM received during these meetings have been used to direct the scope and analysis of this EIS. Public scoping comments were accepted through March 2, 1998. A letter that summarizes both the issues raised at the public scoping meeting and contained in written comments is presented as Appendix C (3/19/98 BLM letter to "Partner") of the DEIS.

Public Review of Draft EIS

On May 14, 1999, both the Environmental Protection Agency's Notice of Availability and the BLM's Notice of Availability were published in the *Federal Register*. Over 850 copies of the DEIS were made available to the public and interested agencies for a 45-day public comment period. Subsequently, the public comment period was extended for 15 additional days. The date by which comments had to be received was July 14, 1999. A total of 52 comment letters were received during the 60-day comment period. The letters received are reproduced in **Appendix E** and the responses to the comments are presented in **Chapter 5**.

CHAPTER 2
PROPOSED ACTION AND ALTERNATIVES

This section describes the proposed Wyodak CBM Project and the alternatives that were developed for consideration in this EIS. Three alternatives are analyzed comparatively in the EIS: 1) the Proposed Action (project area); 2) Alternative 1 (expanded project area); and 3) the No Action Alternative. In addition, other alternatives that were considered but not analyzed in detail, also are discussed. Alternative 1 is the preferred alternative.

Plans for the development of CBM resources within the PRB have been increasing since the Proposed Action and alternatives were developed in 1998. The Proposed Action now represents only a portion (initial stage) of the CBM development that is anticipated within the PRB. Development of non-federal CBM resources (outside the scope of this EIS) is occurring more rapidly than has been anticipated here. As of September 1, 1999, 2,373 of the 2,890 CBM wells analyzed under the No Action Alternative already have been drilled (WOGCC 1999c). For the purpose of this analysis, the Proposed Action and alternatives are considered comparatively in this EIS as an initial stage of CBM development within the PRB.

THE PROPOSED ACTION

Summary

The Proposed Action consists of drilling, completing, operating, and reclaiming approximately 3,000 new productive CBM wells and related production facilities. The fee and state wells included in the Proposed Action are connected actions to the proposed federal wells. The project area is located in the eastern PRB within central Campbell County and northern Converse County, Wyoming (**Map 2-1**). The Companies base this proposed activity on the preliminary development plans that were submitted to the BLM in 1998.

Development of natural gas (coal bed methane) wells and related facilities associated with the Wyodak CBM Project would be included. Proposed CBM development is based on an assumed 40-acre well spacing pattern. The authority to set well spacing rests with the WOGCC. The exact well locations will be determined subsequent to this EIS during the environmental analysis conducted for each well's APD, which would be reviewed and approved on a case-by-case basis. The APD process allows conditions of approval to be developed for each well on the basis of site-specific water monitoring requirements and environmental constraints. In addition to well sites, other facilities, such as access roads, gas gathering and water disposal pipelines, electrical utilities, and compressors, would be developed to facilitate natural gas (methane) production in the well fields.

Coal bed methane is owned by the federal government for approximately 50 percent of the project area. For the purpose of this analysis, the following conditions were assumed: One-half of the 3,000 new productive wells are estimated to be federal wells; wells would be drilled by 20 different companies, on average, each year during the initial development period of five to ten years (an estimated 7.5 years was used in the groundwater and surface water analyses); most drilling activity

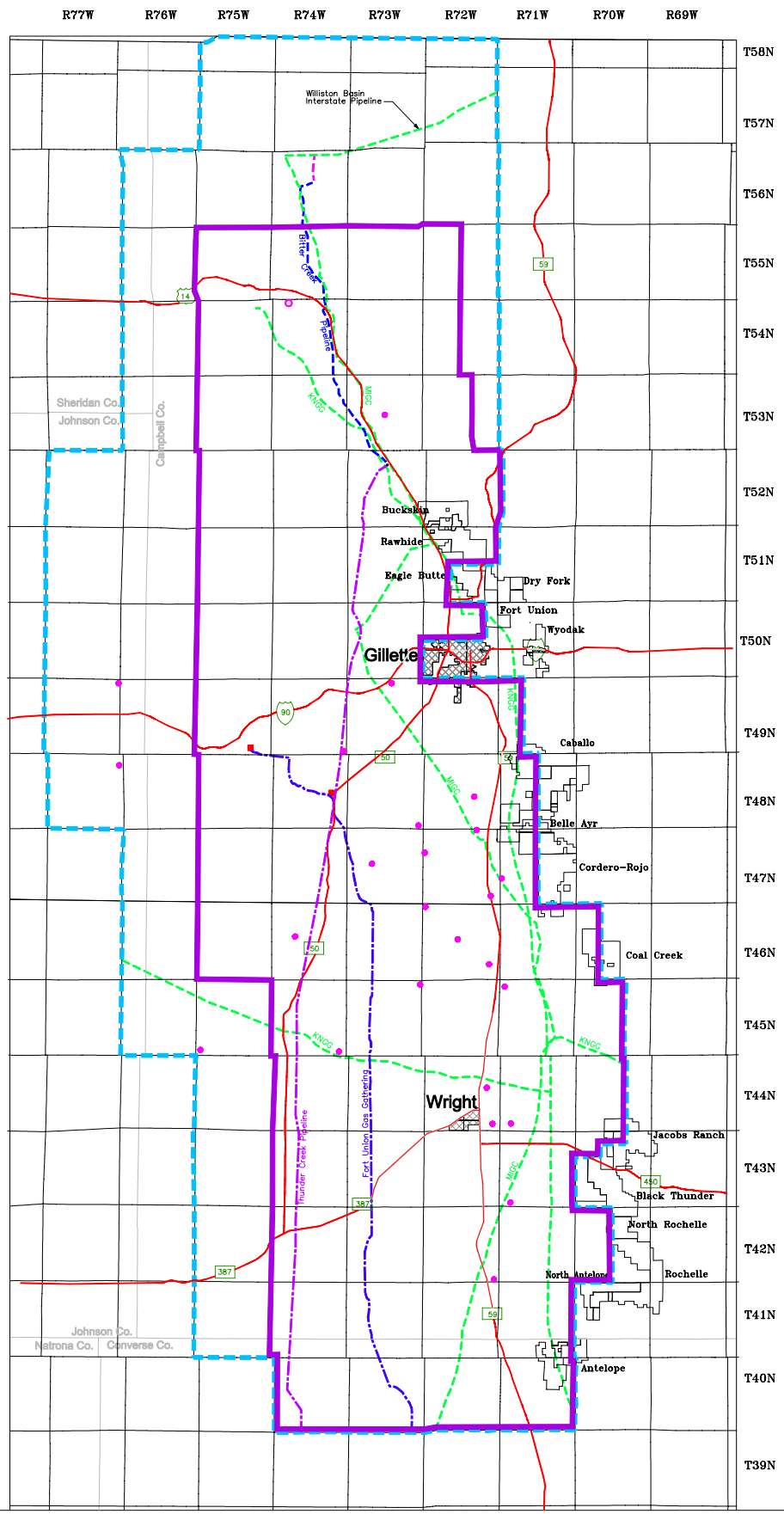
would occur within the initial development period; and the actual rate of development would depend on the productivity of the wells and the ability to compress and market the methane. Currently, interest in immediate CBM development is high. More than 60 companies filed APDs with the WOGCC through August 1999, for CBM well locations on federal, state, and private lands within the PRB (WOGCC, 1999c).

In addition to the proposed new wells, the Proposed Action also includes increased rates of development, CBM production, and surface water discharge and an increased area of disturbance within areas previously analyzed in the Gillette North CBM Project EA and the Gillette South CBM Project EIS (**Map 1-1**). Both the Gillette North CBM Project EA and Gillette South CBM Project EIS assessment areas are contained within the project area boundary for this EIS.

The proposed CBM wells would be located from approximately 33 miles north of Gillette to approximately 24 miles south of Wright, Wyoming. As stated under the "Location of the Proposed Action" in Chapter 1, the project boundary was delineated by industry interest but there is no legal requirement for companies to confine drilling to this area, other than the location of their federal leases. Under the Proposed Action, the project would include well development and production from private, state, and federal properties. However, CBM development likely would continue on private and state mineral estates, even if development of federal mineral estates were denied by the BLM.

The area analyzed under the Proposed Action (the project area) totals approximately 2,400 square miles (1,538,000 acres). Well spacing, combined with a preferred approach to locating wells, results in grouping of most wells into "pods" of about ten wells or more, depending on the structure of the coal seam. Developed areas may have up to 16 wells per square mile based on an assumed 40-acre spacing. Development typically would result in wells drilled within productive portions of the project area on a spacing determined by the WOGCC. The remaining less productive portions of the project area, where initial wells do not yield sufficient quantities of CBM, may never have any subsequent activity. The average density of new wells, if all 3,000 productive wells were drilled, would be approximately 1.3 wells per square mile. Refer to **Table 2-1** for additional information.

The BLM has a general policy that requires access roads to oil and gas wells on federal lands to be crowned, ditched, and, in most cases, graveled or otherwise surfaced. The BLM's general policy is based on the typical requirements for multi-component rigs. For CBM development, an exception has been made to this policy in consideration of the following factors. A shallow well drilling rig would be used for both drilling and completion activities. This type of drill rig and the well servicing equipment that supports its operation are modest in size, when compared with multi-component drill rigs and equipment used to drill deeper conventional oil and gas wells. Each CBM well would be drilled within one to three days. Well completion also would occur within one to three days. Typically, wellpads would not be leveled unless steep terrain could not be avoided. For producing CBM wells, on average, well service visits would be expected to occur



MAP 2-1
Proposed Action and Alternative 1
Wyodak CBM Project

Table 2-1 Proposed Coal Bed Methane Development Alternatives			
	Proposed Action	**Alternative 1**	**No Action**
1. Proposed Project Area (estimated):	1,538,000 ac 2,400 sq mi	2,317,000 ac 3,600 sq mi	1,538,000 ac 2,400 sq mi
2. Wells (projected):			
New Productive CBM Wells (total):	3,000	5,000	2,000
New Productive CBM Wells (federal oil & gas ownership)	1,500	2,500	0
Maximum Well Density:	16 wells/sq mi	16 wells/sq mi	16 wells/sq mi
Average Density (new wells only):	1.3 wells/sq mi	1.4 wells/sq mi	0.8 wells/sq mi
Average Density (all CBM wells):	1.6 wells/sq mi	1.6 wells/sq mi	1.2 wells/sq mi
Depth:	350 to 1,200 ft	350 to 1,200 ft	350 to 1,200 ft
Average Production Rate (per well):	125 MCFD	125 MCFD	125 MCFD
3. Production Pods (estimated):	300	500	200
4. Water Discharge (estimated):			
Water Discharge Points	500 to 1,000	833 to 1,667	333 to 667
NPDES Permits	167 to 333	278 to 556	111 to 222
Maximum Annual Volume (new wells)	58,080 ac-ft/yr	96,800 ac-ft/yr	38,720 ac-ft/yr
5. Compressors (estimated): *			
Booster Compressors (at some production pods):			
Stations Operational by 5/97	13	13	13
Additional Stations	147	147	147
Total Number of Stations	160	160	160
380 HP Booster Compressor Engines Operational by 5/97	13	13	13
Additional 380 HP Booster Compressor Engines	220	220	220
Total Number of 380 HP Booster Compressor Engines	233	233	233
Number of Compressors per Station	1-2	1-2	1-2
Compressor (Engine) Capacity (gas volume)	2.1 MMCFD	2.1 MMCFD	2.1 MMCFD
Compressor (Engine) Capacity (wells)	20	20	20

Table 2-1 (continued) Proposed Coal Bed Methane Development Alternatives			
	Proposed Action	**Alternative 1**	**No Action**
5. Compressors (estimated) - continued: *			
Field Compressors			
Stations Operational by 5/97	15	15	15
Additional Stations	34	34	34
Total Number of Stations	49	49	49
1000 HP Field Gathering Line Engines Operational by 5/97	5	5	5
Additional 1000 HP Field Gathering Line Engines	13	13	13
Total Number of 1000 HP Field Gathering Line Engines	18	18	18
Number of Compressors per Station	1-6	1-6	1-6
Compressor Engine Capacity (Gas volume)	7 MMCFD	7 MMCFD	7 MMCFD
Compressor Engine Capacity (Wells)	56	56	56
1500 HP Field Gathering Line Engines Operational by 5/97	39	39	39
Additional 1500 HP Field Gathering Line Engines	43	43	43
Total Number of 1500 HP Field Gathering Line Engines	82	82	82
Number of Compressors per Station	1-4	1-4	1-4
Compressor Engine Capacity (Gas volume)	5 MMCFD	5 MMCFD	5 MMCFD
Compressor Engine Capacity (Wells)	40	40	40
Pipeline Compressors			
Stations Operational by 5/97	0	0	0
Additional Stations	5	5	5
Number of Stations	5	5	5
1500 HP Transmission Pipeline Engines Operational by 5/97	0	0	0
Additional 1500 HP Transmission Pipeline Engines	18	18	18
Total Number of 1500 HP Transmission Pipeline Engines	18	18	18
Compressor Engine Capacity (Gas volume)	22.5 MMCFD	22.5 MMCFD	22.5 MMCFD
Compressor Engine Capacity (Wells)	N/A	N/A	N/A

Table 2-1 (continued) Proposed Coal Bed Methane Development Alternatives			
	Proposed Action	**Alternative 1**	**No Action**
6. Transmission Pipeline Capacity (estimated):			
Available Pipeline Capacity (by the end of 1998):			
Redstone	40 MMCFD	40 MMCFD	40 MMCFD
Western Gas Resources	120 MMCFD	120 MMCFD	120 MMCFD
TOTAL	160 MMCFD	160 MMCFD	160 MMCFD
Pipeline Capacity (life of project):			
Redstone	40 MMCFD	40 MMCFD	40 MMCFD
Western Gas Resources	585 MMCFD	585 MMCFD	585 MMCFD
Thunder Creek	450 MMCFD	450 MMCFD	450 MMCFD
Misc. (wet gas line capacity for CBM gas)	20 MMCFD	20 MMCFD	20 MMCFD
TOTAL	1,095 MMCFD	1,095 MMCFD	1,095 MMCFD

* Compression facilities were estimated based on logical field-wide development plans, and do not vary by alternative. Alternatives are based on differing well numbers considered in this analysis. Compression is designed to handle both the Proposed Action and Alternative 1 activity levels.

Note:
Gas production is measured in cubic feet per day.
MCFD represents 1,000 cubic feet per day; MMCFD represents 1,000,000 (one million) cubic feet per day.
ac = acres; sq mi = square miles; ac-ft/yr = acre-feet per year (1 acre-foot = 325,829 gallons).

once a month. As a result, two-track unimproved roads or trails would be used for access to the majority of CBM wells. In some cases, roads will need to be upgraded to the BLM's minimum standards due to special conditions such as rough topography or stream drainage areas.

The project would develop over time as the Companies implement their various CBM projects. Drilling activity would be concentrated within an estimated five-year to ten-year initial development period. A certain number of wells would be drilled and connected to pipelines each year within portions of the project area. Numerous companies may drill wells during the same given year. Actual well locations will be determined by the success of previous drilling, which determines where CBM can be produced efficiently. Lower numbers of wells being drilled could result from various economic factors that would cause companies to limit activity. A study conducted by the BLM projects an estimated average CBM well life of 12 years (USDI BLM, 1996a).

For the purposes of this analysis, the productive life of a CBM well is estimated to be 12 years. However, the cessation of groundwater pumping may not occur 12 years after a CBM well is drilled. If all wells in a given geographic area are not drilled at the same time, then groundwater may continue to be pumped from wells that are no longer productive in order to continue efficient CBM production from nearby productive wells. Therefore, for the purposes of groundwater and surface water analysis only, the groundwater withdrawal and surface disposal of produced water is estimated to occur over 15 years (on average). The estimated productive life of the project is 12 to 20 years, as the first wells drilled would no longer be productive after 12 years. The last wells drilled during the five-year to ten-year (7.5-year average duration) initial development period would no longer be productive after 20 years.

The Companies propose to develop well fields within the project area for the Wyodak CBM Project EIS, consisting of the following development activities:

- Approximately 3,000 additional productive wells based on an assumed 40-acre well spacing pattern;
- Associated transportation infrastructure, such as roads, pipelines, and utilities;
- An estimated 34 additional field compressor stations (in May 1997, 15 field compressor stations were in use):
- An estimated 147 additional booster compressor stations (in May 1997, 13 booster compressor stations were in use):
- An estimated 5 new pipeline compressor stations (in May 1997, no pipeline compressor stations were in use); and
- Produced water discharge facilities authorized by the State of Wyoming and other agencies, as appropriate, including an estimated 500 to 1,000 additional NPDES discharge points authorized in 167 to 333 NPDES permits.

The Proposed Action would consist of the following components proposed by any lessees or operators (operators), as defined in Onshore Order No. 1 issued under 43 CFR 3164: a) road access for drilling operations; b) drilling operations; c) well production facilities; d) electrical distribution lines; e) power generation; f) production pods; g) pipelines (gas gathering system, produced water

gathering system and discharge facilities, gas delivery system); and h) pipeline compression (**Tables 2-1 and 2-2**).

Road Access for Drilling Operations

Access to drill locations from the existing road network already in place on federal, state, and private lands will be provided primarily by two-track roads traversing over natural terrain along pipeline rights-of-way whenever feasible. Travel on two-track roads would be rescheduled or postponed during infrequent periods of wet weather when vehicular traffic could cause rutting. Well access roads will be maintained in an undisturbed, two-track status, unless road upgrades are needed to alleviate safety concerns or access difficulties. Gravel or scoria may be applied in problem areas. Troublesome areas, such as stream drainage crossings, low water crossings, and rough topography would be upgraded as the need arises. In less rugged terrain, little earthwork is anticipated for well access road construction.

In more rugged terrain, BLM experience to date has shown that construction of a rough well access road to the drill location using cut and fill construction techniques may be necessary an estimated ten percent of the time. Surface disturbance associated with crowning and ditching (normally required by BLM's general policy on design and construction of oil and gas well access roads) would occur only as required for well access roads traversing steeper terrain or rough, broken topography, or in other exceptional site-specific circumstances. Use of cut and fill construction techniques for well access roads may disturb up to 1.8 acres per well located in difficult terrain. Roads not needed for production will be reclaimed, as needed, as soon as practical after the conclusion of drilling. Roads needed for production may be upgraded, as needed, to ensure safe, year-round access. At the conclusion of the project, roads and culverts that improve access to livestock pastures or calving areas, cultivated fields, ranch buildings, or other areas could be left in place with surface owner concurrence. All roads no longer needed will be reclaimed.

Drilling Operations

Typically, drilling operations will be confined within a 100 feet by 100 feet well site area that is not leveled and is not cleared of vegetation. The use of cut and fill construction techniques to level work areas will be limited to areas where the land surface is too steep to allow the drill rig to set up over natural terrain. In areas where limited cuts and fills are necessary, vegetation may be disturbed or removed. Use of cut and fill construction techniques for well sites may be necessary an estimated ten percent of the time and may disturb up to 0.25 acre per well that is located in difficult terrain. Areas disturbed, but not needed for production, will be reclaimed as soon as practical after the conclusion of drilling. At the conclusion of the project, all disturbed areas no longer needed will be reclaimed.

Table 2-2
Acres of Potential Surface Disturbance Associated with Proposed CBM Development

	Proposed Action	Alternative 1	No Action
Potential Short-term Disturbance Only (until facilities completed and reclaimed)			
Drill Sites (during drilling) [a]	825	1,375	550
Water Discharge Pipelines	4,500	7,500	3,000
Pod Gathering Lines to Trunklines	2,910	4,850	1,940
Trunklines to Compressors	2,038	2,038	2,038
TOTAL Potential Short-term Disturbance (acres) *(percentage of area analyzed)*	*10,273* *0.7%*	*15,763* *0.7%*	*7,528* *0.5%*
Potential Long-term Disturbance (during production)			
Well Access Roads & Pipelines (gathering lines including produced water discharge points)	5,400	9,000	3,600
Well Sites for Productive CBM Wells	36	60	24
Production Pod Facilities	75	125	50
New Field Compressor Stations	51	51	51
New Booster Compressor Stations	37	37	37
New Transmission Pipeline Compressor Stations	15	15	15
Improved Roads to Production Pods	900	1,500	600
TOTAL Potential Long-term Disturbance (acres) *(percentage of area analyzed)*	*6,514* *0.4%*	*10,788* *0.5%*	*4,377* *0.3%*
TOTAL POTENTIAL SURFACE DISTURBANCE (acres) [b] **(percentage of area analyzed)**	**16,751** **1.1%**	**26,491** **1.2%**	**11,881** **0.8%**

[a] Up to 10% more new CBM wells may be drilled (drill sites) than are produced (as well sites). Short-term drilling disturbance from unproductive wells is included. Acreage for drill sites (during drilling) encompasses acreage for productive CBM well sites.

[b] Does not include acreage for productive CBM well sites. This acreage already is included under drill sites (during drilling).

Notes:

Potential Surface Disturbance is estimated in acres. (For reference: 43,560 square feet = 1 acre; 640 acres = 1 square mile).

Short-term Disturbance = Disturbance during drilling or installation of facilities, followed by reclamation, up to approximately 3 years.

Long-term Disturbance = Disturbance continuing during the productive life of the project, which would be approximately 12 to 20 years, followed by reclamation.

A mobile drilling rig will be driven to the well site and erected. Typically, a truck-mounted shallow well drilling rig will be used to drill CBM wells. Additional equipment and materials needed for drilling operations, including water, would be trucked to the well site. The proposed project would require approximately 8,000 gallons (or 0.03 acre-feet) of water per well for cement preparation, well stimulation, dust control, and possibly drilling (non-toxic drilling mud is required to handle certain downhole conditions). Drilling mud usually is native mud and bentonite used for fresh water drilling. As hole conditions dictate, small amounts of polymer additives and/or potassium chloride salts may be added for hole cleaning and clay stabilization.

The drill rig typically will be set up over natural terrain. A temporary mud pit approximately six feet deep, ten feet wide, and up to thirty feet long, would be excavated within each well site area, used during drilling and completion operations, and then allowed to dry before being backfilled and reclaimed. The pits will be fenced on three sides during drilling operations, with the fourth side fenced immediately upon rig release. Each producing well would be drilled to a depth of 350 feet to 1,200 feet or deeper, and would have steel casing cemented from the top of the coal seam to the surface. The well control system would be designed to meet the conditions likely to be encountered in the hole and would be in conformance with BLM and State of Wyoming requirements.

The drilling and completion operation for a CBM well normally requires approximately seven to 25 people at a time, including personnel for logging and cementing activities. Each well would be drilled within a period of one to three days. In preparation for production of gas from a drilled, cased, and cemented well, a well completion program may be initiated to stimulate production of gas and to determine gas and water production characteristics. A mobile completion rig similar to the drill rig may be transported to the well site, erected, and used to complete a well. Completion operations are expected to average one to three days per well. Methane may be vented and water temporarily discharged for a very short period of time during testing to determine whether wells will be produced. Once determined to be productive, wells would be shut-in until pipelines and other production facilities are constructed.

Well Production Facilities

If wells are productive, a very small part of each well site, represented by a square area with perhaps five or six feet on each side of the square, will be leveled to install wellhead facilities. A weatherproof covering will be placed over the wellhead facilities. No additional structure will be constructed at the well site for gas-water separation facilities. A downhole pump typically will be utilized to produce water from the uncased open hole interval located below the steel production casing. Methane gas will flow to the surface using the space between the production casing and the water tubing. No pumpjacks will be located at the wellheads. The long-term surface disturbance (12 to 20 years) at each productive well location where no cut and fill construction techniques are utilized is likely to encompass a negligible area, much less than 0.1 acre. The long-term surface disturbance at each productive well location where cut and fill construction techniques are utilized is likely to encompass approximately 40 feet by 80 feet, or approximately 0.1 acre. Well site production facilities typically will not be fenced or otherwise removed from existing uses.

Pipeline trenches for well gathering lines are expected to disturb portions of 40-foot wide corridors temporarily and to be reclaimed as soon as practical after construction is completed. Trenches will be constructed along the two-track well access roads wherever possible. Separate gathering lines, averaging one quarter to one-half mile long each, will be buried in the trenches and will transport methane gas to production pod facilities and produced water to discharge points.

At the conclusion of the project, roads, culverts, cattleguards, pipelines, stock watering facilities, or other structures could be left in place for any beneficial purpose of the surface owner. Electrical service would be available where CBM wellhead or pod production facilities were located, at the landowner's expense. Water wells and produced water would be available to the surface landowner, with appropriations, diversion, and storage rights already properly filed with the WSEO. Ponds and reservoirs would continue to store water if surface owners elect to manage the wells and continue pumping water from them. All federally-owned surfaces that contain disturbed areas or facilities that are no longer needed will be reclaimed. All disturbed areas and facilities that are no longer needed and are located on private land also will be reclaimed, unless landowners elect to manage the wells and continue pumping water from them, or desire to keep the access roads intact.

Electrical Distribution Lines

Electricity would be used to power downhole pumps during well development and to initiate and maintain production. A limited number of newly-constructed, high-voltage distribution lines are anticipated. Electricity will be routed to well sites and ancillary facilities within the transportation corridor. Direct burial cable will be the preferred method of electrification, unless otherwise impractical. Electrical lines connecting the wells and the production pods will be buried in the trenches excavated for well gathering lines. Overhead electrical lines will be installed along the pod access road or in a more suitable location. All overhead electrical lines will utilize raptor protection designs. At the conclusion of the project, overhead distribution systems not owned by the operators may or may not be salvaged. Operators will reclaim areas and facilities no longer needed.

Power Generation

Both natural gas-fired and diesel engine-powered generators may be used on a temporary basis at individual wells until electrical distribution lines are constructed. Either electrical motors or natural gas-fired reciprocating or microturbine engines will power booster or blower units. Future compressors are anticipated to be natural gas-fired or electrical units.

PRODUCTION PODS

Typically, gas production from each well will be individually measured and mechanically or electronically recorded at a central collection point or pod building. The siting of production pods is tied to the siting of CBM wells, which is accomplished site-specifically at the Application for Permit to Drill/Plan of Development (APD/POD) level of analysis. Gas gathering lines for an average of ten wells will be tied together in a production pod, where metering for all the wells in that

pod will be done. At the production pod, gas is commingled into the gas gathering system, which transports it to the compressor station. An improved road, averaging one-half mile in length, will be constructed to each production pod and will disturb an area not expected to be wider than 50 feet. Each production pod facility will disturb approximately 0.25 acre. At the conclusion of the project all disturbed areas and facilities no longer needed will be reclaimed.

Pipelines

Three types of pipelines would be constructed as part of the proposed project:

1. Gas-gathering pipeline systems (low pressure, from wellhead to pod building, and from pod building through trunkline to the compressor station)

2. Produced water-gathering pipeline systems

3. Gas-delivery pipelines (high pressure, from compressor station to existing transmission pipelines)

Reclamation of pipeline corridors will occur as soon as practical after pipeline construction is completed.

Gas-Gathering System

As part of the transportation corridor system linking the wells and ancillary facilities, gas-gathering pipelines and produced water-gathering pipelines would be constructed, placed together in the same trench/ditch, when practical, and buried. Construction and installation of pipelines would occur immediately after well drilling. Access roads typically will follow the pipeline right-of-way, except in a limited number of cases where topography dictates or as surface owners require. Separate gathering lines will transport methane gas to production pod facilities and produced water away from wells to points where water discharge will occur.

Pod gathering lines, averaging two miles long, each are expected to disturb portions of 40-foot wide corridors, and will transport gas from each production pod to a trunkline. Separate trunklines, averaging six miles long each, will disturb portions of 50-foot wide corridors, and will transport gas to compressor stations.

Produced Water-Gathering System and Discharge Facilities

Based on the production characteristics from a composite of approximately 300 CBM production wells located within the project area (PI/Dwight's, 1998), water production is expected to average 12 gallons per minute (gpm) per well. This estimate of water production was compared to updated production characteristics from a composite of 638 CBM wells in the PRB, which average 10.4 gpm of produced water (PI/Dwight's, 1999) and to WOGCC production statistics for May 1999, covering 902 producing CBM wells within the WOGCC's "Wyodak EIS area", which average 12.4 gpm of

produced water (WOGCC, 1999a). For the purposes of this analysis, water production is expected to average 12 gpm per well over the life of the well.

This value will vary within the project area and throughout the life of a well, with increased values occurring in the western portion of the area and at the beginning of a well's life. Water production, on average, would not be expected to exceed an estimated of 0.05 ac-ft/day/well (17,280 gallons/day/well). As anticipated development expands toward the western portions of the project area and deeper coal beds under greater pressures are developed, water production from CBM wells likely will increase and exceed the average water production for the project. Water production may decrease with time. The approximate productive life for each CBM well is 12 years (USDI BLM, 1996a). Produced water contains an average (mean value) of 764 mg/l Total Dissolved Solids (TDS) based on WDEQ discharge monitoring report data from 577 CBM effluent (discharge) samples taken within the project area and reported to WDEQ between 12/31/93 and 12/31/97 (WDEQ, 1998a).

Produced water may be discharged from individual wells or collected and discharged at a multi-well central point. All produced water would be discharged only at NPDES permitted points. Produced water-gathering pipelines would be constructed along the well access road wherever feasible, from the wellhead to locations where water discharge will occur. These gravity-fed water lines would be placed together in the same trench/ditch as gas gathering lines wherever practical, and buried.

Produced water is expected to be discharged into surface drainages from pipelines that average one half mile in length and disturb portions of 30-foot wide corridors. Some discharged waters may be contained near the discharge point in small impoundments. Produced water is expected to average 12 gpm throughout a 12-year (previously estimated by BLM) to 15-year (possible) production life for each CBM well. Operators will be asked to develop water management plans where multi-well projects are planned. These plans will address how large volumes of produced water would be managed on a drainage-by-drainage basis.

There is likely to be an average of one water discharge point per three to six CBM wells. Several discharge points may be combined into each NPDES permit within the project area.

Gas Delivery System

High-pressure gas delivery lines connecting compressor stations with existing transmission pipelines are expected to be located along existing roads. Disturbance related to these delivery lines is expected to be confined to areas not wider than 40 feet, located within rights-of-way already established.

The pipeline capacity for the life of the project is estimated to be 1,095 million cubic feet per day (MMCFD). As the existing capacity (160 MMCFD as of the end of 1998) of pipelines already in place is reached, the least productive wells are likely to be taken off line until additional pipeline capacity is available. Production must be established before potential additional pipeline locations can be identified for site-specific environmental analysis. Existing and proposed high- pressure gas delivery lines are shown on **Map 2-1**.

Development will be constrained by the pipeline capacity available to transport compressed gas to markets. The total gas production for the number of CBM wells projected exceeds the existing pipeline capacity. As producing areas are depleted, compressors are likely to be removed and relocated to productive areas. Up to 11.4 MMCFD of gas may be utilized locally to generate electricity if the Two Elk Power Plant is constructed. The Two Elk Power Plant also may utilize some CBM produced water in its operations.

Pipeline Compression

Produced natural gas (methane) under wellhead pressure would move through the low pressure gas gathering system to a compressor station. Typical gathering system line pressure is less than 100 pounds per square inch (psi). Gas arriving at the compressor station would be compressed from line pressure to facilitate transport and introduction of the gas into an existing transmission pipeline.

The use of low horsepower (HP) (380 HP) natural gas or electric-powered boosters or blowers may be required to enhance gas flow through certain pipelines. Individual booster compressors may be located at some production pods. As of the end of 1998, 13 booster compressors were in use within the project area. The Proposed Action will require approximately 220 additional booster compressors. An additional 0.25 acre would be disturbed at each production pod where a booster compressor station is co-located with production pod facilities.

Compression of the gas at field compressor station would increase the pressure to an estimated 700 to 1,450 psi. In May 1997, 15 natural gas-fired compressor stations, containing 39 1500-HP engines and five 1000-HP engines were in use within the project area. The Proposed Action will require an estimated 34 additional field compressor stations, containing 56 additional compressors. It is anticipated that 1,500-HP and 1,000-HP natural gas-fired engines would drive 43 and 13 new compressors, respectively. One existing field compressor station ultimately is expected to contain six 1,000-HP engines and to produce a long-term disturbance of 20 acres. The remaining 48 field compressor stations each would support one to four 1,500-HP or one to six 1000-HP engines and each station would disturb approximately 1.5 acres. The Proposed Action also will require five new transmission pipeline compressor stations, which would contain a total of 18 1500-HP engines; each station would disturb approximately 3 acres. All compressors are expected to be housed within structures. Most compressor stations are expected to be built along existing roads and are not expected to require any new roads or improvements to existing roads.

Anticipated Level of Activity and Project Life

The total project life, including production, is expected to be 12 to 20 years. The estimated initial development period (drilling phase) is 5 to 10 years. APDs for federal wells would be approved by the BLM. Twenty companies, on average, may have CBM development projects operating concurrently within the project area during the initial development period. Approximately 50 to 400 wells per year may be drilled by each Company. The minimum number of drilling rigs required to drill 400 wells annually would be twelve drilling rigs conducting drilling or completion operations concurrently for an estimated 200 to 300 days within a calendar year (the estimated period when

weather and soil conditions are suitable for access to the well location and drilling or well completion operations). It is likely that the Companies would utilize, on average, an estimated 25 drilling rigs to allow for poor weather conditions, mechanical problems, and scheduling concerns.

Hydrologic Monitoring and Mitigation

An integral part of the Proposed Action is the hydrologic monitoring that detects impacts on other water users and provides data for control and operation of the Companies' CBM projects. Monitoring plans administered by the State of Wyoming and the BLM will address the following: objectives; standards; procedures; timeframes; data management; and groundwater and surface water monitoring.

Plans would address the following:

- Monitoring required under the terms of NPDES discharge permits issued by the WDEQ, APDs approved by the WOGCC or surface management agency (BLM or FS), groundwater or surface water appropriation permits approved by the WSEO, and on-location pit permits approved by the WOGCC;
- Requirements for reporting on surface flows encountered during drilling to WOGCC; and
- Requirements contained in any executed Water Well Agreement.

Plans for hydrologic monitoring and mitigation would be re-evaluated periodically by the authorizing agencies in collaboration with the BLM, other involved surface management agencies, WDEQ, WSEO, WOGCC, CBM operators, landowners, coal operators, and other downstream interests.

Whether production of methane occurs by encountering free gas trapped in the coal seam or by pumping water to reduce pressure and induce gas flow, it is possible that nearby water wells completed in the coal could experience a decline in hydraulic head (for example, an increase in the depth to the static water level in the well bore). If the decline in head were a significant part of the total available head at a particular water well, then that water well likely would experience a reduction in its capacity to deliver water (yield) and possibly an increase in the concentration of methane.

Monitoring has been occurring in the Gillette North CBM Project EA and Gillette South CBM Project EIS assessment areas to validate predicted impacts and to identify needed mitigation. This monitoring would be continued and expanded to cover the Wyodak CBM EIS assessment area. The Water Well Agreement, previously worked out by landowners and CBM operators as part of the Gillette North CBM Project EA and Gillette South CBM Project EIS, will be required to be offered to affected surface owners before federal APD's will be approved. BLM will continue to suggest that operators also make this agreement available to surface owners when developing private- and state-owned minerals. A copy of this agreement is contained in Appendix D of the DEIS.

A water well agreement format was developed by a working group of affected landowners and industry representatives (USDI BLM, 1997a). The BLM is not a party to this agreement. The BLM

requires that CBM operators on federal leases offer this agreement to affected landowners. The Water Well Agreement between a CBM operator and an affected landowner addresses monitoring of any properly-permitted water well that falls within the Circle of Influence (COI) of a CBM production well. This COI is defined as a one-half mile radius around a CBM well. The Water Well Agreement also addresses how the COI would be expanded, should there be interference with a water well within the COI. If no water well falls within the initial COI, the COI would be expanded to the next nearest water well. If wells within the COI are impaired by CBM activities, they can be mitigated by reconfiguring, redrilling, installing a new well, or by other means.

If landowners do not accept the Water Well Agreement, a second option for water well mitigation will be used. This would be mitigation of CBM impacts in accordance with state water law. This would occur if a determination showed CBM development to be interfering with historic permitted usage of water. Neither well yields or water levels are guaranteed by a water right. Mitigation under state law would be developed on a case-by-case basis, in consultation with the WSEO, the affected landowner, the operator, and the BLM. Possible ways in which mitigation could be accomplished at the cost of the operator are: temporary replacement with commercially-purchased water or water produced by the operator, or reimbursement to a well owner for increased pumping costs associated with a greater lift. Permanent replacement would be accomplished by drilling a replacement well.

Through the independent groundwater monitoring program being carried out by the BLM and the WSEO, information on lowered water levels (drawdown of the static water levels in wells completed within the coal seam) and on the status of the sand aquifers is being obtained and tracked. This information will enable the BLM and the WSEO to evaluate impacts. This information could be greatly supplemented if all monitoring information being gathered by operators were brought into one common database. The coal operators are carrying out this type of activity under the direction of the Gillette Area Groundwater Monitoring Organization (GAGMO).

The Gillette North EA and the Gillette South EIS contained requirements that the CBM operators form a group, Power River Area Groundwater Monitoring Organization (PRAGMO), that would be similar to the coal operators' GAGMO group. This group was formed because impacts to the groundwater were of the highest concern in the respective project areas. The purpose of the group was to provide a common reporting method and data base of their monitoring results. The data this group was to gather was to be compiled, interpreted and furnished to the BLM and the WSEO along with a yearly combined drawdown map of the results of their CBM activity. Their comprehensive, un-interpreted data also was to be furnished to the agencies.

Because of the confidential nature of some of the data and the intense competition among companies in the coal bed methane play, the sharing of information which was required has met with considerable resistance from industry.

As an alternative to the PRAGMO group, the Methane Operators Group has proposed that industry would be willing to drill and equip up to two well pairs or triples per township in the project area. This would allow the BLM and the WSEO to maintain an independent monitoring network that would provide a more accurate depiction of the actual drawdown that is occurring area-wide. These dedicated wells would not be influenced directly by pumping, as are the CBM production wells from which operators are getting their information.

Specific Monitoring Activities

Groundwater

In lieu of the PRAGMO requirement described in the DEIS, the following will be required from the appropriate CBM operator(s):

< Baseline static water levels, production capacity and methane concentrations for all properly permitted wells within the COI as defined by the Water Well Agreement, in Appendix D of the DEIS. Data is to be furnished to the BLM and WSEO in an electronic format.

< Monthly reports containing the following information for each CBM well will be submitted to the WOGCC: a) well name, water well permit number, API number, and location; b) reporting dates, name of individual responsible for report, and method of measurement; c) total volumes of water and gas produced during the reporting period and cumulatively since reporting began; and d) remarks or comments regarding data acquisition. The WOGCC will forward these monthly reports to the WSEO and the BLM in an electronic format.

< Monitoring of produced water discharges as required by WDEQ for NPDES permits. Report is to be furnished to the WDEQ and the BLM.
< Water quality analyses for surface flows encountered during drilling as required by WOGCC.

< Drilling, completion, and equipping, to BLM specifications, of additional (up to two sites per township) paired or tripled dedicated monitor wells by industry. Wells are to be operated by BLM and/or WSEO.

< Depending on available agency funding, possible additional financial support for data collection and support in compiling and interpreting the data.

The following monitoring would be continued by the BLM as a result of the Marquiss, Lighthouse, and Gillette North and Gillette South CBM projects to provide independent verification of hydrologic activities. Depending on federal budget availability, it may become necessary for the CBM operators to pay for some or all of this monitoring through cost reimbursement.

The BLM would conduct continuous monitoring of groundwater levels and gas pressure of selected wells completed in the coal and periodic (one to two months) measurement of methane concentrations at these wells. Several of these monitoring sites could include additional well(s) near the coal well completed in the next shallower sand(s) above the coal. Some of the well sets would include a coal completion well and a well completed in the next sand below the coal. If adequate existing wells are available, they may be substituted for some of the wells described in this analysis (or possibly added to the network). Additional wells would be required with the new development proposed in this EIS. The monitoring well schedule and final location of monitoring wells ultimately would be a function of the final CBM development scenario and schedule. The BLM would conduct the following sampling:

< Periodic (one or two times per year) monitoring of additional water wells that operators are not monitoring, located farther from the project area.

< Water quality sampling from selected monitoring wells on a semi-annual basis, analyzed for the constituents shown in **Table 2-3**.

Additional Monitoring Wells

In coordination with the WSEO, an adequate number of monitoring wells would be added to the existing monitoring wells that were established previously as part of the Gillette North CBM Project EA and Gillette South CBM Project EIS assessment and decision process (**Table 2-4**). Installation of the monitoring wells required under the Gillette South EIS and Gillette North EA progressed in 1998 with the addition of one new well pair and the finalization of one ongoing completion. The WSEO completed five monitoring locations (4 paired) and plans on completing a fifth pair in 1999. With the addition of these wells, there are a few locations where the BLM is waiting on the completion of required wells (**Table 2-5**). This would satisfy BLM's immediate

Table 2-3
Required Constituents for Water Quality Sampling from Monitoring Wells

Parameter	Unit
Total Petroleum Hydrocarbons (TPH)	mg/l
pH	Standard Units
Total Dissolved Solids (TDS)	mg/l
Specific Conductance	µmhos/cm
Chlorides	mg/l
Sulfates	mg/l
Radium-226	pCi/l
Aluminum*	µg/l
Total Antimony	µg/l
Total Arsenic	µg/l
Total Barium	µg/l
Total Beryllium	µg/l
Cadmium*	µg/l
Chromium*	µg/l
Copper*	µg/l
Cyanide (total)	µg/l
Total Iron	µg/l
Lead*	µg/l
Total Manganese	µg/l
Mercury*	µg/l

Table 2-3
Required Constituents for Water Quality Sampling from Monitoring Wells

Parameter	Unit
Nickel	µg/l
Phenol	µg/l
Selenium*	µg/l
Silver*	µg/l
Total Thallium	µg/l
Zinc*	µg/l
Hardness	mg/l as $CaCO_3$

Notes:
µmhos/cm = thousandths of unit of conductance per centimeter (2.54 centimeters = 1 inch)
mg/l = milligram per liter (1 mg = 1 ppm [part per million]; 1 liter = 0.264 gallons)
µg/l = microgram per liter (1 µg = one thousandth of a milligram or 0.001 mg or 1 ppb [part per billion])
* Refers to the acid soluble portion which is derived as the fraction that passes through a 0.45 µm membrane filter after the sample is acidified to a pH of 1.5 - 2.0 with nitric acid.

Table 2-4
Completed CBM Monitor Wells

Approximate Well Location	Target Zone of Completion	Comments
T53N R73W S21	COAL	Existing well Hall #33-2633
T53N R73W S21	OVERBURDEN SAND	Sand well of well pair.
T49N R73W S3	COAL	WSEO CBM MON #2
T49N R73W S3	OVERBURDEN SAND	WSEO CBM MON #2W
T49N R74W S36	COAL	WSEO CBM MON #1
T49N R77W S1	COAL	Gilmore O&G well acquired 3-98, plugged back and recompleted
T48N R73W S36	COAL	WSEO CBM MON #3
T48N R73W S36	OVERBURDEN SAND	WSEO CBM MON #3W
T48N R72W S22	COAL	Coal well of a set of wells completed for the Marquiss project.
T48N R72W S22	OVERBURDEN SAND	Overburden sand well of a set of wells completed for the Marquiss project.
T48N R72W S22	SHALLOW CONFINED SAND	Additional (shallower) overburden sand completed at this location to evaluate vertical leakage.
T48N R72W S22	UNCONFINED SAND	Unconfined (shallowest saturated) sand completed at this location to evaluate vertical leakage and recharge.
T48N R77W S12	COAL	Arco Federal 12-2. Drilled out bridge plug, plugged back and recompleted. (SASQUATCH)
T47N R71W S19	COAL	Existing (Cordero well).
T47N R72W S2	COAL	Coal well of a set of wells completed for the Marquiss project.
T47N R72W S2	OVERBURDEN SAND	Overburden sand well of a set of wells completed for the Marquiss project.
T47N R72W S7	COAL	Hoe Creek DOE project.
T47N R72W S7	OVERBURDEN SAND	Hoe Creek DOE project.
T47N R72W S36	COAL	Existing (Amoco well).
T47N R73W S16	COAL	WSEO CBM MON #4
T47N R73W S16	OVERBURDEN SAND	WSEO CBM MON #4W
T46N R72W S6	COAL	Existing (Cordero well).
T46N R72W S25	COAL	Coal well of well pair
T46N R72W S25	OVERBURDEN SAND	Sand well of well pair
T46N R74W S16	OVERBURDEN SAND	Sand well of well pair
T45N R71W S6	COAL	Coal well of well pair
T45N R71W S6	OVERBURDEN SAND	Sand well of well pair
T45N R73W S1	COAL	Coal completion in a dual completion well.
T45N R73W S1	OVERBURDEN SAND	Sand completion in a dual completion well.

Table 2-4
Completed CBM Monitor Wells

Approximate Well Location	Target Zone of Completion	Comments
T45N R74W S36	COAL	WSEO CBM MON #6
T45N R75W S31	COAL	Shogrin Federal #2 acquired from Exxon 11-96.
T44N R71W S31	COAL	Coal well of three well set
T44N R71W S31	OVERBURDEN SAND	Overburden sand well of three well set
T44N R71W S31	UNDERBURDEN SAND	Underburden sand well of three well set
T44N R72W S14	COAL	Coal well of well pair
T44N R72W S14	OVERBURDEN SAND	Sand well of well pair
T43N R71W S31	COAL	Coal well of well pair
T43N R71W S31	OVERBURDEN SAND	Sand well of well pair
T42N R72W S36	COAL	Bowers 4-36

Table 2-5
Proposed CBM Monitor Wells

Approximate Well Location	Target Zone of Completion	Comments
T54N R74W S4,5	COAL	Coal 1 of well set (3 wells total)
T54N R74W S4,5	COAL	Coal 2 of well set (3 wells total)
T54N R74W S4,5	OVERBURDEN SAND	Sand well of 3 well set
T46N R74W S16	COAL	WSEO CBM MON #5
T46N R74W S16	OVERBURDEN SAND	Sand well of well pair

needs for monitoring wells under these two plans. The BLM still will need additional monitor wells for development outside these assessment areas to meet the needs of determining area-wide drawdowns. Well locations in areas north, west and south of the existing Gillette North CBM Project EA and Gillette South CBM Project EIS assessment areas (**Map 1-1**) are anticipated. The groundwater modeling used to analyze CBM development in this EIS would be used to determine specific well locations. Following is a list of general areas where additional monitoring information is needed:

- Areas north of T54N
- Areas west of R76W
- Areas south of T41N
- Areas west of R75W and north of T53N
- Areas west of R75W and south of T47N

Cost Share on Wells to be Monitored by BLM

Where suitable wells do not exist for monitoring, operators would be required to obtain access, permit, drill, and properly complete wells (including PVC casing, stainless steel screen where appropriate, sand pack where appropriate, logging, and cementing) where necessary, in relation to their projects. In addition, operators would provide and install necessary support facilities (shelter and fence) and would be responsible for the cost of the monitoring equipment as specified by the BLM. The BLM would provide requirements for instrumentation and equipment and would provide labor to monitor the wells.

Implementation of Monitoring

The monitoring well schedule and final locations ultimately would be a function of the CBM development scenario and schedule. If necessary, monitoring wells will be added as conditions of approval for APDs/PODs.

Surface Water

The following would be required of the operators:

< Monitoring of produced water discharges as required by WDEQ for NPDES permits. Report is to be furnished to the WDEQ and the BLM.

< Monitoring of volume of produced water being discharged to the surface as required by the WSEO under Conditions and Limitations specified in each groundwater permit, by the WDEQ under the terms specified in each NPDES permit, and as required by the WOGCC for surface flows encountered during drilling. If the State of Wyoming modifies its CBM reporting requirements, then the revised requirements would apply here.

< Additional surface water stations may be needed on the Little Powder, Powder, Belle Fourche, and Cheyenne Rivers and/or their tributaries. This will depend on the location of discharge points, availability of existing data, and magnitude of the projected impact. The cost of this monitoring would be shared by the BLM and the CBM operators. With the projected budgets, it is anticipated that the operators would have to be responsible for most of this cost.

The following would be conducted by the BLM:

< Operation of a surface water gauging station on the Belle Fourche River and additional stations, as necessary, downstream of the area to be affected by surface discharge of produced water from the project area. In addition, the Cordero-Rojo Mine complex currently is operating a station on Caballo Creek.

< Periodic sampling of water quality would be done at project area discharge points and other locations and analyzed as shown in **Table 2-3**.
< Selected channels receiving produced water would be monitored for signs of accelerated erosion and degradation.

At the BLM operated station(s), stream flow, water temperature, and electrical conductivity of the water would be continuously recorded. In addition, periodic manually collected samples would be analyzed for the constituents listed in **Table 2-3** with the addition of total suspended sediments (TSS).

ALTERNATIVE 1 (PREFERRED ALTERNATIVE)

Alternative 1 to the Proposed Action consists of drilling, completing, operating, and reclaiming approximately 5,000 new productive CBM wells and related production facilities in an expanded project area that includes all of the Proposed Action's project area (**Map 2-1**). This well total would be 2,000 wells more than the 3,000 wells planned under the Proposed Action. Up to 2,500 of the proposed 5,000 wells would be located on lands where CBM rights are owned by the federal government. The fee and state wells included in Alternative 1 are connected actions to the proposed

federal wells. This alternative was developed by BLM in response to expressions of interest in CBM development within additional townships extending north of the northern boundary of the Proposed Action and additional townships located along the western boundary of the Proposed Action. The area covered by Alternative 1 would total approximately 3,600 square miles (2,317,000 acres).

The overall approach and technical procedures for CBM development under Alternative 1 would be the same as described previously for the Proposed Action. Alternative 1 also would consist of those components described in detail for the proposed Action: a) road access for drilling operations; b) drilling operations; c) well production facilities; d) electrical distribution lines; e) power generation; f) production pods; g) pipelines (gas gathering system, produced water gathering system and discharge facilities, gas delivery system); and h) pipeline compression. Because the extent of development under Alternative 1 would be greater than the Proposed Action, the extent of activity and disturbance would be proportionally increased, with the exception of gas compression.

Comparable quantities of compression facilities would be anticipated under the Proposed Action, Alternative 1, and the No Action alternative, as the Companies' field-wide plans for orderly development of CBM resources in the PRB are initiated. The Companies' field-wide compression plans, currently under development, are not constrained by the scope of this EIS analysis and the number of productive wells under consideration here. The compression facilities that would adequately handle the gas volumes anticipated as CBM development continues were estimated in **Table 2-1**. Potential surface disturbance associated with CBM development under Alternative 1 is shown in **Table 2-2**.

Anticipated Level of Activity and Project Life

The estimated productive life of the project is 12 to 17 years, as the first wells drilled would no longer by productive after 12 years. The last wells drilled at the end of a five-year initial development period would no longer be productive after 17 years. The estimated project life of the drilling phase is 3 to 5 years. APDs for federal wells would be approved by BLM. Twenty companies may have CBM development projects operating concurrently within the expanded project area. Approximately 50 to 400 wells per year may be drilled by each company. The minimum number of drilling rigs required to drill 800 to 1,000 wells annually would be 24 rigs conducting drilling or completion operations concurrently for an estimated 200 to 300 days within a calendar year (the estimated period when weather and soil conditions are suitable for access to the well location and drilling or well completion operations). It is likely that the Companies would utilize an estimated 50 drilling rigs to allow for poor weather conditions, mechanical problems, and scheduling concerns.

The hydrologic monitoring and mitigation and prescribed activities defined for the Proposed Action also would be implemented under Alternative 1. The offer of the Water Well Agreement (Appendix D of the DEIS) to affected surface owners would be required before federal APD's would be approved.

NO ACTION ALTERNATIVE

CBM production would be established from an estimated 2,000 coal bed methane wells drilled within the project area, excluding lands with federal CBM ownership. There would be no federal action involving federal CBM wells within the project area that do not address the potential drainage of federally-owned CBM resources. Construction and operation of compressors would be required to move gas to the transmission pipelines. Drilling would occur over a five year period with potentially productive non-federal wells being added each year.

These wells would be drilled anywhere within the project area evaluated under the Proposed Action (2,400 square miles), but only on lands where the CBM mineral estate is not federally owned. Approximately 50 percent of the project area (1,200 square miles) contains lands with federal oil and gas ownership. The remaining 1,200 square miles (approximately) of the project area would be available for drilling under the No Action Alternative. The average well density for new non-federal wells that are likely to be drilled under the No Action Alternative is estimated to be 0.8 well per square mile. Additional information is contained in **Table 2-1**.

Federal surface lands administered by the BLM or FS would not be expected to be affected by disturbance related to CBM drilling, since CBM drilling on lands where the oil and gas estate is federally owned would not be allowed under the No Action Alternative unless potential drainage of federal CBM resources were identified by BLM. Some federally-administered lands may be affected by disturbance related to installation of production facilities or pipelines for private wells drilled under the No Action Alternative. The nature of the disturbance would be similar to the disturbance proposed under the Proposed Action and Alternative 1 (**Table 2-2**).

The No Action Alternative is defined as the rejection of all applications for federal wells that do not involve potential drainage of federally-owned CBM resources. The CEQ regulations at 40 CFR 1501.14(d) require that alternatives analysis in the EIS "include the alternative of no action." The Secretary of the Interior's authority to implement a No Action Alternative is limited. Following is an explanation of this limitation and the discretion the Department has in this regard.

An oil and gas lease grants the lessee the "right and privilege to drill for, mine, extract, remove and dispose of all oil and gas deposits" in the leased lands, subject to the terms and conditions incorporated in the federal lease. Because the Secretary of the Interior has the authority and responsibility to protect the environment within federal oil and gas leases, restrictions are imposed on the lease terms.

Leases within the project area for the Wyodak CBM Project EIS contain various stipulations concerning surface disturbance, surface occupancy, and limited surface use. In addition, the lease stipulations provide that the authorized representative of the Department of the Interior may impose "such reasonable conditions, not inconsistent with the purposes for which the lease is issued, as the BLM may require to protect the leased lands and environment." None of the stipulations imposed would empower the Secretary of the Interior to deny all drilling activity because of environmental concerns where leases have been issued with surface occupancy rights.

Provisions that expressly provide Secretarial authority to deny or restrict lease development in whole or in part would depend on an opinion provided by the U.S. Fish and Wildlife Service (USFWS) regarding impacts to endangered or threatened species or habitats of species that are listed or proposed for listing (for example, bald eagle). If the USFWS concludes that the Proposed Action and alternatives would likely jeopardize the continued existence of any endangered or threatened plant or animal species, then CBM development, including APD(s) and related Sundry Notices, may be denied in whole or in part on the affected federal leases.

Regardless of development of federal minerals, development would likely proceed on private and state leases. Under these conditions, the No Action Alternative would likely consist of drilling, completing, and operating as many as 2,000 additional productive wells, 1,000 fewer wells than the Proposed Action, in the eastern PRB. The additional wells would be not be located within the federal CBM mineral estate; wells would be located only on lands having private or state CBM mineral ownership. As development of the private and state-owned CBM mineral estate is not subject to federal approval or the NEPA process, no boundary can be assigned for activities occurring on non-federal mineral estate. For the purpose of comparative analysis, the estimated 2,000 additional wells developing private and state minerals would be located within the Proposed Action project area boundary (**Map 2-1** and **Tables 2-1** and **2-2**).

ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

A number of additional alternatives to the Proposed Action were considered for the Wyodak CBM Project but were not carried through the full analysis in this EIS for various reasons. These alternatives and the reasons they were not considered to be feasible are listed below.

Restrict Timing on Approval of Federal Wells

This alternative considered slowing the rate of approval for the estimated 1,500 federal wells included in the Proposed Action. It was not analyzed in detail because there is enough flexibility in implementing the Proposed Action to regulate the timing of approval for the estimated 1,500 federal wells. The decision to approve each well is based on the site-specific analysis completed for each APD. The rate at which federal wells are approved could be slowed down, but the mix of mineral ownership in the project area would lead to proportionally more wells being drilled on private and state leases to make up for the reduced number of federal wells approved. This could lead to drainage of gas from the federal CBM mineral estate.

Reduce the Number of Federal Wells Approved

This alternative considered the drilling of fewer than 1,500 federal wells. It was not analyzed in detail because there is enough flexibility in the implementation of the Proposed Action to approve fewer than 1,500 federal wells. Approving fewer than 1,500 federal wells could lead to drainage of federal gas as discussed above. The decision to approve each well is based on the site-specific analysis completed for that well's APD.

Inject Produced Water Underground

Underground injection to dispose of the produced water was considered as an alternative. Produced water from existing projects has been of relatively good quality. Total Dissolved Solids (TDS) levels have averaged 764 mg/l TDS for CBM water discharges reported to WDEQ (WDEQ, 1998a), well within Wyoming standards for livestock water. However, underground injection of produced water currently is being researched as a disposal and/or aquifer enhancement option, but is not a viable alternative at present.

Disposal of produced water in Wyoming currently is limited to aquifers exempt from the definition of fresh and potable water (WOGCC, 1998b). Injection of this water into an exempt formation, as allowed under current regulations, potentially would make water now suitable for irrigation and livestock unusable for any future use. This action would mitigate potential surface water impacts but would create additional potential groundwater impacts.

Injection requires that the receiving formation be capable of accepting the quantity of water being injected. Injection of CBM produced water into the Wasatch Formation above the coal seam has not been tested. Injection into aquifers within the Tullock Member of the lower Ft. Union Formation has been studied by the City of Gillette with encouraging results. Injection into the coal seam would defeat the purpose of removing water from the coal seam to produce methane. Also, injection would require a system of wells and pipelines that would increase the total surface disturbance. Finally, because the produced water is suitable for livestock, wildlife, and possibly irrigation, surface disposal allows it to be put to subsequent beneficial uses.

PROGRAMMATIC MITIGATION PLAN COMMON TO THE PROPOSED ACTION AND TO ALTERNATIVE 1 (PREFERRED ALTERNATIVE)

Mitigating measures that would be required on federal minerals, if applicable site-specifically, at the APD/POD level of analysis under the Proposed Action and Alternative 1 are compiled below as a programmatic mitigation plan for CBM development. These mitigating measures also are described in various sections of Chapter 4 of the DEIS, where they are incorporated within the resource impact analyses. Requirements that are Standard Conditions of Approval for CBM APDs are described in **Appendix B**.

Geology and Minerals

- Methane will be controlled through APD conditions of approval that address well control, casing, ventilation, and plugging procedures appropriate to site-specific CBM development plans.

Surface Water

Mitigation measures in the form of water management plans will be developed and applied as a cooperative effort at the APD/POD level of analysis, on a site-specific basis or under a Plan of

Development (POD) on a project-level basis (**Appendix B**). This effort will include the agencies with jurisdiction (the BLM, FS, COE, WSEO, WOGCC and/or WDEQ) in consultation with the involved land managers and conservation districts, operators, landowners, and nearby downstream interests, including users of waters and landowners affected by impacts of increased flows on access, ranching, or mining operations. The cooperative efforts of all stakeholders will be necessary in developing water management plans that identify mitigating measures for areas or drainages where high CBM generated flows are or could be impacting existing uses. Some of the measures that could be applied at each site include:

- Produced water may be dispersed in the upper reaches of drainages through the installation of stock tanks.

- Produced water may be transported to distant discharge points, which could require the use of water disposal pipelines that are more than one-half mile long.

- Produced water will be discharged into existing stream channels, reservoirs, stock ponds, and stock tanks in a manner that will not cause increased or accelerated erosion. This has been done effectively in past CBM projects by using energy dissipaters at discharge points and by discharging into channels that are well developed and large enough to handle the increased flows. Energy dissipation can be achieved through the use of rock, placement of concrete control structures and/or the establishment of hydrophytic vegetation.

- Discharge points will be located to minimize spring flooding of fields.
- Discharge outfalls may use alternative outfalls for use with irrigation, as agreed upon by operator and landowner or lessee.

- To handle total flows with the addition of CBM produced waters, existing downstream culverts on lease will be replaced should flows exceed culvert capacity. New culverts and/or low water crossings will need to be sized considering total flows. Off lease, it is recommended that the operator work with other operators and with surface owners in the same drainage to replace downstream undersized culverts that would be affected by their discharge.

- Discharges will be limited to a volume less than or equal to the naturally occurring mean annual peak flow (which is roughly equivalent to a peak generated by a 2-year, 24-hour storm) and which can be handled by the natural channel under anticipated conditions.

- Local springs will be identified, and construction will be avoided in these areas.

- Discharge into playas will be avoided unless issues related to potential wetland creation, maintenance of discharge facilities, reclamation, and accountability are agreed upon by the operator and landowner or lessee.

- Discharge points will be selected in stable channels or reservoirs away from any significant downstream headcuts or other major erosional features. Outfall design may include discharge

aprons and downstream stabilization of channel side slopes to prevent erosion and provide energy dissipation.

- Discharge facilities will be designed site-specifically using best management practices, to accommodate livestock access to water, to control erosion, and to limit sedimentation.

- Irrigation diversions to increase channel length and in-stream impoundments will be established, as appropriate, and as agreed upon by the operator and landowner or lessee.

- Downstream impoundments may need new or redesigned outlet works in order to handle the steady inflow provided by CBM discharge water.

- As per State of Wyoming effluent limitations and monitoring requirements contained in approved permits, and BLM or FS monitoring requirements contained in approved monitoring plans, volume and water quality parameters will be monitored at discharge sites by CBM producers. Monitoring also will occur at selected stations or downstream points of compliance on the Little Powder, Powder, Belle Fourche and Cheyenne Rivers and/or their tributaries.

- The areal extent of surface disturbance and the length of time that the area will remain disturbed before interim or final reclamation activities commence will be minimized.

- Interim and final reclamation of all disturbed areas will proceed in a timely manner. Reclamation activities will be conducted during time frames established by federal land management agencies, landowners and affected interests.

- Reclamation must produce a natural appearance and must be consistent with site conditions, area management standards, and projected uses, as agreed upon by the operator, landowner or lessee, and appropriate state and federal agencies.

- Reclamation will include, as appropriate, recontouring, establishment of desirable, perennial vegetation, stabilization and erosion control of all disturbed areas. Additional measures, such as topsoil conservation, temporary fencing, mulching, or weed control will be utilized, as appropriate, to ensure long-term vegetative stabilization of all disturbed areas. Reclamation standards will be agreed upon by the operator, landowner or lessee, and appropriate state and federal agencies.

- A water management plan must accompany each plan of development for federal wells and must address all potential CBM development in a watershed area, regardless of surface and mineral ownership **(Appendix B)**.

- At the discretion of the surface owner, dams can be removed and the impoundment area reclaimed after the produced water is no longer available.

- Design and siting of discharge facilities must be carefully controlled or limited where channels are not stable, armored, or large enough to accommodate the flows that would be anticipated.

- Design and location of discharge points must be carefully controlled or limited or localized flooding may occur with increased frequency and magnitude where channel or basin capacity is insufficient to handle increased flows.

- Potential impacts to spring flow, specially those related to scoria aquifers like the one feeding Moyer Springs, can be analyzed site-specifically, as needed, during review of APDs/PODs or Sundry Notices, and impacts mitigated through the application of special conditions of approval for drilling or production operations.

- The quality of discharged waters can be protected through the application of special conditions of approval that provide for the careful location and design of discharge facilities in the vicinity of improved water bodies.

- The feasibility of designing surface water discharge facilities that could prevent increased sediment loads from reaching the affected segments of the Belle Fourche drainage having curtailed beneficial uses will be analyzed site-specifically.

- Timely recontouring and revegetation of disturbed areas can be required to limit runoff from disturbed areas that could cause sediment concentrations in surface waters to rise over present levels.

- Additional surface water monitoring sites will be established in order to collect information related to surface water characteristics, flow regimes, substrates, and aquatic habitats. Monitoring related to specific habitats, such as those of the sturgeon chub, will be incorporated within monitoring plans at the site-specific APD/POD level of analysis where suitable existing habitat may be affected by CBM activities.

Groundwater

- A standard agreement has been developed by CBM operators and landowners to monitor and mitigate water well impacts caused by CBM operations.

Air Quality

- Air quality issues related to stationary sources of air pollution will be addressed in accordance with the authorities of the WDEQ. Air quality issues related to mobile sources of air pollution will be addressed in accordance with the authorities of the EPA. Visibility impairment within federally mandated Class I areas will be addressed in accordance with federal regulations on regional haze. Visibility impairment at other Class I and sensitive Class II areas will be addressed accordance with the recommendations from interagency and stakeholder coordinating groups.

- At the discretion of the surface owner, and in accordance with permitting decisions made by the WDEQ, compressors and compressor stations should be sited to avoid sensitive surface resources and potential conflicts with other uses.

- Under the regulatory authority of the WDEQ and at the discretion of the landowner and the CBM operator, the implementation cost and effectiveness of electrification of compressors and other BACT will be considered.

Soils

- Accelerated soil loss will be minimized by limiting the following: the removal of vegetation; the leveling of work areas; and the location of wells on slopes that require cuts-and-fills for well pad construction.

- Timely initiation of reclamation and revegetation efforts will be required to effectively and immediately control accelerated soil loss due to either wind or water erosion.

- Road construction that requires cuts-and-fills will be minimized. Pipeline construction also will avoid steeper slopes where possible. Where necessary, erosion control features, such as water bars or other means of diverting flows off sloping pipeline rights-of-way, will be constructed to control increased runoff and erosion.

- Areas of highly erosive soils will be avoided when drill sites, two-track access routes, and pipeline routes are surveyed and staked, in order to substantially reduce the amount of soil loss.

Vegetation Resources

- Reclamation and final closure of the proposed operations will re-establish vegetation suitable for forage and wildlife habitat in the disturbance areas.

- Actions that will enhance restoration of vegetation productivity from desirable species include the following site preparation and reclamation techniques: mechanical loosening or roughening of the soil where compacted (discing or ripping); fertilization or soil amendment; seeding to proper depth with desirable species; mulching to retain soil moisture; transplanting containerized plants to speed the establishment of slow-growing species; control of noxious weeds; or temporary fencing to exclude livestock until vegetation is re-established successfully. These actions will be required, as appropriate.

- Mitigation activities most effective in reducing the potential for decreased vegetation production include timely and well planned reclamation and effective noxious weed management, avoidance of disturbance within playas (old lake beds), and avoidance of discharge within closed basins, playas, and areas with soils that would be difficult to revegetate. These mitigation activities will be required, as appropriate.

Wetlands

- For any jurisdictional wetlands identified that may be impacted, a detailed mitigation plan would be developed during the APD/POD or Sundry Notice approval process. Federal requirements to replace all impacted wetlands would mitigate this loss, so environmental impacts would occur only during the life of the project (including reclamation).

- The State of Wyoming Department of Environmental Quality, Water Quality Division administers a State Wetland Bank. Landowners have the opportunity to "bank" newly created or expanded wetland areas. While banking provisional wetlands from CBM discharges does serve to record the existence or non-existence of prior non-wetland status, there is no temporary mitigation. Wetlands used for mitigation purposes become jurisdictional and must be maintained in perpetuity. If wetland characteristics are lost due to inadequate hydrology, or other factors, then the banked credit is lost.

- Mitigation activities most effective in reducing the potential for adversely impacting existing wetlands include the following: avoidance of discharge within playas and closed basins; avoidance of discharge within or near existing wetlands (if increased discharge volumes or subsequent recharge of shallow aquifers would inundate and kill woody species, especially willows or cottonwoods); and avoidance of disturbance within all delineated or recognized wetlands.

- At the discretion of the surface owner, fencing of wetlands and providing off-site watering for livestock could be used to allow vegetation development and maintenance of water quality in key wetlands. Any fences used should be placed well back from the wetlands to prevent waterbird mortalities and should be constructed to standards that allow big game movement.

- If possible, wetlands and ponds will be built on accessible public lands where recreational users can benefit from the development.

Wildlife

- All power lines will be built to protect raptors from accidental electrocution.

- Power line corridors will avoid wetlands, to the extent possible, in order to reduce the chance of waterfowl hitting the lines.

- At the discretion of the surface owner, several small ponds could be consolidated into one larger pond in order to provide more open water and a longer shoreline at one site, which may be more beneficial to wildlife.

- The appropriate standard seasonal or year-long stipulations for raptors, sage grouse, and big game, as identified by the BLM's Resource Management Plan, will be applied.

- Roads will be constructed to the minimum standard needed, so that disturbance to soil and vegetation on each road would be minimized.

- Fences along service roads will be avoided unless absolutely necessary, in order to prevent a maze of barriers to big game movements. Fences will be constructed to standards that allow for easy big game passage, in order to avoid big game entanglements.

Fisheries

- At the discretion of the surface owner, several small ponds could be consolidated into one larger pond that may have the characteristics needed to support a fishery.

- At the discretion of the surface owner, reservoirs developed as part of CBM activities could be sited within natural stream courses, to provide benefits to fish and wildlife resources.
- Under the authority of the WDEQ, CBM produced water and receiving waters should be analyzed before wetlands, ponds, or lakes are formed or expanded. Selenium levels that would cause adverse effects in fish or waterfowl should be not be present.

Special Status Species

- Surveys for nesting mountain plovers are recommended if ground disturbance (wells, roads, pipelines, etc) of the proposed project occurs between May 1 and June 30.

- Special habitats for raptors will be analyzed site-specifically during the review of the APD/POD or Sundry Notices. A minimum disturbance-free buffer zone of one-half mile will be established for all raptors during the nesting season (February 1 through July 31), in accordance with the BLM's Resource Management Plan for the area. Enlarged disturbance-free buffer zones will be established for specific species, as appropriate, at the APD/POD level of analysis.

- Prairie dog towns will be surveyed for the presence of black-footed ferrets if the towns meet USFWS guidelines. Disturbance in prairie dog towns will be avoided or minimized, to protect sensitive species such as the burrowing owl.

- A disturbance-free buffer zone of one-quarter mile is established around a sage grouse lek to reduce the likelihood that proposed activities will disrupt breeding and nesting activities. A seasonal timing restriction will extend outward for another 1¾ mile from the one-quarter mile buffer-free zones applicable during February 1 through July 31.

- At the discretion of the surface owner, native species will be planted to re-establish special habitats.

Cultural Resources

- All areas of proposed ground disturbing activity will be inventoried for cultural resources at the APD/POD or Sundry Notice phase of each action.

- Specific plans for avoidance or data recovery will be recommended for any significant sites within the area of potential effect of the proposed activities.

Land Use and Transportation

- If CBM development activities are proposed in the vicinity of scattered subdivisions near Gillette, site-specific mitigating measures will be developed to minimize the impacts and to resolve conflicts.

- Over the project life, uneconomic and depleted wells will be plugged and abandoned, and the disturbance reclaimed and revegetated to approximate pre-project conditions.

- Reclamation and final closure of the proposed operations will re-establish the land uses of grazing and wildlife habitat in the disturbance areas.

- CBM facilities such as production pods or compression facilities will be fenced as specified by the BLM. Access from properties adjacent to production pods or compression facilities may be restricted by this fencing.

- Roads and facilities no longer needed will be removed and the affected area will be rehabilitated.

- Where feasible, each access road will be constructed in a transportation corridor that will also include gas and water pipelines, and electrical cables.

Visual Resources

- Gathering lines, water lines, high pressure gas lines and underground electrical cables would be located along road rights-of-way whenever feasible.

- Long-term visual impacts will be minimized by designing permanent structures to harmonize with the surrounding landscape to the extent feasible, recontouring and revegetating disturbed areas no longer needed for operations as soon as practicable, and by reshaping straight edges of clearing resulting from roads, pipelines, well pads, and compression facilities to create irregular or indistinct edges.

- Proposed facility developments on BLM-administered federal surface would be consistent with BLM management objectives for mapped VRM classes.

- All proposed wells and facilities on FS-administered federal surface would be consistent with FS Visual Quality objectives for the Thunder Basin National Grassland. Adverse visual impacts would be minimized through careful location of facilities, minimal disturbance of affected sites, and design of facilities so that they harmonize with the surrounding landscape.

- Use of two-track and existing roads and centralization of gas compression facilities along existing roads will minimize the visual impact of the road network.

- The use of buried power lines to each well, where feasible will reduce the linear element in the landscape.

- Construction debris will be removed immediately, as it creates undesirable textured contrasts with the landscape.

- Resource protection measures proposed for erosion control, road construction, rehabilitation and revegetation, and wildlife protection will be implemented during the approval of APDs and Sundry Notices. These measures also would mitigate impacts to visual quality.

Noise

- Compressors should be located at least 600 feet from sensitive receptors (residences, schools, medical facilities, and recreation areas). Under current Wyoming law, the WDEQ can only require this mitigation to occur if municipal or county land use plans address siting of noise emitters.

CHAPTER 3
AFFECTED ENVIRONMENT

GROUNDWATER

Most groundwater resources in the study area are derived from non-regional, Quaternary alluvial aquifers adjacent to rivers and aquifers within the lower Tertiary Wasatch/Fort Union Fms. Deeper, underlying regional aquifers include the following: the Upper Cretaceous Lance/Fox Hills; the Lower Cretaceous Dakota; and the Paleozoic Madison. These units represent the majority of the significant water-bearing strata; however, there are a few wells completed in formations that are included in "aquitard" groups. These wells typically have lower yields and are of poorer quality except near the outcrop. In addition to water supplies that can be developed from these aquifers, there are a few springs typically of the contact type, often at the base of exposed clinker. A generalized description of the Wasatch/Fort Union geology of this area is shown in Table 3-1 of the DEIS.

The prediction of groundwater movement and chemical quality in the PRB can be complex and locally variable. Local leakage between aquifers can occur as a result of faulty well completion techniques and corrosion of casing in old wells where poor quality water initially was cased off (USGS, 1974). In addition, the PRB has been drilled extensively in the course of mineral exploration; inconsistent plugging of test holes also is a potential concern. Commingling of aquifers could occur to some degree within the study area.

The Wasatch/Fort Union aquifer group includes the Wasatch Fm and the Tongue River (which includes the Wyodak coal), Lebo, and Tullock members of the Fort Union Fm. Discontinuous sands and shales form the top of this sequence. It is underlain by the Wyodak coal, the source of the coal bed methane for this project. The thickness of the shallowest of the bedrock aquifer systems in the PRB ranges to over 3,000 feet (Feathers et al., 1981).

Alluvial Aquifers

Alluvial aquifers consist of unconsolidated sand, silt, and gravel that underlie floodplains and the adjacent stream terraces. Thicknesses are usually less than 50 feet. Alluvium overlying Tertiary sediments (Fort Union and above) in the central part of the PRB is mostly fine-to medium-grained sand and silt. Coarser deposits occur in the valleys of the Belle Fourche, Cheyenne, Powder, and Little Powder rivers (USGS, 1973). Water yield from the alluvium is a function of grain size and grain-size distribution. Recharge results from surface infiltration and discharge from underlying strata. Local groundwater movement dominates in these systems; movement is along the drainage in a downstream direction.

Alluvial groundwater levels in Donkey and Stonepile Creeks, in the City of Gillette, are shallow and close to the ground's surface (Appendix E, Letter No. 23). The City of Gillette pumped approximately 4.7 gpm for total of 135,744 gallons in June 1999 from twenty-four wells (Carson, 1999). Pumping occurs throughout the year. Water levels rise during the summer lawn-watering period.

Water quality in alluvium within the PRB is quite variable, with TDS concentrations varying from 100 to over 4,000 mg/l. Common ranges are from 500 to 1,500 mg/l (USGS, 1973). Analyses from eight wells completed in alluvium within the study area have TDS concentrations averaging 2,232 mg/l, and varying between 467 and 6,610 mg/l. Most waters have calcium or sodium as the dominant cation and sulfate as the dominant anion. An area of sodium bicarbonate alluvial groundwater exists in the northeast portion of the study area (USGS, 1973).

Wasatch Aquifer System

The Wasatch aquifer consists primarily of fine- to medium-grained lenticular sandstone beds and sand channels surrounded and interbedded with siltstone, shales, and coals. The thickness increases from east to west from zero at the eastern boundary of the study area to over 1,000 feet at the western limit of the study area. Wasatch shales and siltstones generally do not yield enough water even for intermittent livestock use.

Wells completed in sandstone lenses or sand channels yield 10 to 50 gpm (approximately 0.02 to 0.1 cfs) in the northern portion of the study area. Wells completed near the southern portion of the PRB can yield as much as 500 gpm, which is approximately equivalent to 1 cfs, (USGS, 1988). Artesian conditions are common away from the outcrop particularly from deeper isolated sands. Recharge to the Wasatch Fm is through surface infiltration of precipitation and lateral movement of water from adjacent clinker and alluvium.

Natural discharge occurs at small seeps and springs along surface drainages. Local flow systems are predominant with discharge occurring along creeks and tributaries near recharge areas. Regional groundwater movement, if it exists, is toward the north but is extremely slow due to the fine-grained and discontinuous nature of most of the Wasatch sands.

Water types within the Wasatch Fm are predominantly sodium sulfate and sodium bicarbonate. There are some calcium or magnesium sulfate waters found in the eastern portion of the study area (USGS, 1973). Dissolved solids concentrations in 257 samples acquired from the Wasatch vary between 227 and 8,200 mg/l, have a median concentration of 1,010 mg/l, and have an average concentration of 1,298 mg/l (USGS, 1986c). Analyses from approximately 143 wells completed in the Wasatch Fm, located in and near the study area, vary between 146 to 8,200 mg/l dissolved solids and have an average concentration of 1,415 mg/l (USGS, 1984).

Selenium concentrations can pose water quality risks in Wyoming. Geochemically, the primary source for selenium is volcanic emanations associated with volcanic activity. Sources of selenium in the study area are associated with secondary sources located in biological pools in which selenium has bioaccumulated (NAS, 1974). Shales have the highest concentration of selenium and are the primary source for selenium in the PRB (ASSMR, 1995).

Analysis of trace metals was conducted for approximately 33 wells completed in the Wasatch Fm (USGS, 1984). Selenium concentrations in groundwater range from below the analytical method detection limits in 32 of the samples to 0.02 mg/l (USGS, 1984). The Quality Standards for

Wyoming groundwaters identify acceptable concentrations of selenium for domestic, agriculture and livestock use as 0.01 mg/l, 0.02 mg/l and 0.05 mg/l, respectively. The detection limit in a number of the samples (1 mg/l) was greater than the standards. Selenium exceeded the drinking water standard in 4 of 159 samples compiled from the Powder River coal field. Dissolved selenium concentrations, ranging from 0.003 to 0.330 mg/l, reported in Selenium: Reclamation and Environmental Impacts, Special Symposium June 1995, have been recognized in shallow post mining groundwater (spoils) from coal mines in the PRB (USGS, 1988 and Naftz and Rice, 1989). The selenium concentrations in these areas probably result from exposure of crushed Wasatch Fm overburden materials to oxidizing conditions. Oxidizing conditions decrease the stability of selenium-containing oxides and organic matter, resulting in increased selenium concentrations within backfill materials and waters discharging from them (ASSMR, 1995).

Fort Union Formation

The Fort Union Fm. has been divided into three members: the Tongue River (which includes the Wyodak coal); Lebo; and Tullock. In the southern part of the basin the Lebo and the Tongue River are not identified as separate members.

Tongue River Member

The Tongue River Member of the Fort Union Fm contains seven to nine major coal seams (USGS, 1986a), and many discontinuous, lenticular sandstone layers. The Wyodak coal bed occurs in the upper part of the Tongue River Member. It has been correlated in many parts of the PRB and has been given different names in different parts of the basin. The coal bed has been called the Wyodak-Anderson or the Wyodak-Canyon coal bed. North of Gillette, the Wyodak coal bed splits into Upper Wyodak and Lower Wyodak coal beds. In places, the Upper Wyodak separates into the Smith, Swartz, and Anderson coal beds, and the Lower Wyodak separates into the Canyon and Cook coal beds. South of Gillette, the Wyodak occurs as essentially a single coal seam that may have a number of thin splits within it. South of Wright, in the vicinity of the Antelope mine, the Wyodak separates into the Anderson and Canyon coal beds. Coal beds equivalent to the Wyodak are tentatively correlated in the vicinity of Sheridan on the western side of the PRB. Recent work by the USGS indicates that the Wyodak combines with other coals to form a 200-ft thick coal seam known as the Big George at a depth of over 1,000 feet in western Campbell County. For ease of reference in this report, the main coal seam that is the target of CBM development will be referred to as the Wyodak, and where it splits into two distinct seams they will be referred to as the Upper and Lower Wyodak.

The Wyodak coal occurs at the top of the Fort Union sequence and is the most continuous hydrogeologic unit in the study area. Away from the outcrop, water in the Wyodak coal bed is confined between a basal shale of the overlying Wasatch Fm and a thick shale sequence underlying the coal bed (USGS, 1988). The determination that the coal is a confined aquifer away from the outcrop is further documented by the USGS (1986c) and in various mine permit application packages (PAPs) on file with the WDEQ/LQD. Artesian conditions exist away from the outcrop. The aquifer consists of the Wyodak and associated coals. Where the Wyodak splits and separates into multiple seams, it contains interbedded sandstones, and clinker beds. Flow of water in the aquifer is affected

in places where the coal seam splits and is interbedded with claystone, shale, and sandstone. Flow in the aquifer also is affected by differences in aquifer properties, caused by a varying pattern and degree of fracturing in the coal and by faulting. The permeability of the coal-bearing bed is a function of fracturing. The coal is anisotropic (not uniform), and the flow occurs in fractures within the coal. Wells completed within coal generally yield from 10 to 50 gpm (approximately 0.02 to 0.1 cfs) (USGS, 1975).

Recharge occurs primarily along the clinker outcrop areas with a small amount of leakage from the overlying Wasatch Fm. Recharge and discharge also occur locally, where coal underlies valley fill deposits (USGS, 1988). As more operating mines are reclaimed, reclaimed mine areas may become recharge areas for adjacent, undisturbed Wyodak coal. Regional flow is to the northwest and away from the recharge areas, as indicated by the potentiometric surface map prepared by Daddow (USGS, 1986b). In the southern portion of the study area, water flow is to the north, moving toward local discharge areas where Antelope and Porcupine Creeks cross coal outcrops (USGS, 1988). Local flow patterns may differ from regional flow.

Available data suggest that near-surface Fort Union wells do not show a dominant water type but consist primarily of calcium or magnesium sulfate water. As depth increases below 100 feet, sodium replaces calcium and magnesium and bicarbonates replace sulfates. The predominant water types of existing water wells within the Fort Union Fm consist primarily of sodium bicarbonate and to a lesser extent sodium sulfate (USGS, 1973). Wells penetrating coal seams or other carbonaceous deposits often yield both water and gas (primarily methane).

Solute concentrations within the Fort Union Fm are variable. The average concentration for 73 samples in the study area from the Fort Union Fm is approximately 1,350 mg/l (USGS, 1984). The best quality water typically is obtained from clinker areas. Water from coal beds typically contains 1,000 to 2,000 mg/l TDS (USGS, 1974). The quality of water contained in the coal seam is described in various coal mine PAPs and annual monitoring reports on the file with WDEQ/LQD, and was summarized by the USGS (1988). Based on 379 samples from the Wyodak-Anderson coal aquifer, the median concentration of TDS is 1,310 mg/l. Baseline data from the Rocky Butte Mine lists average TDS concentrations of 1,210 and 2,120 mg/l, reported by Carter and Wyodak, respectively (USDI BLM, 1992f).

Produced water contains an average (mean value) of 764 mg/l Total Dissolved Solids (TDS), based on discharge monitoring report data for 577 CBM effluent (discharge) samples reported to WDEQ between 1/31/93 and 12/31/97 (WDEQ, 1998a) (**Table 3-1**). Specific conductance of water from 32 discharge points in the Marquiss and Lighthouse CBM fields averaged 560 mg/l (ranging from 375 to 710 mg/l for 153 samples, assuming TDS is roughly equivalent to 0.667 times the specific conductance (USDI BLM, 1991). Available monitoring results are not very conclusive as to whether TDS levels within discharged CBM waters vary geographically in any pattern. Preliminary analysis of monitoring results reported to WDEQ suggests that TDS levels may be higher in some northern portions of the study area than levels observed within the Marquiss and Lighthouse areas south of Gillette. These CBM monitoring results also suggest that reported TDS levels in discharged CBM waters are lower than solute concentrations that typically have been documented within the Ft. Union Fm (see above).

Analysis of trace metals was conducted for approximately 31 wells completed in the Fort Union Fm (USGS, 1984). Selenium concentrations in groundwater range from below the analytical method detection limits in 29 of the samples to 0.020 mg/l. However, the detection limit in all of the samples was above the most stringent guidelines within the Quality Standards for Wyoming Groundwaters (0.01 mg/l).

Table 3-1
Statistical Summary of WDEQ Discharge Monitoring Report Data(12/31/93 - 12/31/97)

	Flow		EC	TDS[1]	pH	Radium 226	TPH
	mgd	gpm	µmhos/cm	mg/l	S.U.	pCi/l	mg/l
Mean	0.05	34.6	1146	764	7.2	<0.44	<0.529
Standard Error	0.0028		22.70	22.70	0.014	0.0489	0.015
Median	0.03	23.3	992	662	7.2	<0.20	0.500
Minimum	0.00	0.0	110	73	5.7	<0.20	0.000
Maximum	1.14	791.5	6380	4255	8.7	10.60	8.400
Count	569	569	577	577	580	350	576.000
Confidence level (0.95)	0.0055	0.0055	44.49	44.49	0.028	0.0959	0.029

[1] TDS values derived from multiplying conductivity values by 0.667.
Source: WDEQ, 1998a.

Table 3-2, after Lowry and others (USGS, 1986b), shows trace metal concentrations in groundwater within Coal Area 50, the PRB, which includes all of the study area. This table shows manganese and iron concentrations exceeding secondary domestic standards with some frequency, but also shows a median concentration for all samples acquired that is less than the secondary domestic standard. Water containing manganese and iron concentrations that have been measured in the study area can be used safely for irrigation or stock watering.

Lower Tongue River/Lebo Confining Layer

The lower part of the Tongue River/Lebo consists of sandstone lenses contained in a predominantly shale and siltstone matrix (USGS, 1988). Thick coal beds occur in the upper part of the Lebo Shale member (USGS, 1974). Wells in the lower Tongue River/Lebo unit typically yield adequate quantities of water for domestic and livestock use if a sufficient thickness of saturated sandstone is penetrated. The towns of Gillette and Wright, as well as many of the subdivisions surrounding Gillette, obtain most of their municipal water supply from wells screened within the sands of the lower Tongue River, Lebo and Tullock members of the Fort Union Fm (HKM Associates, 1994). The City of Gillette has recently installed seven new water supply wells screened in the lower Tongue River, Lebo and Tullock members (Wester-Wetstein & Associates, 1999d). Generally, these water supply wells are not screened through the upper part of the Tongue River, and are screened several hundred feet below the Wyodak Coal.

Table 3-2
Trace Metal Concentrations of Groundwater in Coal Area 50

Dissolved Trace Metal	Number of Analyses	Number of Analyses Exceeding Drinking Water Standards	Percent of Analyses Exceeding Drinking Water Standards	Drinking Water Standards (mg/l)	Median Value	Maximum Analyzed Value (mg/l)
Arsenic	154	1	0.6	0.05a	0.001	0.120
Barium	95	1	1.0	1.0a	0.00	1.100
Cadmium	165	1	0.6	0.01a	0.002	0.017
Chromium	116	0	0.0	0.05a	0.010	0.050
Copper	123	0	0.0	1.0b	0.001	0.104
Iron	366	56	15.3	0.3b	0.100	120.0
Lead	165	6	3.6	0.05a	0.002	0.180
Manganese	257	100	38.9	0.05b	0.040	4.800
Mercury	122	0	0.0	0.002a	0.0004	0.0015
Selenium	159	4	2.5	0.01a	0.001	0.031
Zinc	141	0	0.0	5.0b	0.020	1.800

Source: USGS, 1986.
a National interim primary drinking-water standards (USEPA, 1977).
b National secondary drinking-water regulations (USEPA, 1979).

The shales underlying the Wyodak coal act as a confining layer, providing partial isolation of the coal from underlying strata. Stratigraphically lower aquifers are partially isolated from impacts resulting from dewatering associated with mine activities and CBM production in the Wyodak coal aquifers. As with other Fort Union aquifers, recharge is primarily from inflow at outcrop areas. Groundwater generally flows north. Water quality for the Tongue River/Lebo is similar to that described above for the Wyodak coal aquifer.

Tullock Aquifer

The Tullock aquifer consists of fine- to medium-grained sandstone layers and thin coal seams interbedded with siltstone, shale, and carbonaceous shale (USGS, 1988). The sandstone layers in the Tullock tend to be somewhat coarser and more massive than the overlying Tongue River/Lebo members of the Fort Union Fm. In areas where the Lebo Shale is well defined, it provides a hydraulic separation between the Tullock and the coals of the upper part of the Fort Union Fm. The Tullock is exposed in the west along the Bighorn Uplift and in the east, east of the Little Powder River, in a series of dissected ridges (USGS, 1987). Water yields of 200 to 300 gpm (approximately 0.4 to 0.6 cfs) are available from the Tullock, making this zone attractive for municipal and industrial uses. Most wells for mine facilities are completed in this aquifer. Recharge to the Tullock results from leakage through overlying strata and infiltration along the outcrop areas.

Water Use

Groundwater consumption in the study area averages 28.84 million gallons per day or 32,300 acre-feet per year (Table 3-7 of DEIS) (USGS, 1998b). More than 40 percent of this consumption is in

the Belle Fourche River basin. Mining-related withdrawals associated with pit dewatering and operational consumption account for 77 percent of the groundwater use in the study area. All water for domestic consumption is derived from groundwater supplied predominantly from the Fort Union and Wasatch aquifers. Over 90 percent of domestic consumption occurs in the Belle Fourche River basin, where most of the population resides. Stockwatering and irrigation uses of groundwater accounted for slightly more than one million gallons per day in 1990.

CBM water withdrawals were not significant in 1990, and therefore, are not included in the table. However, approximately 890 productive CBM wells are in place as of the end of 1998. Produced water from the Fort Union aquifer averaged 6.92 million gallons per day based on actual reported production from 420 wells, February 1998 (PI/Dwight's, 1998).

The Wasatch and Fort Union aquifers are the most important local sources of groundwater in the PRB (Feathers et al., 1981). They are developed extensively for shallow domestic and livestock wells. Domestic and livestock wells usually are low yield, (less than 25 gpm or 0.05 cfs), intermittent producers. Water suitable for domestic and livestock uses typically can be found less than 1,000 feet below the surface. Industrial water wells are used primarily to obtain water for use in subsurface injection that promotes secondary recovery of petroleum. At coal mines these wells are used for drinking water and dust abatement. Municipal water supply wells in the project area are predominantly associated with the City of Gillette's use of the Fort Union Fm. (Tongue River, Lebo and Tullock members). Municipal water use in Gillette has a winter base demand of 3.0 to 3.5 million gallons per day (gpd) and a peak demand of 10 million gpd (Wester-Wetstein & Associates, 1994). Peak demands for the Gillette area are projected to grow to 18.1 million gpd by the year 2020 (HKM Associates, 1994).

There are more than 10,000 WSEO-permitted water wells in and around the study area (T40-58 N R70-75W; T45-56N R76W; and T48-52N R77W) of which approximately 3,600 have been canceled or abandoned. Of the remaining approximately 6,900 wells, approximately 4,000 are monitor wells. The remaining approximately 2,900 wells are used for domestic, industrial, irrigation, municipal, reservoir and stock purposes. The water well location data for all permitted water wells in Wyoming is too lengthy to include in this document but is available from the Wyoming State Engineers Office (WSEO, 1998b and 1999). **Table 3-3** summarizes groundwater use in the Wyodak study area in 1990.

Table 3-3 1998-1999 Data on Type and Number of Wells in the Wyodak Study Area (T40-58 N R70-75 W; T45-56N R76W; and T48-52N R77W)	
Primary Use	**Number of Wells**
Monitor, Miscellaneous, Dewater	3,966
Domestic	510
Industrial	195
Irrigation	25
Municipal	28
Reservoir	22
Stock (not including CBM)	2,163
Unknown	16
TOTAL	6,925

6/10/1998 and 2/1/99 Listings
Source: WSEO, 1998b and WSEO, 1999

DEIS CHAPTER 3 AFFECTED ENVIRONMENT ERRATA

Page No./Paragraph/Line	Errata
3-3, Table 3-1	The text under Formation should read "**Upper Fort Union (Upper Tongue River/Wyodak Coal**" instead of "Wyodak Coal" and should read "**Upper Fort Union (Lower Tongue River) and Lebo**" instead of "Upper Fort Union (Tongue River/Lebo)."
3-5 3 6	Insert the following sentence after the fifth sentence: "**However, the development of CBM in the PRB is occurring under confined conditions (FEIS, p. 3-3).**"
3-7 3 2	Insert the following sentence after the first sentence. "**As of September 1, 1999, 2,373 CBM wells had been drilled of the 3,890 active APDs in the Wyodak Study area (WOGCC, 1999c).**"
3-8 4 2 and 3	Delete the last sentence of the fourth paragraph.
3-11, Table 3-4	Replace Table 3-4 of the DEIS with the revised Table 3-4 occurring on page 3-11 of the FEIS.
3-10 3 1	The text should read "1)Wyoming's Belle Fourche River (**77** percent of CBM generated flow); 2) Little Powder River, WY and MT (**19** percent of CBM generated flow); and 3) Wyoming's Cheyenne River (**4** percent of CBM generated flow)."

Page No./Paragraph/Line	Errata
3-14 3	Insert the following paragraph, after the third paragraph: "**The study area includes several streams which are designated for aquatic life:** **Little Powder River Warm water fishery Class-2** **Belle Fourche River Warm water fishery Class-2** **Rawhide Creek Marginal fishery Class-3** **Antelope Creek Warm water fishery Class-2** **Little Thunder Creek Warm water fishery Class-2** **The remaining tributaries are Class-4 waters, protected for only livestock and irrigation.**"
3-37 1 1	The text should read "..., and wetlands**, including isolated wetlands,** within the study area, are jurisdictional areas ..."
3-37 1 5	The text should read "... not an activity regulated by the COE **if the activity does not include a discharge of fill material into waters of the U.S.** (US Army COE, 1998)."
3-40 1 5	The correct dates for restricting disturbance are February 1 through July 31.
3-40 1 9	The text should read "... only **26** leks ..." Delete last sentence of paragraph, line 10.
3-40 2 6	The text should read "black bullhead (***Ameiurus*** *melas*), ..."
3-40 2 10	The text should read "(*Scaphirhynchus* ***platorynchus***), ..."
3-40 3 4	The text should read "... and, the endangered Ute Ladies'-Tresses (*Spiranthes diluvialis).* ***The mountain plover*** **(*Charadrius montanus*), for which the USFWS changed its status from candidate to proposed, has been identified as potentially occurring within the area.** In addition to the threatened and endangered species, **two** candidate species have been identified as potentially occurring with the area: the swift fox and sturgeon chub."

Page No./Paragraph/Line	Errata
3-40 1	Insert following paragraph after the first paragraph: **"Limited existing information is available for use in characterizing aquatic habitats in perennial receiving waters, flow regimes, and anticipated stream erosion downstream of the discharge points or the proposed discharges of CBM produced water. A comparison of 1990's and 1960's fish survey data from the Missouri River basin indicated that the sturgeon chub has a stable or increasing distribution (Patton et al, 1998). This survey was restricted to native warm-water species in non-montane regions. An estimated 40 to 50 percent of the fish species surveyed indicated a possibility of declining distributions (Patton et al, 1998). Two aquatic habitat types were common among the species with declining distributions indicated in the study: turbid rivers having silt and sand substrates; and small-to medium-sized streams having relatively cool, clear water, and preferably having gravel substrates for spawning. Patton et al (1998) suggested that reservoirs and diversion dams may have stabilized flows and reduced silt loads in rivers, and that land management and irrigation practices may have increased turbidity and siltation in many small- to medium-sized streams.**
3-45, Table 3-16	The binomial for flathead chub listed in column one should read "(***Platygobio*** *gracilis*)"
3-51 2 3	The text should read "Active coal mines located south of Gillette include Caballo **(includes Rocky Butte)**, Bell Ayr, Cordero-Rojo Complex, Coal Creek, Jacobs Ranch, Black Thunder, North Rochelle, **North Antelope/Rochelle**, and Antelope.
3-51 4 1	The text should read "The study area has **two** major **railroads** and numerous oil and gas pipelines. The Burlington-Northern/Santa Fe and Union Pacific **railroads pass** through ..."
3-56, Table 3-20	The Wyoming Valuation (first row) under Other Minerals (sixth column) should read "293 **million**"

Table 3-4 Predicted Storm Flows from USGS Gaging Stations[1]								
Station Name	Station Number	Drainage Area (sq. mi.)	Flow					
			2-Year 24-Hour	5-Year 24-Hour	10-Year 24-Hour	25-Year 24-Hour	50-Year 24-Hour	100-Year 24-Hour
Powder River Basin								
Dead Horse Creek tributary near Midwest	06312910	1.53	223	386	524	733	917	1,130
Rucker Draw near Spotted Horse	06317050	3.98	84	335	696	1,530	2,570	4,100
Little Powder River Basin								
Little Powder River tributary near Gillette, WY	06324800	3.45	9	24	41	74	112	163
Little Powder River near Broadus, MT	06325500	2040	1,120	1,750	2,170	2,690	3,070	3,450
Belle Fourche River Basin								
Donkey Creek tributary above reservoir near Gillette, WY	06426195	0.2	27	65	99	152	198	249
Belle Fourche River below Rattlesnake Creek, near Piney	06426500	1690	797	1,740	2,770	4,720	6,830	9,660
Cheyenne River Basin								
Pritchard Draw near Lance Creek	06382200	5.1	610	1,160	1,660	2,450	3,180	4,030

[1] USGS 1988

USGS 1988. Streamflows in Wyoming. Prepared by H.W. Lowham. Water-Resources Investigations Report 88-4045. Prepared in cooperation with the U.S. Bureau of Land Management and the Wyoming Highway Department. Cheyenne, WY.

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

GROUNDWATER

In developing CBM, a portion of the water contained in the coal aquifer is removed at specific locations, releasing methane for collection. The primary groundwater impact associated with development of the Wyodak CBM Project involves loss in available hydraulic head in the target formation (the Wyodak-Anderson coal seam). This head loss could impact water wells completed in the coal seam, in the form of reduced well yields and potential methane production. Surface discharge of extracted groundwater from CBM operations potentially can enhance recharge of shallow aquifers underlying creek areas.

The effects of CBM development on groundwater resources are described in terms of a loss in hydraulic pressure head in the coal aquifer. The effects are seen as a drop in the water level (drawdown) in nearby wells that are completed in the coal aquifer. As groundwater leaves the aquifer and enters the well bore, the water level in a well completed in the coal aquifer rises above the level of the aquifer, and a hydraulic pressure head is generated. Partial removal of groundwater from the coal aquifer (through coal mining operations or CBM development) can reduce the hydraulic pressure head and lower the water level in nearby wells completed in the coal seam. After CBM development (and water removal) ends, water levels in nearby wells are expected to recover somewhat as coal aquifer recharge occurs.

The effects of CBM development, coal mining activities and other existing or reasonably foreseeable development activates are analyzed cumulatively for the Proposed Action, Alternative 1, and the No Action alternative later within this chapter.

Specific groundwater issues associated with the proposed Wyodak CBM development include:

- Local and regional coal aquifer drawdown resulting from CBM development and surface coal mining.
- Maximum areal extent of coal aquifer drawdown.
- The magnitude of projected coal aquifer drawdown under various CBM development scenarios.
- The extent of coal aquifer utilization and the effect of predicted drawdown on this use.
- Wasatch sand aquifer drawdown resulting from CBM development and surface coal mining.
- The rate of coal aquifer recharge after CBM operations cease.
- The contribution of surface discharge of extracted coal groundwater to the recharge of shallow Wasatch sand aquifers.
- The differentiation of coal aquifer drawdown effects resulting from coal mining and CBM development.

Hydrogeologic Framework

A detailed description of the geology and hydrology of the area is given in Chapter 3. The focus of the impact assessment is the Wyodak-Anderson coal seam (top of the Fort Union Fm) and the overlying Wasatch Fm. The dip of the Fort Union coals in the eastern PRB is generally 1-2 degrees to the west-northwest, although the Wyodak-Anderson coal has numerous "rolls" so that, locally, dips may be quite variable. The Wasatch Fm has several discontinuous sand units that are utilized for water supply. The base of the Wasatch Fm, directly above the Wyodak-Anderson seam, typically is a low permeability claystone that forms a hydraulic confining unit for the coal.

The coal and overburden are eroded where the Wasatch Fm and Wyodak-Anderson coal contact intercepts the land surface to the east. Range fires and spontaneous combustion have ignited the areas of exposed coal at the land surface. The burning of these coal deposits has created a land form composed of permeable material (clinker), formed from the baking and subsequent collapse of the sediments originally above the coal.

Recharge to groundwater aquifers occurs from surface infiltration and from vertical and horizontal migration from adjacent strata. Precipitation provides a minimal source of recharge over most of the area because the climate and surface features prohibit significant infiltration. Infiltration is significant within more permeable surface geologic units such as the clinker occurrences along the eastern outcrop of the Wyodak coal. The clinker areas are generally considered to form significant recharge areas for the coal. Infiltration of surface water in creek valleys is also generally considered to be an important source of recharge to shallow aquifers. The Wyoming Board of Control currently considers surface water losses in river flows due to evapotranspiration and leakage (termed conveyance loss) to be about one percent of the flow per mile. Evapotranspiration probably accounts for most of the conveyance losses, particularly during the summer months. Recharge of shallow aquifers due to leakage from rivers is likely to be approximately 20 percent of the conveyance loss.

Hydraulic connection between the shallow Wasatch sands and the Wyodak-Anderson coal is limited due to the low permeability claystones that separate the two units. However, if the hydraulic head (water level) in the coal is naturally lower than in the overlying sands, then there is potential for leakage from the sands into the coal, or vertical recharge. The natural leakage rate will typically be extremely small, but taken over a large area can amount to a significant portion of the total recharge into the coal. Locally, hydraulic connection between the coal and Wasatch sands may be enhanced should the integrity of the confining layer be compromised by water supply wells screened through both the coal and the overlying sands, by deteriorating well casings, or by poorly plugged oil and gas wells or exploratory drill holes. Leakage from the Wasatch sands into the coal may be enhanced if water levels in the coal are lowered as a result of coal dewatering activities. Due to the limited hydraulic communication between the coal and the overlying Wasatch sands, a significant period of time (typically several years) will likely pass before significant drawdown (drop in water level) effects in the sands are apparent.

Through time, many clinker deposits have become saturated as a result of the infiltration of precipitation and snowmelt. "Ponding" of water may occur along the interface where the clinker

meets the less permeable coal and sediments of the Wasatch Fm. Springs may form at the base of the clinker deposits. The Moyer Spring north of Gillette is a good example of this situation.

Regional groundwater flow is generally to the northwest (downdip) towards potential discharge areas in the north central part of the PRB (USGS, 1986b). Coal wells in the vicinity of the Powder River exhibit flowing artesian conditions that indicate upward flow gradients. This supports the potential for groundwater discharge along the northern part of the Powder River, although physical evidence for this, in the form of springs and sustained river baseflow, are not readily apparent. It is assumed that most of the discharge is diffuse and may be consumed by evapotranspiration so that it does not appear as a surface flow.

Groundwater Modeling Methodology

Numerical groundwater flow modeling was used to predict the impacts of the Wyodak CBM Project. Modeling was necessary because of the large extent, variability, and cumulative stresses imposed by mining and CBM development on the Fort Union and Wasatch aquifer units. Assessment of CBM development impacts has been performed for earlier environmental assessments for the Marquiss, Lighthouse, North Gillette, and South Gillette areas (USDI BLM, 1992a, 1995c, 1996a and 1997a). A detailed modeling study was completed for the Little Thunder drainage basin in the southeastern part of the PRB (WWRC, 1997). The information from earlier studies was reviewed and has been incorporated into the modeling work for the Wyodak CBM EIS, wherever practical.

The main features and assumptions of the model used for the Wyodak CBM EIS are briefly described here. The complete technical description of this groundwater analysis is found in the *Final Technical Report for the Wyodak CBM Project, Groundwater Modeling of Impacts Associated with Mining and Coal Bed Methane Development in the Eastern Powder River Basin (September, 1999)*, on file at the BLM Casper Field Office in Casper, WY and at the BLM Buffalo Field Office in Buffalo, WY. This report describes the specific hydrogeologic data on which the model was based. It also describes the numerical model and model assumptions in more detail.

The hydrogeologic model code selected was the latest version of the USGS Three Dimensional Finite Difference Modular Groundwater Flow Model MODFLOW96. This model code is widely accepted by regulatory agencies and currently is used by the BLM.

The model consists of eight geologic layers. The lowermost two layers (layers 7 and 8) represent the Lower Tongue River/Lebo Members of the Fort Union Fm and the shale confining layer separating the Lower Tongue River/Lebo from the overlying Wyodak coal bed. The Wyodak coal bed is represented by layers 4, 5 and 6 in the model. The Wyodak consists of several coal beds that split and merge in the PRB. The model consolidates these splits into two coal beds (layers 4 and 6), separated by an intervening shale parting (layer 5). The Wyodak coal transitions into more highly permeable clinker at the eastern outcrop area. Data on the coal seams and structure were weakest in the northern portion of the modeled area. Overlying the coal is a layer (layer 3) representing shales within the Wasatch Fm that act as a confining unit between the coal and the discontinuous sandstones within the Wasatch Fm. The second layer represents the Wasatch Fm discontinuous

sandstone units. The uppermost layer (layer 1) represents the surface geologic units that include shales, sandstones, and alluvial sands within creek valleys.

Other geologic boundaries that were incorporated into the model include faults and lineaments where these are suspected of having a significant influence on groundwater flow regimes. Faults may act as impermeable (no-flow) boundaries or zones of flow restriction, and lineaments as zones of augmented hydraulic conductivity in the model.

Stresses imposed from surface mining were simulated as drains. Stresses imposed from CBM development were simulated as wells pumping at a constant rate of 12 gpm for an estimated 15-year life. Due to the large number of proposed CBM wells, the uncertain location of the wells, and the large area involved, the model wells actually simulated "pods" of CBM wells, consisting of between eight to twelve wells that are located in relatively small areas.

Model calibration was done to pre-mining, or in a few cases, earliest available static water levels. This was assumed to represent steady state conditions. The model was calibrated in transient state by matching against available historic water level monitoring data.

The mining sequence was simulated, for geographic locations projected to be mined, as incremental impacts in one year stress periods from approximately 1975 (the earliest mining along the Wyodak outcrop with the exception of the Wyodak mine east of Gillette) to the present. Predictive simulations of impacts were modeled to year 2225, about 200 years beyond the presently anticipated end-of-mining, in year 2021. Historic mining records and life of mine plan maps on file with the Office of Surface Mining in Denver, Colorado were used to develop historic mine sequences and to project the approximate future mining sequence. It is recognized that life-of-mine plans are dynamic and may change in future years, but they give a general projection of likely coal removal sequences and mine progression. Annual progress of the mine plans was superimposed on the grid as drains within the model, with the pits left open for two years and then closed.

Current CBM production was simulated in the area using the historic operational data from the existing fields. Future CBM development was simulated using the best estimate of future development rate that is described in Chapter 2. Mining impacts were modeled with, and without CBM development in order to differentiate the impacts of the two imposed stresses.

The groundwater flow model was used to predict the areal extent of aquifer drawdowns due to the superimposed stresses of the proposed CBM development and mining operations on a year-by-year basis. CBM development of the PRB started in 1989. The Rawhide Butte field represented the first commercial CBM production in the PRB. Most of the CBM development to date has been in the Marquiss and Lighthouse areas south of Gillette, and in the vicinity of the Buckskin and Eagle Butte mines north of Gillette. In March 1998, there were approximately 420 operating CBM wells in the project area (PI/Dwight's, 1998). By November 1998 production data was available for 638 operating CBM wells in the PRB (PI/Dwight's, 1999). Information from the Wyoming Oil and Gas Commission indicates that as of May 1999 there were 902 producing CBM wells in the EIS project area. The model assumed, by the end of 1998, a total of 890 productive CBM wells, 250 wells in the Gillette North assessment area and 640 wells in the Gillette South assessment area. The

approximate locations and timing of CBM development through 1998 were input into the model based on actual well records. The location and timing for future CBM development were based on permit applications and engineering judgement considering the distance from existing and proposed pipelines and known favorable areas for CBM development.
For the model, the No Action Alternative assumed 2,890 wells would be operating in the project area (2,000 new wells plus the 890 wells existing at the end of 1998). For this alternative, the new wells are assumed to be completed over the next five years (1999 to 2003). The Proposed Action has 3,890 wells operating in the project area (3,000 new wells and 890 wells existing at the end of 1998). For this alternative, the new wells are assumed to be completed over the next seven years (1999 to 2005). The Alternative 1 development scenario has 5,890 wells operating in the expanded project area (5,000 new wells and 890 wells existing at the end of 1998). For this alternative, the new wells are assumed to be completed over the next five years (1999 to 2003).

The following discussion outlines the projected impacts to groundwater quantity and quality under the Proposed Action, Alternative 1, and the No Action Alternative. The differences in projected impacts under the three alternatives are only significant with respect to the extent of drawdown in the coal and Wasatch aquifers. There is very little difference in the impacts to water quality under the three alternatives.

Proposed Action

Water Quantity

Prediction of Local and Regional Coal Aquifer Drawdown Resulting from the Development

Figure 4-1 shows the interpreted pre-mining groundwater elevations (potentiometric surface) in the Wyodak coal. This map is based on water level measurements in coal wells taken on dates prior to, or closely following, the start of mining in any given area. Some water level measurements taken at a later date are used to generate the pre-mining map if the well is located at a sufficient distance from mining so that it was unlikely to be affected. Sources of the data used to generate the pre-mining map include Daddow (USGS, 1986b), the Gillette Area Groundwater Monitoring Organization (GAGMO) database for 1980 water levels, individual mine data, and the BLM.

Figure 4-2 shows the interpreted cumulative water level changes measured in the coal aquifer between the years 1980 and 1995 based on data collected by GAGMO. This map has consolidated the drawdowns for the Anderson and Canyon coal seams in the southern part of the

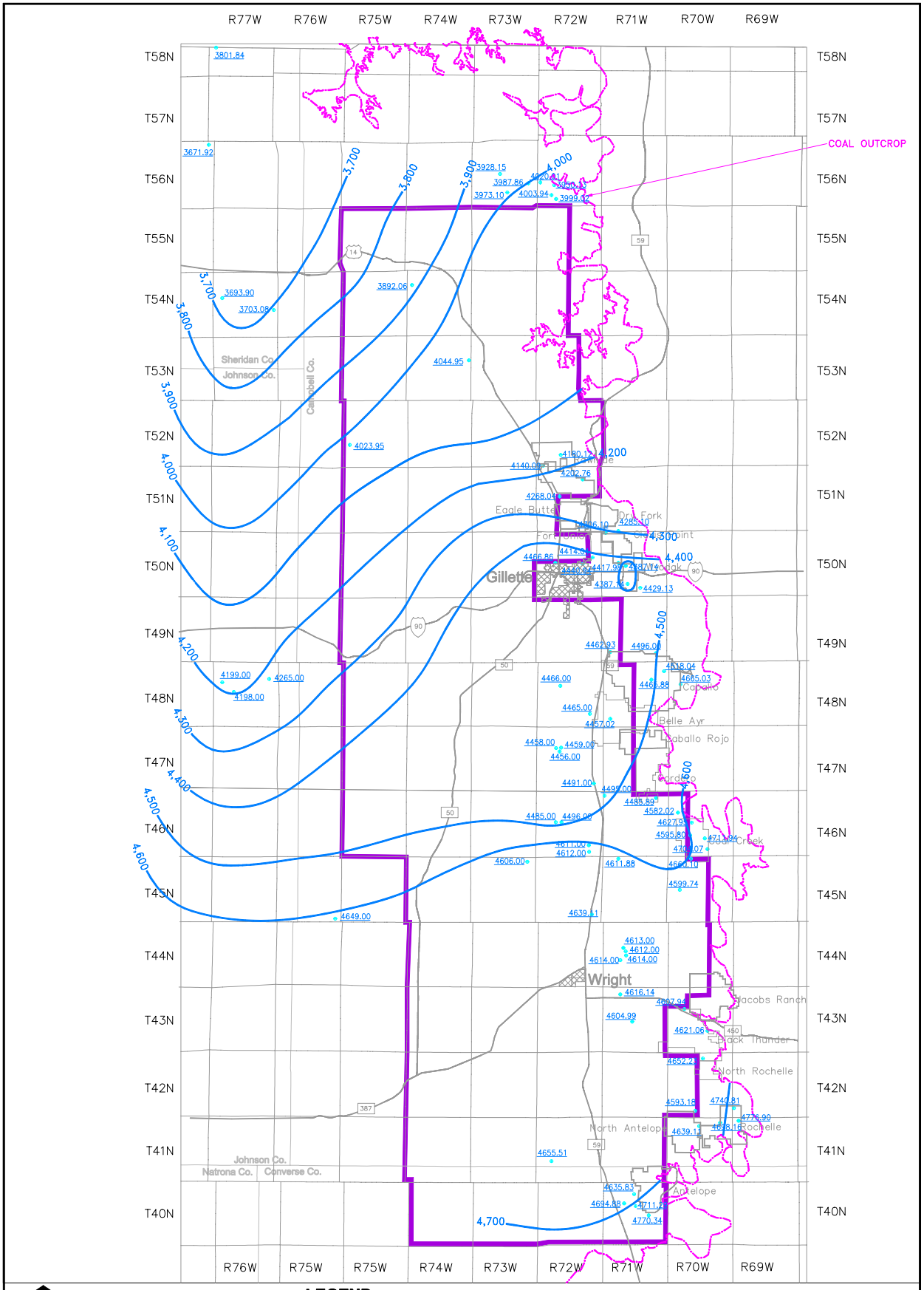
area. Most of the mining in the PRB was initiated after 1977 (with the exception of the Wyodak and Belle Ayr mines) so that the use of 1980 as the baseline year (i.e. pre-mining) is reasonable.
For comparison, the model predicted drawdowns for year 1995 are shown superimposed on the GAGMO interpreted drawdowns in **Figures 4-2A, 4-2B and 4-2C**. It can be seen that the model predicted drawdowns for the year 1995 generally compare favorably with actual measured drawdowns. The model predicted extent of drawdown, represented by the 5-foot drawdown contour, tends to be more extensive than the GAGMO interpretation in the northern and southern portions of the Wyodak study area (**Figures 4-2A and 4-2C**). This may be partly attributable to the fact that the model drawdown assumes 1975 as the base year, while the GAGMO drawdown assumes 1980 as the base year. The model also accounts for drawdown in the coal that occurs due to pumping of the underlying Fort Union sands by the city of Gillette and the town of Wright that started prior to 1980. This has the effect of imposing a small amount of coal drawdown (5 to 10 feet) over an extended area above these well fields. The drawdown in the vicinity of the mines compares fairly closely, as represented by the similarity of the modeled and actual 20-foot drawdown contour.

In the area immediately west of the Belle Ayr Mine, the extent of drawdown predicted by the model, represented by the five-foot drawdown contour, is very similar to that actually observed, as shown **Figure 4-2B.** The model under-predicts the amount of drawdown in the center of the Marquiss field drawdown cone created by the superimposed influences of mining and CBM. The under-prediction of drawdown in this area is primarily during the early mining period. From 1980 to 1992, prior to significant CBM development, drawdown west of the Belle Ayr mine was between 60 and 100 feet. After CBM development in the Marquiss field, drawdowns in this area increased significantly to over 250 feet. The model matches the increase in drawdown due to CBM development fairly closely, but under predicts the early mining drawdown, resulting in an overall under-prediction of drawdown in this area for 1995. This is described later in the section.

Prediction of Coal Aquifer Drawdown Rate

The model predicted drawdowns in the year 1995 for the Wyodak study area are shown in **Figures 4-3 and 4-4** for the Upper Wyodak and Lower Wyodak coals, respectively. It can be seen that, on a regional scale, the model predicted drawdowns for the year 1995 compare favorably with actual measured drawdowns shown in **Figure 4-2**. The extent of coal drawdown, represented by the five-foot drawdown contour, tends to be more extensive than the GAGMO interpretation in the north and south of the Wyodak study area, for the reasons given earlier.

The model predicted maximum drawdown in the coal aquifer for the Proposed Action CBM development is in the year 2008, and is shown in **Figures 4-5 and 4-6** for the Upper Wyodak and Lower Wyodak coals, respectively. Because the mining and CBM operations are dynamic, the maximum areal extent of drawdown changes over time and may increase in some areas of the PRB while recovering in others. The CBM water production in the project area under the Proposed Action is expected to peak in years 2005 to 2007, resulting in maximum drawdown in about the year 2008.



LEGEND

- Monitoring Well
- Proposed Action Project Boundary
- Coal Lease Boundary
- Population Area
- Potentiometric Surface Contour

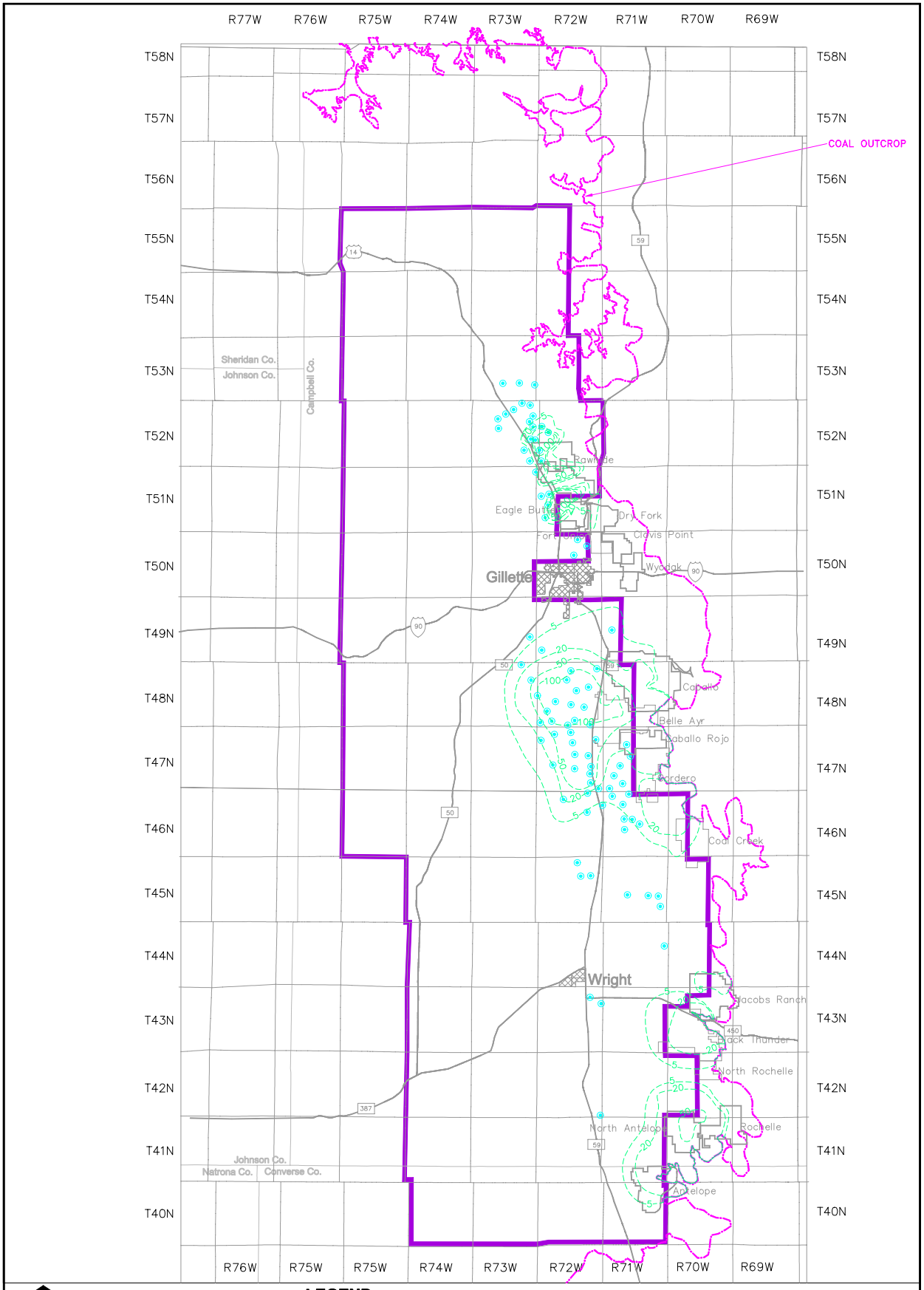
Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-1
Pre-mining Potentiometric Surface

WORKING-DWG-INSERT.DWG
PREMINING-POTSRF.SCR



LEGEND

- Existing Well Pods
- Proposed Action Project Boundary
- Coal Lease Boundary
- Population Area
- GAGMO 15 Year Coal Seam Water Level Changes

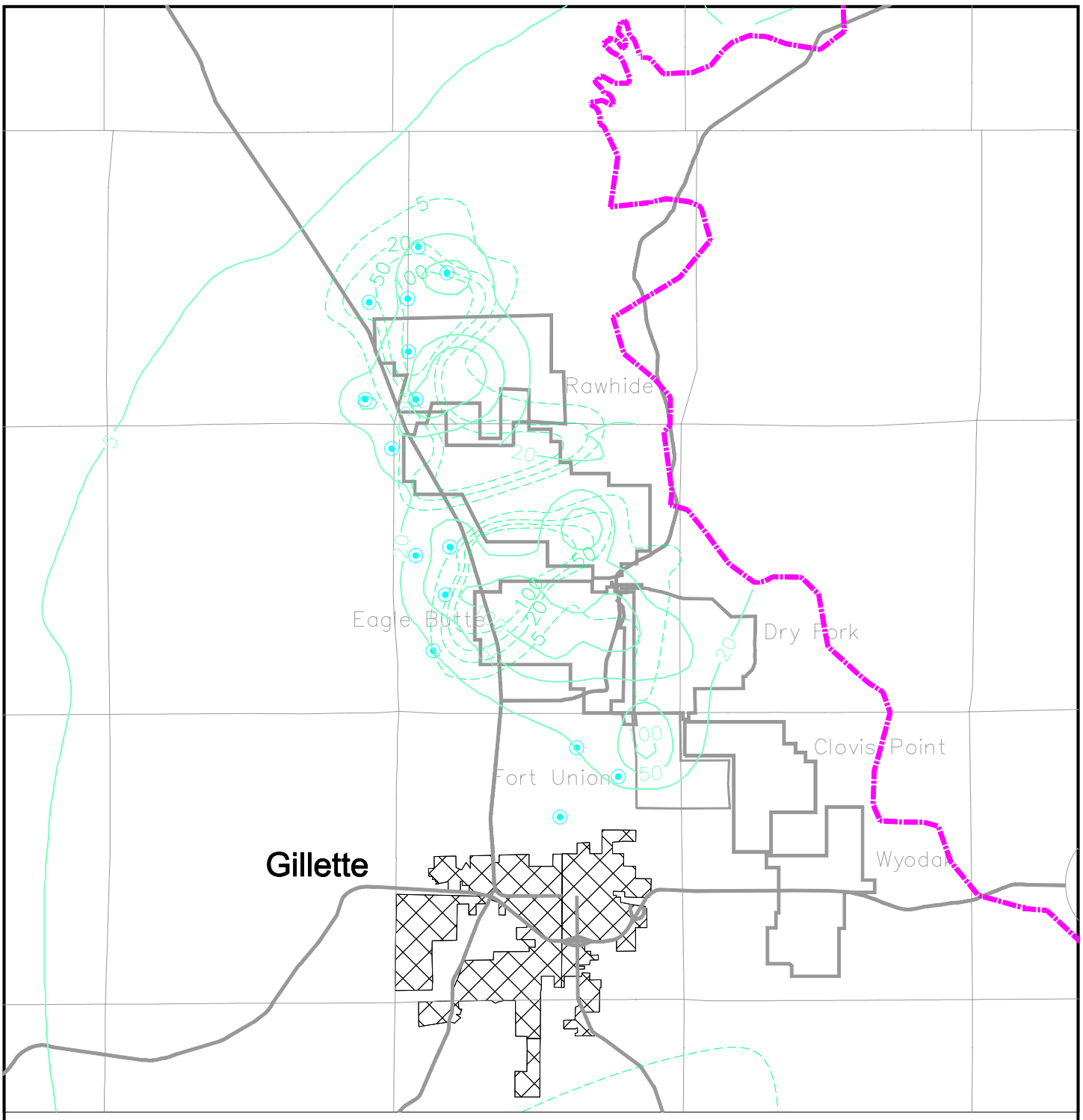
Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-2
GAGMO Coal Drawdown 1995

WORKING-DWG-INSERT.DWG
GAGMO-DD1995.SCR



N

Note: 1 Pod = 10 Wells

0 3 6

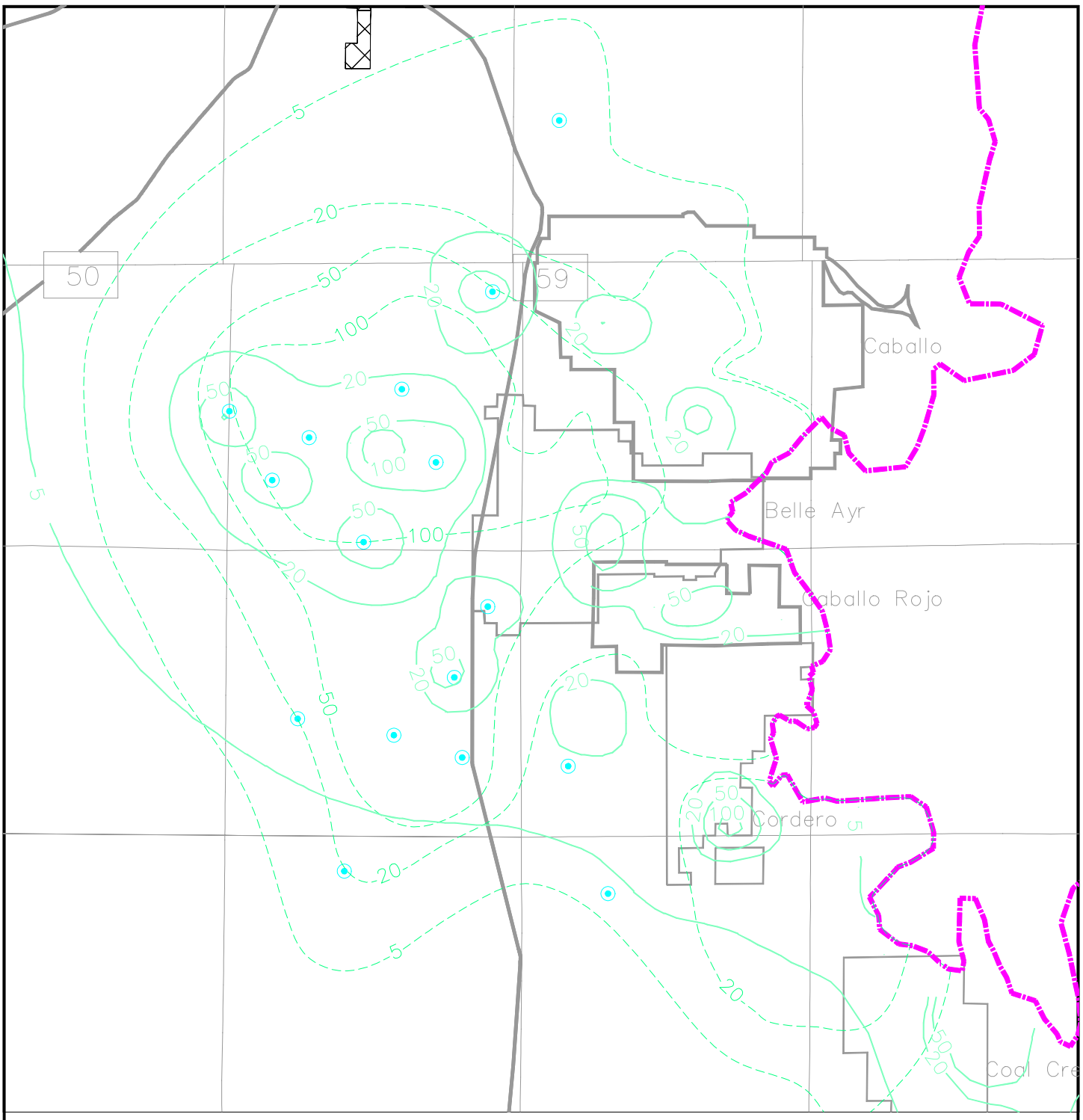
Scale (mi)

LEGEND

- Existing Well Pods in 1995
- Coal Lease Boundary
- Population Area
- GAGMO 15 Year Coal Seam Water Level Changes
- Modeled 1975-1995 Coal Seam Water Level Changes

Figure 4-2a
Comparison of Actual and Modeled 1995 Water Level Changes Northern Project Area-Wyodak Coal

WORKING-DWG-INSERT.DWG
GAGMO-MODELED-DD1995.SCR



N

Note: 1 Pod = 10 Wells

0 3 6

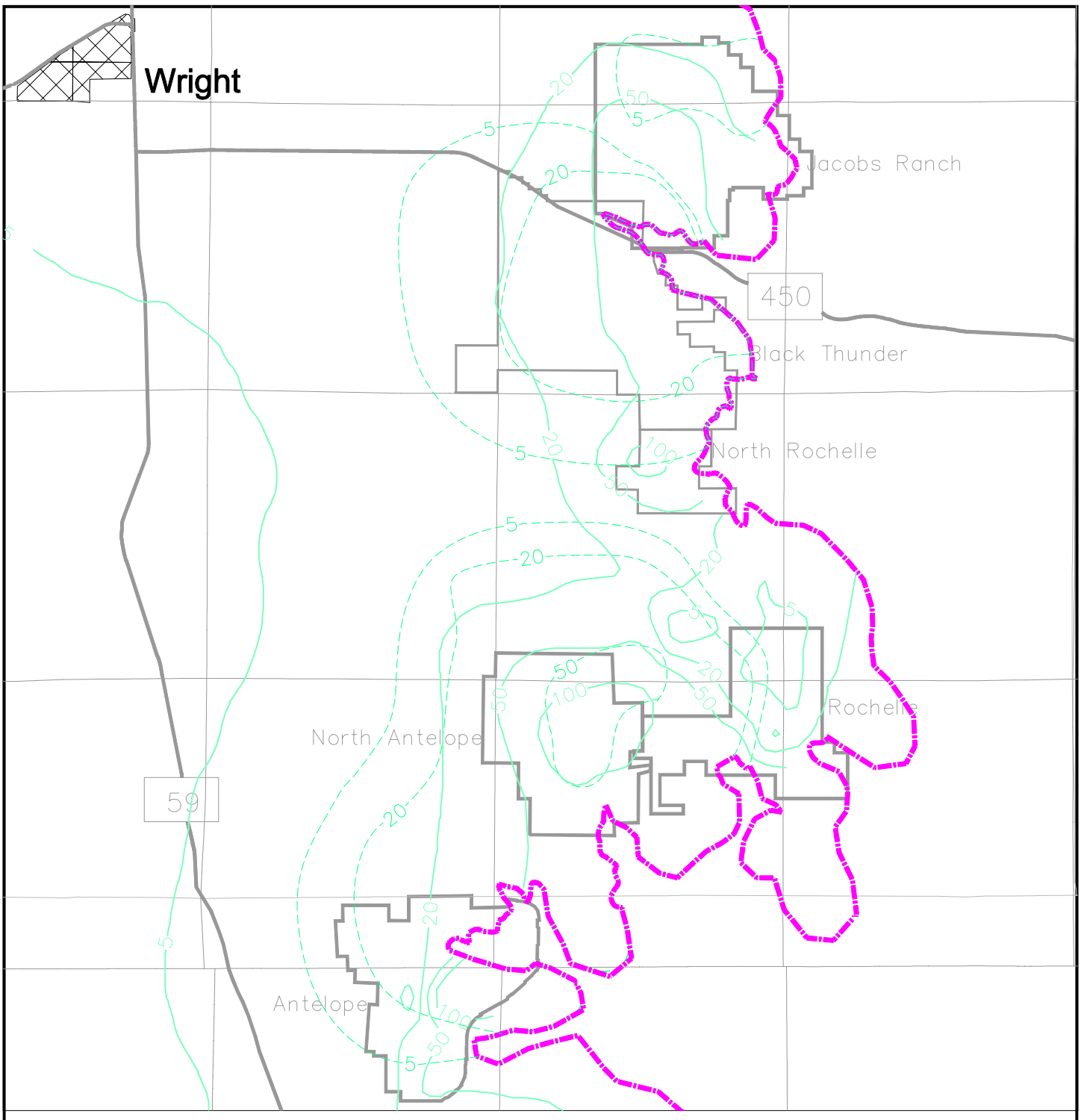
Scale (mi)

LEGEND

- Existing Well Pods in 1995
- Coal Lease Boundary
- Population Area
- GAGMO 15 Year Coal Seam Water Level Changes
- Modeled 1975-1995 Coal Seam Water Level Changes

Figure 4-2b
Comparison of Actual and Modeled 1995 Water Level Changes Middle Project Area-Wyodak Coal

WORKING-DWG-INSERT.DWG
GAGMO-MODELED-DD1995.SCR



N

Note: 1 Pod = 10 Wells

0 3 6

Scale (mi)

LEGEND

- Existing Well Pods in 1995
- Coal Lease Boundary
- Population Area
- GAGMO 15 Year Coal Seam Water Level Changes
- Modeled 1975-1995 Coal Seam Water Level Changes

Figure 4-2c
Comparison of Actual and Modeled 1995 Water Level Changes Southern Project Area-Wyodak Coal

WORKING-DWG-INSERT.DWG
GAGMO-MODELED-DD1995.SCR

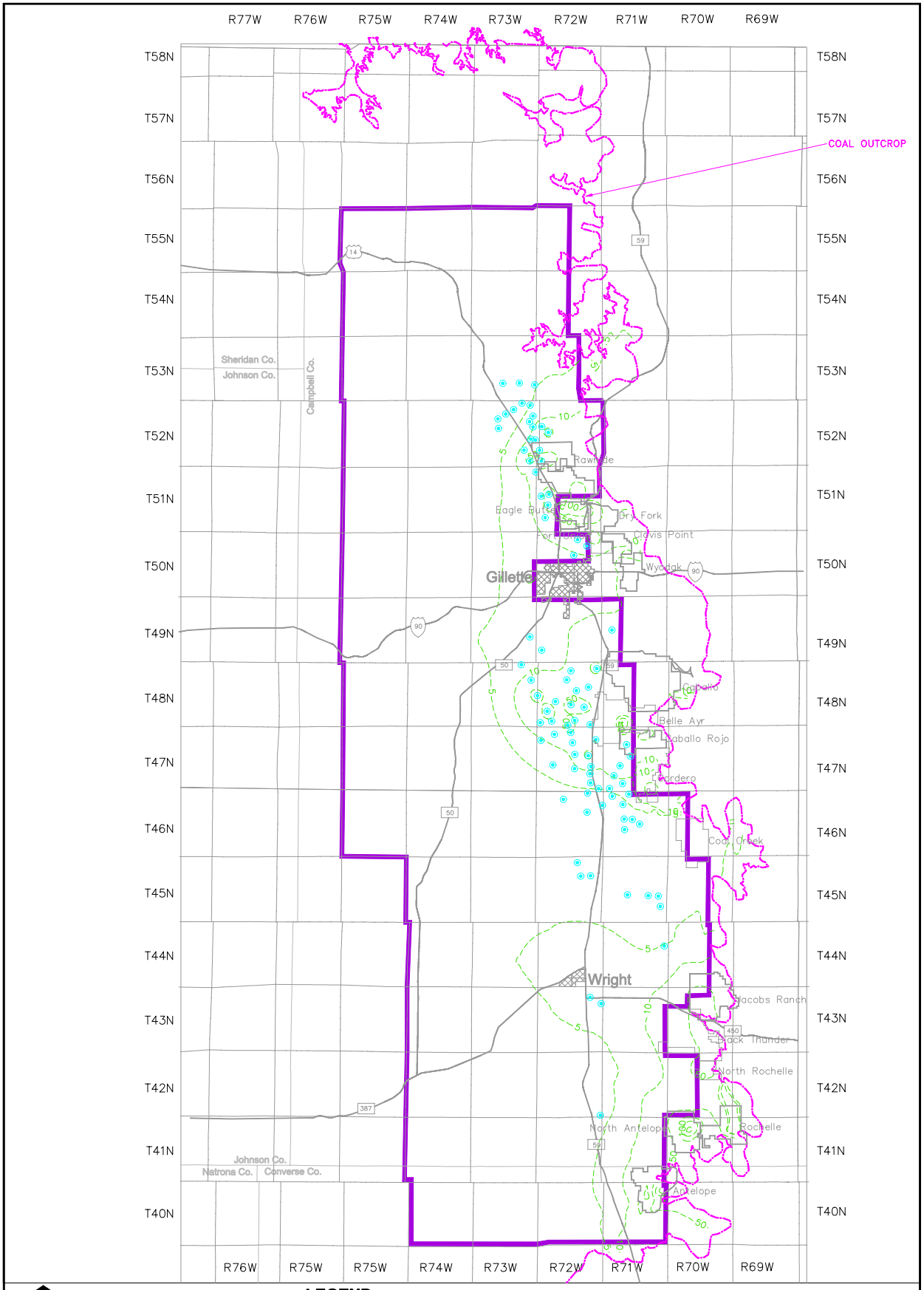


Figure 4-3
Modeled Existing Drawdown 1975-1995

Upper Wyodak Coal

WORKING-DWG-INSERT.DWG
NOACT-DD1995-UP.SCR

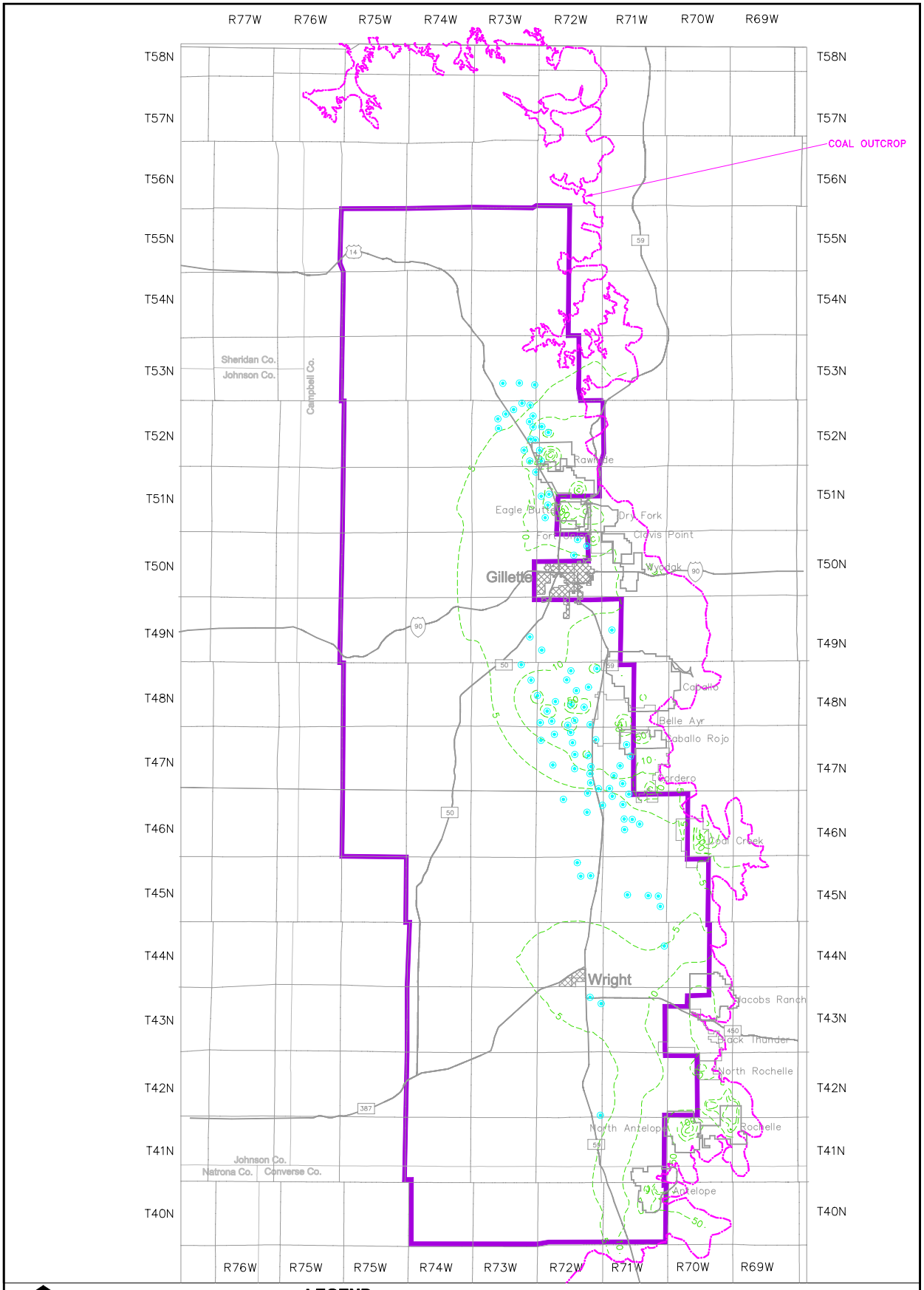
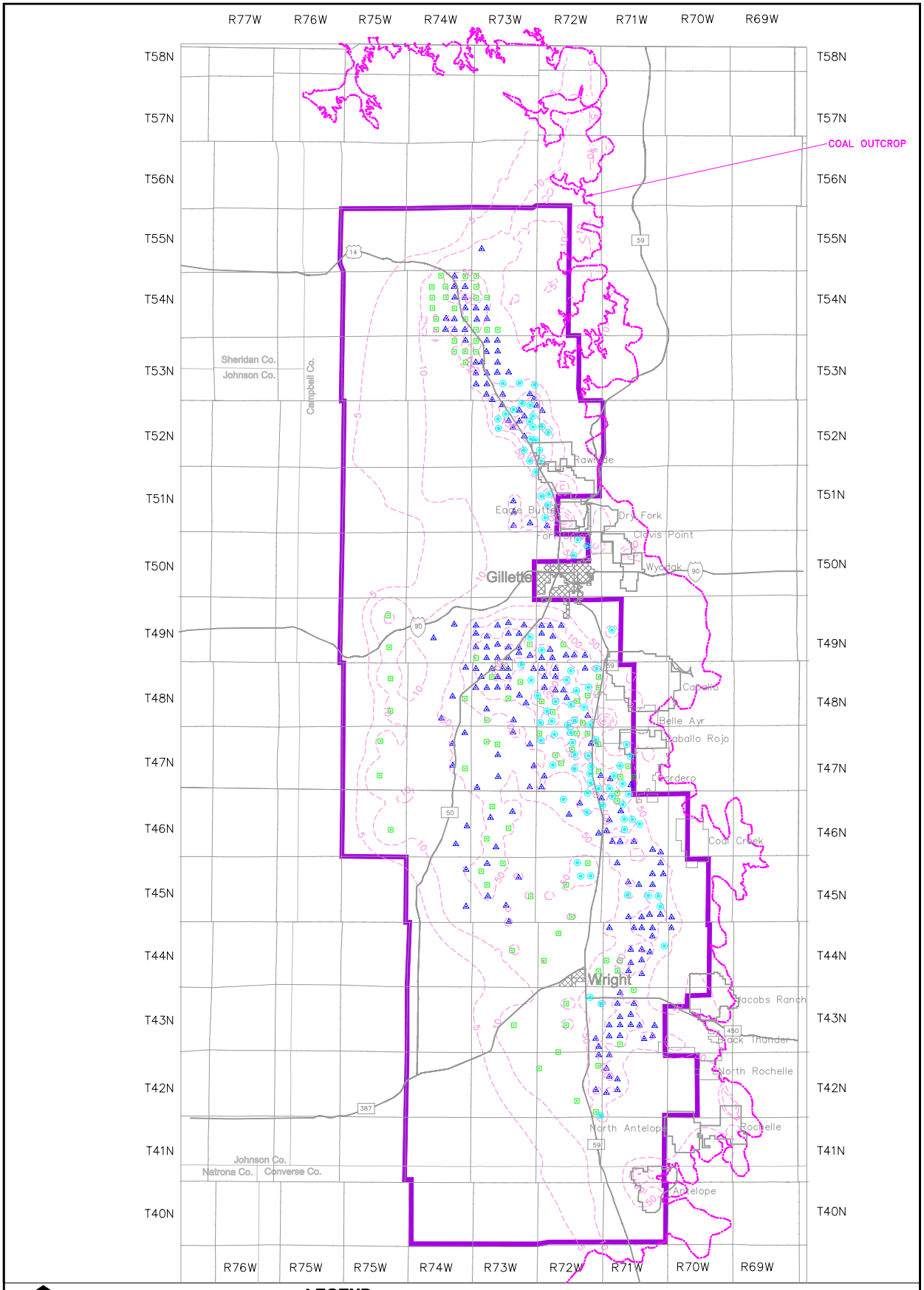


Figure 4-4
Modeled Existing Drawdown 1975-1995

Lower Wyodak Coal

WORKING-DWG-INSERT.DWG
NOACT-DD1995-LWR.SCR



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Projected "Proposed Action" Well Pods
- Proposed Action Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-5
Maximum Modeled Drawdown 1975-2008
Proposed Action
Upper Wyodak Coal

WORKING-DWG-INSERT.DWG
PROPACT-MAX-DD2008-UP.SCR

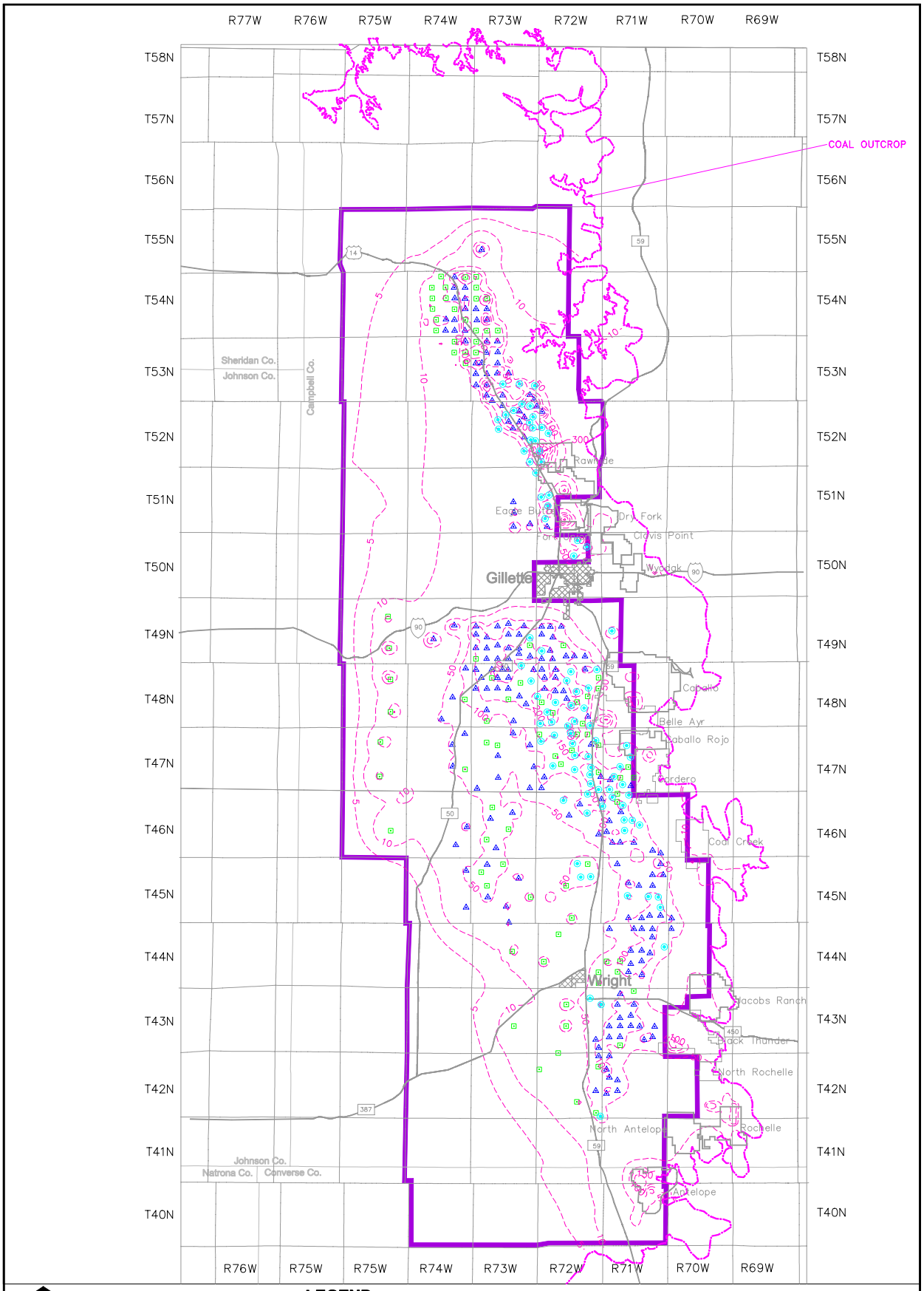


Figure 4-6
Maximum Modeled Drawdown 1975-2008
Proposed Action
Lower Wyodak Coal

WORKING-DWG-INSERT.DWG
PROPACT-MAX-DD2008-LWR.SCR

The maximum extent of drawdown, defined as a drawdown of at least five feet, extends 15 to 24 miles from the point of maximum drawdown within areas of potential dense CBM development such as in the central part of the project area. Predictions of maximum drawdown and extent of drawdown are based on the projected well pod locations. Actual drilling locations and density of drilling may result in shifts of drawdown contours from the results illustrated in the figures.

Maximum drawdowns occur in the vicinity of active mining operations and in the centers of CBM development. Because of the way the numerical model is subdivided into discrete cells, drawdowns due to CBM well pumping are averaged over the area of a cell (typically ten acres). Consequently, the drawdown at a pumping well is not accurately simulated, and would actually be more than represented by the model. The model simulations are representative for areas located greater than 200 to 300 feet from a pumping well. Within the northern portion of the project area, CBM production is primarily from the Upper Wyodak. In this area, model projected drawdowns are generally over 200 feet within the center of the well field and over 300 feet in localized areas. In the southern portion of the project area, the maximum drawdowns are projected to be greater than 100 feet over most of the active well fields, over 200 feet in the center of the well fields and over 300 feet in localized areas. Depths of drawdown are approximately 50 feet more in the Lower Wyodak coal than in the Upper Wyodak coal within active fields.

Hydraulic head in the coal, as measured by the water level in a well completed in the coal, may be several hundred feet above the top of the coal. This is particularly true in the western part of the project area where the depth to the coal may be over 1200 feet while the depth to water in a well tapping the coal may be only 400 feet, resulting in a hydraulic head of 800 feet. Dewatering of the coal in these areas by CBM development can result in drawdown of the hydraulic head to the top of the coal (up to 800 feet) at the location of the pumping wells, even though the thickness of the coal itself may only be 100 feet.

Recovery of water levels in the coal is apparent after CBM production starts to decline. Production is expected to start declining around 2012 and end by around the year 2021. Recharge to the coal comes primarily from the redistribution of stored water in the surrounding coal and continued slow leakage from overlying Wasatch sand aquifers. By 2050, water levels in the coal are projected to recover to within 20 to 50 feet of pre-mining levels. The maximum extent of the 5-foot drawdown to projected to extend 2 to 5 miles from the edges of former CBM development.

The rate of coal aquifer drawdown is presented by graphs of modeled drawdown versus time at selected locations in the model. These graphs also illustrate the recovery of water levels following the cessation of CBM operations and mining operations. The locations of the monitoring points are shown on **Figure 4-7**. A comparison of model projected drawdown in the area of maximum CBM development, for the three development scenarios considered, is shown in **Figure 4-8**. Water levels under the Proposed Action recover more slowly than under Alternative 1 because the drilling of wells under the Proposed Action was modeled to occur over 7.5 years while Alternative 1 was modeled to occur over 5 years. Water level drawdown graphs for selected monitoring wells in the northern and southern portions of the project area are shown in **Figure 4-9**. The graphs show that the water level changes in the coal aquifer induced by CBM operations tend to be fairly rapid. Initial recovery of coal water levels following cessation of CBM operations also is rapid, with levels

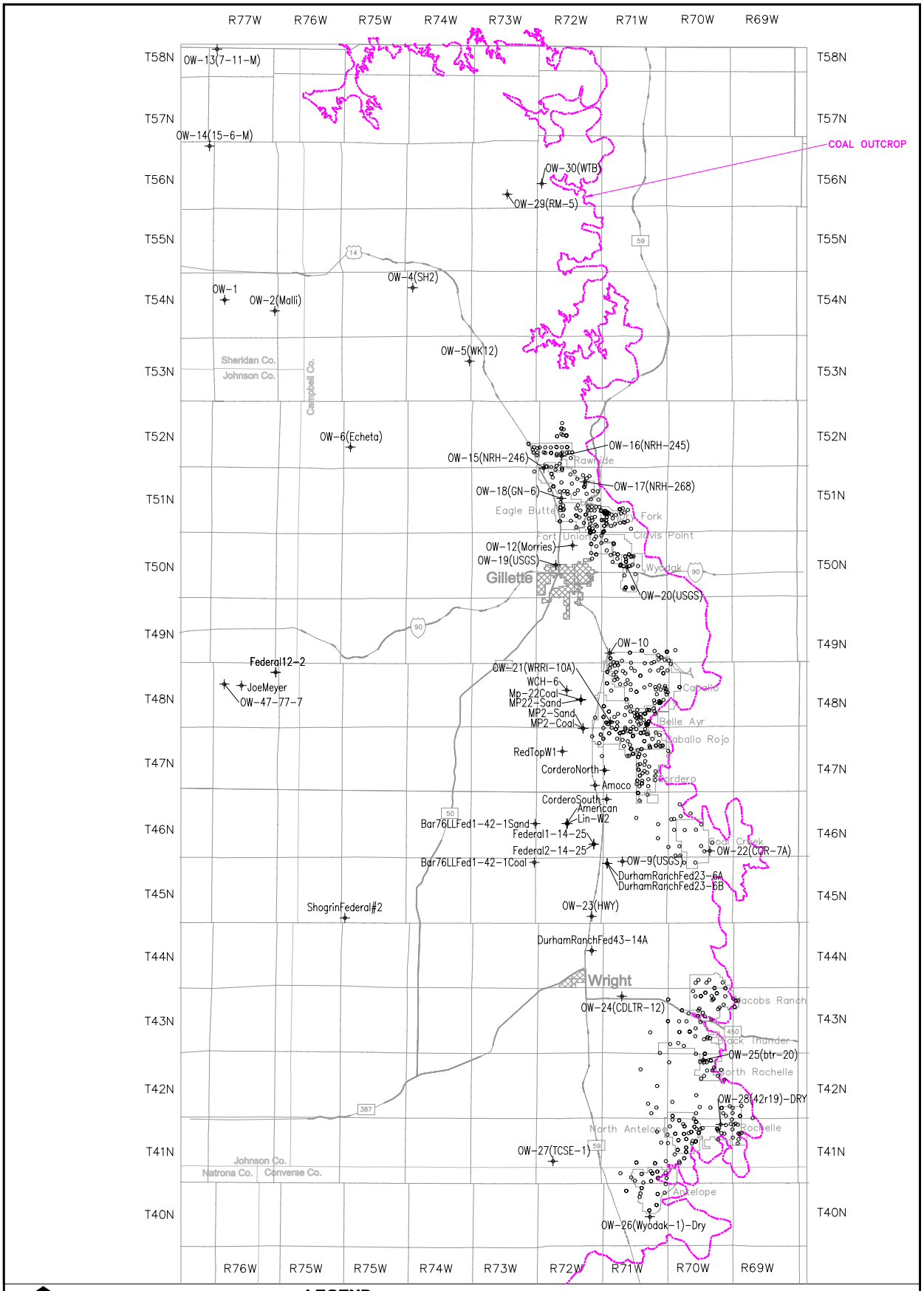
recovering to within less than 40 feet of pre-mining levels within a few years following cessation of CBM operations. However, the rate of recovery slows dramatically after the first few years, and complete recovery to pre-operation conditions may take hundreds of years.

Extent of Aquifer Utilization and the Effect of Predicted Drawdown on this Use

The extent of aquifer utilization has been largely documented in previous assessments. This work was updated and supplemented by examination of WSEO records (**Table 3-8**). Impacts to individual water wells completed within the coal, and in sands above the coal, would depend on proximity to dewatering wells, depth and completion interval of the water well, and the water well yield required to maintain it as a usable source. Drawdown of water levels in coal aquifers caused by CBM development potentially may impact individual well users by reducing well yield. Withdrawal of water from the coal aquifer during CBM development can depressurize the aquifer and induce methane release into nearby water wells. Water level changes are not expected to be as significant in the aquifers above or below the coal because the coal is partially confined both above and below by low permeability claystone layers. Drawdown of water levels in the overlying Wasatch sand aquifers also can impact individual well yields but is not likely to induce methane production in these wells. The model indicates that the sand units within the lower Tongue River and Lebo members of the Fort Union Fm may experience water level declines of up to 50 feet in areas of intensive CBM production in the overlying Wyodak coal. This is unlikely to significantly impact the utilization of these aquifer units for water supply. For individually impacted water wells, see the "Hydrologic Monitoring and Mitigation" section of Chapter 2. A standard agreement has been developed by CBM operators and landowners to monitor and mitigate impacts to individual well owners that are caused by CBM operations. A copy of this agreement format is contained in Appendix D of the DEIS.

Wells fully penetrating the coal with pumps set low within the coal are likely to be less impacted than those only partially penetrating the coal and with relatively shallow set pumps. Water still will be available from the coal at a deeper depth and from shallower or deeper aquifers.

Under the Proposed Action, the model predicts over 300 feet of coal aquifer drawdown near the centers of active CBM development, with drawdown in excess of five feet extending some 15 to 24 miles from these areas (**Figures 4-5 and 4-6**). The maximum available drawdown (the hydraulic pressure head) in the coal aquifer in the affected areas ranges from 300 to 1,000 feet. Most individual water supply wells in the coal seam do not exceed 600 feet and have up to 300 feet of available drawdown. Well pumps typically are set between 50 to 200 feet below the static water level in the well. Significant impact in terms of well yield or availability is likely to be an issue only if the drawdown exceeds about 20 to 30 percent of available drawdown at any given location. This area would tend to coincide with the area of drawdown in excess of about 100 feet. The decreased head against which the well pump has to operate may cause the pump discharge to decrease.



LEGEND

- Pre-mining Calibration or BLM Well
- Transient Calibration Well (GAGMO Well)
- Proposed Action Project Boundary
- "Alternative 1" Project Boundary
- Coal Lease Boundary
- Population Area

Note: 1 Pod = 10 Wells

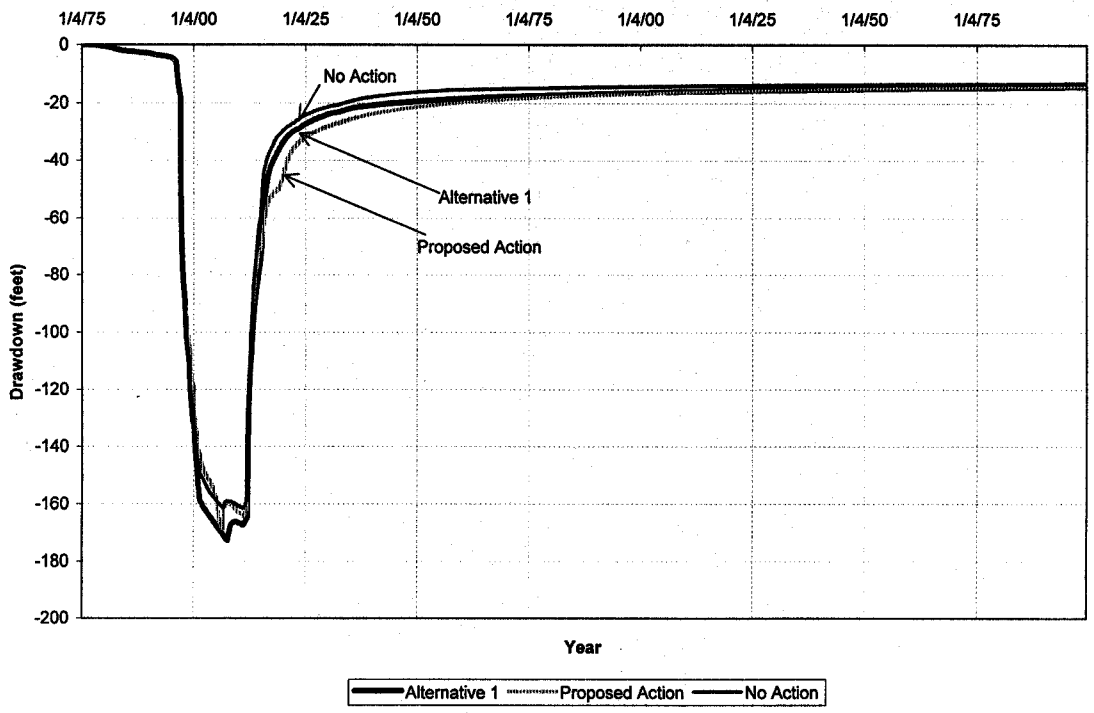
0 8.5 17

Scale (mi)

Figure 4-7
Locations of Monitoring Wells

WORKING-DWG-INSERT.DWG
MW-WELL_LOC.SCR

Figure 4-8
Comparison of Alternatives for Maximum Drawdown Over Time



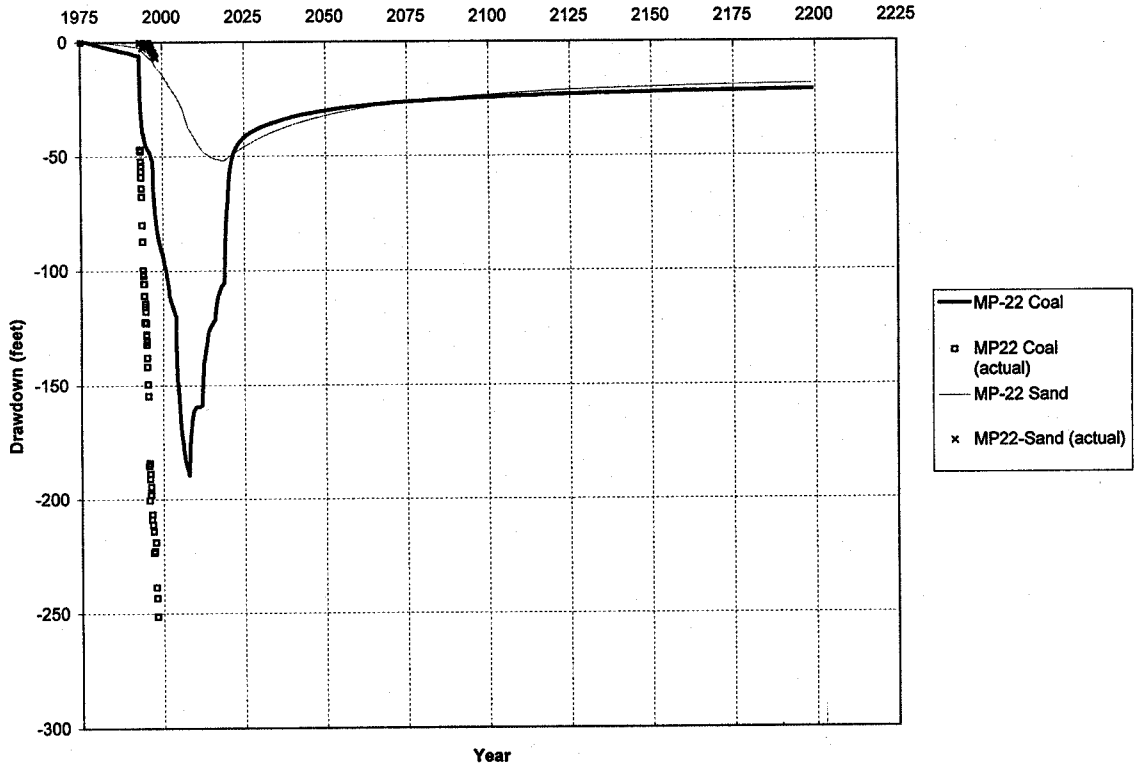
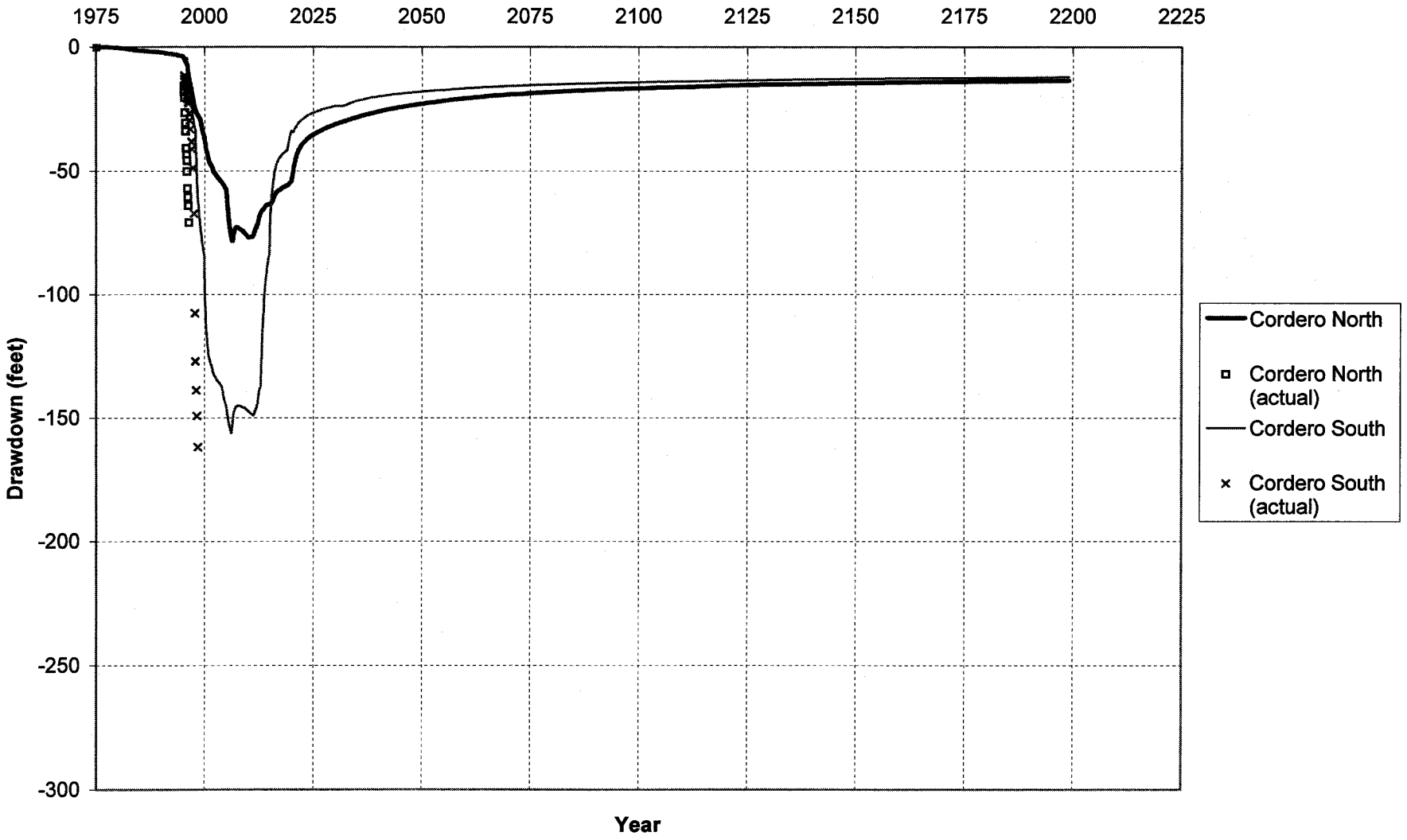


Figure 4-9
Drawdown vs. Time Graphs for Selected BLM Monitoring Wells



However, if sufficient available drawdown remains in the well, yield may be restored by installing a larger pump. In cases where the drawdown causes the water level in a well to drop below the intake of the pump, the pump may have to be lowered in the well.

Individual coal aquifer well users may experience increased methane emissions if their wells fall within an area of significant aquifer depressurization. Records of first indications of methane production in monitoring wells that have experienced water level drops due to mining indicate that methane emission from the coal can occur with as little as 50 feet of head drop (Stowe, 1998). Consequently, coal wells within the predicted 50- foot drawdown area may be susceptible to this impact. Methane emissions by a well pose a potential explosive safety hazard, particularly if gases can build up in an enclosed space. In areas within two miles of operational CBM well fields, well houses and basements should be well ventilated and periodically checked for methane gas.

Over most of the eastern PRB, the Wyodak-Anderson coal is separated from sands in the overlying Wasatch Fm by continuous, low-permeability clay and silt units of variable thickness. Examination of drilling and geophysical logs from coal mine permits and from twelve state-owned sections south of Gillette and west of the coal mine permit areas shows that the thickness of this confining unit ranges from 11 to 363 feet. In most cases, the clay confining unit was at least 30 feet thick. The large variation in thickness is mostly a function of whether any significant sands exist in the lower part of the Wasatch Fm at a given location. This clay unit has the effect of partially isolating the coal from the overlying Wasatch sands. This low permeability zone allows limited hydraulic communication between the coal and the overlying Wasatch sands. A significant period of time (typically several years) will likely pass before drawdown effects in the overlying Wasatch sands are apparent as a result of pumping groundwater from the coal. In addition, as noted in Chapter 3, the integrity of the confining layer may be compromised locally by water supply wells screened through both the coal and the overlying sands, by deteriorating well casings, or by poorly plugged oil and gas wells or exploratory drill holes.

Partial isolation of aquifers overlying the coal has been supported by the results of the BLM water monitoring efforts at the Marquiss CBM project, which has had the longest history of operation (since 1993). In this instance, the BLM has operated two paired wells (a well completed in the coal and a well completed in the next overlying sand zone) since the beginning of the project (see Well MP-22 in **Figure 4-9**). Communication has been seen between the deeper (coal) wells and the shallow (sand) wells. Water level decline in the coal well is up to 200 feet during the five years of monitoring while the water level decline in the overlying aquifer has been documented, but at a relatively mild rate (ten to twenty feet over five years in one well).

CBM production relies on the integrity of the confining layer above the coal. Without the confining layer, the gas would be free to escape to the atmosphere and water leaking downward from shallower layers would make it more difficult or impossible to lower the pressure in the coal seam by pumping water from it.

Drawdown impacts in the overlying Wasatch sand aquifers are predicted to be much less than in the coal aquifer, but may be significant. Model predictions in the Wasatch sands are less reliable than in the coal because of the discontinuous nature of the sands. Predictions are for a sand unit ranging from 200 to 500 feet above the coal. **Figure 4-9** shows the drawdown vs. time predicted in the

Wasatch sands for some selected monitoring well locations. **Figures 4-10, 4-11 and 4-12** show the maximum predicted drawdowns in the Wasatch sands under the Proposed Action, Alternative 1, and No Action CBM development scenarios respectively. The maps show that maximum drawdowns in the Wasatch sands occur in the vicinity of active mining operations and in the centers of CBM development.

The predicted maximum drawdown in the Wasatch Fm associated with CBM development under the Proposed Action occurs in the year 2015, several years after the maximum drawdown predicted in the coal in 2008 (**Figure 4-10**). Drawdown in the Wasatch sands tends to increase slowly as leakage is induced by partial dewatering of the underlying coal. The maximum drawdown is about 60 feet in the northern area at this time. The maximum extent of drawdown in the Wasatch is projected to be as much as 16 miles from the edge of the main centers of CBM development in the central area. The drawdown continues after CBM operations cease, and coal water levels start to recover, because the Wasatch Fm is a source of recharge to the coal. Recovery in the Wasatch tends to occur once coal water levels have recovered significantly and induced leakage from the Wasatch is minimal. The model predicts that water levels in the areas of highest drawdown will recover to within about 20 feet of pre-operational conditions (**Figure 4-9**). There are likely to be local areas in the Wasatch sands which see greater drawdown than predicted by the model due to conducive faults, poorly grouted well bores, and exploration borings. This amount of drawdown may cause impacts to users of Wasatch aquifer water. The water well agreement would provide sufficient protection to landowners if impacts occur.

The predicted maximum drawdown in the Wasatch Fm associated with CBM development under Alternative 1 also occurs in the year 2015, several years after the maximum drawdown predicted in the coal for this alternative in 2010 (**Figure 4-11**). The maximum drawdown is about 80 feet. The maximum extent of drawdown in the Wasatch is projected to be slightly more than in the Proposed Action at about five miles from the edge of the main centers of CBM development.

The predicted maximum drawdown in the Wasatch Fm associated with CBM development under the No Action alternative also occurs in the year 2015, several years after the maximum drawdown predicted in the coal for this alternative in 2008 (**Figure 4-12**). The maximum extent of drawdown in the Wasatch is projected to be slightly less than in the Proposed Action at about three miles from the edge of the main centers of CBM development.

Projected Impacts to Springs

Springs issuing from the Wasatch sands into surface drainages are unlikely to be affected by CBM development. This is due to the projected limited effect of CBM development on Wasatch Fm water levels described in the previous section.

The public expressed concern regarding the potential impact of CBM development on springs issuing from the clinker outcrops, such as the Moyer Springs north of Gillette. Moyer Springs is located in Sec. 30 T51N R71W, outside the proposed project area but its recharge area is close to the CBM development area.

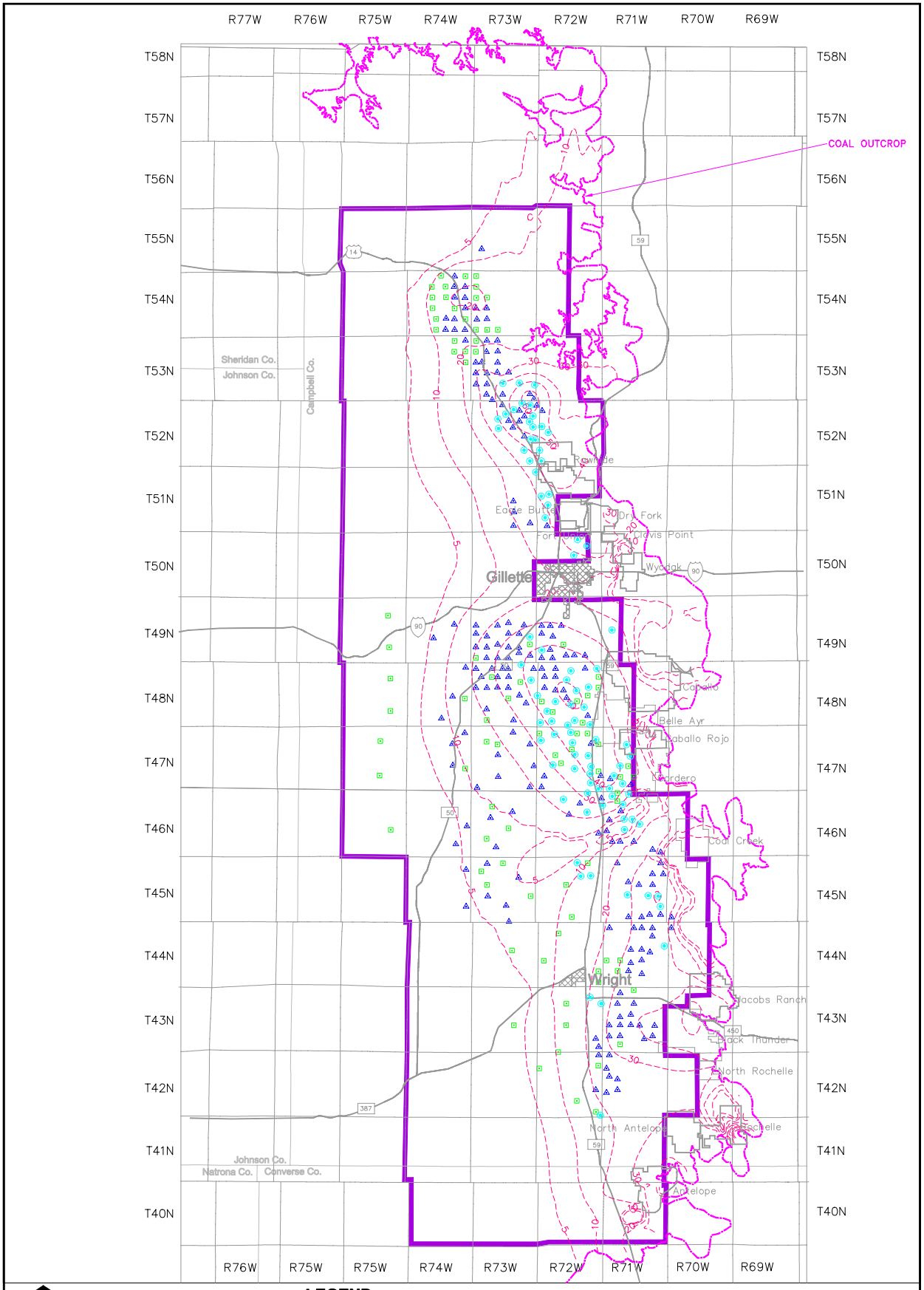
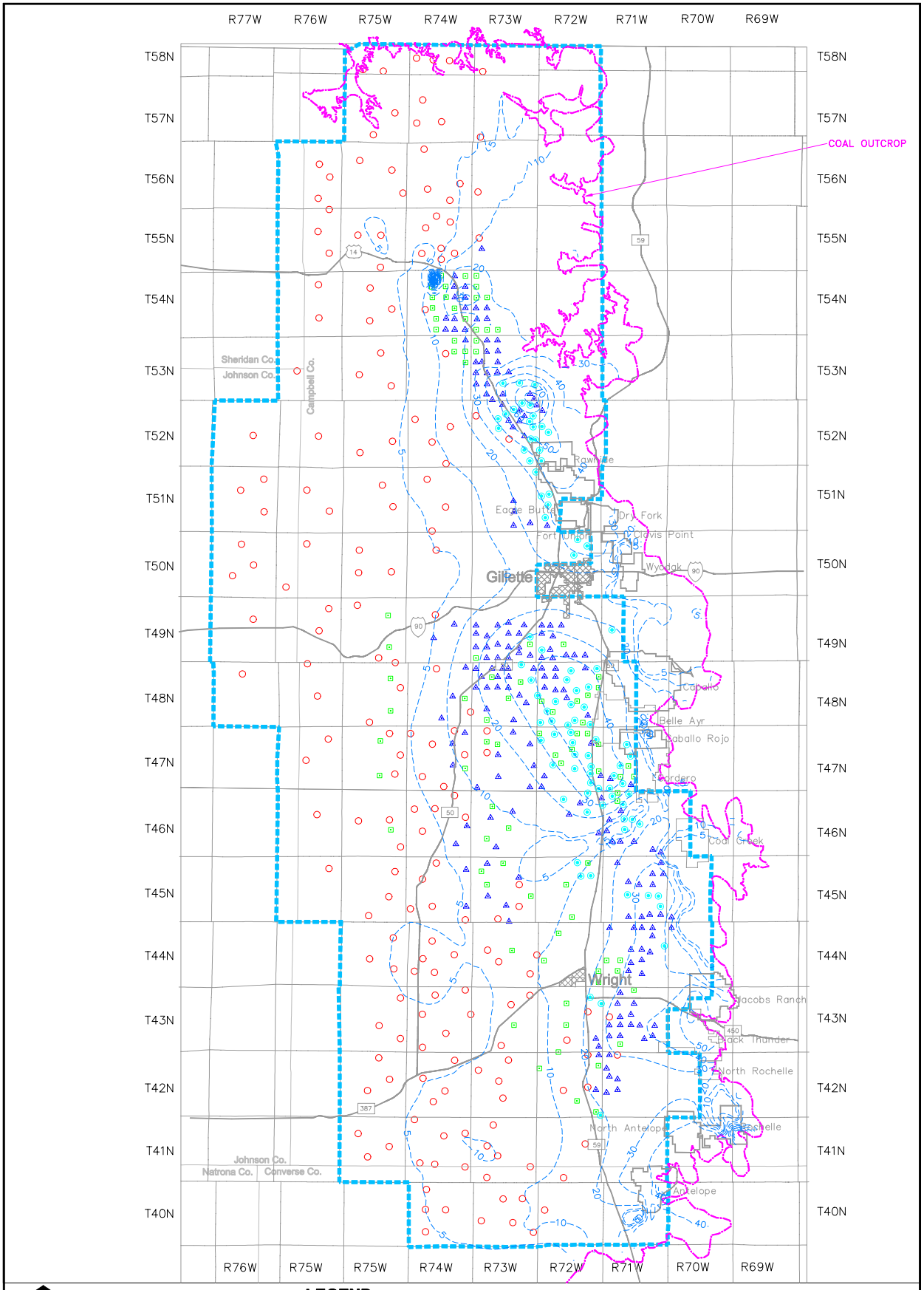


Figure 4-10
Maximum Modeled Drawdown 1975-2015
Proposed Action
Wasatch Sand

WORKING-DWG-INSERT.DWG
PROPACT-MAX-DD2015-WASATCH.SCR



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Projected "Proposed Action" Well Pods
- Projected "Alternative 1" Well Pod
- "Alternative 1" Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

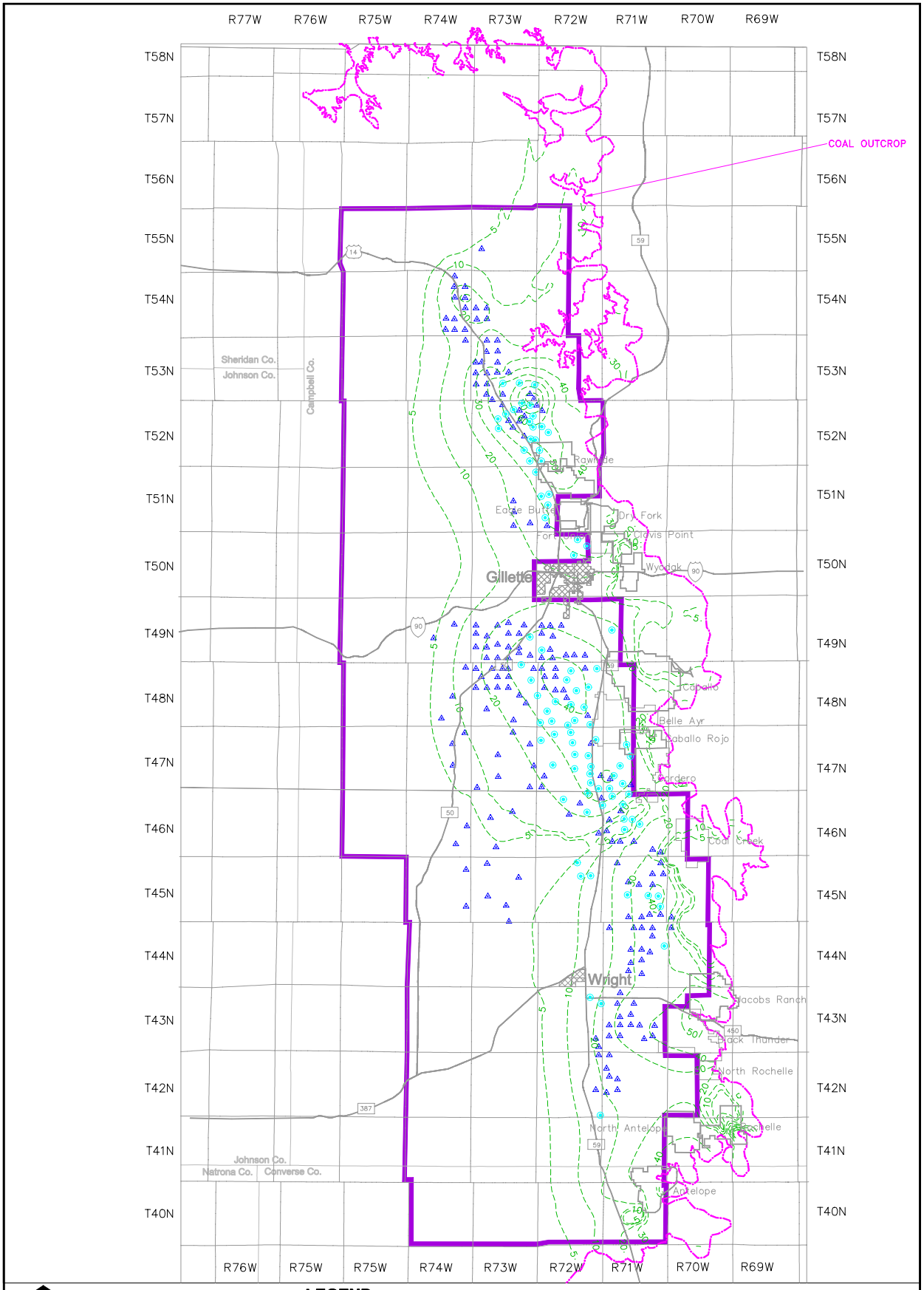
Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-11
Maximum Modeled Drawdown 1975-2015
Alternative 1
Wasatch Sand

WORKING-DWG-INSERT.DWG
ALT1-MAX-DD2007-WASATCH.SCR



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Proposed Action Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-12
Maximum Modeled Drawdown 1975-2015
No Action
Wasatch Sand

WORKING-DWG-INSERT.DWG
NOACT-MAX-DD2015-WASATCH.SCR

Moyer Springs is located at the base of an exposed clinker deposit that is in the outcrop area of the target coal seam (known as the Roland-Smith in this area of the PRB). Recharge of the springs is through surface infiltration and lateral movement of water from adjacent clinker and alluvium. Large areas of clinker are exposed northeast and southeast of Moyer Springs (USGS, 1978).

This exposure allows a large amount of recharge to the clinker by infiltration of rainfall and snowmelt. USGS (1973) reported a flow of 200 gallons per minute from Moyer Springs. The contact between the clinker and the associated coal seam in this area appears to have a low permeability. Although the natural discharge of springs potentially can be impacted by a reduction in the hydraulic head in the source aquifer unit, the presence of a low permeability zone between the clinker and the target coal results in water in the clinker being channeled to the spring rather than recharging the coal. The presence of the low permeability zone between the clinker and the target coal inhibits flow between these units. This fact and the high flow rate observed at Moyer Springs imply that production of Wyodak groundwater during CBM operations should not adversely affect the hydrology of Moyer Springs. The potential impact to Moyer Springs flows by proposed surface mining has been recognized, as removal of the Wasatch Fm and alluvial overburden during mining operations may decrease recharge to the spring. Accordingly, the Dry Fork Mine Permit requires Dry Fork Coal Company to protect the clinker aquifer that feeds Moyer Springs.

CBM operations are not expected to have any impact on Moyer Spring water quality because discharge water is not likely to encroach on the recharge area of the spring. Water from Moyer Springs is of calcium sulfate chemical type, with total dissolved solids concentrations in the 1,000 mg/l to 2,000 mg/l range (USGS, 1973). CBM production water from the Wyodak coal will be of equal or better quality. Therefore, even if some CBM discharge water did recharge the Moyer Springs, CBM operations should not adversely affect its water quality.

The description of potential impacts to Moyer Springs is applicable to other springs issuing from clinker outcrops. Therefore, no impacts to these springs are projected.

Rate of Coal Aquifer Recharge after CBM Operations Cease

Recovery of groundwater levels in the coal aquifer after CBM operations cease is best illustrated in the comparative drawdown graph for the various CBM development scenarios in **Figure 4-8** and in the graphs of selected monitoring locations in **Figure 4-9**. Initially recovery is primarily due to redistribution of groundwater stored in the aquifer. When the stresses of pumping are removed, the groundwater in storage to the west, north and south of the CBM development area will resaturate and repressurize the areas that were partially depressurized during operations. The amount of groundwater storage within the coal to the west of the development is enormous, and redistribution is predicted to result in a fairly rapid initial recovery of water levels in the coal. The model predicts that this initial rapid recovery period will occur over three to four years, but water levels only will recover to within 20 to 30 feet of pre-operational conditions.

Complete water level recovery will be a very long-term process because actual recharge to the coal aquifer needs to replace groundwater removed from storage during CBM operations. Actual recharge to the coal through surface infiltration at the eastern outcrop area is a relatively slow process. Coal mining along the eastern outcrop results in minimal recharge to the coal while mines are active, due to the groundwater sink caused by pit dewatering. As mines are reclaimed and eventually shut down, the backfilled areas would become long-term recharge zones for the coal aquifer. Infiltration through backfill areas may be very significant because the permeability of the backfill materials tends to be much higher than in the original unmined materials. In addition, most of the creeks would be diverted over these backfilled areas, providing a significant source of recharge water.

Contribution of Extracted Coal Groundwater to the Recharge of Shallow Wasatch Sand Aquifers

Extracted groundwater from CBM operations currently is released to surface waters. A portion of the released water recharges the alluvium along the creek valleys that in turn recharges the underlying Wasatch units. AMAX Coal West's Belle Ayr Mine monitoring data noted slight "mounding" of groundwater levels within the Wasatch sand in the vicinity of Caballo Creek, indicating that this recharge is occurring. Monitoring of alluvial water levels in Hoe Creek has also indicated water level rises due to increased creek recharge. The extent of recharge has not been quantified and is primarily a function of the permeability of the surficial Wasatch geologic units underlying the creeks in any given area.

Alluvium with near-surface water tables, similar to the Donkey Creek alluvium in Gillette, will likely see increases in water levels from CBM produced water discharge. The increase in water level may be exhibited as standing water in areas not previously displaying this condition or as wetland development. The City of Gillette is pumping the alluvium within the community (Appendix E, Letter No. 23 and Carson 1999). The city's rate of pumping will likely have to increase to maintain current water levels during continued CBM field development.

The recharge effect was evaluated in this analysis by examining the area of affected alluvial drainages and the probable range of vertical infiltration rates into the Wasatch Fm below the creeks. The total discharge from CBM operations was calculated for each of the major surface drainages under the three alternatives (**Tables 2-1 and 2-2**). This discharge was assumed to flow toward the major creeks within each drainage. Surface water losses in river flows due to conveyance losses (evapotranspiration and leakage) were assumed to be one percent of the flow per mile (WSEO, 1998a). Recharge of shallow aquifers due to leakage from rivers was assumed to be 20 percent of the conveyance loss (Babb, 1998). The area of alluvium was estimated for all major creeks downgradient from proposed CBM operations and the river leakage then expressed as an equivalent recharge. An upper recharge limit of five inches per year was assumed, based on the expected ability of the underlying Wasatch to accept this recharge. This recharge along the major drainages was then input into the model for the time period when CBM operations are expected to be active.

The Wasatch sand maximum drawdown for the year 2015 (**Figures 4-10, 4-11, and 4-12**) shows much less drawdown than the Fort Union coals. This is primarily due to the sand isolation from the

pumped coals, but also because the Wasatch sands are recharged by water infiltrating into the alluvium. There is significantly less drawdown of the Wasatch sands in the vicinity of major creeks as a result of the recharge. In some areas, a build-up of water levels is predicted due to recharge derived from CBM produced waters discharged into streams.

Effect of Variable Pumping Rates on Predicted Impacts

The projected pumping rates for the proposed CBM development scenarios are estimated based on experience from current operations. As stated earlier, the model used a uniform well extraction rate of 12 gallons per minute for the entire duration of an assumed 15-year life for each well. This rate is considered to be conservative in terms of drawdown prediction because the more extensive dewatering effect of the denser well spacing in the proposed development may result in lesser pumping rates for individual wells or a more rapid decline in these rates.

Water Quality

Groundwater produced from the Wyodak coal during CBM operations will be discharged to local drainages. This water has the potential to recharge shallow aquifers, primarily local alluvial aquifers and Wasatch Fm sands, as discussed in the section of water quantity impacts. Drilling is not expected to modify water quality in the formations drilled in the development of the CBM well. Thus, there should be no impact to the quality of aquifers in the Wasatch sands or the Wyodak coal. Similarly, groundwater quality in the major bedrock aquifers below the Wyodak coal will not be affected by CBM operations. Alluvial water quality may become less saline with active constant recharge from surface waters.

Recharge by coal aquifer water will result in localized mixing with the waters of the alluvial and Wasatch aquifers. Comparison of total dissolved solids (TDS) and specific chemical constituent concentrations in the Wyodak coal groundwater with Wasatch and alluvial aquifer groundwater will show the impact this mixing will have on water quality in these upper aquifers.

Potential Water Quality Impacts Due to Recharge of Coal Aquifer Water

As discussed in Chapter 3, groundwater quality in the Wyodak coal (average TDS = 764 mg/l, WDEQ, 1998a) is typically equal to or better in quality than that in the Wasatch Fm (average TDS = 1,415 mg/l) and alluvial aquifers (average TDS = 2,232 mg/l). Chemical groundwater type in the Wyodak coal is predominantly sodium bicarbonate as compared with the Wasatch Fm and alluvium (calcium and sodium sulfate). Coal aquifer water typically does not have elevated concentrations of selenium. Therefore, discharge of Wyodak production water from the CBM program to local alluvial and Wasatch aquifers is not projected to adversely affect groundwater quality in these aquifers. There may be a slight shift from a calcium/sodium sulfate dominated water chemistry towards a more sodium bicarbonate type. However, this shift is only likely to be noticeable in localized areas of alluvial recharge. The water chemistry shift is not anticipated to be very significant or detrimental. Sodium bicarbonate water generally is considered to be better than calcium/sodium sulfate water for domestic and stock uses. Sulfate has a secondary drinking water quality standard of 250 mg/l while bicarbonate has no water quality standard.

Potential Impacts to Groundwater Quality Due to Drilling Operations

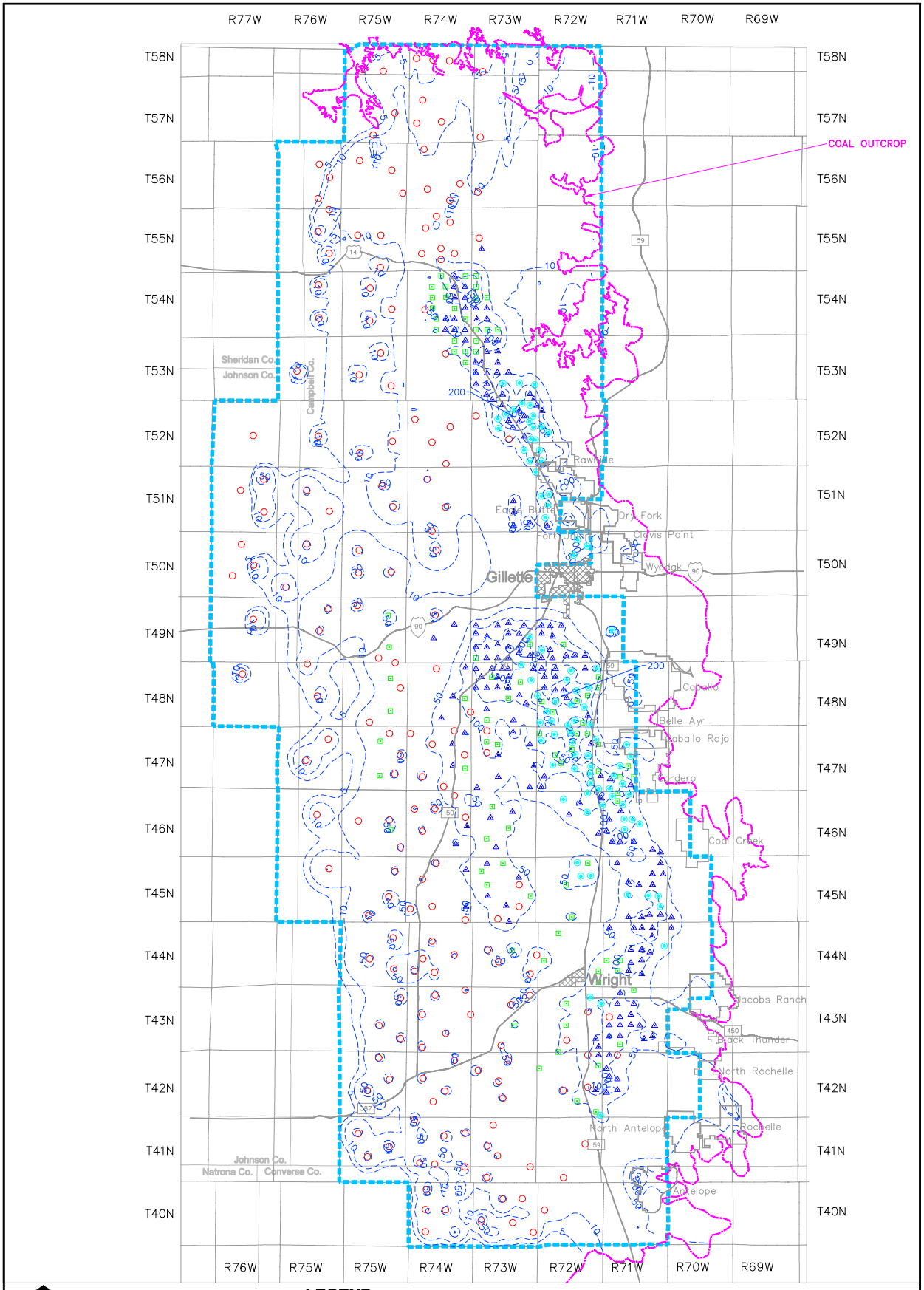
During drilling of CBM production wells, various chemical additives are added to the drilling fluids to enhance drill cutting removal and hole stability. Typically, the Wasatch Fm is drilled using mud rotary drilling techniques. Drilling mud is usually native mud and bentonite. As hole conditions dictate, small amounts of polymer additives and/or potassium chloride salts may be added for hole cleaning and clay stabilization. The potassium chloride and the chemicals within the polymers do not pose toxicity problems if used in accordance with manufacturers' specifications. Well casing extending to the top of the target coal seam is cemented into place. The coal is then drilled out using air rotary drilling techniques. A drilling foam is usually added to the air to enhance cuttings removal. The chemicals within the foam are also non-toxic, when used in accordance with manufacturers' specifications.

Most of the drilling fluids are removed from the borehole during well completion and are collected in surface drilling pits during both the mud-rotary and air-rotary drilling operations. After drilling is complete, the drilling pits are allowed to dry out and then are backfilled and revegetated. Post drilling fracturing of the coal seam for permeability enhancement involves the injection of clean water only. This water is removed during subsequent water production from the well. Based on the use of non-toxic chemicals during well-drilling operations and the removal of most drilling fluids, there is an extremely low potential for degradation of groundwater in either the coal or Wasatch sand aquifers due to CBM exploration and development.

Alternative 1

Drawdowns in the coal aquifer are more extensive for Alternative 1, compared with the Proposed Action. This is illustrated in **Figures 4-13 and 4-14** for year 2010 as the time of greatest drawdown impact in the expanded project area. The more extensive drawdown area results from more widespread CBM development and the extraction of groundwater from a larger number of wells. As noted previously, modeled results reflect educated projections of the locations and densities of well pods within the expanded project area. Actual drilling sites may modify the locations of maximum drawdown and the extent of drawdown. A comparison of the extent and depth of drawdown for the three alternatives is summarized on **Table 4-1**.

The maximum extent of drawdown in both the Upper and Lower Wyodak coals, defined as a drawdown of at least five feet, extends about 27 to 30 miles from the maximum point of CBM drawdown. In areas of potentially less dense development, such as west of Highway 50 and south of the town of Wright, the extent of drawdown is about 30 miles from the maximum point of drawdown in the CBM development areas. Maximum drawdowns in the areas of most extensive development under Alternative 1 are similar to or slightly more than drawdowns under the Proposed Action. The maximum predicted drawdown in the northern portion of the expanded project area and in the area south of Gillette is over 200 feet. The maximum drawdown is over 100 feet in the southern portion of the expanded project area for the Upper Wyodak coal seam.



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Projected "Proposed Action" Well Pods
- Projected "Alternative 1" Well Pods
- "Alternative 1" Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-13
Maximum Modeled Drawdown 1975-2010
Alternative 1
Upper Wyodak Coal

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ALT1-MAX-DD2007-UP.SCR

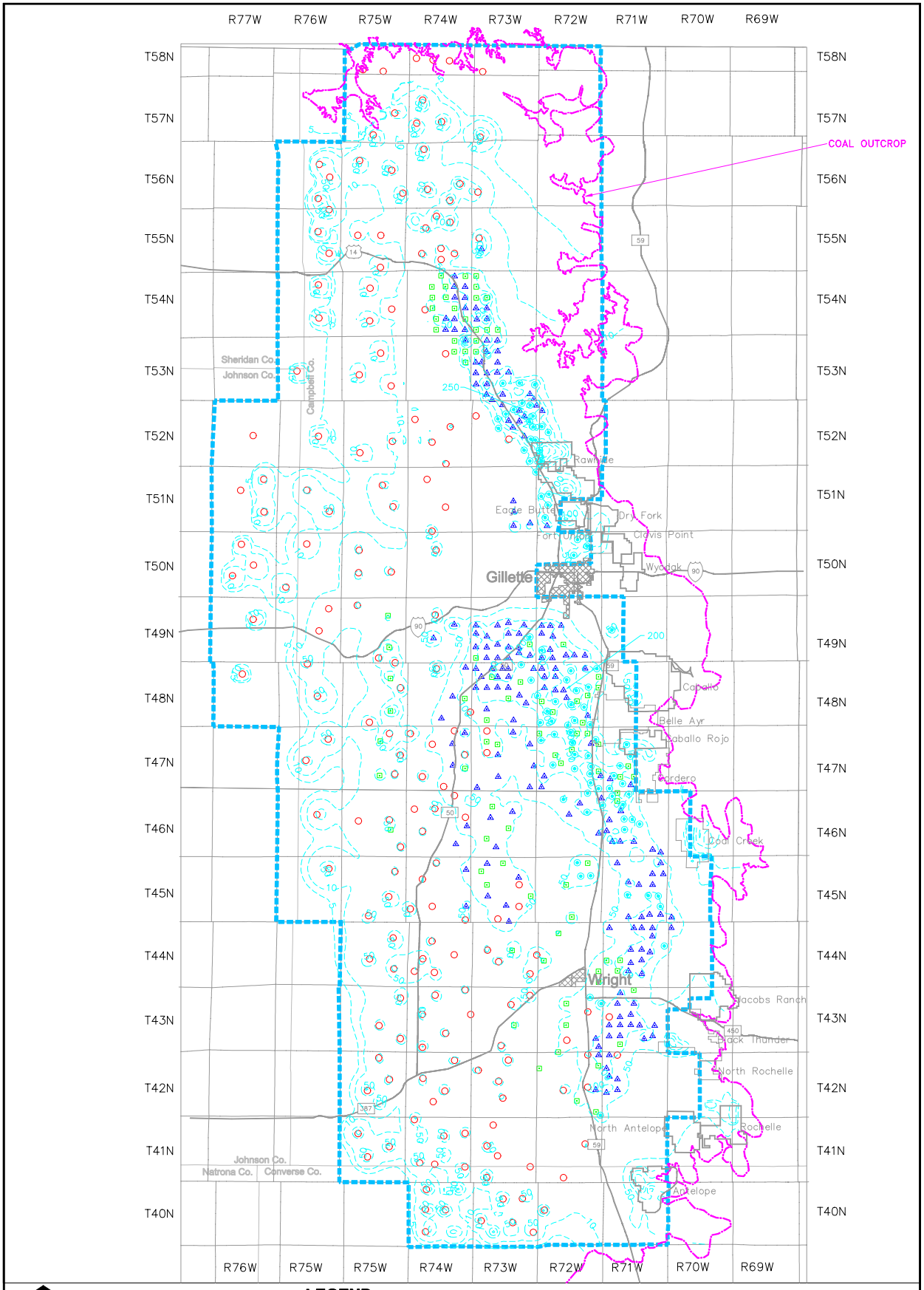


Figure 4-14
Maximum Modeled Drawdown 1975-2010
Alternative 1
Lower Wyodak Coal

WORKING-DWG-INSERT.DWG
ALT1-MAX-DD2007-LWR.SCR

Table 4-1 Comparison of Extent and Depth of Maximum Drawdown by Alternatives			
	Proposed Action 2008	**Alternative 1 2010**	**No Action 2008**
Upper Coal Maximum 5' Drawdown Extension (miles)			
North	19	27	18
Central	24	34	20
South	21	30	22
Maximum Drawdown (feet)			
North	>200	>200	>200
Central	>200	>200	>200
South	>100	>100	>100
Lower Coal 5' Drawdown Extension (miles)			
North	20	30	20
Central	22	30	25
South	15	30	14
Maximum Drawdown (feet)			
North	>300	>250	>250
Central	>250	>200	>200
South	>100	>100	>100
	Proposed Action 2015	**Alternative 1 2015**	**No Action 2015**
Wasatch 5' Drawdown Extension (miles)			
North	15	17	15
Central	16	18	17
South	18	30	16
Maximum Drawdown (feet)			
North	>60	>80	>80
Central	>50	>40	>40
South	>50	>60	>50

Maximum Wasatch Fm drawdowns are up to 80 feet and occur in the year 2015 (**Figure 4-11**. Maximum drawdowns border the eastern boundary of the expanded project area near the coal outcrop. The areal extent of drawdown to the 5-foot contour level is about 17 to 30 miles from the maximum point of drawdown in the areas of most intense CBM development.

No Action

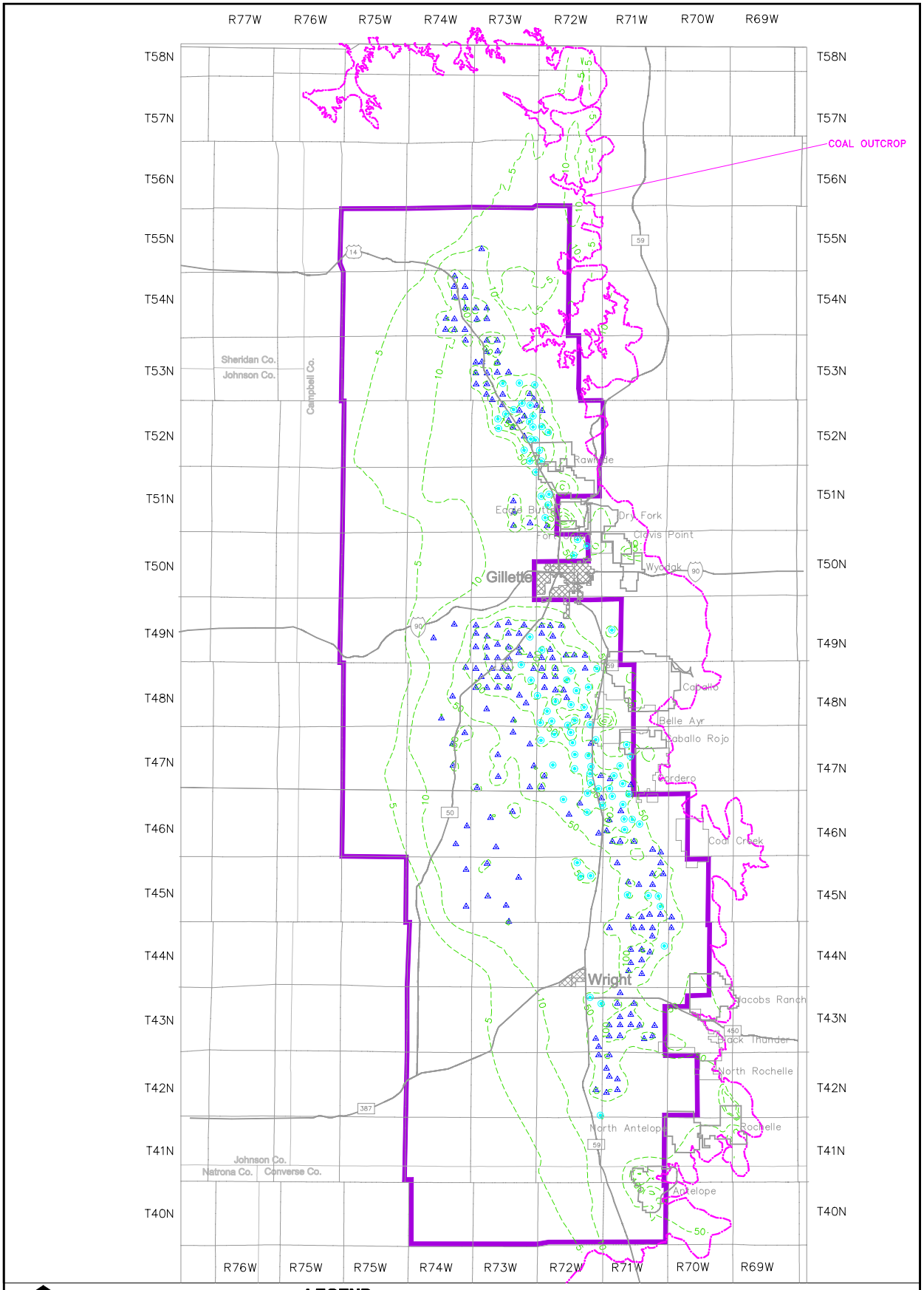
Compared with the Proposed Action, drawdowns in the coal aquifer are less extensive under the No Action Alternative. This is illustrated in **Figures 4-15 and 4-16** for year 2008 as the time of greatest drawdown impact in the project area. The less extensive drawdown results from lower and less dense CBM development. The maximum extent of drawdown extends about 14 to 25 miles from the maximum point of drawdown in the areas of most intense CBM development. Maximum drawdowns in the areas of most extensive development are similar or slightly less than expected drawdowns for the Proposed Action. The maximum predicted drawdown in the Upper Wyodak coal for the northern portion of the project area is over 200 feet, for the central portion of the project area south of Gillette is over 200 feet, and for the southern portion of the project area is over 100 feet. The extent of drawdown and maximum drawdown is slightly greater for the Lower Wyodak coal (**Table 4-1**).

The maximum drawdown projected for the Wasatch Fm will occur along the eastern boundary of the project area and will range from 40 to 80 feet (**Figure 4-12**). The maximum extent of drawdown in the Wasatch is projected to be slightly less than in the Proposed Action and ranges from 15 to 17 miles from the main centers of CBM development.

GROUNDWATER CUMULATIVE IMPACTS

The cumulative impact of surface coal mining and CBM development on groundwater emerged as an area of concern during the scoping process and in comments received on coal leasing proposals and the CBM projects. The Land Quality Division (LQD) of the WDEQ is required by the Surface Mining Control and Reclamation Act (SMCRA) and LQD rules and regulations (WDEQ, 1998d) to assess the potential for cumulative hydrologic impacts of current and anticipated mining on the ground and surface water systems each time a mine permit application or a mine permit revision is made.

In 1987, the USGS, in cooperation with the LQD and the Office of Surface Mining, Reclamation and Enforcement (OSM), conducted a study of the hydrology of the eastern PRB. The purpose of the study was to provide the hydrologic information needed to perform these assessments. The resulting document, "Cumulative Potential Hydrologic Impacts of Surface Coal Mining in the Eastern Powder River Structural Basin, Northeastern Wyoming," (CHIA) describes the cumulative effects of all current and anticipated mining (as of 1987) on the hydrologic system (USGS, 1988). At the time, the 1988 CHIA was the most comprehensive basin-wide assessment of the potential hydrologic impacts of surface coal mining in the Wyoming PRB. However, the CHIA did not address the impacts of CBM development, as this was not anticipated at the time.



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Proposed Action Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

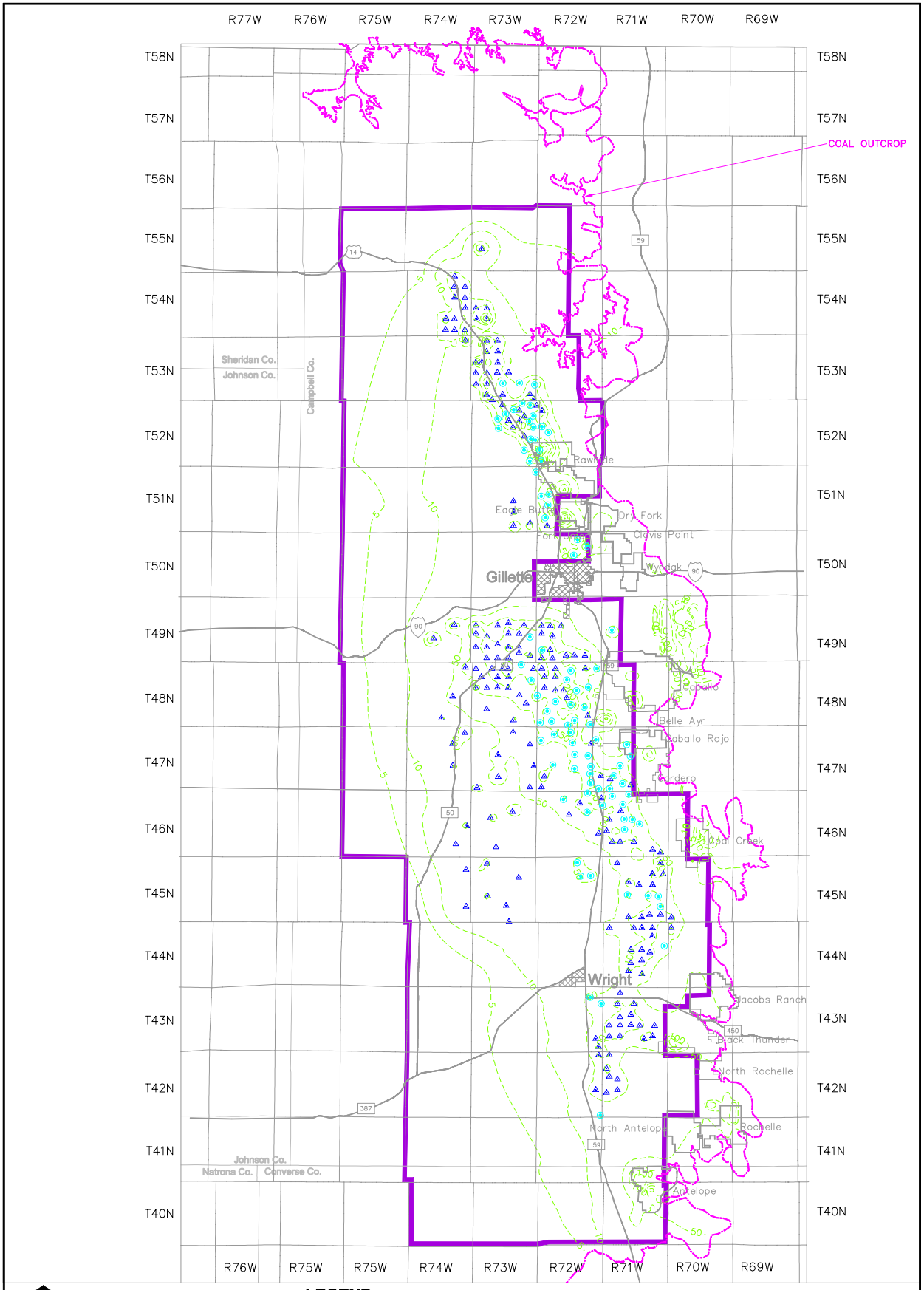
Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-15
Maximum Modeled Drawdown 1975-2008
No Action
Upper Wyodak Coal

WORKING-DWG-INSERT.DWG
NOACT-MAX-DD2008-UP.SCR



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Proposed Action Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-16
Maximum Modeled Drawdown 1975-2008
No Action
Lower Wyodak Coal

WORKING-DWG-INSERT.DWG
NOACT-MAX-DD2008-LWR.SCR

As a result of a cooperative agreement signed in 1993, BLM, OSM, the University of Wyoming, and the WSEO provided assistance to LQD in updating the CHIA process. A pilot CHIA study was performed in the Little Thunder Drainage Basin (WWRC, 1997).

The common, and potentially cumulative impacts to groundwater resources by activities associated with CBM development and those impacts associated with coal mining include withdrawal of water from the coal seam resulting in a loss of head in the coal, and the surface discharge of this produced water. The groundwater model used to assess existing and reasonably foreseeable groundwater conditions included the impacts of both mining and proposed CBM development. The impact assessment was presented in Chapter 4.

Differentiation of impacts between CBM development activities and coal development activities is presented below. There are some similarities and also significant differences in the impacts associated with mining and CBM development. These include:

Impacts to the Coal Aquifer: Both mining and CBM development result in partial removal of water from the coal seam. In mining, the coal is removed so that impacts to the coal aquifer in the areas of mining are significant. Immediately adjacent to active mine pit areas, the coal will drain into the pit and become dewatered. The extent of coal aquifer dewatering and depressurization associated with mining is largely dependent on the continuity of the coal in the vicinity of the mine and its overall permeability (a function of fracturing). In areas of high coal permeability, which tend to coincide with major fracture trends, the extent of drawdown may be several miles. Areas of limited coal drawdown related to mining are associated with lower permeability or less fracturing in the coal.

During active CBM development, pumping groundwater from the coal induces depressurization. Pumping removes water (and methane) from the coal but leaves the coal itself essentially undisturbed. Depressurization within the coal caused by CBM development will be more widespread than that due to mining because CBM development will cover a much larger area than mining. Mining is limited to an area within 2 to 3 miles from the coal outcrop because of overburden-coal strip ratios. CBM development is projected to cover most of the Wyodak CBM project area.

Impacts to Aquifers Stratigraphically above the Coal: The sand aquifers of the Wasatch Fm are hydrologically separated from the Wyodak Coal by low permeability claystones. In mining, the shallower aquifers (the overburden) must be removed to access the coal. Impacts to these aquifers in the areas of actual mining are significant. Immediately adjacent to active mine pit areas, the Wasatch sands that are intercepted by mining may drain into the pit and become dewatered. The extent of Wasatch aquifer dewatering associated with mining is largely dependent on the continuity of the sand units in the vicinity of the mine, and whether these sand units are actually intercepted by mining. There are many examples of overburden monitoring wells, completed in relatively isolated sand units that show very little influence due to close mining. Mining also induces drawdown in coal aquifer water levels as described above. This drawdown, in turn, induces vertical leakage from the overlying Wasatch sands, contributing to drawdown in these sands.

During CBM development, the Wasatch sand aquifers are not directly impacted. Leakage from the Wasatch sands into the coal may be enhanced by CBM development because water levels in the coal are lowered as a result of partial coal dewatering. Due to the limited hydraulic communication between the coal and the overlying Wasatch sands, a significant period of time (typically several years), may pass before significant drawdown effects in the sands are apparent. Drawdown effects in the Wasatch sands are projected to be in the range of 10 to 20 feet above areas of CBM development. As for coal drawdowns, the area of Wasatch sands impacted by CBM development will be much larger than that caused by mining due to the greater area of CBM development.

Changes in Infiltration Rates and Recharge: During mining, the overburden and coal aquifers are removed and replaced with backfill material. The recharge through the spoils is likely to be higher than the original undisturbed materials. During CBM development, the aquifers remain essentially undisturbed and the recharge mechanism is unchanged. Water discharged from CBM operations into creeks will increase recharge to alluvial aquifers and underlying Wasatch sands.

Changes in Groundwater Quality: After mining, the coal and Wasatch sand aquifers are replaced with mine spoils which have the potential to change the quality of the groundwater in the aquifer. During CBM development, water removed from the coal may recharge the alluvial and Wasatch sand aquifers. This has the potential for water quality changes as described earlier in Chapter 4. Generally, however, groundwater quality changes caused by CBM development are relatively minor.

Discharge of Produced Waters: Both mining and CBM development result in water collection and discharge to surface streams. Mine inflow water is first stored in sediment ponds to reduce sediment that is picked up in the pit and much of the water is used for dust suppression. The discharge water from sediment ponds is potentially higher in TDS and of lower quality due to sediment mixing and concentration by evaporation. CBM discharge is essentially sediment free, although discharge to creeks can increase sediment loading. Infiltration of discharged water can recharge the alluvial and shallow Wasatch sand aquifers, and potentially influence their water quality.

Subcoal Fort Union Aquifers: Mining may impact subcoal aquifers by influencing recharge water quality. Groundwater withdrawals from lower aquifers for mine use also may impact subcoal aquifers. CBM development may impact the subcoal aquifers by inducing upward leakage from them into the coal as a result of coal depressurization. These cumulative influences were included in the groundwater model and the results discussed in Chapter 4.

Existing Monitoring Programs

Monitoring programs required by LQD and administered by the mining companies have been established in the eastern PRB. Each mine is required to monitor groundwater levels in the coal itself as well as in shallower aquifers in the area surrounding their operations. There are also requirements for drilling monitoring wells in the backfill areas of the mines in order to record the water level recovery in these areas. In addition to the mine monitoring required by LQD, the WDEQ, WSEO, WOGCC, and the BLM have required water monitoring to be done for different aspects of CBM projects.

The Gillette Area Groundwater Monitoring Organization (GAGMO) is a voluntary group formed in 1980. The purpose of GAGMO is to assemble and report the hydrologic monitoring data being collected by the coal mining companies operating in the eastern PRB of Wyoming, from the Buckskin Mine north of Gillette to the Antelope Mine in northern Converse County. Members of GAGMO include most of the companies with operating or proposed mines in that area, the WDEQ, the WSEO, the BLM, the USGS, and the OSM, which joined in 1991. The Dave Johnston Mine near Glenrock is not a member of GAGMO.

Each year GAGMO contracts with an independent firm to publish the results of the monitoring for that year. In 1996 GAGMO published two reports--an annual report for 1995 and a 15-year report. The 15-year report, prepared by Hydro-Engineering, summarized the data accumulated during the past 15 years of monitoring in the PRB. According to that report, approximately 600 monitoring wells were operated at 20 operating or proposed coal mines in 1995 (Hydro-Engineering, 1996).

A major groundwater issue is the extent of the loss in hydraulic head in the coal and shallower aquifers in the area surrounding the mines. Most of the monitoring wells included in the GAGMO 15-year report are completed in the coal beds, in the overlying sediments, or in sand channels or interburden between the coal beds. **Figure 4-2**, taken from the GAGMO 15-year report, shows the changes in water levels in the coal seams after 15 years of monitoring (Hydro-Engineering, 1996). **Figure 4-17** shows the area where actual decline in hydraulic head in the coal seam has been greater than 5 feet in 15 years, in comparison with the predicted worst-case five-foot decline derived from groundwater modeling done by the mines. The LQD requires the mining companies to determine the maximum probable extent of the five-foot drawdown line through modeling.

In general, drawdown in the coal does not extend east of the coal mines because the mines are located on or near the coal outcrop line. The actual 15-year, five-foot groundwater drawdown contours have not exceeded worst-case development drawdown predictions for the mines north and east of Gillette or for the mines east and southeast of Reno Junction (which includes the North Rochelle Mine). Drawdowns are reaching the predicted worst-case drawdown levels in the central group of mines, located between Gillette and Wright (**Figure 4-17**). This is because there is an overlap of drawdown impacts from coal mining and CBM development. The projected worst-case drawdown lines shown in **Figure 4-17** are based on projected coal mining only.

Similarly, the actual five-foot drawdown levels are well within the cumulative drawdown levels predicted by the CHIA for the mines north and south of Gillette (USGS, 1988). However, actual drawdown levels have reached the CHIA's predicted cumulative drawdown level in the group of mines between Gillette and Wright because of overlapping CBM and coal mining impacts. The 1988 CHIA predicted the approximate area of five feet or more water level decline in the Wyodak

coal aquifer that would result from "all anticipated coal mining." "All anticipated coal mining",as referred to in the 1988 CHIA, included 16 surface coal mines operating at the time the report was prepared and six additional mines proposed at that time. All of the currently producing mines were considered in the CHIA analysis (USGS, 1988). CBM development was not anticipated at the time that analysis was prepared. The 1988 CHIA concluded that water supply wells completed in the coal may be affected as far away as eight miles from mine pits as a result of the anticipated coal mining, but the effects at that distance were assumed to be minimal.

The additional groundwater impacts that would be expected as a result of the Wyodak CBM development would be additive in nature and would extend the area experiencing a loss in hydraulic head to the west of the coal mining area. The area between the CBM fields and the mines would be subjected to the cumulative impacts of these two distinct activities. The overlapping drawdown impacts of the two activities is additive. The 15-year GAGMO report (Hydro-Engineering, 1996) points out the area of apparent overlapping impacts between the Marquiss and Lighthouse CBM projects and the Caballo, Belle Ayr, Caballo Rojo, and Cordero mines (**Figure 4-17**). The groundwater flow model developed for the Wyodak CBM Project EIS, described in earlier Chapter 4, accounts for impacts due to both mining and CBM development.

Differentiation of Drawdown Effects from Coal Mining and CBM Operations

The differentiation of drawdown effects from coal mining and CBM operations also was simulated using the computer model. This was done by performing a simulation of mining effects alone, and then performing a separate simulation with the superimposed stresses of the CBM operations. The difference in projected drawdown in the coal may be attributed to the CBM operations.

The result of this differentiation is presented in the form of drawdown maps showing the drawdown attributed to CBM operations alone (Alternative 1) for the year 2007, the anticipated maximum drawdown year for CBM operations, in **Figures 4-18 and 4-19**. The maximum areal extent of drawdown, defined as a drawdown of at least five feet, ranges to the west about 25 to 30 miles from the centers of CBM development.

Comparison of drawdown extent due to CBM operations alone with that of combined CBM development and mining for the same year, (**Figures 4-5 and 4-6**), shows that CBM withdrawals are primarily responsible for drawdowns to the west of the major CBM developments. For the Upper Wyodak coal, the maximum predicted drawdown due to CBM operations is about 200 feet in the northern portion of the project area; it is about 200 feet in the central portion of the project area; and it is about 100 feet in the southern portion of the project area.

Proposed Monitoring Program

A proposed groundwater monitoring program has been outlined in Chapter 2 “Proposed Action and Alternatives”. General locations for new monitoring wells are suggested. The modeling results confirm that most of the drawdown associated with CBM development will be concentrated in the area of dense CBM development. Drawdown in excess of 50 feet, which has the potential

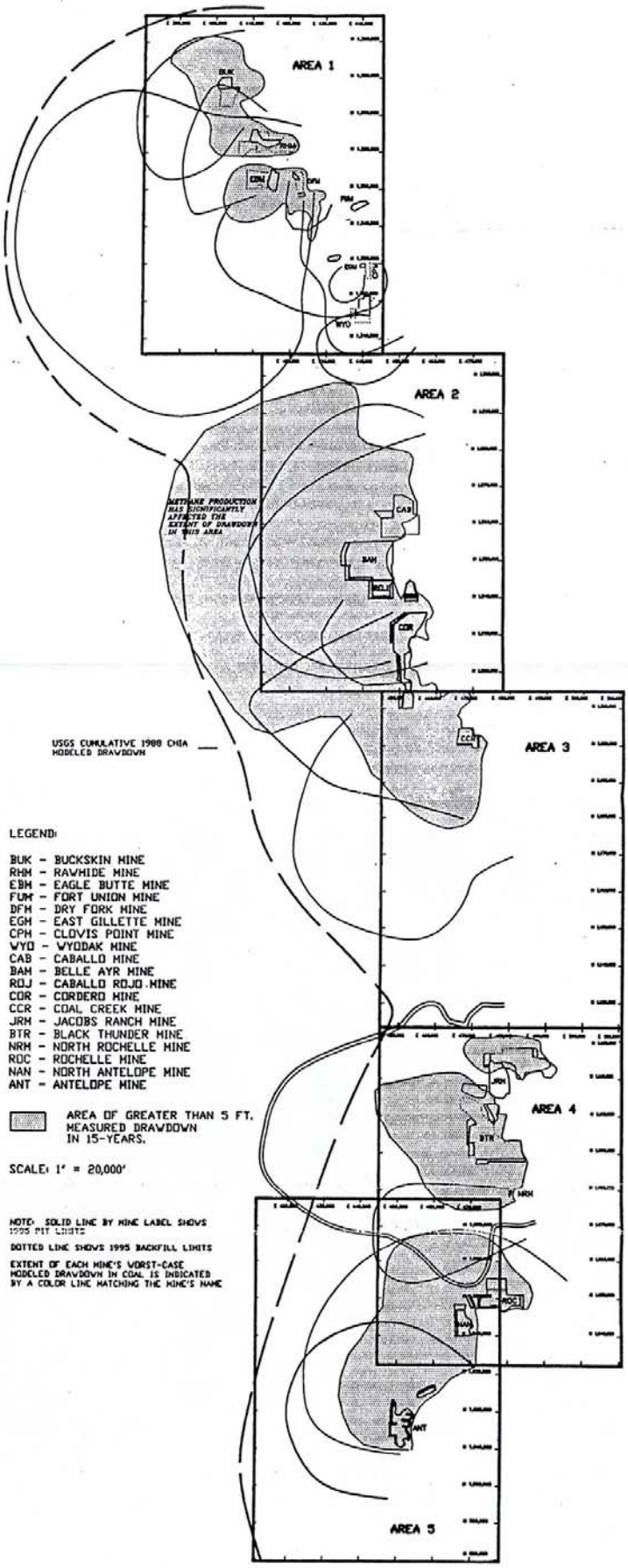


FIGURE 4-17 COMPARISON BETWEEN THE 1995 CUMULATIVE DRAWDOWNS AND THE MINE'S WORST-CASE DRAWDOWN AND THE USGS PREDICTED CUMULATIVE DRAWDOWNS IN THE COAL AQUIFER.

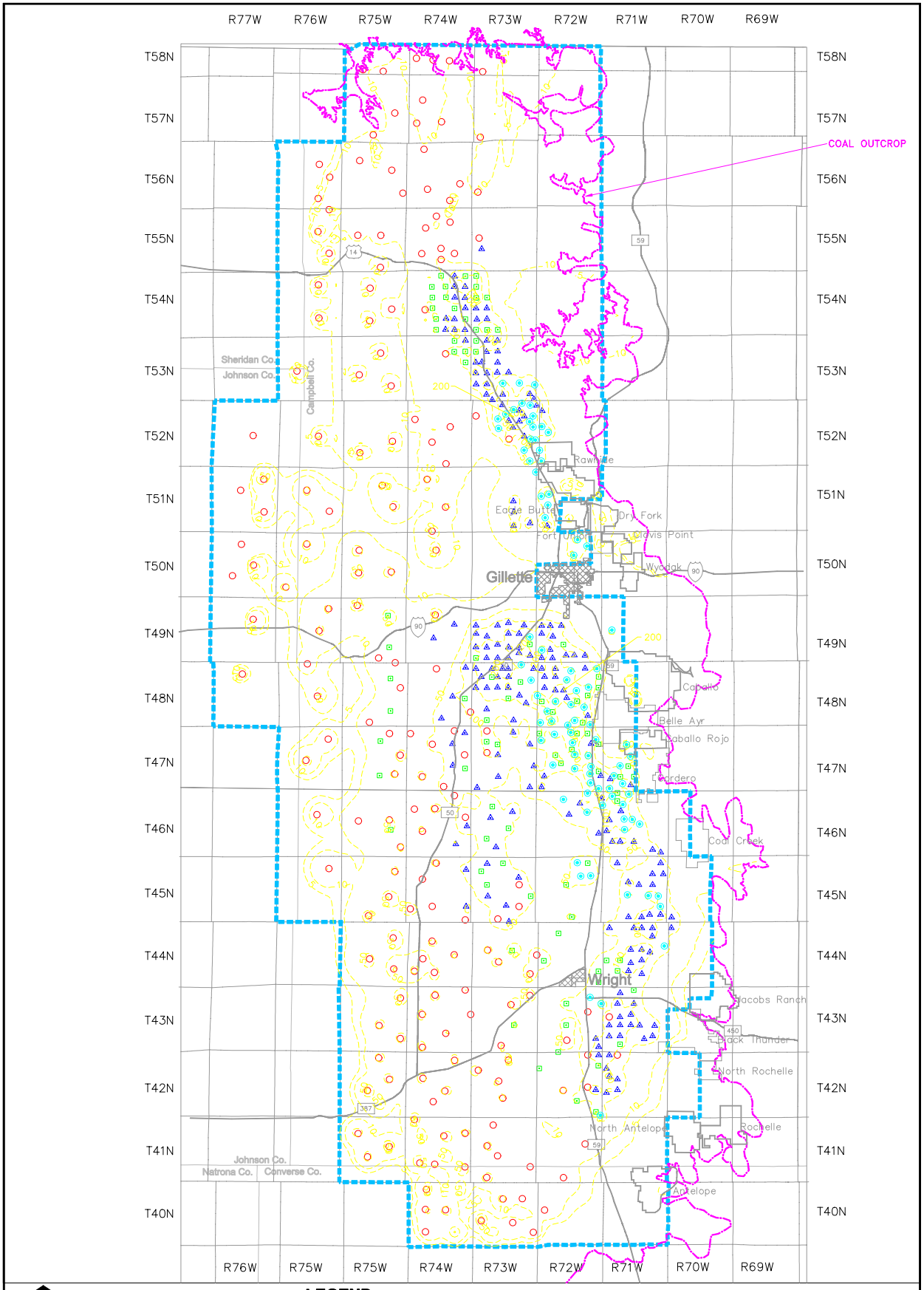
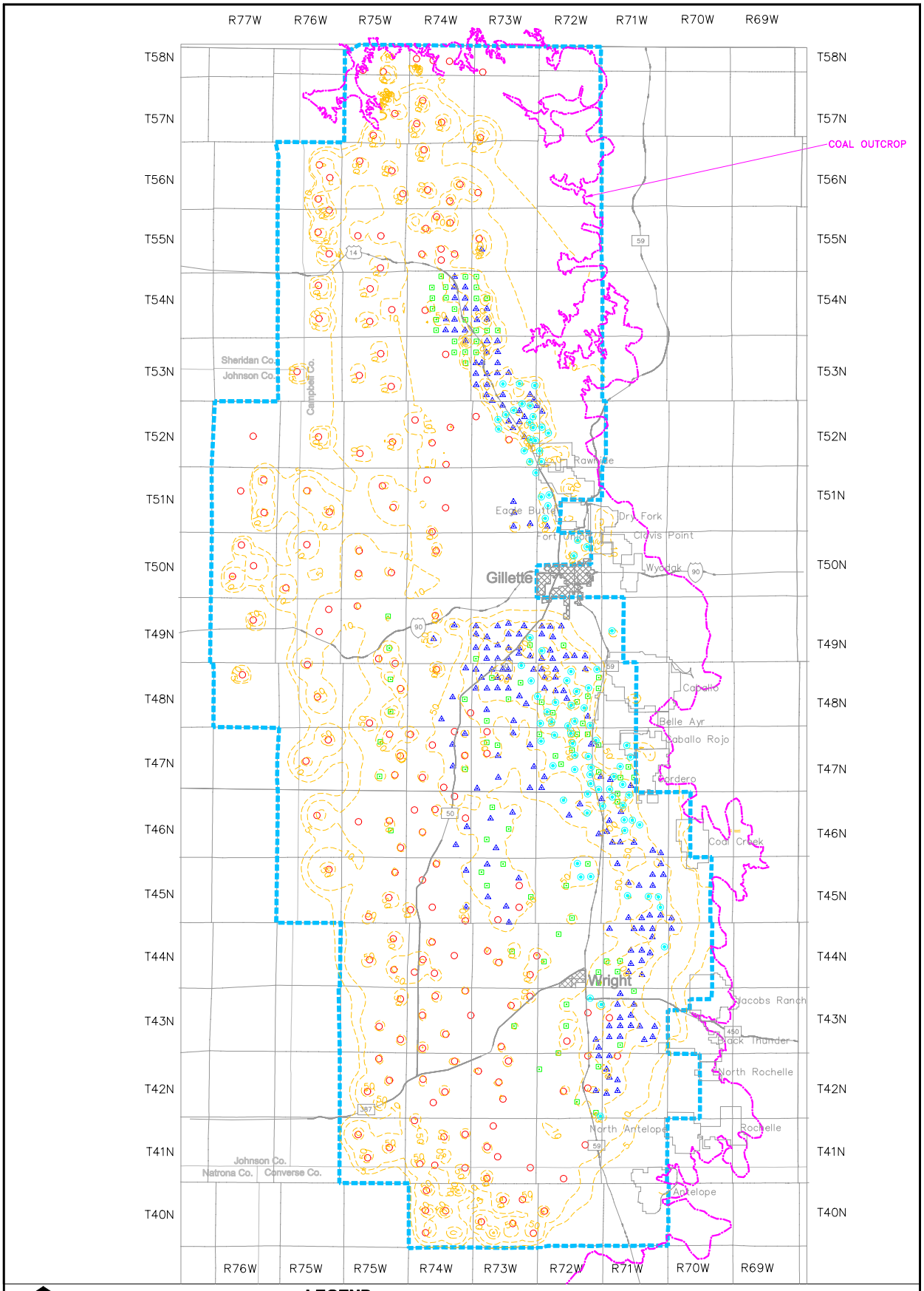


Figure 4-18
Maximum Modeled Drawdown 1975-2007
Alternative 1-CBM Only
Upper Wyodak Coal

WORKING-DWG-INSERT.DWG
CBMONLY-MAX-DD2007-UP.SCR



LEGEND

- Existing Well Pods
- Projected "No Action" Well Pods
- Projected "Proposed Action" Well Pods
- Projected "Alternative 1" Well Pod
- "Alternative 1" Project Boundary
- Coal Lease Boundary
- Population Area
- Drawdown Contour (ft)

Note: 1 Pod = 10 Wells

0 8.5 17

Scale (mi)

Figure 4-19
Maximum Modeled Drawdown 1975-2007
Alternative 1-CBM Only
Lower Wyodak Coal

WORKING-DWG-INSERT.DWG
CBMONLY-MAX-DD2007-LWR.SCR

to impact water well yields and methane generation, extends up to 15 to 20 miles from areas of concentrated development. Monitoring wells should be located on the periphery of these development areas. Initially, monitoring wells should be located within the area where drawdown in excess of 50 feet is projected. Actual monitoring data will confirm the projections and will allow refinement of the model as development proceeds. Additional monitoring wells may be required farther from the development areas if drawdown exceeds projections.

Alternative 1

The cumulative impacts for groundwater resources will be similar to those described under the Proposed Action. However, additional CBM development, coupled with coal mining dewatering would expand the area of drawdown in excess of 50 feet to 15 to 25 miles from the centers of intense CBM development. Coal bed dewatering from coal mining would be a smaller component of the predicted dewatering than noted for the Proposed Action.

No Action

The general cumulative effects discussion on groundwater resources from the Proposed Action is similar for the No Action Alternative. However, the maximum drawdown would be approximately fifty feet less than under the Proposed Action, at more than 200 feet for the northern project area, and more than 100 feet in the southern area. The relative importance of coal mine dewatering to total dewatering would be greater under this alternative than under the two other alternatives.

DEIS CHAPTER 4 ENVIRONMENTAL CONSEQUENCES ERRATA

Page No./Paragraph/Line	Errata
4-4 4 4	The text should read "The productive life of a CBM well has been estimated **for a previous project** to be 12 years (USDI BLM, 1997a). **Based on current estimates and for the purposes of this analysis, a 15-year period has been selected to represent an individual CBM well production life.**
4-4 5 8	The text should read "... before the **12** to 20 year ..."
4-5 2 4	Replace the second sentence in the second paragraph with the following: "**If the maximum flow (0.22 cfs) were discharged continuously through a rectangular channel three feet wide, water depth in the channel would be only 0.7 inch along a channel slope of two percent, with a velocity of 1.24 feet per second**."
4-5 5 1	The text should read "... only **12** to 20 years."
4-5 6 1	The text should read "... from **15.4** million gallons per day to a maximum of **67.2** million gallons per day..."
4-5 7 2	The text should read "...estimated **17,230** ac-ft per year in 1998 to **75,310** ac-ft per year..."
4-6 1 4, 5	The text should read "... Proposed Action would **triple** the annual yield ..." Add the following sentence to the end of the paragraph: "**Recharge to adjacent alluvial aquifers will result in higher water tables. In locales of previously elevated water levels, ponding or wetland development may occur.**"

Page No./Paragraph/Line	Errata
4-7, Table 4-1	Footnote 1 should read "**Only included drainage channels adjacent to or downgradient of CBM well fields within the Wyodak study area. The hypothetical locations of CBM well pods were considered in calculating the average drainage channel lengths**." The following text should be added to Footnote 4: "**Conveyance Loss is calculated as Total Produced Water Discharge in Drainage Basin ($0.99^{\text{avg. drainage channel length}}$ x Total Produced Water in Drainage Basin). Outflow at the Wyodak Study area boundary is calculated as Total Produced Water Discharge in Drainage Basin - Conveyance Loss**."
4-10 4 1	The text should read "**Sediment concentrations in surface waters will increased if discharges**....."
4-12 3 4	The text should read "Approximately **1,700** discharge points ..."
4-16 4 1	The text should read "...from **15.4** mgd to **101.8** mgd..."
4-16 5 2	The text should read "...estimated **17,230** ac-ft per year in 1998 to **114,030** ac-ft per year..."
4-17 4 1	The text should read "...estimated **15.4** mgd to **49.9** mgd..."
4-21 1 2	The text should read "... approximately **1972** (the earliest ..."
4-35 4 14	Delete sentence: "For individually impacted water wells, see the "Mitigation Measures" section."
4-44 3 3	The test should read "... duration of an **estimated** 15-year life **from the range of 12 to 20 years for the life of a** well."
4-62 3 9	Add sentence to end of paragraph: "**The U.S. Environmental Protection Agency has the regulatory authority to control emissions from the mobile pollutant sources analyzed in this EIS."**

Page No./Paragraph/Line	Errata
4-68 1 3	The text should read "... catalytic controlled rich-**burn** engines ..."
4-69 2 5	The text should read "The average **annual** NO_2 background ..."
4-71 4 2	The text should read "... complex, would address **the risk of exposure to formaldehyde.**"
4-74 5 7	The text should read "For ammonium nitrate **and ammonium sulfate** the maximum ..."
4-85 5 4	The text should read "... not an activity regulated by the COE **if the activity does not include a discharge of fill material into waters of the U.S. (US Army COE, 1998)** (Appendix A)."
4-87 2 3	The text should read "... long-term, approximately **12 to 20** years."
4-89 1 9	The text should read "... levels, **but may be initially displaced away from short-term CBM well drilling, well completion, and ancillary facilities construction.**"
4-89 2 8	The text should read "... potential for **CBM production-related** impacts."
4-89 3 1	Replace the first sentence with "**Twenty six active and 35 inactive (5 year period) sage grouse leks have been identified within the project area; two active and two inactive sharptail grouse have also be identified.**"

Page No./Paragraph/Line	Errata
4-94 1	Insert following paragraph after the first paragraph: **"CBM produced water cannot be discharged until it meets WDEQ requirements for effluent limitations that are necessary for the continued safe consumption or use of water downstream by humans and other species. Therefore, impacts to the sturgeon chub population present in the Powder River (expanded project area) are not anticipated. Because of the low number of wells projected (in this analysis) to discharge into the tributaries of the Powder River (Table 4-1 on p.4-7), and the channel lengths of these tributaries where infiltration will occur, substantial flows of CBM produced water are not expected to reach the Powder River. The flows that do reach the Powder River are expected to remobilize channel sediments deposited as river flows decrease during the summer. As flows in the Powder River increase, the silt-carrying capacity of the river also will increase. The turbid nature of the Powder River is not expected to change during CBM development and production activities. The sturgeon chub, which has adapted its habitat to turbid waters of large rivers with gravel substrates, is not expected to be affected."**
4-104 3 6	Add the following sentence at the end of the third paragraph: "**Impacts to the Fortification Creek WSA will be analyzed site-specifically at the APD/POD level of analysis**."
4-128 4	Insert the following text as a new paragraph following the fourth paragraph on the page: "**Current information on the ongoing construction of the Thunder Creek and the Fort Union Gas Gathering pipelines, that will gather and ship CBM gas to market, identifies the approximate length of the Thunder Creek pipeline as being 74 miles, and its right-of-way width is 50 feet. Seeding by the contractor is scheduled for completion by the end of October, 1999. A number of landowners along the pipeline route have elected to do their own seeding, and their completion date cannot be estimated. An estimated 450 acres have been affected by short-term construction activities along this pipeline route. The Fort Union Gas Gathering pipeline is about 106 miles long, and its right-of-way width is 50 feet. An estimated 650 acres have been affected by short-term construction activities along this pipeline route. In all, an estimated 1,100 acres have been affected by construction activities for these two pipelines.**"
4-130 3 1	The text should read "... the next **12** to 20 years."

Page No./Paragraph/Line	Errata
4-133 6 4, 7	The text should read "... water **carried by the Powder and Little Powder rivers** would ..." The text should read "... water storage in **the Belle Fourche River's** Keyhole Reservoir ..."
4-134 1 1, 2	The text should read "... approximate 4,000 **acre Keyhole Reservoir** nor ..." The text should read "**The Cheyenne River's** Angostura Reservoir ..."
4-135 2 4	The text should read "... higher in TDS due to sediment mixing ..."
4-151, Table 4-20	The heading of the second column should read "Type of **Area**"
4-158 3	The third paragraph is rewritten as follows: "**Habitat disturbance and reclamation, the creation of barriers to movement, increased human presence, and mortality due to increased poaching and vehicle collisions involving pronghorn would produce cumulative impacts to pronghorn populations using the area. These impacts result from the combined effects of coal mining and other mining activities, conventional oil and gas development, and CBM development. These activities already are affecting pronghorn. Additional CBM development would increase the acres of habitat disturbed, but is not likely to create additional barriers to movement. Human populations associated with CBM development may become involved in poaching, vehicle/pronghorn collisions, and disturbance of animals**."

AIR QUALITY IMPACT ANALYSIS TECHNICAL REFERENCE DOCUMENT ERRATA

Page No./Paragraph/Line	Errata
i 3 3	The text should read "At that time **additional site specific air quality analyses, such as Best Available Control Technology analysis of Prevention of Significant Deterioration increment analysis, may be performed.**"
ii 4 5	The text should read "... considered the mean **of the cleanest 20%** background visibility data ..."
2-1 1 9	The text should read "... catalytic controlled **rich**-burn engines ..."
2-8 1 1	The text should read "... Gillette **NO_2** monitoring."
5-29 1 1	The text should read "... operations, **truck dumps**, wind ..."
6-6 2 7	The text should read "Conversely, **a computed deciview change on or greater than one day that exceeds 0.5 deciview is above the threshold of concern ("limit of acceptable change") for visibility impairment, and may, under some circumstances, be considered an adverse impact.**"

CHAPTER 5
CONSULTATION AND COORDINATION

SCOPING PROCESS

The scoping process and public participation are addressed in the "Public Participation" section of Chapter 1 of this EIS.

DRAFT EIS COMMENTS

The BLM thanks all commentors for their interest in the coal bed methane EIS process.

The 52 comment letters submitted by the public and interested agencies during the 60-day comment period and shortly after the formal comment period closed on the Wyodak CBM Project DEIS have been reproduced in **Appendix E**, with each letter given a unique identifying number. Comments containing only opinions or preferences did not receive a formal response. All comments were considered and included as part of the BLM decision making process.

A response by comment category has been prepared. Substantive comments received have been summarized and organized in issue statements under the following comment categories:

- General (common to all resource categories)
- Water Resources
  - Groundwater
  - Surface Water
  - Wetlands
- Air Quality
- Geology, Mineral Resources, and Geologic Hazards
- Wildlife/Fisheries
- Land Use

The identifying numbers of all comment letters used to develop the issue statement for a comment category are listed at the end of each comment category. Issue statements and responses have been repeated in all comment categories where they are applicable.

Additional analysis and/or specific changes (errata) in the text of the DEIS are found in each chapter of this FEIS. Where the response to an issue statement indicates a change has been made in a particular chapter of this FEIS, that chapter should be consulted for the specific rewording, clarification, additional analysis, or new information.

ISSUE STATEMENTS AND RESPONSES BY COMMENT CATEGORY

The following section was summarized from substantive comments received on the BLM's Wyodak CBM Project DEIS from May 1999 to July 1999; refer to **Appendix E** for full text of all comments received.

General

General Issue Statements and Responses:

No Action Alternative

The No Action Alternative should not include any CBM wells in order to establish an accurate baseline for the study area.

Response:

The No Action Alternative considered in this analysis represents "no federal action" but includes connected actions related to CBM development that are outside the scope of this EIS. The proposed CBM development considered under the No Action Alternative represents fee and State wells, for which the BLM has no authority, and federal drainage wells, for which the BLM has no discretionary decision (or action to take) regarding whether to allow the development. Any decisions regarding non-federal development and federal drainage development are outside the scope of this EIS. This development is expected to occur regardless of the decisions that are made based on the analysis contained in this EIS. The information that was known about these connected actions (the development of non-federal CBM resources and federal drainage wells) when the scope of this EIS was determined has been incorporated within Chapter 2.

EIS Scope - Reasonably Foreseeable Development Scenario - Staged Development

More CBM development is anticipated than is analyzed in the EIS. As many as 15,000 to 20,000 CBM wells have been estimated by industry sources. CBM development is likely to occur outside the area considered in the EIS. All anticipated CBM development should be analyzed. NEPA requires an analysis of the cumulative effects of reasonably foreseeable actions, such as the future expansion of CBM and coal mining in the basin. In order to accurately address cumulative impacts from the project, the industry goal of 15,000 to 20,000 wells must be used. Anything less does not accurately depict the cumulative impacts from the project.

Because the impacts resulting from CBM development are difficult to predict for such considerable development, the BLM should consider a staged approach to CBM development, approving only a portion of the proposed development so that the implementation of CBM development can be adequately monitored and the environmental effects of staged development can be documented for use in future analyses.

The EIS must analyze the impacts of connected and cumulative actions such as transportation and utility corridors, rights-of-way, the construction of the Thunder Creek pipeline and the Fort Union Gas Gathering pipeline, and other high pressure pipelines that will be constructed to gather and ship CBM gas to market. The EIS should explain how the BLM will mitigate the environmental effects resulting from the many pipelines that will cris-cross the area.

Response:

The scope of CBM development considered in this EIS has been consciously set by the BLM, in order to complete detailed computed modeling of anticipated effects to groundwater and air quality. Computer modeling requires detailed analysis of a finite number of wells and compression facilities in order to project effects. While more CBM development is anticipated, it is not advisable at this time to add more CBM development to this analysis.

This analysis was intended to encompass all reasonably foreseeable CBM development in the eastern PRB when it was begun in 1998, but perhaps three or four times that level of activity may be anticipated at the present time (August, 1999). Such a "moving target" for project scope does allow this EIS analysis to represent a staged development plan for CBM activities. The Proposed Action and Alternative 1 are staged development alternatives as they would be implemented. The BLM will approve CBM projects over time. The estimate of 400 APDs that likely could be approved in a year is low based on recent auxiliary funding obtained by the BLM for management of CBM development activities. As the level of cumulative impacts analyzed in this EIS is surpassed, another development stage (a regional EIS for as yet unspecified development levels) will be analyzed. The BLM is actively pursuing this issue and is seeking budget to analyze all reasonably foreseeable mineral and energy resource development in the PRB in a basin-wide analysis subsequent to this one.

Less than ten percent of the land surface in the 3,600 square mile area analyzed in this EIS is federally owned and administered by the BLM; only two percent of the land surface is federally owned and is administered by the FS. Neither the BLM nor the FS has any authority to conduct transportation or utility planning where the surface is privately owned.

More information now is available regarding the Thunder Creek pipeline and the Fort Union Gas Gathering pipeline that will gather and ship CBM gas to market. The approximate length of the Thunder Creek pipeline within the Wyodak study area is 74 miles, and its right-of-way width is 50 feet. Seeding by the contractor is scheduled for completion by the end of October, 1999. A number of landowners along the pipeline route have elected to do their own seeding, and their completion date cannot be estimated. An estimated 450 acres have been affected by short-term construction activities along the pipeline route. The Fort Union Gas Gathering pipeline is about 106 miles long within the Wyodak study area, and its right-of-way width is 50 feet. An estimated 650 acres have been affected by short-term construction activities along this pipeline route. In all, an estimated 1,100 acres have been affected by pipeline construction activities.

The preceding paragraph has been added as the fourth full paragraph on page 4-128 of the DEIS, to clarify the cumulative effects of pipeline construction. Each future pipeline that represents a federal

action will be analyzed site-specifically by the BLM and/or FS as soon as enough information is available to begin the analysis.

Level of Detail in EIS - Site-Specific Information

More specific information should be in the EIS, not included in subsequent APDs or Sundry Notices. Information should be available to the decision maker and public before the decision is made.

Water management plans that describe how water will be managed on a drainage-by-drainage basis should be included in the EIS so they are available for review and comment by agencies and the public. Detailed and specific water management plans should be developed for each of the major drainage in the analysis area. Plans should identify areas off-limits to disposal of produced water, such as closed basins and playas; identify suitable disposal sites, including shallow and deep aquifers; and should include a mitigation and monitoring plan.

The EIS should disclose whether suitable habitat is available in adjacent areas for wildlife populations displaced by CBM development activities.

The EIS should identify suitable locations for siting of production pods. It is important that pods be sited to avoid sensitive surface resources (e.g. wetlands, erosive soils, wildlife habitat) and potential conflicts with other uses.

The EIS should include a transportation plan showing preferred corridors and alternatives that minimize environmental impacts and resource conflicts. Major access roads and utility corridors serving the project area should be identified and selected to result in the least impact.

Response:

The Wyodak CBM Project EIS is, by design, a programmatic analysis of the environmental effects that may be expected to occur as a result of CBM development activities. During intense and widespread development activities, the environment can be expected to be affected on several levels or scales. Frequently, National Environmental Policy Act (NEPA) analyses, like this EIS, are prepared first (or staged) to address widespread and cumulative environmental effects. This type of analysis presents an overview or an accumulation of the environmental effects of CBM development. Site-specific analysis, using detailed natural resource data, follows in a later analysis that is tied (or tiered) to this EIS.

The analysis done for this EIS is not a site-specific regulatory permit determination. Computer modeling for the programmatic analysis of a project area containing over two million acres, even though very detailed, is much more generalized than site-specific modeling done to analyze a single coal mine permit application that my involve several thousand acres. To accurately evaluate potential impacts, computer modeling utilizes some very detailed information and assumptions. As a result, there can be some confusion over whether this EIS represents a programmatic environmental analysis or a site-specific environmental analysis, such as the analysis done to permit a specific CBM well, a specific coal mine, or a specific power plant. The Wyodak CBM Project EIS is a

programmatic analysis that evaluates the potential impacts associated with a reasonably foreseeable level of development over a 2.3 million acre area. Therefore, even an overview of the issues and environmental effects of CBM development is very complex.

The analysis done for this EIS supports a programmatic NEPA analysis, not a site-specific analysis that could be used to support decisions relating to a specific CBM well or group of CBM wells. Detailed natural resource data on wildlife and fisheries populations and habitats in a specific area would be utilized in the APD/POD level of environmental analysis. As this EIS is programmatic in nature, site-specific resource information typically is not presented in Chapter 3 (Affected Environment) section. Typical environmental effects, including widespread or cumulative environmental effects are presented in Chapter 4 (Environmental Consequences). Mitigating measures that are broadly applicable to all action alternatives are presented in Chapter 2. Analysis of a specific area that would be affected by a group of proposed wells or other facilities would be tied (or tiered) to this EIS at the APD/POD level of analysis.

Site-specific inventory, analysis, and mitigating measures will be applied to projects at the APD/POD level of analysis so that wildlife impacts, such as those to sage grouse or migratory birds, are mitigated below the level of concern or are addressed in site-specific environmental analyses. Availability of suitable habitat in adjacent areas for displaced wildlife populations must be analyzed site specifically, so that resource inventories can be reviewed. Mitigation measures and consultation with agencies such as the U.S. Fish and Wildlife Service, requested by commentors, already are agency commitments under existing BLM policy. For species that are intolerant of longer-term disturbances, a buffer zone is utilized per standard BLM Wyoming State Office policy.

Although some sensitive resource areas can be identified early, through oil and gas lease stipulations, suitable well pod locations must be determined site-specifically. The identification of suitable locations for production pods is accomplished at the APD/POD level of analysis when resource inventories are reviewed. At the discretion of the surface owner, pods will be sited to avoid sensitive surface resources and conflicts with other uses.

Where rights-of-way, pipelines, utilities, and roads are proposed on federal surface, the BLM will analyze these proposals site-specifically (individually or collectively, as appropriate). Where federal mineral leases under private surface ownership are involved, the BLM will meet its responsibility as conservator of the federal mineral estate, and will ensure that transportation and utility corridors are developed in a safe and environmentally sound manner. However, once the methane gas passes through a metering point that is either on-lease or off-lease, the BLM has no authority to regulate the corridors along which it is moved to market, unless federal surface is crossed.

Residual Impacts

Impacts that may be present after the project's completion (residual impacts) are not identified and evaluated in the DEIS.

The EIS should address the long-term impacts to groundwater levels over time as CBM development occurs.

Response:

Residual impacts are described at various locations in Chapter 4 (Environmental Consequences). For example, residual impacts to vegetation and related resources are described on p. 4-155, 4-156, and 4-157 of the DEIS. Coal aquifer drawdown over time (to the year 2200) is plotted on p.4-23 and is described on p. 4-14 of the FEIS.

Mitigation Plan

Under NEPA, the BLM is required to present a plan for mitigation in the EIS and it has to be available for public comment. There is a lack of a plan for mitigation of impacts in the EIS. Some data is fragmented and hard to find. Mitigation plans are deferred for review in APDs and Sundry Notices, which are not included in the EIS and are not subject to public comment as required by NEPA. The costs to implement the mitigating measures identified and the effectiveness of the mitigating measures included in the analysis should be included in the EIS.

Response:

The BLM agrees that mitigating measures which would be considered as conditions of approval (mitigation plan) at the APD/POD level of analysis are listed separately in various Chapter 4 sections and in Appendix B. This document organization may make it difficult for a reader to develop a comprehensive understanding of the mitigation plan that would be developed at the APD/POD level of analysis. A compilation of specific mitigating measures that would be considered under any action alternative at the APD/POD level of analysis has been incorporated within Chapter 2. These mitigating measures would supplement the BLM's standard conditions of approval (an APD mitigation plan) that are presented in **Appendix B**.

The permit requirements (in total) for a CBM well, consisting of the APD conditions of approval developed site-specifically by the BLM, the surface use plan (including a water management plan) prepared by the CBM operator, and the permit requirements of various agencies such as the WDEQ (AQD and WQD), WSEO, WOGCC, and COE, are the mitigation plan for that well. The specific requirements contained in mitigating measures would vary depending on site conditions. The applicability, cost to implement, and effectiveness of a particular mitigating measure can only be determined site-specifically. Some mitigating measures are not within the authority of the BLM to require or implement, and are so noted in the compilation.

APDs are posted for public review during a 30 day period upon receipt by BLM. A site-specific environmental analysis which addresses the cumulative effects of all wells within a POD is conducted by the BLM. That analysis complies with NEPA requirements and is available to the public for review.

Project Life/Life of a CBM Well

There is a lack of consistency in the document regarding the descriptions of the productive life of a CBM well and the expected life of the project.

Response:

The estimates for the productive life of a CBM well and the productive life of the project used for the purposes of this analysis have been clarified in Chapter 2 (FEIS, p.2-8). The rationale for these estimates is explained. The document text has been corrected at several locations for consistency.

Well Spacing

The well spacing could be different. Both more dense and less dense well spacings should be analyzed in the EIS.

Response:

The Wyoming Oil and Gas Conservation Commission (WOGCC) has the authority to set well spacing in Wyoming. The current CBM well spacing of 40 acres set by the WOGCC was used for the purposes of this analysis. While well spacing for CBM could become less dense in the future (80 acres), it is not likely to become more dense.

Applicable Comment Letters (General):

1, 7, 8, 9, 11, 15, 16, 18, 19, 23, 26, 28, 29, 34, 38, 43, 44, 50

Water Resources

Groundwater Issue Statements and Responses:

Groundwater Analysis - Modeling

The accuracy of the projected groundwater drawdown levels in response to CBM development is questioned. Related impacts to drinking water, livestock supply wells, coal industry monitoring wells, and (potentially) nearby in-situ uranium mining activities should be adequately addressed in the analysis.

The groundwater model is not calibrated with sufficient accuracy to be reliable as a predictive tool for future impacts. In particular, the steady-state (pre-mining) model water levels were one to two hundred feet different from actual water levels. This led to over-prediction of drawdown due to CBM development because of greater available drawdown.

The model is based on the Little Thunder stochastic model as well as the models used in the Lighthouse and Marquiss environmental impact analyses. These models showed poor calibration and their use in developing the Wyodak DEIS model likely contributed to the DEIS model's calibration problem.

Groundwater modeling relies heavily on hydraulically 'isolating' the coal layers from underlying and overlying aquifers. Confining layers have been assigned very low hydraulic conductivities, apparently uniformly. Field lithologic or hydrologic data do not support the presence of a laterally continuous confining unit with such a low hydraulic conductivity (1×10^{-10} meters per second) throughout the Powder River Basin.

Estimates of quantities of water that will be pumped out by CBM development are not compared with the quantity of groundwater in storage, recharge rates, or any other values that could affect water level recovery.

The model did not use the large amount of data currently available through the GAGMO database. Only 44 wells completed in the coal layer were used for model calibration despite the modeling domain of almost 20,000 sq. mi.

The average pumping rate of 12 gpm for the life of a CBM well was questioned as being representative of the entire area and as being appropriate for use in the model as the average water production rate for all wells. Several wells drilled in the western parts of the basin are reportedly producing at much higher rates.

The model does not take into account structures (faults and lineaments) and variable permeability within the coal. The failure to account for structures may explain much of the error in the modeled results.

The groundwater model did not include the Tongue River Member of the Fort Union Formation as an aquifer unit. It therefore cannot take into account the impacts to this unit which is used for water supply in the Gillette and Wright areas. Also, references to the Tullock Member being the major source of groundwater for municipal wells are not correct.

The model does not accurately simulate the overburden (Wasatch Fm) geology. The model's predictions overestimate the effect due to mining and underestimate the effect due to CBM development.

Response:

The groundwater model was re-calibrated in steady-state for the pre-mining condition. The revised calibration is accurate to within +/- 15 feet for most locations. There are a few areas where modeled and actual water levels may differ by as much as +/- 50 feet. However, it should be noted that the pre-mining data from these wells is acknowledged to be questionable. In many cases, the water level data actually post-date mining but are assumed to be representative of pre-mining data because they are sufficiently far from mining operations at the time that the data was collected. This level of accuracy for calibration is believed to be reasonable given the regional nature of the model with a grid spacing of about ¼ mile. The model should not be expected to match water levels accurately at a smaller scale such as a mine site. An improved pre-mining calibration has resulted in much lower predicted drawdowns due to mining and CBM development in comparison to results presented in the DEIS and supporting groundwater technical reference document. The transient calibration of

the model to monitored water level changes resulting from mining and CBM development has also been revised. The revised transient calibration is accurate to within +/- 20 feet for most locations.

The data compilation that was used in the Little Thunder, Lighthouse and Marquiss models was reviewed; however, the Wyodak CBM Project EIS model was developed entirely from scratch (FEIS, p. 4-3 and 4-4). Changes to the references in the Technical Report have been made to clarify this point.

The entire GAGMO historical water-level database was imported into the Wyodak model to improve the calibration of the model over the large domain.

A review of Wyoming Oil and Gas Conservation Commission (WOGCC) data for CBM wells as of May 1999 indicates that the current average produced water yield for a CBM well is 12.4 gpm. However, there is wide variation in reported well yields, as well as some anomalies in the data. There are no obvious patterns of higher yields in certain areas, and there is very limited data for wells in western parts of the PRB. Based on current information, the 12-gpm-average rate of water production for the operating life of a well is a supportable, best estimate.

Faults and lineaments have been further defined in the revised model as part of the re-calibration effort. The coal units, underlying Tongue River Member, overlying Wasatch Fm., and the intervening layers, all have variable hydraulic characteristics. The revised model includes far more variability in these hydraulic input parameters than the earlier version, which has resulted in an improved calibration to both steady-state and transient-state conditions.

The groundwater model has been revised to include the Tongue River/Lebo Shale Members as the lowermost layer (layer 8) of the model. A layer (layer 7) of variable permeability separates the Tongue River from the Lower Wyodak coal (layer 6). Pumping wells representing the City of Gillette, Wright, and several of the major subdivisions in the vicinity of Gillette were added to the model. These water supply wells are screened in the lower layer of the model. Data for locations, screened intervals and pumping rates were provided by the City of Gillette and their contractor Wester-Wetstein & Associates, and by the Wyoming Water Development Commission. The revised model will allow the influence of the CBM development on the Tongue River Member to be assessed. The connection between the Tongue River and The Lower Wyodak can be varied in the model by changing the vertical permeability of the intervening confining unit (layer 7). References in the EIS that identified the Tullock as being the major source of groundwater for municipal wells have been changed to reflect the correct situation.

The model of the overburden sands is necessarily simplified because of the variability of the Wasatch. Even the more detailed mine models often do not attempt to address the overburden due to its variability. The EIS model's predicted overburden water level changes are generalized, and the model, being regional in scope, should not be expected to project water levels that precisely match local area conditions. However, the potential influences of mining and CBM development on the Wasatch (overburden sand) water levels require analysis. Although data are limiting for the overburden sands, available data from both the GAGMO database and the BLM monitoring wells were used to improve calibration.

Injection of Produced Water

The EIS should evaluate injecting the produced water elsewhere in the basin for long-term storage (e.g. water banking).

It is not clear why produced water can't be injected into the Wasatch Sand Aquifer, particularly when recharge from surface disposal is anticipated (DEIS, p. 4-43).

DEIS, p. 2-26: Consideration also should be given to injecting produced CBM water to the Lower Ft. Union Formation aquifers in the Tullock Member. The City of Gillette has conducted a short term feasibility study with very encouraging results. (See Wester-Wetstein Association report to the City of Gillette, April 20, 1999)

Response:

The discussion regarding injection of produced water underground in Chapter 2 (FEIS, p. 2-27) has been clarified. Injection of large quantities of produced water underground in the PRB is being researched, but is not a viable alternative at present. Injection requires that the receiving formation be capable of accepting the quantity of water being injected. Injection of CBM produced water into the Wasatch Formation above the coal seam has not been tested. Injection into aquifers within the Tullock Member of the Ft. Union Formation has been studied by the City of Gillette, with encouraging preliminary results. The BLM will continue to monitor this study as a possible means of future disposal of produced water. Disposal of produced water in Wyoming currently is limited to aquifers exempt from the definition of fresh and potable water. Injection of this water into an exempt formation, as allowed under current regulations, would make water now suitable for livestock use unusable.

Water Well Agreement

The BLM should modify the Water Well Agreement.

The BLM should require the Water Well Agreement.

The BLM has no authority to require the Water Well Agreement.

Response:

The existing Water Well Agreement format was developed by a working group of affected landowners and industry representatives. The BLM was not and is not a party to this agreement. However, the BLM requires that CBM operators on federal leases offer this agreement to affected landowners. If landowners do not accept the Water Well Agreement, water well mitigation would be accomplished in accordance with state law (FEIS, p. 2-17).

Shallow Groundwater in the Gillette Area

The EIS does not address the potential impact of increased discharges from CBM development and subsequent infiltration of water into zones of shallow groundwater accumulation in the Gillette area. These areas of shallow groundwater already have posed a significant problem to structures in the Gillette area.

Response:

The analysis contained in the FEIS (p. 4-38) has been modified to address the shallow groundwater conditions in the Gillette area. The discharge of CBM produced water into drainages in the Gillette area could add to the existing problems related to shallow groundwater. The ongoing pumping of shallow groundwater would have to continue and likely would need to increase in rate in order to maintain acceptable groundwater levels in the Gillette area for the life of the contributing CBM well water discharges.

Moyer Spring

A large buffer should be established around Moyer Spring until further studies are conducted to ensure the spring is protected. Otherwise, CBM development in the area could severely impact the spring before the relationship between the coal and the clinker is understood. The Land Quality Division of WDEQ has conditioned the Dry Fork Mine Permit to leave a buffer of coal next to the clinker to provide additional protection until the interaction between the coal and the clinker is better understood.

Response:

Moyer Spring (T.51N., R.71W., Section 30, 6th P.M.) is not located within the Wyodak EIS area (the project area under the Proposed Action or the expanded project area under Alternative 1). No indirect impacts to the spring are anticipated (FEIS, p. 4-30 and 4-37).

Groundwater Withdrawal, Methane Migration and Seepage, Aquifer Collapse, and Underground Fires

Groundwater withdrawal associated with CBM production may effect the release of methane and possibly H_2S from seeps or existing residential, livestock, and coal-monitoring wells. There is no understanding of the effects that dewatering the coal seam will have on the subsurface. These effects could include lowered water levels and yields in nearby water wells, aquifer collapse, ground subsidence, methane seepage into homes or water wells, and underground fires.

Response:

Seepage of methane and methane hazards in water wells within the PRB were discussed in the Geology and Mineral Resources section of the DEIS's Chapter 4 Environmental Consequences. Methane migration and seepage could occur within the PRB. Limited information is available for

use in characterizing methane mobility and anticipated movements in the PRB over time. Experience from the PRB has shown that methane seeps involving potentially explosive concentrations of methane can occur in the vicinity of near-surface coals seams (DEIS, p. 4-2 and DEIS references Glass et al., 1987 and Jones et al., 1987). Conditions for methane release will be dependent on site-specific geologic conditions and/or the specific well development conditions that remain after construction. H_2S is not a constituent of CBM in the PRB; and therefore, does not pose a risk to human health or the environment.

Where unconsolidated alluvial aquifers have collapsed in other geographic areas due to dewatering, significant ground subsidence has occurred. The Ft. Union Formation is a consolidated rock unit, and is only being partially dewatered to the top of the coal seam.

Coal mining has been ongoing in this area for more than 20 years, and has resulted in the partial dewatering of the coal beds that are downdip from the coal mines, but no underground fires have occurred as a result. Along the coal outcrop there has not been an increase in spontaneous fires as a result of adjacent coal mining or CBM development occurring to date. Combustion has been associated with water level drops in unconfined coal aquifers (DEIS, p. 3-5), however, CBM development in the PRB is occurring under confined conditions.

Uranium

CBM development and associated production of water may adversely affect the ability to mine uranium by in-situ leach mining procedures. Any reduction or loss of the natural water table (hydrostatic pressure) within the permeable host sandstones, which contain the uranium deposits, reduces the solubility of dissolved oxygen and causes a geometric reduction in uranium production. Oxygen and carbon dioxide are reactants that dissolve and stabilize the uranium in the water. If the water table drops to or below the depth of the uranium deposit, in-situ leach recovery methods become physically and chemically impractical. As CBM development involves the reduction in hydrostatic pressure with in the target coal seam and aquifer, any hydraulic connection between the coal aquifer and the uranium bearing sandstones may adversely impact the ability to extract the uranium resource.

Response:

Subsurface uranium deposits located near the southwestern portion of the Wyodak study area are associated with Wasatch Formation sandstones (DEIS, p. 4-3). CBM development in the PRB is occurring under confined conditions. Withdrawal of CBM and water from the stratigraphically lower Ft. Union Formation would not be likely to affect the potential recovery of uranium resources.

However, depending on the proximity of operations and the local geologic conditions, CBM development could adversely impact the in-situ leach extraction process of uranium mining operations in the PRB. Coordination between the industries and with the appropriate regulatory agencies will be required to minimize adverse impacts to either industry and their energy resource recovery programs.

Conflicts between CBM development and uranium mining will be analyzed site-specifically at the APD/POD level of analysis, as APDs and plans of development for federal CBM wells are reviewed by the BLM. Site-specific mitigating measures relating to a specific CBM well or group of CBM wells will be developed based on that analysis.

Applicable Comment Letters (Groundwater):

1, 5, 7, 8, 12, 14, 15, 16, 19, 21, 23, 25, 26, 27, 28, 29, 31, 33, 34, 36, 37, 38, 39, 40, 42, 41b, 44, 45, 46, 49, 51

Surface Water Issue Statements and Responses:

Water Pollution Potential and Potential Toxic Pollutants

The discussion related to water quality of CBM produced waters focuses only on sediment and dissolved solids. There needs to be improved analysis of water pollution potential from TDS, sediments, and potential toxic pollutants. The FEIS should disclose the toxicity of discharges from existing CBM wells and estimate how many CBM wells are expected to have discharges which exhibit toxicity. The FEIS also should disclose the mitigation plans for toxicity, i.e., no pumping allowed until toxicity is removed or an alternative disposal method is installed. It is anticipated that there may be toxicity problems from iron, manganese, and salinity. A basic plan for mitigating water quality addressing the standard requirements for mitigation of sediment or treatment of toxic discharges should be included in the analysis. The FEIS should establish some trigger levels for constituents of water discharges.

Very low selenium levels can cause adverse effects in fish and waterfowl. Reservoirs or ponds created to retain the discharge of CBM produced water may create an attractive hazard to many species of birds and wildlife through the evaporative concentration of selenium. Water should not be stored in closed impoundments.

Response:

For federal wells, water quality standards and effluent limitations in NPDES permits are administered by the WDEQ. BLM administers its resource conservation and surface protection responsibilities. CBM wells, once drilled, cannot be produced until CBM produced water can be discharged in accordance with WDEQ and other agency requirements. CBM produced water cannot be discharged unless these requirements, including treatment if necessary, are met. WDEQ reviews NPDES applications on a case-by-case basis. The agency's NPDES permitting process, effluent limitations, and monitoring requirements for CBM produced water currently are being reevaluated.

In an NPDES application, the receiving waters and the proposed effluent (CBM produced waters) are characterized by the CBM operator. This analysis is specific to a limited area, and is presented to WDEQ as supporting information in order to obtain approval for the proposed CBM discharge. WDEQ analyzes water pollution potential and establishes effluent limitations (currently under review by WDEQ), water quality standards and aquatic standards under its authority from EPA to

administer the federal Clean Water Act (as amended). These WDEQ requirements represent the water characteristics that are necessary for continued safe consumption or use of water downstream by humans and other species.

After an NPDES permit is issued, the effluent (CBM produced water) and the receiving waters downstream from the discharge point are monitored regularly by the CBM operator as specified by WDEQ and other agencies).

Characteristics of Surface Waters

The flow regimes, temperature, turbidity, and water chemistry anticipated as a result of CBM development should be disclosed and analyzed in comparison with the aquatic habitat required by species already inhabiting receiving waters (rivers and tributaries) downstream of the discharge points. Changes in pH, TDS, and salts are critical to fish and aquatic life. Since the discharge water quality is variable, specific analysis must be done and included in this EIS in order to accurately assess impacts to fish and aquatic life. Field scientific study, using water discharge data and projected ecosystem changes needs to be done to accurately assess impacts.

Response:

Limited existing information is available for use in characterizing the perennial receiving waters, flow regimes, and anticipated stream erosion downstream of the discharge points or the proposed discharges of CBM produced water. Environmental conditions between a discharge point and the perennial waters downstream will vary according to soil type, geology, existing stream flows, and other factors. Natural variations in the character of the produced water also will occur.

Localized conditions in existing downstream perennial waters could change as mixing of different types of water occurs, if produced water discharged directly into a drainage having perennial flow. Localized conditions are unlikely to change where discharge into an ephemeral drainage occurs. It is unlikely that existing turbid perennial waters downstream of discharge points will clear up.

Additional surface water monitoring sites will be established in order to collect information related to surface water characteristics, flow regimes, substrates, and aquatic habitats. Parameters such as water temperature, turbidity, or chemistry, that could affect the suitability of downstream waters as habitat for various aquatic species will be measured at these surface water monitoring sites. Monitoring related to specific habitats (such as sturgeon chub) will be incorporated within monitoring plans where suitable existing habitat may be affected by CBM activities.

Surface Flows - CBM Produced Water

Vast quantities of water will be discharged during CBM development. Realistic estimates were not used in the EIS for the number of wells and the volume of water produced. There is no specific mitigation plan or compensation plan for landowners in the EIS.

Response:

Larger volumes of water are produced from CBM wells at the onset of production and shortly thereafter. Later in the life of a CBM well, water production declines. Flow averages over the life of a well are used in this analysis to provide an estimate of cumulative groundwater withdrawal and surface water discharge.

Flow rates, annual flow volumes, and maximum instantaneous flows are projected by CBM operators in applications for groundwater appropriation permits. These values typically are somewhat overestimated to ensure that an adequate groundwater right is filed with the WSEO. Well completion reports document the actual flow when a well is completed. Monthly production reports filed with the WOGCC document water production over time during the life of a well.

The estimate of water production used in this analysis (CBM produced water) was compared to WOGCC production statistics for May 1999 that covered 902 producing CBM wells within the Wyodak study area. Producing CBM wells averaged 12.4 gpm per well of produced water in May 1999. An earlier WOGCC analysis of 500 producing CBM wells showed an average water production per well of 14.6 gpm.

Even through water production may vary within the PRB and over time as wells continue production, it is necessary to take a hard look at cumulative groundwater withdrawals and cumulative surface water discharges. In order to analyze water volumes and water flows, these values must be estimated, even though they may be variable. The BLM has used the available data and its best professional judgement to make a representative estimate of water production for use in this NEPA analysis.

A specific mitigation plan or compensation plan for landowners is outside the authority of the BLM. The existing Water Well Agreement contained in Appendix D of the DEIS represents one such plan. It was developed by a working group of affected landowners and industry representatives (FEIS, p. 2-17).

Water Management Plans

Water management plans containing site-specific information are essential to address impacts, use/storage, mitigation, and monitoring related to water resources. These plans should be limited to BLM jurisdictional lands, developed with public involvement, and included within the EIS.

Approval of any "hydrologic watershed analysis" would exceed the BLM's authority. The BLM does not have the authority to make approval of an APD/POD dependent on the treatment of non-jurisdictional lands (off-site mitigation) in the water management plan.

Response:

As described in Appendix B, a water management plan is site-specific to a CBM Project Plan of Development (POD) for a small group of APDs, and is properly part of the APD/POD level of

analysis, not this programmatic analysis for the Wyodak CBM Project (refer to FEIS, p. 1-14 and 1-15, Chapter 2, and Appendix B). A water management plan and the surface use plan it accompanies are public documents. BLM posts the non-confidential portions of APDs, (which would include surface use plans and water management plans), publicly for 30 days upon receipt. This information is available to agency decision makers and the public.

Water management plans are analysis tools that the BLM will use to address cumulative impacts of a CBM POD and reasonably connected actions site-specifically within a watershed area. As conservator of the federal mineral estate (56 percent of the Wyodak study area), the BLM retains responsibility for ensuring that the federal mineral resource is conserved (not wasted), and is developed in a safe and environmentally sound manner. The BLM does not have jurisdiction over privately-owned surface lands.

Injection of Produced Water

The EIS should evaluate injecting the produced water elsewhere in the basin for long-term storage (e.g. water banking).

It is not clear why produced water can't be injected into the Wasatch Sand Aquifer, particularly when recharge from surface disposal is anticipated (DEIS, p. 4-43).

DEIS, p. 2-26: Consideration also should be given to injecting produced CBM water to the Lower Ft. Union Formation aquifers in the Tullock Member. The City of Gillette has conducted a short term feasibility study with very encouraging results. (See Wester-Wetstein Association report to the City of Gillette, April 20, 1999)

Response:

The discussion regarding injection of produced water underground in Chapter 2 (FEIS, p. 2-27) has been clarified. Injection of large quantities of produced water underground in the PRB is being researched, but is not a viable alternative at present. Injection requires that the receiving formation be capable of accepting the quantity of water being injected. Injection of CBM produced water into the Wasatch Formation above the coal seam has not been tested. Injection into aquifers within the Tullock Member of the Ft. Union Formation has been studied by the City of Gillette, with encouraging preliminary results. Disposal of produced water in Wyoming currently is limited to aquifers exempt from the definition of fresh and potable water. Injection of this water into an exempt formation, as allowed under current regulations, probably would make water now suitable for livestock use unusable.

Moyer Spring

A large buffer should be established around Moyer Spring until further studies are conducted to ensure the spring is protected. Otherwise, CBM development in the area could severely impact the spring before the relationship between the coal and the clinker is understood. The Land Quality Division of WDEQ has conditioned the Dry Fork Mine Permit to leave a buffer of coal next to the

clinker to provide additional protection until the interaction between the coal and the clinker is better understood.

Response:

Moyer Spring (T.51N., R.71W., Section 30, 6th P.M.) is not located within the Wyodak EIS area (the project area under the Proposed Action or the expanded project area under Alternative 1). No indirect impacts to the spring are anticipated (FEIS, p. 4-30 and 4-37).

Applicable Comment Letters (Surface Water):

1, 6, 7, 8, 9, 9a, 9b, 9c, 11, 14, 15, 16, 18, 19, 22, 23, 24, 26, 27, 31, 32, 34, 35, 36, 38, 40, 41b, 43, 44, 45, 48, 49, 51

Wetlands Issue Statements and Responses:

Mitigation of Impacts to Wetlands

Fencing of wetlands and providing off-site watering for livestock would allow vegetation development and facilitate maintenance of water quality in key wetlands.

Where possible, wetlands and ponds should be built on accessible public land where recreational users can benefit from the development.

Response:

As the percentage of federally-owned surface lands in the Wyodak EIS area (the project area under the Proposed Action or expanded project area under Alternative 1) ranges from about eight to twelve percent, the implementation of protective federal statutes and policies regarding wetlands by surface management agencies such as the BLM and the FS will be limited. As stated on page 4-85 of the DEIS, in accordance with BLM policy surface disturbance is prohibited within 500 feet of wetlands unless an acceptable plan for mitigation of impacts developed and implemented. Disturbance of all wetlands is mitigated acre for acre. On private lands (most of the Wyodak EIS area) reclamation planning, including wetland mitigation, considers the landowners' goals for post-project land use.

Applicable Comment Letters (Wetlands):

6, 9, 9a, 34, 38

Air Quality

Air Quality Issue Statements and Responses:

Modeling - Air Quality Impacts

The data, assumptions, model settings (parameters), measuring points (receptors), and checks and balances (calibrations) used in computer modeling of impacts to air quality and air quality related values (the air quality analysis protocol) could have been selected to represent the impacts from future coal mining more accurately. The computer model, as used by the BLM, produced results that exaggerated the contributions of nearby coal mines to the projected cumulative impacts in the eastern PRB and surrounding areas, and would not be appropriate for use in coal permitting. The modeled impacts are not consistent with the observed effects of two decades of expanding coal mining activities.

All activities that would contribute to air quality impacts should be modeled, including, for example, vehicle traffic and controlled burns by land management agencies. Model results should be compared with existing monitoring data to calibrate computer modeling with "real world" conditions.

Response:

This analysis, using the latest state of the art computer models and programmatic location of facilities, demonstrated that the air quality effects from the proposed Wyodak CBM Project alone would not lead to any violations of ambient air quality standards (State of Wyoming or Federal) or air quality related values at Class I or sensitive Class II areas with 230 kilometers of the Wyodak study area. Therefore, the BLM can make the determination that the proposed Wyodak CBM Project would not have significant adverse air quality impacts.

The cumulative impact analysis in this EIS evaluated all permitted and proposed new stationary point sources, including the proposed Wyodak project sources, all incremental increases in coal mining activities, and all increases in coal train emissions. The cumulative impact analysis demonstrated that adverse visibility impacts from regional haze may occur at Class I and sensitive Class II areas when all pollutant sources, currently permitted and reasonably expected to occur in 2015, are analyzed. WDEQ permitting analysis for a single point source facility typically does not consider all possible pollutant sources over a large area. The contribution to air quality impacts from each individual source may be insignificant.

Emissions from stationary sources and monitoring activities for these sources are regulated by the WDEQ. The WDEQ has the authority to set permit limits, mitigating measures, monitoring requirements, and BACT (Best Available Control Technology) for stationary sources.

The EPA has the authority to set permit limits, mitigating measures, monitoring requirements, and maximum allowable emission rates for mobile sources (including coal trains). The BLM does not have any authority to make decisions related to air quality emissions or monitoring.

The protocol for the air quality and air quality related values impact analysis done for this EIS was developed by an interagency committee Wyodak Air Quality Advisory Committee (WAQAC) that consists of air quality specialists from the Bureau of Land Management, National Park Service, U.S. Forest Service, Environmental Protection Agency, Wyoming Department of Environmental Quality, and BLM's contractor, Greystone. The regional haze visibility analysis, performed by EnviroNet AeroScience, LLC, followed the recommendations of the Interagency Workgroup on Air Quality Modeling (IWAQM) with the approval of WAQAC and specific input from National Park Service air quality specialists.

The data, assumptions, model settings (parameters), measuring points (receptors), and checks and balances (calibrations) used in computer modeling of impacts were selected to reasonably represent the impacts from CBM development and the cumulative impacts from other permitted and projected sources for which data were available. Data and assumptions were continually revised and updated throughout the analysis in an effort to utilize the best and most recent data and projected regulatory requirements whenever possible. Key points concerning modeling parameters and methods are discussed below:

- Receptors were placed within Class I and sensitive Class II areas on a 2.5 to 5 kilometer resolution. At the distances involved from the cumulative sources to the receptors, this resolution was considered adequate by the WAQAC.

- Coal train emissions were modeled as diffuse volume sources per the recommendations of the WAQAC and Earth Tech, Inc., the firm that developed and maintains the CALMET/CALPUFF model under contract from the EPA.

- Point sources were combined, when appropriate, to reduce computational time. Combinations used EPA-approved methods. Only sources at least 50 kilometers from a receptor were combined. At distances beyond 50 kilometers, the combination of point sources is valid methodology. Wyodak Project sources were combined within 10 X 10 kilometer areas. Cumulative sources were combined only if located on the same facility, i.e., a single property boundary.

- Background values for ammonia and ozone were selected from IWAQM guidance and further modified for the eastern Wyoming area by the WAQAC.

- Terrain and land use data were provided by National Park Service meteorologists. This data has been previously used for other CALMET/CALPUFF modeling projects.

- The chemical mechanism used in the Wyodak modeling analysis is the method recommended by the EPA for regulatory purposes.

- Comparisons of the results from the Wyodak CBM Project modeling with other CALMET/CALPUFF modeling analyses can be valid only if all parameters (total emissions, type of pollutants, location of emission sources, distance between sources and receptors, meteorology, topography, etc.) are virtually identical. Comparing apparently similar projects without an in-depth analysis of the projects is not scientifically valid.

- The analysis used 100 days per year with precipitation greater than 0.01 inches, a value that was interpolated from USEPA AP-42, Section 13.2.2.3, Unpaved Roads Controls, Figure 13.2.2-1 (dated 9/98). To further verify this parameter, Local Climate Data during the period 1960-1990 for three stations east of the Rocky Mountains in Wyoming were reviewed. These stations reported the following values for the number of days with precipitation greater than 0.01 inches: Cheyenne - 100.7 days; Casper - 95.8 days; and Sheridan - 106.8 days (Reference, Western Regional Climate Center via Internet http://www.wrcc.dri.edu).

The purpose of the analysis was to predict potential effects to air quality and air quality related values within and near the Wyodak study area and at distant Class I and sensitive Class II areas. The analysis examined expected contributions of nearby coal mines to the projected cumulative impacts in the eastern PRB and surrounding areas. As explained in Chapter 5 of the Wyodak CBM Project Air Quality Technical Reference Document (5/99), the increased emissions from coal operations were scaled to incremental increases in reasonably foreseeable coal production. Likely future emission reductions were not included in computer modeling for either CBM development or coal activities. Modeling considered CBM compressor emissions at levels higher than current WDEQ permitting limits, and coal train locomotive emissions at present conditions rather than considering anticipated regulatory reductions. As new information becomes available, it will be used in future coal and/or CBM documents to analyze air quality impacts predicted for the proposed actions.

The results of the analysis were presented in the formats requested by the agencies (specifically the National Park Service and the U.S. Forest Service). These formats do not draw attention to the results as representing projections or estimates or being an incomplete cumulative increment tracking analysis due to the cutoff emissions inventory year. The detailed results potentially may be confusing to a reader unfamiliar with the use of a computer model in environmental analysis. Introductory language has been added to Chapter 4 to emphasize the limitations of analysis using computer-generated projections and to explain that even though quantified results have been obtained from the computer modeling, these results represent an overview effort to assess and disclose BLM's best estimate of what these emissions might be in the future and what impacts this level of emissions might have on regional haze at distant Class I and sensitive Class II areas.

The best data available at the time the analysis was being conducted were utilized in the analysis. The BLM and the State of Wyoming were the primary data sources for coal information. Burlington Northern/Santa Fe provided fuel usage data and emission factors for a coal train per mile. The emission factor used is based on the pollutant emissions from three locomotives hauling 100 coal cars. Certain detailed projections and assumptions that would be considered in a site-specific regulatory permit determination were not considered in this programmatic analysis. It would not be appropriate to apply the methodology of this programmatic analysis to the analysis for a site-specific regulatory permit determination.

Regional Haze

Projections of regional haze occurring at National Parks, National Monuments, National Forest Wildernesses, and the Northern Cheyenne Reservation are unrealistically high worst case estimates and do not represent what is really expected to occur. Projected coal mining and transportation of coal by railroad in 2015 (reasonably foreseeable development scenario) and the impacts resulting from these activities were not accurately considered in the computer model. Transportation along the proposed DM&E railroad route was not considered.

There are new federal rules for regional haze. These new requirements should be addressed.

Response:

The non-CBM project analysis underestimated the impacts to regional haze by not including the diesel soot particulate and SO_2 emissions from the coal haul trains or the projected DM&E rail route, currently under consideration, that would pass very near some of the sensitive areas evaluated in this analysis. While rail transport to the east was considered for one-third of the reasonably foreseeable coal production in 2015 (DEIS, p. 4-107), rail transport specifically along the DM&E rail route currently under consideration was not included in the analysis since the DM&E route has not yet been approved. As new rail lines are established, future analyses will address emissions site-specifically.

New federal relations on regional haze require reductions in haze over time. The approach taken by the BLM in the Wyodak CBM Project EIS to identify potential problems in a widespread area through an overview analysis of potential regional haze impacts has strengthened interagency and stakeholder cooperation on air quality issues and has provided a starting point for proactive regional strategies to reduce regional haze.

Formaldehyde

There is a health (cancer) risk from potential formaldehyde emissions, especially near large compressor stations like the prospective 12,000-hp station containing eight 1,500-hp engines that was used as a basis for calculation of ambient air concentration levels of formaldehyde. Formaldehyde risk and appropriate mitigating measures should be adequately addressed.

Response:

The risk from exposure to formaldehyde must be examined site-specifically. This risk is dependent upon the size of the gas-fired compression facilities and their proximity to residences. The BLM's authority is limited to the siting of compressors on federal leases.

The authority for permitting stationary compressors, including control of emissions, rests with WDEQ. When air quality permits are considered by WDEQ, possible mitigation to lessen the risk of exposure to formaldehyde could include raising the stack to reduce ground level impacts or adding

a CO catalytic oxidizer that would result in more complete combustion of natural gas and thus reduce the formation of formaldehyde (DEIS, p. 4-71).

Applicable Comment Letters (Air Quality):

1, 3, 12, 20a, 31, 37, 38, 39, 40, 44, 45, 47, 49, 51, 52

Geology/Mineral Resources/Geo-hazards

Geology/Mineral Resources/Geo-hazards Issue Statements and Responses:

Multiple Mineral Development Conflicts (Coal/CBM)

Where CBM development will take precedence over future coal mining it will impair future growth in the coal industry and will cause an economic hardship to the largest industry in Campbell County for 15 years or more.

CBM development cannot be allowed to proceed unrestricted and impede or delay coal development in the PRB.

Response:

The BLM is working to minimize coal/CBM conflicts. Where new leasing for oil and gas is proposed within existing mine permit boundaries, a stipulation is being added to the oil and gas lease requiring the lessee to come to agreement with the coal company prior to CBM development. Where a new coal lease is being issued, similar language is being added to the coal lease requiring the coal lessee to work out an agreement with the oil and gas lessee that will allow all coal to be recovered. Where oil and gas leases already exist, the BLM is working with the two mineral lessees to develop an agreement to recover as much of the methane as possible before mining occurs.

Geo-hazards, Methane Migration and Seepage, Aquifer Collapse, and Underground Fires

There is no understanding of the effects that dewatering the coal seam will have on the subsurface. These effects could include lowered water levels and yields in nearby water wells, aquifer collapse, ground subsidence, methane seepage into homes or water wells, and underground fires.

Methane and hydrogen sulfide gas seeps, underground coal fires, explosive levels of methane in domestic water wells, and the contamination of homes in areas of coal mining and methane development has occurred in Wyoming and other states. Wyoming state officials have refused to do baseline testing for methane gas in water wells and homes.

Response:

Seepage of methane and methane hazards in water wells within the PRB were discussed in the Geology and Mineral Resources section of the DEIS's Chapter 4 Environmental Consequences. Methane migration and seepage could occur within the PRB. Limited information is available for use in characterizing methane mobility and anticipated movements in the PRB over time. Conditions for methane release will be dependent on site-specific geologic conditions and/or the specific well development conditions that remain after construction. H_2S is not a constituent of CBM in the PRB; and therefore, does not pose a risk to human health or the environment.

Where unconsolidated alluvial aquifers have collapsed in other geographic areas, due to dewatering, significant ground subsidence has occurred. The Ft. Union Formation is a consolidated rock unit, and it is not being substantially dewatered. The Ft. Union Formation is only being partially dewatered to the top of the coal seam.

Coal mining has been ongoing in this area for more than 20 years, and has resulted in the partial dewatering of the coal beds that are downdip from the coal mines, but no underground fires have occurred as a result. Along the coal outcrop there has not been an increase in spontaneous fires as a result of adjacent coal mining or CBM development occurring to date. Combustion has been associated with water level drops in unconfined coal aquifers (DEIS, p. 3-5), however, CBM development in the PRB is occurring under confined conditions.

Uranium

CBM development and associated production of water may adversely affect the ability to mine uranium by in-situ leach mining procedures. Any reduction or loss of the natural water table (hydrostatic pressure) within the permeable host sandstones, which contain the uranium deposits, reduces the solubility of dissolved oxygen and causes a geometric reduction in uranium production. Oxygen and carbon dioxide are reactants that dissolve and stabilize the uranium in the water. If the water table drops to or below the depth of the uranium deposit, in-situ leach recovery methods become physically and chemically impractical. As CBM development involves the reduction in hydrostatic pressure with in the target coal seam and aquifer, any hydraulic connection between the coal aquifer and the uranium bearing sandstones may adversely impact the ability to extract the uranium resource.

Response:

Subsurface uranium deposits located near the southwestern portion of the Wyodak study area are associated with Wasatch Formation sandstones (DEIS, p. 4-3). CBM development in the PRB is occurring under confined conditions. Withdrawal of CBM and water from the stratigraphically lower Ft. Union Formation would not be likely to affect the potential recovery of uranium resources.

However, depending on the proximity of operations and the local geologic conditions, CBM development could adversely impact the in-situ leach extraction process of uranium mining operations in the PRB. Coordination between the industries and with the appropriate regulatory

agencies will be required to minimize adverse impacts to either industry and their energy resource recovery programs.

Conflicts between CBM development and uranium mining will be analyzed site-specifically at the APD/POD level of analysis, as APDs and plans of development for federal CBM wells are reviewed by the BLM. Site-specific mitigating measures relating to a specific CBM well or group of CBM wells will be developed based on that analysis.

Applicable Comment Letters (Geology/Mineral Resources/Geo-hazards):

4, 5, 9b, 12, 23, 26, 31, 33, 37, 38, 39, 41b, 44, 46

Wildlife/Fisheries

Wildlife/Fisheries Issue Statements:

Special Status Species

Improved analysis and consultation with agencies such as the U.S. Fish and Wildlife Service are needed for special status species.

Response:

Site-specific mitigating measures will be applied to projects at the APD/POD level of analysis so that wildlife impacts are mitigated below the level of concern or are addressed in site-specific environmental analyses. Mitigation measures and consultation with agencies such as the U.S. Fish and Wildlife Service, requested by Commentors already are agency commitments under existing BLM policy. For species that are intolerant of longer-term disturbances, a buffer zone is utilized per standard BLM Wyoming State Office policy.

Noise

Disturbance issues for wildlife species should include loss of habitat security due to noise and disturbance from humans/vehicles, not just ground breaking disturbance. Noise impacts need further study.

Response:

The Wyodak CBM Project encompasses a patchwork of private ranches interrupted by small parcels of public lands in a part of Wyoming where significant levels of mineral and energy resource development and production activities have been occurring for a long time. The low number of CBM project workers and the low level of daily activity throughout the project life make it unlikely that noise and disturbance from humans/vehicles will change significantly. Under Alternative 1 less than 800 people would work over a 3,600 square mile area during the initial development period of

3 to 5 years. After the initial development period, less than 400 people would be employed during production and maintenance activities across 3,600 square miles. Less than 500 vehicles would be dispersed over 3,600 square miles during the initial development period. After the initial development period, an estimated 260 vehicles would support production and maintenance activities (DEIS, p. 4-108).

Noise from stationary compressors can be analyzed site-specifically, but the BLM has very limited authority, which is limited to the siting of 380-hp compressors on federal leases. The authority for permitting stationary compressors, including control of emissions and noise, rests with WDEQ. Under current Wyoming laws, control of noise from stationary compressors would have to be implemented under municipal or county land use plans in order to limit the disturbance of nearby residents or wildlife populations.

Sturgeon Chub

Improved analysis for this species is needed. Much greater and more regular flows will occur in the Powder River, which supports the largest known reproducing population of sturgeon chub. The wells in these drainages will pump much more water than existing development on the eastern edge of the project. Industry estimates are over 100 gpm.

Response:

Because of the low number of wells projected (in this analysis) to discharge into the tributaries of the Powder River, and the channel lengths of these tributaries where infiltration will occur, substantial flows of CBM produced water are not expected to reach the Powder River. The flows that do reach the Powder River are expected to remobilize channel sediments deposited as river flows decrease during the summer. As flows in the Powder River increase, the silt-carrying capacity of the river also will increase. The turbidity of the Powder River is not expected to change during CBM development and production activities. The sturgeon chub, which has adapted its habitat to turbid waters of large rivers having gravel substrates, is not expected to be affected.

The following modifications to the DEIS text have been made.

> (Page 3-40) Limited existing information is available for use in characterizing aquatic habitats in perennial receiving waters, flow regimes, and anticipated stream erosion downstream of the discharge points or the proposed discharges of CBM produced water. A comparison of 1990's and 1960's fish survey data from the Missouri River basin indicated that the sturgeon chub has a stable or increasing distribution (Patton et al, 1998). This survey was restricted to native warm-water species in non-montane regions. An estimated 40 to 50 percent of the fish species surveyed indicated a possibility of declining distributions (Patton et al, 1998). Two aquatic habitat types were common among the species with declining distributions indicated in the study: turbid rivers having silt and sand substrates; and small-to medium-sized streams having relatively cool, clear water, and preferably having gravel substrates for spawning. Patton et al (1998) suggested that reservoirs and diversion dams may have stabilized flows and reduced silt

loads in rivers, and that land management and irrigation practices may have increased turbidity and siltation in many small- to medium-sized streams.

(Page 4-94) CBM produced water cannot be discharged until it meets WDEQ requirements for effluent limitations that are necessary for the continued safe consumption or use of water downstream by humans and other species. Therefore, impacts to the sturgeon chub population present in the Powder River (expanded project area) are not anticipated. Because of the low number of wells projected (in this analysis) to discharge into the tributaries of the Powder River (Table 4-1 on p. 4-7), and the channel lengths of these tributaries where infiltration will occur, substantial flows of CBM produced water are not expected to reach the Powder River. The flows that do reach the Powder River are expected to remobilize channel sediments deposited as river flows decrease during the summer. As flows in the Powder River increase, the silt-carrying capacity of the river also will increase. The turbid nature of the Powder River is not expected to change during CBM development and production activities. The sturgeon chub, which has adapted its habitat to turbid waters of large rivers with gravel substrates, is not expected to be affected.

The following reference has been added: Patton, T., F.J. Rahel, and W.A. Hubert. 1998. Using Historical Data to Assess Changes in Wyoming's Fish Fauna. Conservation Biology, v.12, no. 5, p. 1120-1128.

The following mitigation measure has been added in Chapter 2: Additional surface water monitoring sites will be established in order to collect information related to surface water characteristics, flow regimes, substrates, and aquatic habitats. Monitoring related to specific habitats, such as those of the sturgeon chub, will be incorporated within monitoring plans at the site-specific APD/POD level of analysis where suitable existing habitat may be affected by CBM activities.

Water Management Plans

The management and proposed beneficial use of CBM produced water should be addressed in a water management plan that is a public document and is part of the EIS. The impact of new water flow into waters that support fisheries and aquatic habitat should be addressed.

Response:

As described in Appendix B, a water management plan is site-specific to an APD or a small group of APDs, and is properly part of the APD/POD level of analysis, not this programmatic analysis for the Wyodak CBM Project (refer to FEIS, p. 1-14 and 1-15, Chapter 2, and Appendix B). A water management plan and the surface use plan it accompanies are public documents. BLM posts the non-confidential portions of APDs, (which would include surface use plans and water management plans), publically for 30 days upon receipt. This information is available to agency decision makers and the public.

Water Pollution Potential and Potential Toxic Pollutants

The discussion related to water quality of CBM produced waters focuses only on sediment and dissolved solids. There needs to be improved analysis of water pollution potential from TDS, sediments, and potential toxic pollutants. The FEIS should disclose the toxicity of discharges from existing CBM wells and estimate how many CBM wells are expected to have discharges which exhibit toxicity. The FEIS also should disclose the mitigation plans for toxicity, i.e., no pumping allowed until toxicity is removed or an alternative disposal method is installed. It is anticipated that there may be toxicity problems from iron, manganese, and salinity. A basic plan for mitigating water quality addressing the standard requirements for mitigation of sediment or treatment of toxic discharges should be included in the analysis. The FEIS should establish some trigger levels for constituents of water discharges.

Very low selenium levels can cause adverse effects in fish and waterfowl. Reservoirs or ponds created to retain the discharge of CBM produced water may create an attractive hazard to many species of birds and wildlife through the evaporative concentration of selenium. Water should not be stored in closed impoundments.

Response:

For federal wells, water quality standards and effluent limitations in NPDES permits are administered by the WDEQ. BLM administers its resource conservation and surface protection responsibilities. CBM wells, once drilled, cannot be produced until CBM produced water can be discharged in accordance with WDEQ and other agency requirements. CBM produced water cannot be discharged unless these requirements, including treatment if necessary, are met. WDEQ reviews NPDES applications on a case-by-case basis. The agency's NPDES permitting process, effluent limitations, and monitoring requirements for CBM produced water currently are being reevaluated.

In an NPDES application, the receiving waters and the proposed effluent (CBM produced waters) are characterized by the CBM operator. This analysis is specific to a limited area, and is presented to WDEQ as supporting information in order to obtain approval for the proposed CBM discharge. WDEQ analyzes water pollution potential and establishes effluent limitations (currently under review by WDEQ), water quality standards and aquatic standards under its authority from EPA to administer the federal Clean Water Act (as amended). These WDEQ requirements represent the water characteristics that are necessary for continued safe consumption or use of water downstream by humans and other species.

After an NPDES permit is issued, the effluent (CBM produced water) and the receiving waters downstream from the discharge point are monitored regularly by the CBM operator as specified by WDEQ and other agencies).

Characteristics of Surface Waters

The flow regimes, temperature, turbidity, and water chemistry anticipated as a result of CBM development should be disclosed and analyzed in comparison with the aquatic habitat required by

species already inhabiting receiving waters (rivers and tributaries) downstream of the discharge points. Changes in pH, TDS, and salts are critical to fish and aquatic life. Since the discharge water quality is variable, specific analysis must be done and included in this EIS in order to accurately assess impacts to fish and aquatic life. Field scientific study, using water discharge data and projected ecosystem changes needs to be done to accurately assess impacts.

Response:

Limited existing information is available for use in characterizing the perennial receiving waters, flow regimes, and anticipated stream erosion downstream of the discharge points or the proposed discharges of CBM produced water. Environmental conditions between a discharge point and the perennial waters downstream will vary according to soil type, geology, existing stream flows, and other factors. Natural variations in the character of the produced water also will occur.

Localized conditions in existing downstream perennial waters could change as mixing of different types of water occurs, if produced water discharged directly into a drainage having perennial flow. Localized conditions are unlikely to change where discharge into an ephemeral drainage occurs. It is unlikely that existing turbid perennial waters downstream of discharge points will clear up.

Additional surface water monitoring sites will be established in order to collect information related to surface water characteristics, flow regimes, substrates, and aquatic habitats. Parameters such as water temperature, turbidity, or chemistry, that could affect the suitability of downstream waters as habitat for various aquatic species will be measured at these surface water monitoring sites. Monitoring related to specific habitats (such as sturgeon chub) will be incorporated within monitoring plans where suitable existing habitat may be affected by CBM activities.

Surface Flows - CBM Produced Water

Vast quantities of water will be discharged during CBM development. Realistic estimates were not used in the EIS for the number of wells and the volume of water produced. There is no specific mitigation plan or compensation plan for landowners in the EIS.

Response:

Larger volumes of water are produced from CBM wells at the onset of production and shortly thereafter. Later in the life of a CBM well, water production declines. Flow averages over the life of a well are used in this analysis to provide an estimate of cumulative groundwater withdrawal and surface water discharge.

Flow rates, annual flow volumes, and maximum instantaneous flows are projected by CBM operators in applications for groundwater appropriation permits. These values typically are somewhat overestimated to ensure that an adequate groundwater right is filed with the WSEO. Well completion reports document the actual flow when a well is completed. Monthly production reports filed with the WOGCC document water production over time during the life of a well.

The estimate of water production used in this analysis (CBM produced water) was compared to WOGCC production statistics for May 1999 that covered 902 producing CBM wells within the Wyodak study area. Producing CBM wells averaged 12.4 gpm per well or produced water in May 1999. An earlier WOGCC analysis of 500 producing CBM wells showed an average water production per well of 14.6 gpm.

Even through water production may vary within the PRB and over time as wells continue production, it is necessary to take a hard look at cumulative groundwater withdrawals and cumulative surface water discharges. In order to analyze water volumes and water flows, these values must be estimated, even though they may be variable. The BLM has used the available data and its best professional judgement to make a representative estimate of water production for use in this NEPA analysis.

A specific mitigation plan or compensation plan for landowners is outside the authority of the BLM. The existing Water Well Agreement contained in Appendix D of the DEIS represents one such plan. It was developed by a working group of affected landowners and industry representatives (FEIS, p. 2-17).

Impoundments

Development of reservoirs on natural stream courses could severely impact native aquatic species and their habitats. Reservoirs should be sited in the uplands unless it can be shown that they will provide benefits to fish and wildlife resources.

Constructing larger (rather than smaller) ponds to retain produced water would provide more open water and a longer shoreline at one site. Larger ponds also may have the characteristics needed to support fisheries. Larger ponds may be more beneficial to wildlife.

Reservoirs or ponds created to retain the discharge of CBM produced water may create an attractive hazard to many species of birds and wildlife through the evaporative concentration of selenium. Water should not be stored in closed impoundments.

Response:

Impoundments on private land are considered and controlled by the surface owner, not the BLM. The BLM does recommend that water not be placed in playas or reservoirs that do not have properly designed flow-through structures. The BLM also recommends that main stem reservoirs not be used for water storage. WSEO authorizes surface water impoundments (reservoirs) based on engineering designs submitted by the applicant. Over 80 percent of the land area included in this analysis is privately owned. The impoundments on these lands are privately owned. The BLM has no authority relative to the future maintenance or reclamation of these structures.

Applicable Comment Letters (Wildlife/Fisheries):

1, 7, 8, 9a, 11, 15, 17, 18, 19, 25, 28, 33, 34, 40, 43, 44, 48

Land Use

Land Use Issue Statements and Responses:

U.S. Supreme Court Decision Regarding Coal Bed Methane Ownership

The recent U.S. Supreme Court decision regarding the ownership of coal bed methane rights should be included in the EIS.

Response:

The U.S. Supreme Court decision in Southern Ute Indian Tribe vs. Amoco Production Company, was issued after the DEIS was published. Under the current management situation that is analyzed in the DEIS, coal bed methane is managed by the federal government as an oil and gas right. The U.S. Supreme Court determined that coal bed methane is an oil and gas right, not a coal right. The decision does not require any change to the analysis documented in the DEIS. Impacts, mitigation, and monitoring related to development conflicts between separate plans to develop the coal estate and the oil and gas estate are addressed.

Fortification Creek Wilderness Study Area (WSA)

The anticipated impacts to the Fortification Creek Wilderness Study Area (WSA) should be adequately addressed. Analysis should include whether noise and activities on the edge of the Fortification Creek WSA diminish the area's wilderness potential. The BLM's management goals for preservation of this area must be met until a decision is made regarding its status as a wilderness area.

Response:

Noise and activities, including transportation corridors, already occur near the Fortification Creek WSA. BLM's policies mandate that the agency preserve the wilderness character of federal lands within this study area until a decision is made regarding its wilderness status. Indirect impacts to the WSA from CBM development activities will be limited for the following reasons. The WSA is not downstream of proposed CBM wells or discharge points. Oil and gas leases are not issued with surface occupancy rights (for drilling, access routes, or production facilities) within the WSA. Road access and pipeline routes would not cross federal lands within the WSA before a decision in made regarding the wilderness status of the WSA. Impacts to elk populations occurring in the vicinity of this WSA are described on page 4-89 of the DEIS. Impacts to this WSA will be analyzed site-specifically as APDs and PODs for federal CBM wells are reviewed by the BLM. A paragraph containing this clarification has been added to page 4-104.

"Wild Areas" and "Sense of Place"

An analysis of impacts to mixed public and private "wild areas" (unroaded areas containing 5,000 acres or more) should be included.

Public access, ranching and private recreation use (by outfitters) and "the sense of place" of the Wyodak area will change as a result of CBM development, and should be addressed in the EIS.

Response:

Public access, ranching, and recreation use by outfitters could change as a result of CBM development. Impacts to land uses will be analyzed site-specifically as APDs and plans of development for federal CBM wells are reviewed by the BLM. However, the BLM has no authority to manage private lands.

The "sense of place" of the Wyodak study area is a patchwork of private ranches interrupted by small parcels of public lands in a part of Wyoming where significant levels of mineral and energy resource development and production activities have been occurring for a long time. The low number of project workers anticipated for CBM production activities, and the low level of daily activity anticipated after drilling operations are concluded in an area, makes it unlikely that the "sense of place" in the Wyodak study area will change. Less than ten percent of the land area analyzed is federally owned and administered by the BLM.

Noise

Disturbance issues for wildlife species should include loss of habitat security due to noise and disturbance from humans/vehicles, not just ground breaking disturbance.

Noise impacts need further study.

Response:

The Wyodak CBM Project encompasses a patchwork of private ranches interrupted by small parcels of public lands in a part of Wyoming where significant levels of mineral and energy resource development and production activities have been occurring for a long time. The low number of CBM project workers and the low level of daily activity throughout the project life make it unlikely that noise and disturbance from humans/vehicles will change significantly. Under Alternative 1 less than 800 people would work over a 3,600 square mile area during the initial development period of 3 to 5 years. After the initial development period, less than 400 people would be employed during production and maintenance activities across 3,600 square miles. Less than 500 vehicles would be dispersed over 3,600 square miles during the initial development period. After the initial development period, an estimated 260 vehicles would support production and maintenance activities (DEIS, p. 4-108).

Noise from stationary compressors can be analyzed site-specifically, but the BLM has very limited authority, which is limited to the siting of compressors on federal leases. The authority for permitting stationary compressors, including control of emissions and noise, rests with the WDEQ. Under current Wyoming laws, the control of noise from stationary compressors would have to be implemented under municipal or county land use plans in order to limit the disturbance of nearby residents or wildlife populations.

Alternatives - Beneficial Use

The alternatives for beneficial use of the CBM produced water should be analyzed in the EIS before a decision is made regarding the disposal of CBM produced water.

Response:

WSEO authorizes the proposed appropriation of groundwater from a CBM well, the beneficial use(s) of the appropriated groundwater, and the specific locations of use identified by the applicants (landowner and CBM operator) in a groundwater appropriation permit (U.W.5). A coal bed methane well is recognized by the agency as a beneficial use of groundwater in Wyoming. Other beneficial uses, such as stock watering or irrigation, when applicable, also are listed on the permit application. The alternatives for beneficial use of the CBM produced water are not analyzed by the WSEO. The groundwater appropriation permit documents the nature and priority of groundwater rights filed in Wyoming.

The specific location where the appropriated groundwater is discharged onto the land surface and the effluent (water discharge) are authorized by WDEQ in an NPDES permit. Alternative locations for CBM produced water discharge points are not analyzed by WDEQ. The WDEQ's analysis focuses on requirements for effluent limitations and discharge monitoring that provide for continued safe use or consumption of Wyoming surface waters.

Surface use plans, including water discharge points, for federal wells are reviewed by the BLM (and/or FS). The analysis of plans for federal wells involving private surface ownership is a collaborative effort among the agency, the landowner, and the CBM operator. As conservator of the federal surface and mineral estate, the BLM retains responsibility for ensuring that the federal mineral resource is conserved (not wasted), and is developed in a safe and an environmentally sound manner. However, the BLM does not control the appropriation or use of groundwater.

Livestock Grazing - Rest Rotation Practices

Grazing management plans that rely upon turning water on and off in different areas to move or disperse livestock and manage the utilization levels of available forage could be affected by the continued availability of CBM produced water throughout the year.

Response:

Impacts from the "new" perennial flows of CBM produced water on grazing rest-rotation practices will be analyzed site-specifically as APDs and plans of development for federal CBM wells are reviewed by the BLM. The potential mitigation of removing livestock from an area or fencing out livestock likely would be the only feasible ways of preserving the objectives of rest-rotation grazing systems, where the water could no longer be turned on or turned off at will. Where federal surface is involved, water management plans (and plans for water disposal) would have to meet the provisions established in AMPs (allotment management plans) or the AMP would have to be revised.

Land Surface Impacts and Reclamation

Soil and vegetation loss and noxious weed invasions are significant impacts of CBM development and should be addressed adequately in the EIS.

Reclamation standards, requirements, and goals should be described in detail in the EIS. The future maintenance and reclamation of impoundment structures (dams) also should be addressed. Only native species should be used in revegetation mixes.

Response:

Soil and vegetation loss and noxious weed invasions will be analyzed site-specifically as APDs and plans of development for federal CBM wells are reviewed by the BLM.

Reclamation standards, requirements, and goals, including any requirements to utilize native species for revegetation, will be analyzed site-specifically as APDs and plans of development for federal CBM wells are reviewed by the BLM.

Land Use Conflicts

Conflicts between CBM development and other land uses should be addressed in the EIS. The BLM's decisions regarding CBM development on federal leases significantly affect private landowners. Other agency decisions regarding CBM development on fee and state leases also significantly affect private landowners.

Response:

Conflicts between CBM development and other land uses will be analyzed site-specifically as APDs and plans of development for federal CBM wells are reviewed by the BLM. The BLM's decisions regarding CBM development on federal leases do significantly affect private landowners. Other agency decisions regarding CBM development on fee and state leases also significantly affect private landowners. Landowners will be involved in (on-lease) decisions that affect their (off-lease) land. Water management plans are public documents and will be posted for public review upon receipt.

Stakeholder Involvement

Landowners should be involved in (on-lease) decisions that affect their (off-lease) land.

Response:

At the APD/POD level of analysis landowners are invited to onsite inspections for proposed activities involving their land (FEIS, p.1-14). BLM requires that CBM operators certify in their surface use plan that they have or will reach a surface use agreement with the surface landowner.

Water Management Plans

Water management plans containing site-specific information are essential to address impacts, use/storage, mitigation, and monitoring related to water resources. These plans should be limited to BLM jurisdictional lands, developed with public involvement, and included within the EIS.

Approval of any "hydrologic watershed analysis" would exceed the BLM's authority. The BLM does not have the authority to make approval of an APD dependent on the treatment of non-jurisdictional lands (off-site mitigation) in the water management plan.

Response:

As described in Appendix B, a water management plan is site-specific to a CBM Project Plan of Development (POD) for a small group of APDs, and is properly part of the APD/POD level of analysis, not this programmatic analysis for the Wyodak CBM Project (refer to FEIS, p. 1-14 and 1-15, Chapter 2, and Appendix B). A water management plan and the surface use plan it accompanies are public documents. BLM posts the non-confidential portions of APDs, (which would include surface use plans and water management plans), publicly for 30 days upon receipt. This information is available to agency decision makers and the public.

Water management plans are site-specific analysis tools that the BLM will use to address cumulative impacts of a CBM POD and reasonably connected actions within a watershed area. As conservator of the federal mineral estate (56 percent of the Wyodak study area), the BLM retains responsibility for ensuring that the federal mineral resource is conserved (not wasted), and is developed in a safe and environmentally sound manner. The BLM does not have jurisdiction over privately-owned surface lands.

Landowner Compensation

Improved discussion of compensation to potentially flooded landowners is needed.

Response:

Discussion of compensation to potentially flooded landowners is outside the scope of the EIS analysis. Landowner compensation is an issue that must be resolved between the CBM operators and the landowners. The BLM has no authority related to landowner compensation. There is no decision the agency could make.

Applicable Comment Letters (Land Use):

1, 12, 15, 17, 22, 25, 28, 34, 40, 44

CONSULTATION AND COORDINATION

The following agencies, groups, and companies have provided input to this EIS.

Federal Agencies

U.S. Forest Service
U.S. Geological Survey
U.S. Fish and Wildlife Service
National Park Service
U.S. Environmental Protection Agency
Department of the Army, Corps of Engineers
Bureau of Reclamation
Office of Surface Mining
Natural Resources Conservation Service

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Northern Arapaho Business Council, Chairman
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Crow Creek Sioux Tribal Council, Chairman
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State of Wyoming

Wyoming Department of Administration and Information
Wyoming Department of Agriculture
Wyoming Department of Environmental Quality

Wyoming Game and Fish Department
Wyoming Geological Survey
Wyoming Office of Federal Land Policy
Wyoming Office of State Lands and Investments
Wyoming Oil and Gas Conservation Commission
Wyoming Public Service Commission
Wyoming State Engineer's Office
Wyoming State Historic Preservation Office
Wyoming Water Development Commission

Citizens' Groups and Regional Societies

Powder River Basin Resource Council
Inyan Kara Grazing Association
Wyoming Independent Producers Association
National Mining Association

Companies

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Devon Energy Corporation
M. John Kennedy
Barrett Resources Corporation
Redstone Resources, Inc.
Western Gas Resources, Inc.
Lance Oil & Gas Company, Inc.
Yates Petroleum
Rim Operating
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CHAPTER 6
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The following reference should be deleted from Chapter 6 in the DEIS:

WWRC. (in press). (Modeling Study of the Lighthouse CBM Development)

CHAPTER 7
ACRONYMS

ac-ft	Acre-feet (1 acre-foot = 329,829 gallons)
ac-ft/yr	Acre-feet per year
APD	Application for permit to drill
AQD	Air Quality Division, Wyoming Department of Environmental Quality
ASSMR	American Society of Surface Mining and Reclamation
AUM	Animal unit month
BACT	Best Available Control Technology
bbl	Barrel (42 gallons)
bpd	Barrels per day
bcf	Billion cubic feet
BEA	Bureau of Economic Analysis
BFO	Buffalo Field Office, Bureau of Land Management
BLM	Bureau of Land Management, U.S. Department of the Interior
CBM	Coal bed methane
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations. Numbers refer to title and part; that is, 40 CFR 1500 refers to title 40, part 1500.
cfs	Cubic feet per second (equivalent to 448.83 gallons per minute)
CO	Carbon Monoxide
COE	U.S. Army Corps of Engineers
COI	Circle of influence of a CBM production well

CHIA "Cumulative Potential Hydrologic Impacts of Surface Coal Mining in the Eastern Powder River Structural Basin, Northeastern Wyoming"

CCEDC Campbell County Economic Development Corporation

dBA A-weighted scale, decibels

DOE U.S. Department of Energy

EA Environmental assessment

EC Electrical conductivity, measured in µmhos/cm

EIS Environmental impact statement

EPA U.S. Environmental Protection Agency

ESP Exchangeable sodium percentage

Fm Formation (geologic)

FS U.S. Forest Service, U.S. Department of Agriculture

gm/hp-hr Grams per horsepower-hour

gpm Gallons per minute (equivalent to 0.002 cfs, approximately)

GAGMO Gillette Area Groundwater Monitoring Organization (coal operators)

HAP Hazardous Air Pollutants

HP Horsepower

km Kilometer

LBA Lease by application

LQD Land Quality Division, Wyoming Department of Environmental Quality

LRMP Land and Resource Management Plan

mcf Thousand cubic feet

MCFD One thousand cubic feet per day

mg/l	Milligrams per liter (1 mg = 1 ppm [part per million]; 1 liter = 0.264 gallons)
mgd	Million gallons per day
µg/l	Micrograms per liter (1 µg = one thousandth of a milligram or 0.001 mg or 1ppb [part per billion])
µg/m^3	Micrograms per cubic meter (1 cubic meter = 1.308 cubic yards)
mmcf	Million cubic feet
mmhos/cm	Soluble salts (salinity) in a soil expressed in millimhos per centimeter
MMCFD	One million cubic feet per day
MT	Montana
NAAQS	National Ambient Air Quality standards
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act of 1969
NO_X	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent (to prepare an EIS)
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service, U.S. Department of Interior
NRHP	National Register of Historic Places
NRCS	Natural Resources Conservation Service
OSM	Office of Surface Mining, Reclamation and Enforcement
PAP	Permit application packages
pci/l	Picocurie per liter, used to measure Radium 226

pH Acidity, measured in standard units

PM_{10} Particulate matter less than 10 micrometers (respirable)

PRAGMO Powder River Area Groundwater Monitoring Organization

PRB Powder River Basin

psi Pounds per square inch

PVC Plastic (polyvinyl chloride-type, used in plastic pipes and well casings)

R__W Range number West, an east-west rectangular land survey area coordinate

RMP Resource Management Plan

ROD Record of Decision

S__ Section number, a rectangular land survey area

SAR Sodium Absorption Ratio

SCS Soil Conservation Service, U.S. Department of Agriculture

SHPO State Historic Preservation Officer

SMCRA Surface Mining Control and Reclamation Act of 1977

SO_2 Sulfur dioxide

Sq mi Square miles

STATSGO State Soil Geographic Database

T__N Township number North, a north-south rectangular land survey area coordinate

TBNG Thunder Basin National Grassland

TDS Total dissolved solids

TPH Total petroleum hydrocarbons

TSP Total suspended particulates

TSS Total suspended sediments

µmhos/cm	Micromhos per centimeter {thousandths of unit of specific conductance) (a measure of electrical conductivity)
USDA	U.S. Department of Agriculture
USDC	U.S. Department of Commerce
USDI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service, U.S. Department of the Interior
USGS	Geological Survey, United States Department of the Interior
VOCs	Volatile Organic Compounds
VOR	VHF (very high frequency) Omnidirectional Range (radio aid used for navigation)
VQO	Visual Quality Objective
VRM	Visual resource management
WDEQ	Wyoming Department of Environmental Quality
WDR	Wyoming Department of Revenue
WGA	Wyoming Geological Association
WGFD	Wyoming Game and Fish Department
WGS	Wyoming Geological Survey
WOGCC	Wyoming Oil and Gas Conservation Commission
WQD	Water Quality Division, Wyoming Department of Environmental Quality
WSA	Wilderness Study Area
WSEO	Wyoming State Engineer's Office
WWRC	Wyoming Water Resources Center
WY	Wyoming