2005 Annual Coalbed Methane Regional Ground-water Monitoring Report: Northern Portion of the Powder River Basin

OPEN-FILE REPORT
538

John Wheaton
Teresa Donato
Shawn Reddish
Licette Hammer

Montana Bureau of Mines and Geology

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Abstract

This report presents groundwater data and interpretations from within the northern portion of the Powder River Basin, collected during 2005. This is the third year in which the Montana coalbed-methane (CBM) regional ground-water monitoring network has been fully active. The network was initiated to document baseline hydrogeologic conditions in current and prospective CBM areas in southeastern Montana, to determine actual ground-water impacts and recovery, to help dispel rumors of impacts, and to provide data and interpretations to aid environmental analysis and permitting decisions. Detailed discussions of the regional ground-water systems were presented in the first annual report (Wheaton and Donato, 2004). The current network consists of a combination of pre-existing monitoring wells installed during the late 1970's and early 1980's in response to actual and potential coal mining; recently installed monitoring wells specific to CBM impacts; domestic wells; stock wells; and springs.

Methane (natural gas) production from coal beds is a potentially important industry in Montana. The CX field near Decker, Montana, operated by Fidelity Exploration and Production Company, began producing methane in October, 1999 (Plate 1). The CX field now includes 516 wells which produced methane, water, or both during 2005. A total of 10.5 million-thousand standard cubic feet (million mcf) of CBM were produced from the CX field during 2005. No other Montana CBM wells produced gas in 2005; however there are several other projects in various stages of development (Plate 1).

Coalbed methane is held in coal seams by adsorption on the coal due to weak bonding and water pressure. Reducing the water pressure, by pumping ground water from the coal aquifers, allows the methane to desorb from the surfaces in the coal. Ground water is typically pumped at a rate and scale that reduces the water pressure (head) within the coal bed to a few feet above the top of the coal across large areas. The extraction and subsequent management of CBM production water has raised concerns about potential for loss of stock and domestic water supplies due to ground-water drawdown, and impacts to surface-water quality and soils due to the management of produced water.

The dissolved constituents of water in methane-prospective coal beds in the Powder River Basin (PRB) of Montana are dominated by ions of sodium and bicarbonate. Across the Montana portion of the PRB, sodium adsorption ratios in CBM production water will likely be between 34 and 57, with total dissolved solids concentrations between 875 and 1,525 mg/L. Sulfate concentrations in production water will be very low, typically less than 65 mg/L. This production water is typically of acceptable quality for domestic and livestock use, however its high sodium content makes it undesirable for direct application to soils, particularly those with appreciable clay content (particularly montmorillonite and smectite).

Hydrostatic heads in monitored coal seams have been lowered as much as 150 feet or more within areas of production. After 6 years of CBM production, the 20-foot drawdown contour extends about 1.0 to 1.5 miles beyond the edges of the CX field,

which is somewhat less than originally predicted. The distance to the 20-foot drawdown contour is expected to increase as the duration of production increases; however, little change in this distance was noted during 2005 monitoring. Based on computer modeling and reviews of current data from mines and other CBM production fields, drawdown of 20 feet is expected to eventually reach as far as 4 miles beyond the edges of large production fields. Less drawdown will occur at greater distances, and drawdown of 10 feet was predicted to reach as far as 5 to 10 miles beyond production fields after 20 years (Wheaton and Metesh, 2002). Aquifers will recover after production ceases, but it may take decades for them to return to the original levels. The extent of drawdown and rates of recovery will mainly be determined by the rate, size and continuity of CBM development, and the site-specific aquifer characteristics including the extent of faults in the Fort Union Formation.

Models and predictions are important for evaluating potential hydrogeologic impacts. However, inventories of existing resources and long-term monitoring of aquifer responses are necessary to determine the actual magnitude and duration of impacts. After 6 years of CBM production it continues to be apparent that these monitoring data and interpretations are key for making informed development decisions and for determining the true causes of observed changes in ground-water availability.

Introduction

This report presents groundwater data and interpretations from within the northern portion of the Powder River Basin (PRB) collected during 2005. This is the third year in which the Montana regional coalbed methane ground-water monitoring network has been active. This program was initiated to document baseline hydrogeologic conditions in current and prospective coalbed methane (CBM) areas in southeastern Montana, to quantify ground-water impacts and lack of impacts, ground-water recovery, and to provide data and interpretations for use in environmental and permitting decisions. Additional background is presented in Wheaton and Donato (2004). Future reports are anticipated to be released early each spring.

This report includes: 1) a description of ground-water conditions outside of CBM production areas, which provides an overview of normal variations, helps improve our understanding of the ground-water regime in southeastern MT and provides water quality information for planning CBM projects; and 2) a description of ground-water conditions within and near CBM fields, which shows actual impacts from CBM production. The area covered by the CBM regional ground-water monitoring network is shown on Figure 1 and Plate 1.

All hydrogeologic monitoring data collected under the CBM regional monitoring program (including the data presented in this report) are available from the Montana Ground-Water Information Center (GWIC). To access data stored in GWIC, connect to http://mbmggwic.mtech.edu/. On the first visit to GWIC, select the option to create a login account. Users may access CBM related data by clicking on the picture of a CBM well head. Choose the project and type of data by clicking on the appropriate button. For supported browsers, data can be copied and pasted from GWIC to a spreadsheet.

Methane-production data and produced-water data used in this report were retrieved from the Montana Board of Oil and Gas Conservation (MBOGC) web page (http://www.bogc.dnrc.state.mt.us/).

Fidelity Exploration and Production (Fidelity) has been producing from the CX field near Decker, Montana (Plate 1) since September, 1999. Based on data from the Montana Board of Oil and Gas Conservation web page, this field now includes 529 wells. Of those wells, 516 are listed as producing gas or water during 2005. During 2005 Fidelity expanded the area of development within the CX field to the east, bringing portions of Coal Creek and Deer Creek North POD areas into production. Fidelity has also proposed changing its spacing from 1 to 2 wells per 160 acres.

CBM production along Prairie Dog Creek in Wyoming is adjacent to the CX field. The Prairie Dog Creek field is operated by Fidelity, Nance Petroleum Corporation (Nance), and J. M. Huber Corporation (Huber). Nance is also operating the Antelope

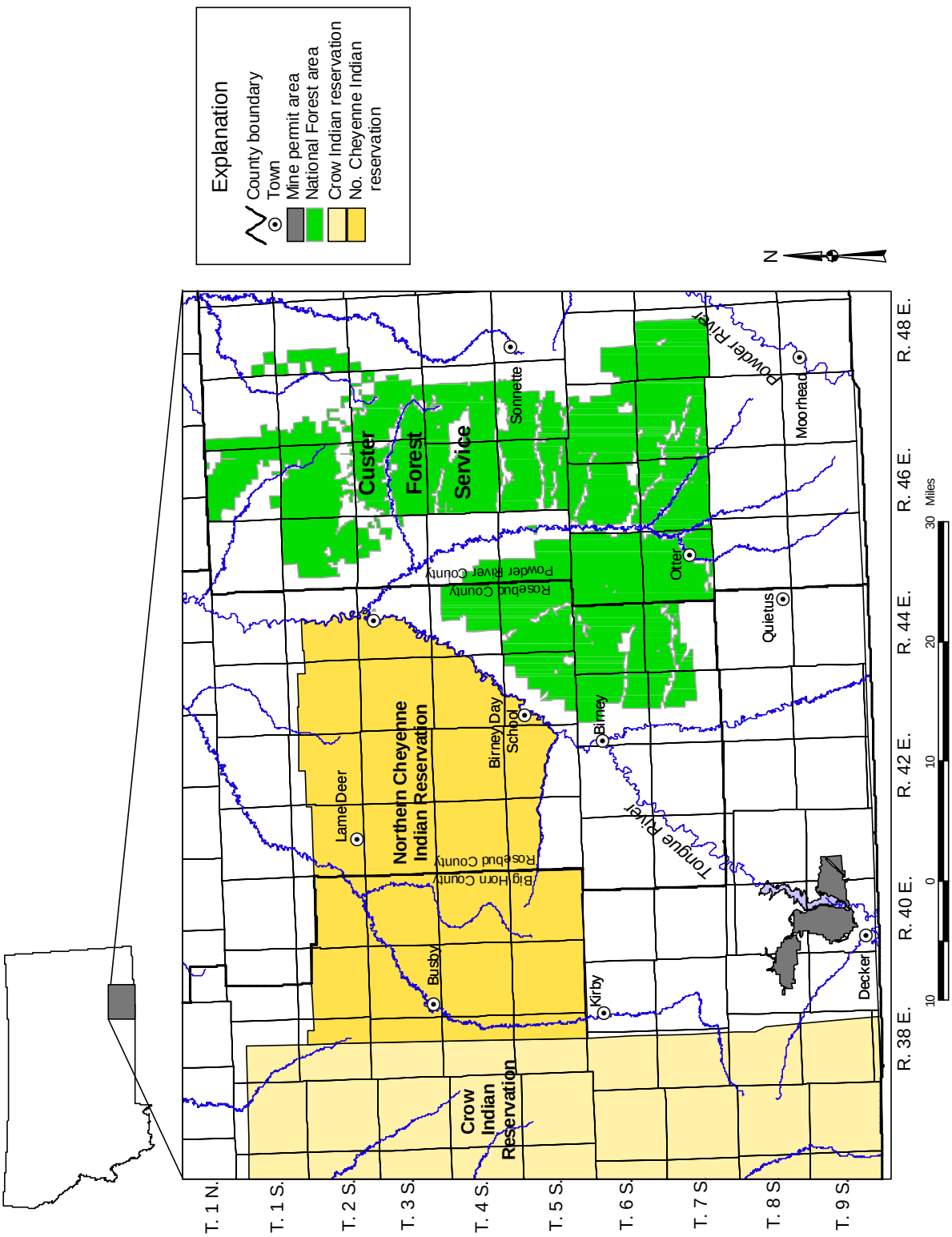

Figure 1. Location of study area.

Creek field in Wyoming near the Montana border in the Hanging Woman Creek drainage (Plate 1).

During 2005 Pinnacle Gas Resource, Inc. (Pinnacle) installed 12 test wells in the Coal Creek field just north of the Tongue River Dam (Plate 1). During 2005 the Coal Creek field produced water, and some gas was flared; however no gas was sent to market. During 2005 Pinnacle also expanded its operations near the Coal Creek field with the Dietz expansion on state and private minerals to the east of the Tongue River Reservoir; however none of the Dietz wells produced water or gas in 2005.

Powder River Gas has exploration wells in the Castle Rock field (Plate 1) but reported no gas or water production in 2005. Powder River Gas has also proposed an exploration project on the east edge of Ashland Ranger District during 2005 (Plate 1).

Acknowledgments

The landowners and coalbed methane producers who have allowed drilling and installation of monitoring wells on their land and leases, and those that are allowing monitoring access are gratefully thanked for their cooperation in this project. Funding for the current and much of the previous work has been provided by the U. S. Bureau of Land Management, U. S. Department of Energy and the Montana Department of Natural Resources. The USDA Forest Service is providing funding in support of monitoring on the Custer Ranger District. The Rosebud, Big Horn, and Powder River Conservation Districts have been long-term supporters of coal hydrologeology work. The statewide Ground-Water Assessment Program, operated by MBMG, monitors several wells and springs in the Powder River Basin, and those data are incorporated in this work. Clay Schwartz monitors these wells and provides additional assistance to the Regional Program. Data are also collected by the Northern Cheyenne Indian Tribe with assistance from USGS.

Location and description of area

The study area is that part of the Powder River Basin bounded by the Montana-Wyoming line on the south, roughly the Powder River on the east, the Wolf Mountains on the west and extending north to about Ashland (Figure 1 and Plate 1).

This area is semi-arid, receiving on average less than 15 inches of precipitation per year, based on data from Decker and Moorhead stations. Unfortunately, the weather station near Decker is no longer operational, having been removed from service at the end of 2004. Typically in the Powder River Basin, May and June are the wettest months and November through March the driest. Greatest monthly snowfalls occur from November through April. The annual average high temperature is in the low 60º F range

with July and August being the warmest. Annual average low temperature is about 30º F with December and January being the coolest months.

Aquifers are recharged by precipitation and shallow ground-water levels reflect both short- and long-term precipitation patterns. Precipitation data for the Moorhead station in the southeast part of the study area along the Powder River near the Montana/Wyoming state line, indicate average total annual precipitation is 12.3 inches, based on records from 1958 through 2005 (http://www.wrcc.dri.edu/summary/climsmmt.html). During 2005, Moorhead received 16.3 inches of precipitation, which is 33% above normal (Figure 2). Long-term trends that may affect ground-water levels become more evident when the departure-from-average precipitation for each year is combined to show the cumulative departure (line graph on Figure 2). Cumulative departure from annual-average precipitation does not provide a quantitative measure of potential recharge, but rather an indication of periods of decreasing and increasing moisture in possible recharge areas.

The Powder River Basin (PRB) is a geologic structure in southeast Montana and northeast Wyoming. The Tertiary Fort Union Formation and the overlying Wasatch Formation are the dominant bedrock exposures. Both formations consist of sandstone, siltstone, shale and coal units. The Fort Union Formation is divided from, top to bottom, into the Tongue River, Lebo Shale and Tullock Members. The coal beds in the Tongue River Member are the primary targets for CBM development in Montana. The geologic and structural relationships above the Lebo Shale are shown on the cross section on Plate 1. The cross section is based on MBMG monitoring wells and on published well logs and correlations (Lopez, 2005; McLellan, and others, 1990; McLellan, 1991; Culbertson, 1987; Culbertson, and Klett, 1979a; Culbertson, and Klett, 1979b). Generally, the coal zones between and including the Anderson and Knobloch coal seams are considered the most likely prospects for CBM in southeastern Montana (Van Voast and Thale, 2001).

A generalized stratigraphic column, showing relative stratigraphic position of the major coal beds, is presented in Figure 3. Not all coal seams shown on Figure 3 are present across the entire basin. The Anderson and Dietz coal seams are mined near Decker. Ground-water monitoring wells are completed in numerous coal beds and overburden and underburden sandstone units. The monitored intervals are indicated on Figure 3, as are intervals that are the source units for monitored springs. Several sets of nomenclature are used for coal beds in the Decker, Montana area. Table 1 shows the correlation between several different naming conventions.

Modern streams in Montana have formed valleys that cut through the entire coal-bearing Tongue River Member. Coal seams are exposed along valley walls, allowing ground-water seepage to form springs and allowing methane to naturally leak to the atmosphere. Ground-water monitoring wells that are completed in a coal bed occasionally release methane under static-water level conditions. It is interpreted that these wells are completed in an area of the coal bed where methane adsorption sites are saturated and free methane is either held in a structural or sedimentary trap or is migrating.

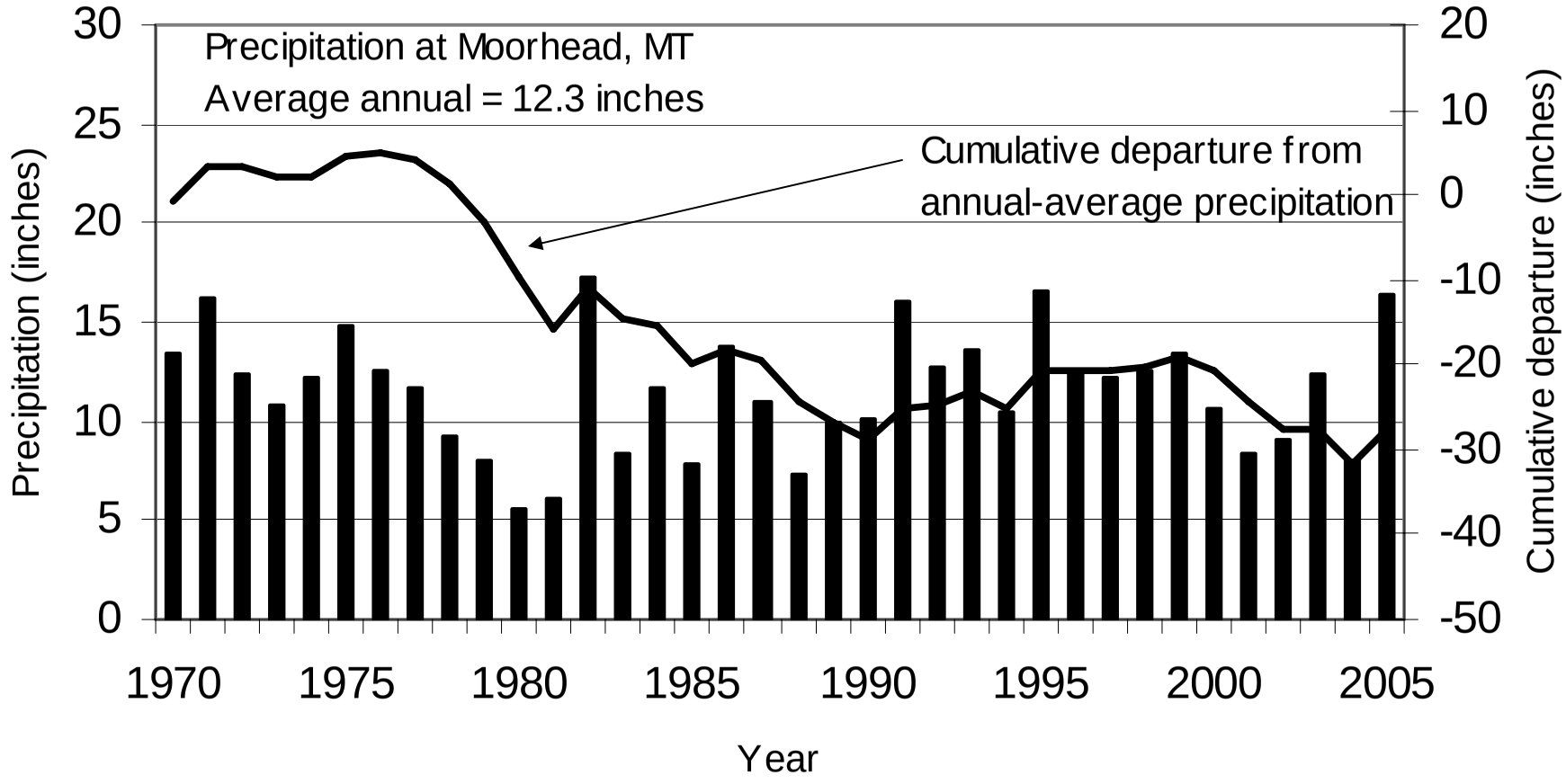

Figure 2. Annual precipitation (bar graph) at Moorhead MT. Cumulative departure from average precipitation provides a perspective on the long-term moisture trends that may effect ground-water recharge.

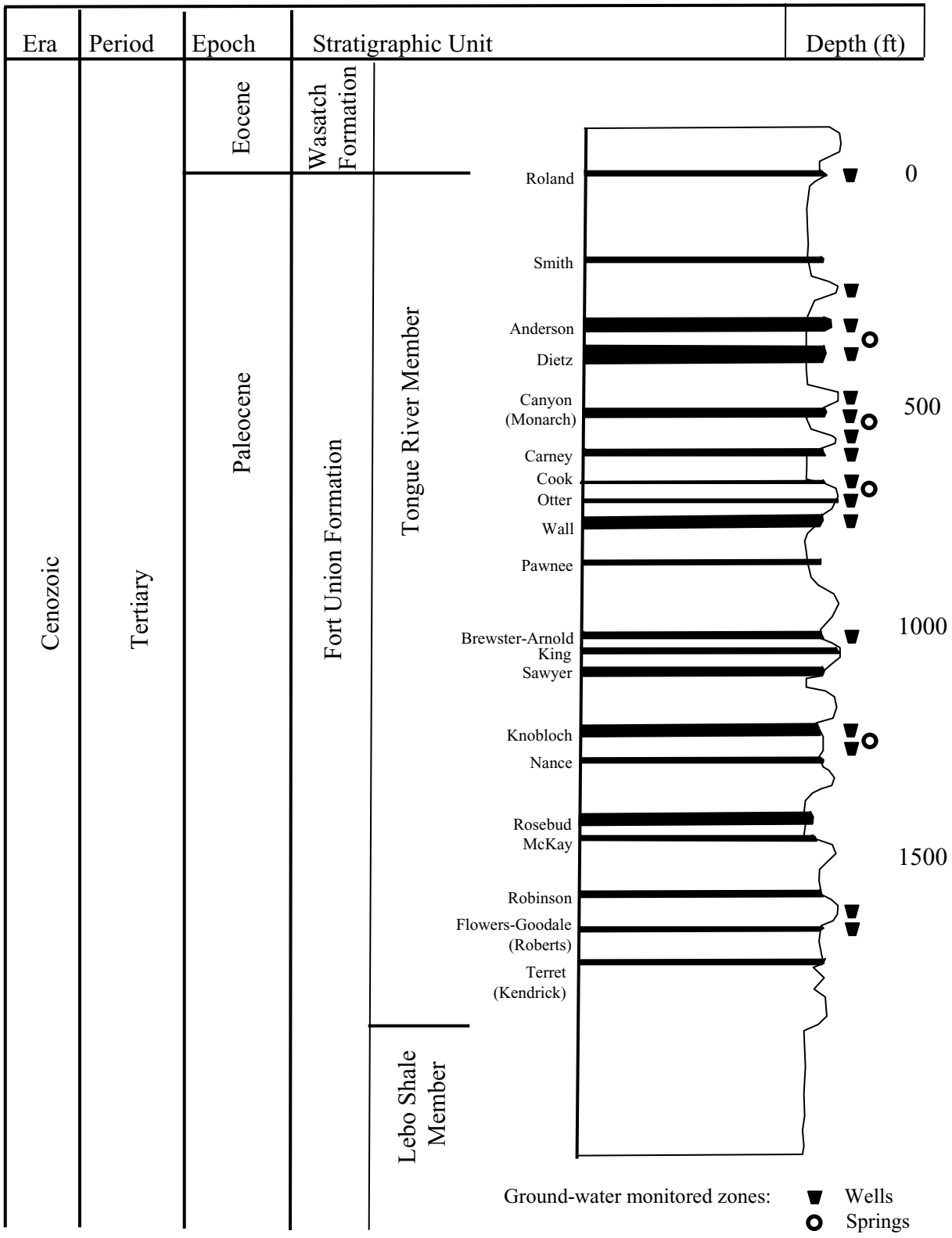

Figure 3. Many coal beds have been mapped within the Tongue River Member of the Fort Union Formation. The general relative positions are shown here, with the right edge of the column indicating generally sandy interburden to the right and shale by the line curving to the left. Not all coals exist across the entire basin and the interburden thickness varies considerably. The indicated depths are only approximations. Sources: Matson and Blumer, 1973; McLellan and others, 1990; Law and others, 1979; Fort Union Coal Assessment Team, 1999.

Table 1. Correlation of nomenclature used by MBMG, USGS, coal mine companies, and CBM companies in the Decker, Montana area.

MBMG This report and B-91	USGS C-113, I-1128, I-1959-A	DECKER COAL MINE PERMITS	SPRING CREEK COAL MINE PERMITS	FIDELITY EXPLORATION AND PRODUCTION COMPANY	PINNACLE GAS RESOURCES
ROLAND	ROLAND		ROLAND	ROLAND	
SMITH	SMITH		SMITH	SMITH	
ANDERSON	ANDERSON / D1	D1 UPPER		D1	
DIETZ 1	D2 UPPER	D1 LOWER	ANDERSON – DIETZ	D2	
DIETZ 2	D2 LOWER / D3	D2		D3	
CANYON	MONARCH/CANYON	CANYON / D3	CANYON	MONARCH	
COOK/CARNEY	COOK/CARNEY	D4	D4	CARNEY	
WALL	WALL	D6	D6	WALL	WALL
KING	KING			KING	
KNOBLOCH	KNOBLOCH	KNOBLOCH	KNOBLOCH	KNOBLOCH	KNOBLOCH
FLOWERS-GOODALE	FLOWERS-GOODALE			ROBERTS	FLOWERS-GOODALE

Sources:

Culbertson, 1987	USGS C-113
Hedges and others,1998	MBMG RI-4
Law and others, 1979	USGS I-1128
Matson and Blumer,1973	MBMG B-91
McLellan and others,1990	USGS I-1959-A

Methane that may be migrating east and discharging at the outcrop of the Canyon coal in the Powder River valley was measured at three monitoring wells (SL-5CC, SL-6CC, and SL-7CC) near the Montana – Wyoming state line. Well completion records for the wells are listed in Appendix A and locations are marked on Plate 1. A cross section showing the relationship between the wells is shown on Figure 4. These wells are beyond the influence of any CBM production.

Well SL-5CC does not release gas under static water-level conditions. When the water level is lowered during pumping, methane is released. At SL-6CC, methane is released from the Canyon coal under static-water level conditions and when shut in builds up to 59 psi. A gas-flow meter was installed on the well and fitted with a 1/8-inch discharge orifice plate. The pressure held fairly constant at about 6 psi for the 3-week duration of the test. At this pressure the calculated gas flow rate is 7000 standard cubic feet per day (mcf/d). At SL-7CC, methane is also released from the Canyon coal under static conditions and builds up to 17.5 psi when the well is shut in. Using the same flow meter, the pressure held at 13 psi over the 2 week duration of the flow test. This pressure equates to a flow rate of 11 mcf/d.

Ground-water conditions outside of areas of coalbed-methane production and influence

Hydrogeologic data were collected at 210 wells and 17 springs during 2005. Of those monitoring sites, 21 wells and 17 springs are located within the boundary of the Ashland Ranger District of the Custer National Forest. Six monitoring wells, located on the Northern Cheyenne Reservation, are monitored by tribal employees and data are being stored in GWIC. Eighteen monitoring wells were installed during 2005, along the Montana-Wyoming state line. In addition, a CBM exploration well was transferred to MBMG to serve as a monitoring well. Completion records for these monitoring wells are in Appendix A. Descriptions of all wells included in the regular monitoring program and the most recent data are listed in Appendix B. Site descriptions for monitored springs and the most recent flow data are listed in Appendix C. Water-quality data collected during 2005 are listed in Appendix D. All data were entered in and are available electronically from GWIC (http://mbmggwic.mtech.edu/). The locations of all monitoring sites are shown on Plate 1.

Three distinct ground-water flow systems are present in the Powder River Basin: local and regional bedrock flow systems, and local alluvial flow systems. As used in this report, the terms local and regional bedrock flow systems do not refer to specific geologic units but rather are used to describe changing ground-water conditions with respect to

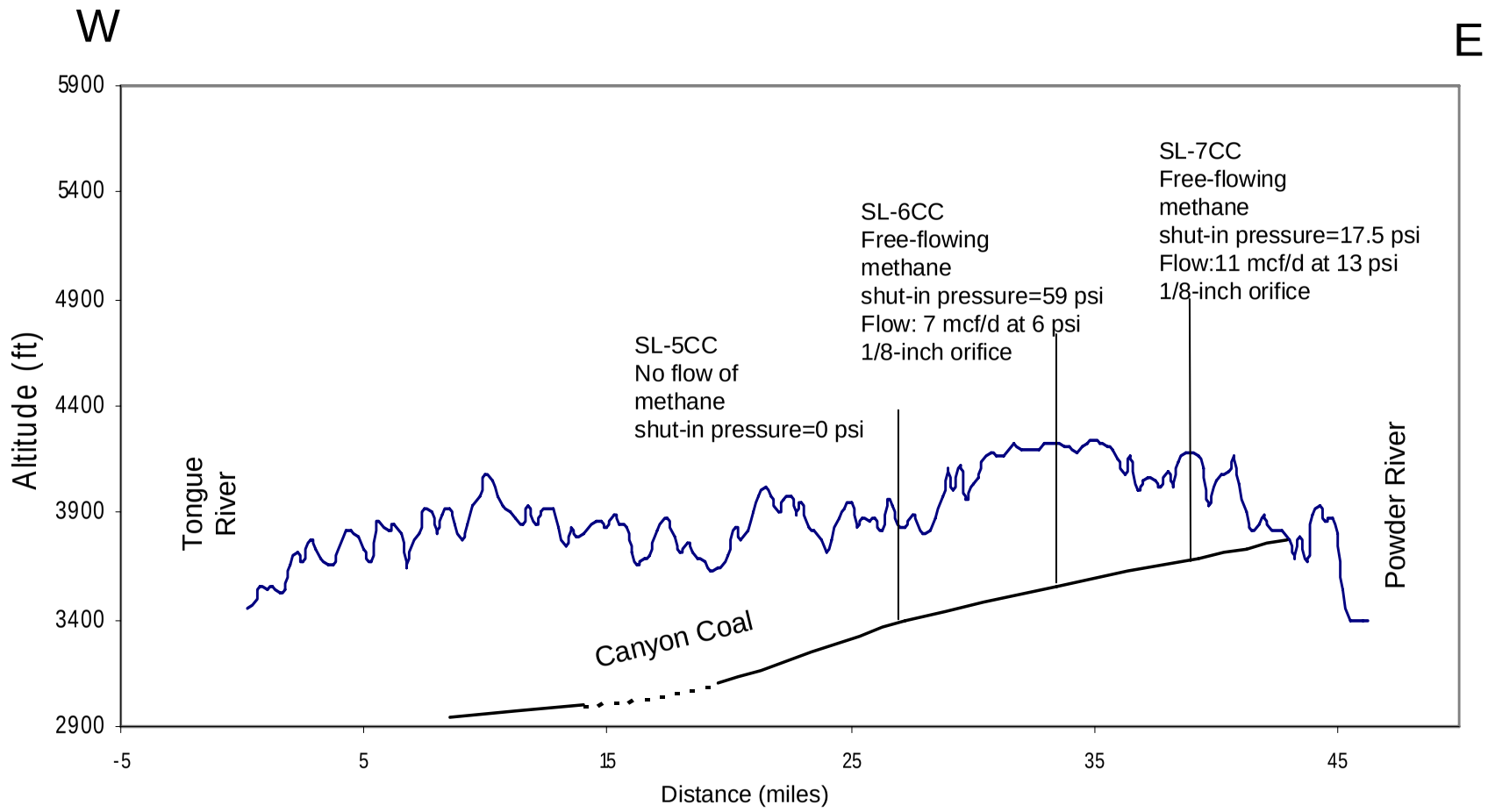

Figure 4. Cross section along the state line showing the relationships between wells and locations of free-flowing methane gas. The gas pressure decreases toward the outcrop and gas flow rate increases towards the outcrop.

depth and position along flow paths. Where there are sufficient water-level data to support detailed potentiometric mapping, local flow systems demonstrate topographic control of flow direction, whereas regional systems flow toward and then follow the northward trend of the basin axis. Water quality also distinguishes the flow systems, with local ground-water quality typically dominated by Ca^{2+}, Mg^{2+} and SO^{2-}_4 and regional systems being dominated by Na^{+} and HCO^{-}_3.

Locally, recharge along high, clinker-capped ridges and local outcrops produces shallow bedrock flow systems that follow topography. These local flow systems either discharge to alluvial aquifers, form springs at bedrock outcrops or seep vertically into the deeper bedrock aquifers. Some seepage between aquifers occurs, however it is probably very limited due to the low permeability of the numerous shale layers. Regional flow systems are recharged near the perimeter of the PRB in areas where aquifers crop out. Regional ground-water flow is generally to the north and discharges at springs, in subcrop areas to streams or leaves the PRB as deep ground-water flow. Alluvial aquifers occur adjacent to major streams and rivers.

Water-level differences between aquifers indicate possible downward gradients (water-level altitude is lower in deep aquifers than in shallow aquifers) or upward gradients (water-level altitude is higher in deep aquifers than in shallow aquifers). Downward gradients indicate recharge areas and upward gradients indicate discharge areas.

Ground-water quality in the Powder River Basin has been well documented. The general chemical characteristics of ground water in different parts of the flow systems and an overview of baseline water quality across the PRB are briefly discussed in Wheaton and Donato (2004). In the Powder River Basin, coalbed methane exists only in chemically reduced zones where the water quality is dominated by ions of Na^{+} and HCO_3^{-} (Van Voast, 2003).

Bedrock aquifer water levels

In regional bedrock aquifers, ground water flows from Wyoming northward towards the Yellowstone River. The coal-bearing Tongue River Member is bounded on the bottom by the Lebo Shale aquitard. Limited vertical flow through the Lebo Shale forces most ground water in the Tongue River Member to discharge to springs and streams along the contact between the units south of the Yellowstone River, adding baseflow to streams, and supporting springs. In terms of coalbed methane development, the Lebo Shale effectively limits the potential for impacts from reduced hydrostatic pressure and management of produced water to those units lying stratigraphically above this aquitard.

Ground-water flow in the Dietz coal seam is shown on Plate 2. This plate shows the potentiometric surface and flow lines of the Dietz coal seam. There is little

topographic control of flow patterns away from outcrop; however near the outcrop areas, topography exerts a strong control on flow patterns. Other regional bedrock aquifers in the Tongue River Member should have similar flow patterns relative to their outcrops.

The distinct drawdown areas that are apparent in the Dietz coal near Decker are a result of CBM production. Data from new monitoring wells installed during 2005 (Appendix A) have allowed a new interpretation of the Dietz coal potentiometric surface and ground-water flow, as compared to that presented in the 2004 annual report (Wheaton and others, 2005).

The axis of the PRB in Montana coincides roughly with the Tongue River. Geologic dip is toward the west on the eastern side of the PRB and toward the east on the western side. The base of the Tongue River Member is deepest in the central part of the study area nearer the basin axis (Lopez, 2005). East of the axis ground-water recharge occurs along outcrop areas and ground water flows north from Wyoming. Ground-water flow in the Dietz coal is generally toward the west and north, eventually discharging along outcrop areas. West of the basin axis recharge occurs in the topographically high areas in Wyoming and on the Crow Indian Reservation. Ground water flows to the east, toward the Tongue River. Near the Tongue River Reservoir it is interrupted by coal mines and coalbed methane production. The effects of CBM production on the potentiometric surface of the Dietz coal is discussed in a following section of this report.

Water levels in shallow aquifers respond to seasonal variations in precipitation. Deeper aquifers show little if any measurable seasonal changes in water level except for long periods of low or high precipitation. Hydrographs and geologic cross sections for selected monitoring sites that are outside of potential coalbed-methane impacts are presented in figures 5 through 15.

At monitoring site CBM03-12, data from 1974 through 2005 from an overburden sandstone and the Canyon coal indicate a downward gradient, which is indicative of a recharge zone (Figure 5). These wells are located in the eastern part of the study area near Bear Creek, and show no response to CBM production. They do, however, show a decline in water levels that is likely related to the long-term precipitation trend (Figure 2).

At site CBM03-11, the Anderson, Dietz and Canyon coals also show a downward gradient, indicating a recharge zone (Figure 6). This site is in the south-central portion of the monitoring area, near the Anderson coal outcrop and reflects background conditions.

Monitoring site CBM02-8 is just west of the Tongue River near the outcrop of the Knobloch coal where hydrostatic pressures in the Knobloch coal and Knobloch overburden have been reduced by discharge to nearby outcrops in Coal Creek and along the Tongue River (Figure 7). Water levels in wells completed in the deeper Flowers-Goodale overburden and Flowers-Goodale coal are higher than those measured in the Knobloch overburden and coal, the upward gradient suggests that this is a discharge area for the Flowers-Goodale units. Flowing wells near Birney, including the town water supply well, also reflect this upward gradient. These deeper wells flow at ground surface

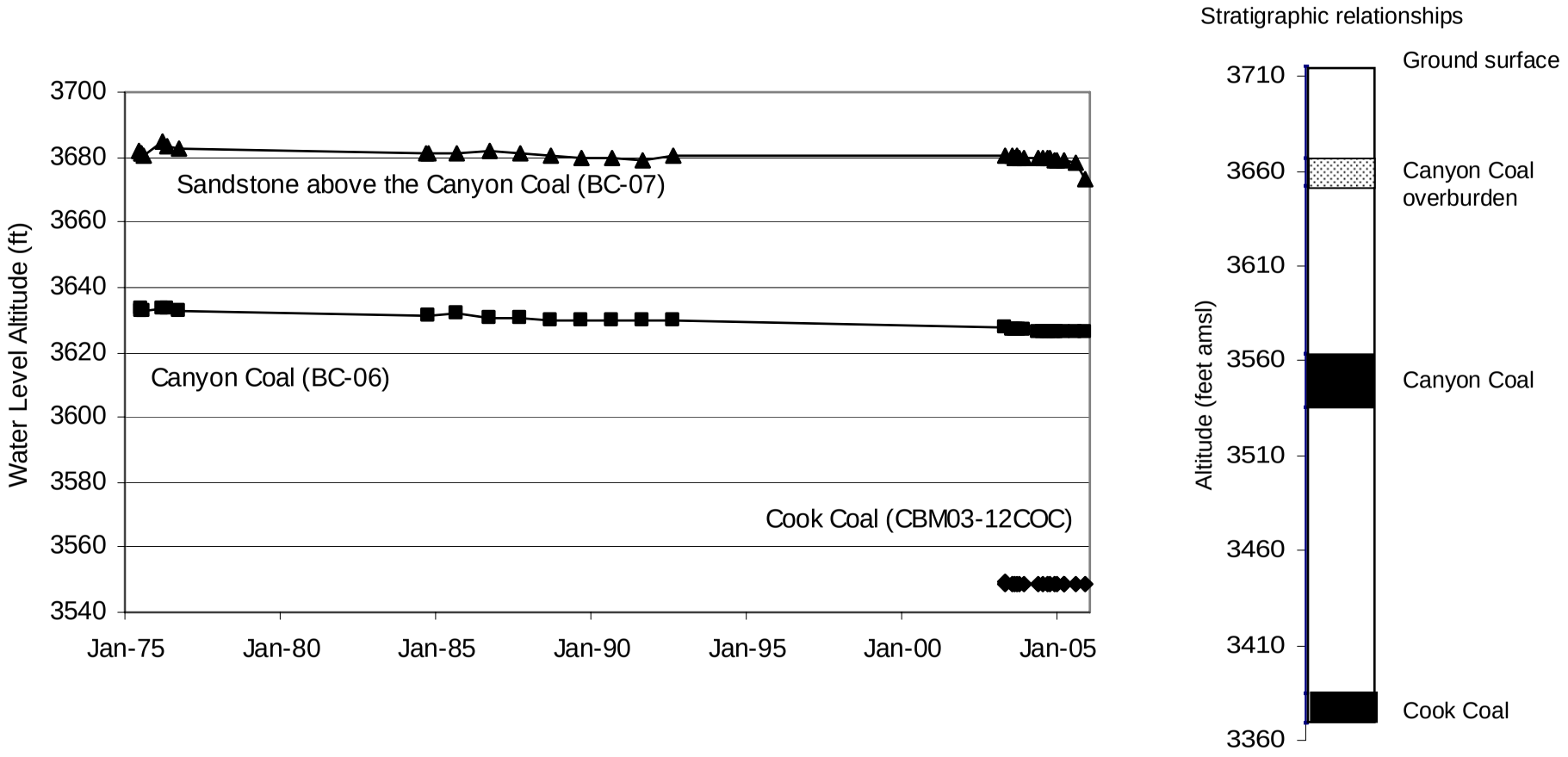

Figure 5. The long-term decrease in water levels in the Canyon overburden sandstone (BC-07), and Canyon coal (BC-06), likely relates to precipitation patterns shown on Figure 2. The short period of record for the Cook coal (CBM03-12COC) at this site does not indicate meteorological influence.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

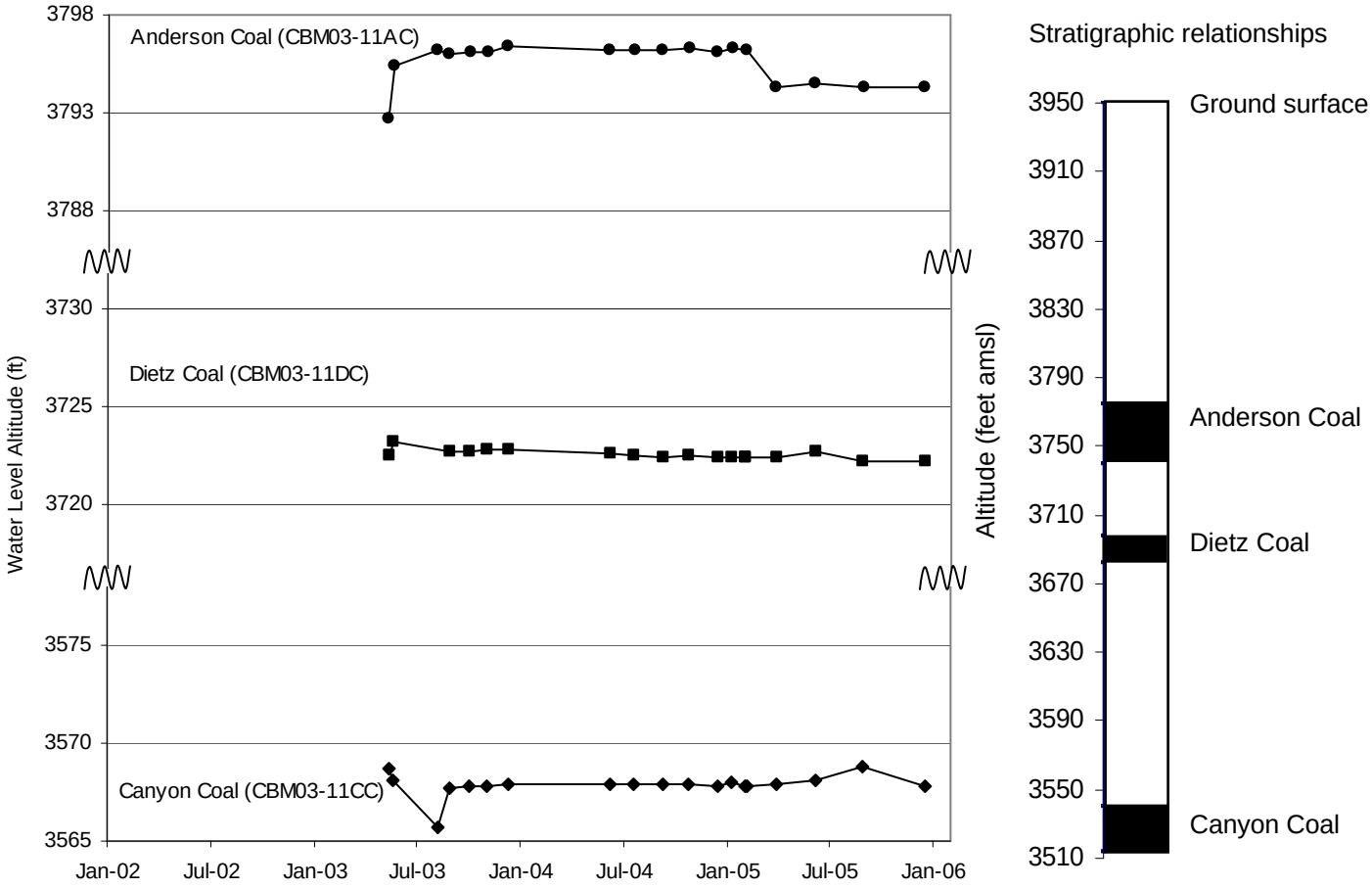

Figure 6. A downward hydraulic gradient is evident between the Anderson, Dietz, and Canyon coal beds at the CBM03-11 site.

Note: The vertical scales of the stratigraphic relationship and the hydrograph are different. The Y axis scale is broken to show better hydrograph detail.

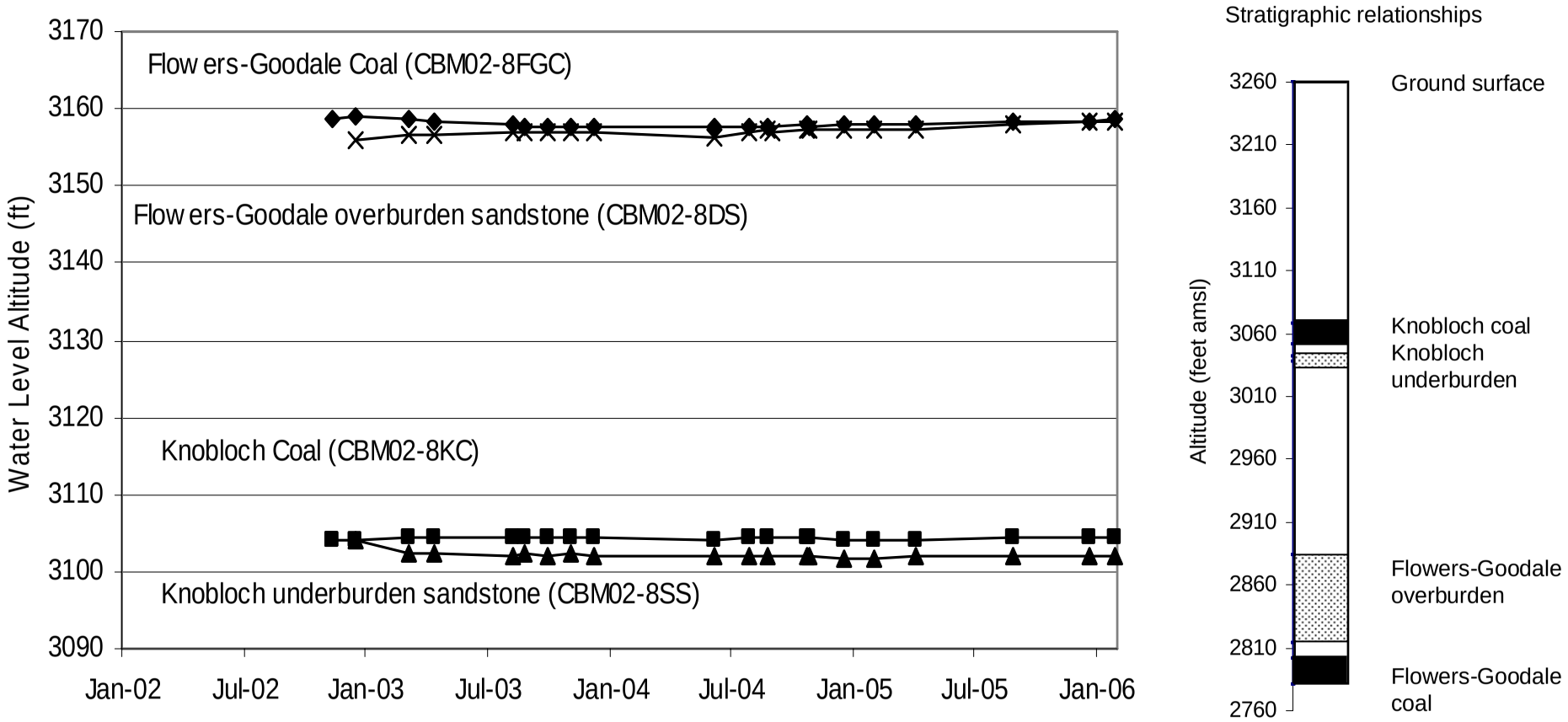

Figure 7. Water levels in wells completed in the stratigraphically deeper Flowers-Goodale units are higher than those in the shallower Knobloch coal units at the CBM02-08 site.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

due to the high hydrostatic pressure at depth and the relatively low land surface near the Tongue River.

At monitoring site CBM02-1, near the community of Kirby, just east of Rosebud Creek, a downward gradient exists between the Brewster-Arnold coal, a local unnamed coal and the Knobloch coal, indicating a recharge zone (Figure 8). Water-level data from the Brewster-Arnold coal demonstrates a slight annual trend, with lowest levels in late summer or early fall, indicating a relationship with precipitation patterns. The deeper aquifers do not reflect a seasonal pattern and are most likely part of the regional flow systems.

At monitoring site WO-1, along Otter Creek, an upward vertical gradient exists, indicating a discharge zone (figures 9 and 10). Several landowners have flowing wells in this area, owing to this upward gradient. The shallow sandstone (WO-3) which sub-crops to the alluvium is directly discharging to the Otter Creek alluvium which in turn is providing baseflow for the creek. The deeper units (WO-1 and WO-2) are likely confined, and therefore are flowing towards their outcrop/sub-crop nearby.

Bedrock aquifer water quality

Water quality from sandstone aquifers in the Tongue River Formation sampled during 2005 indicate total dissolved solids (TDS) concentrations between 394 and 3,032 mg/L and SAR values between 0.5 and 55 (Appendix D). Deeper sandstone aquifers typically have higher SAR values and lower TDS values. Stiff diagrams showing relative major ion concentrations for all samples collected during 2005 are presented on Plate 3.

Water-quality samples were collected from the Smith, Anderson, Dietz, Canyon, and Cook coal seams (Appendix D and Plate 3). Concentrations of TDS ranged from 1,075 to 3,316 mg/L and SAR values were between 28 and 66. Low sulfate (SO_4^-) concentrations indicate favorable conditions for the presence of CBM (Van Voast, 2003). Water quality data collected during 2005 indicate favorable conditions in the sampled coal beds in all areas except for the Anderson and Dietz coals at site CBM03-11 where both coal beds are less than 300 feet deep.

Alluvial aquifers

Water levels in the Otter Creek alluvium are lower than those in the underlying bedrock aquifers at site WO-8. The upward vertical gradient described above for the bedrock aquifers indicates a discharge zone (figures 9, 10 and 11). Based on the upward hydrologic gradient at this site, the Otter Creek alluvium, and therefore baseflow in Otter Creek, is somewhat dependent upon receiving discharge from bedrock aquifers in this area (i.e. it is a gaining stream).

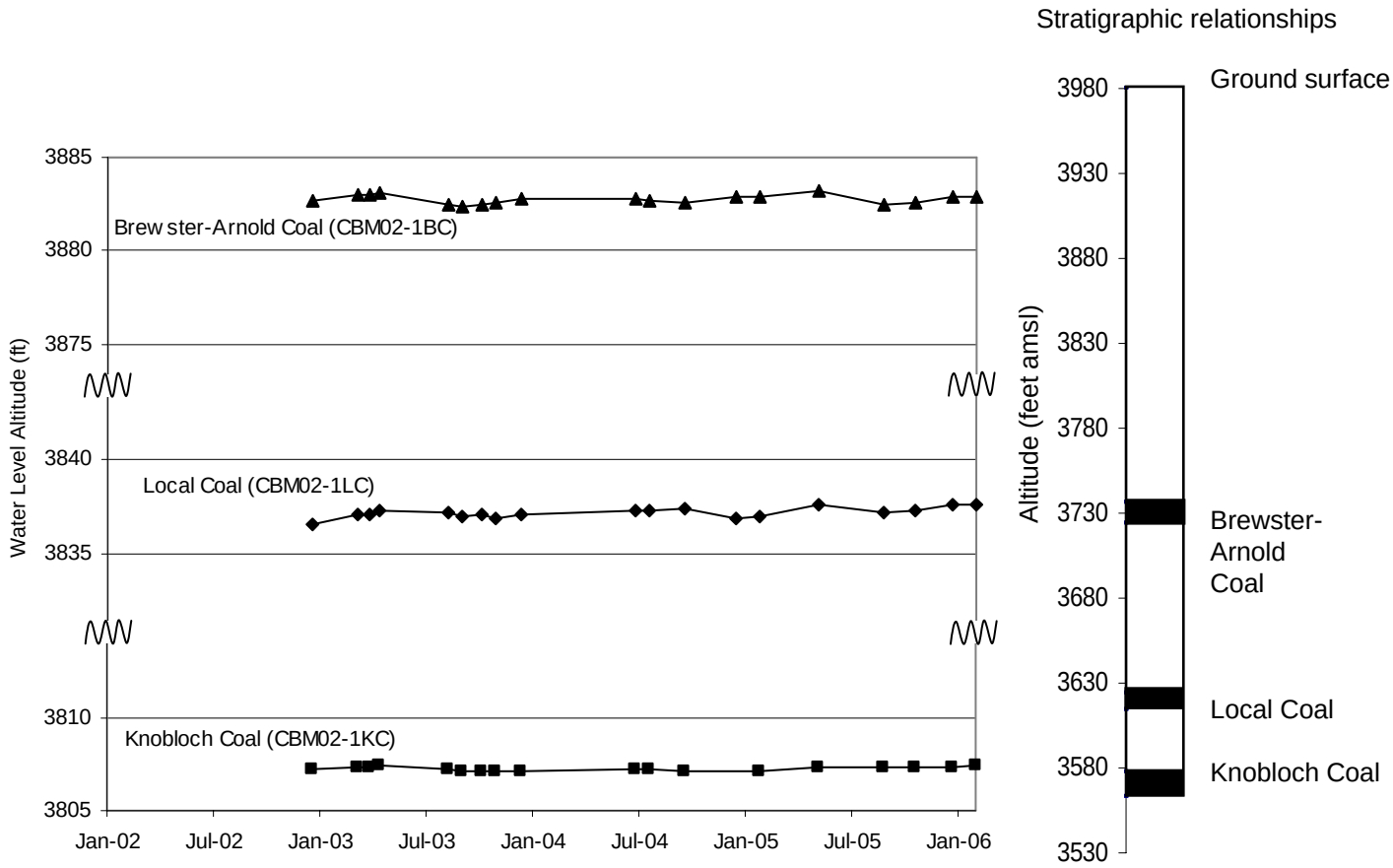

Figure 8. A downward hydrostatic gradient is evident between the Brewster-Arnold coal, local coal, and Knobloch coal at the CBM02-1 site.

Note: The vertical scales of the stratigraphic relationship and the hydrograph are different. The Y axis scale is broken to show better hydrograph detail.

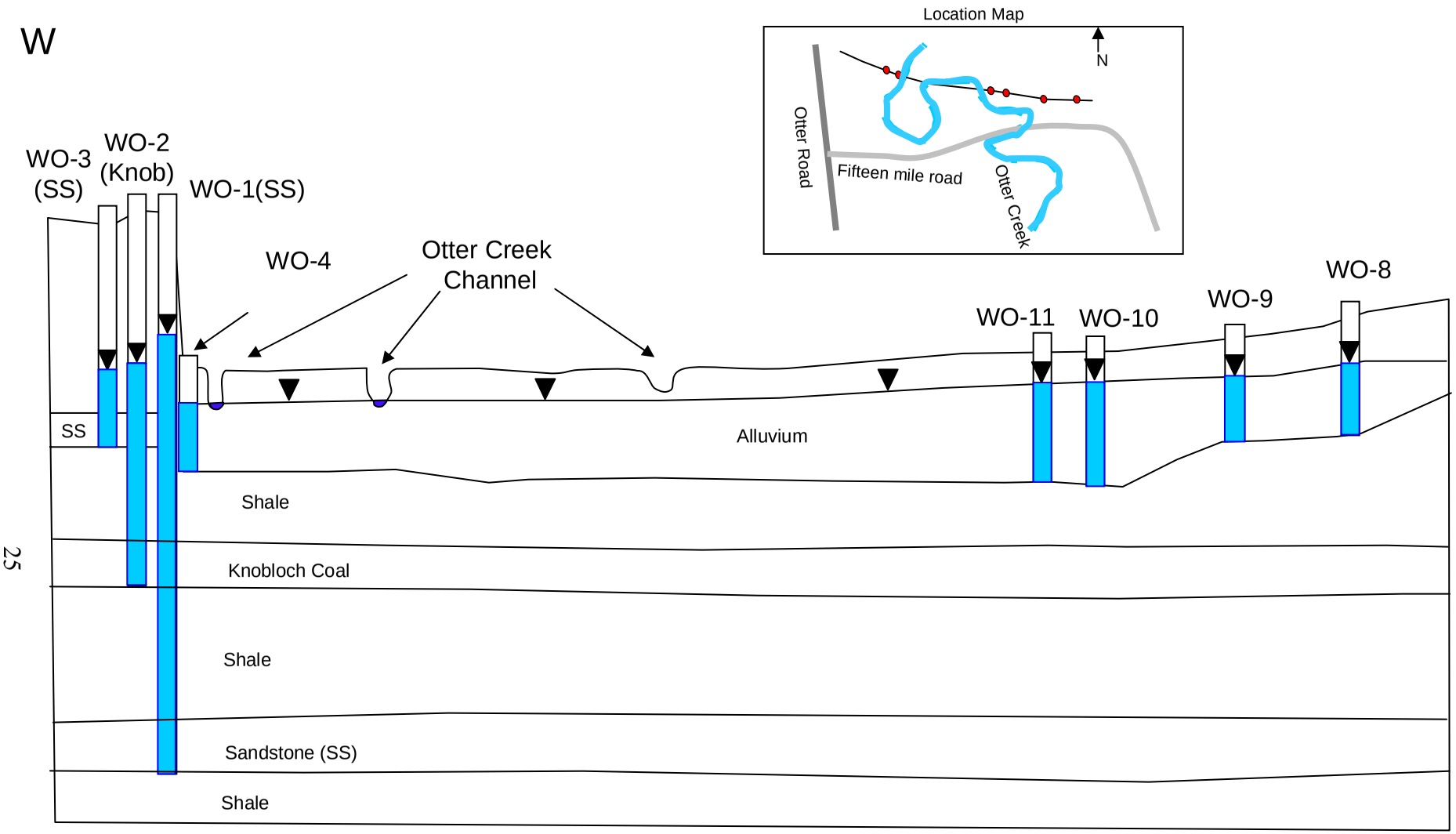

Figure 9. Geologic cross section for the Otter Creek alluvium and bedrock wells located in T05S R45E sec 23. Water levels in the alluvium are lower than the underlying bedrock aquifers. The water levels in the bedrock wells completed in stratigraphically deeper units are higher than those in shallower units. The water levels for this cross section were taken in January 2006. Vertical exaggeration is 9.6:1.

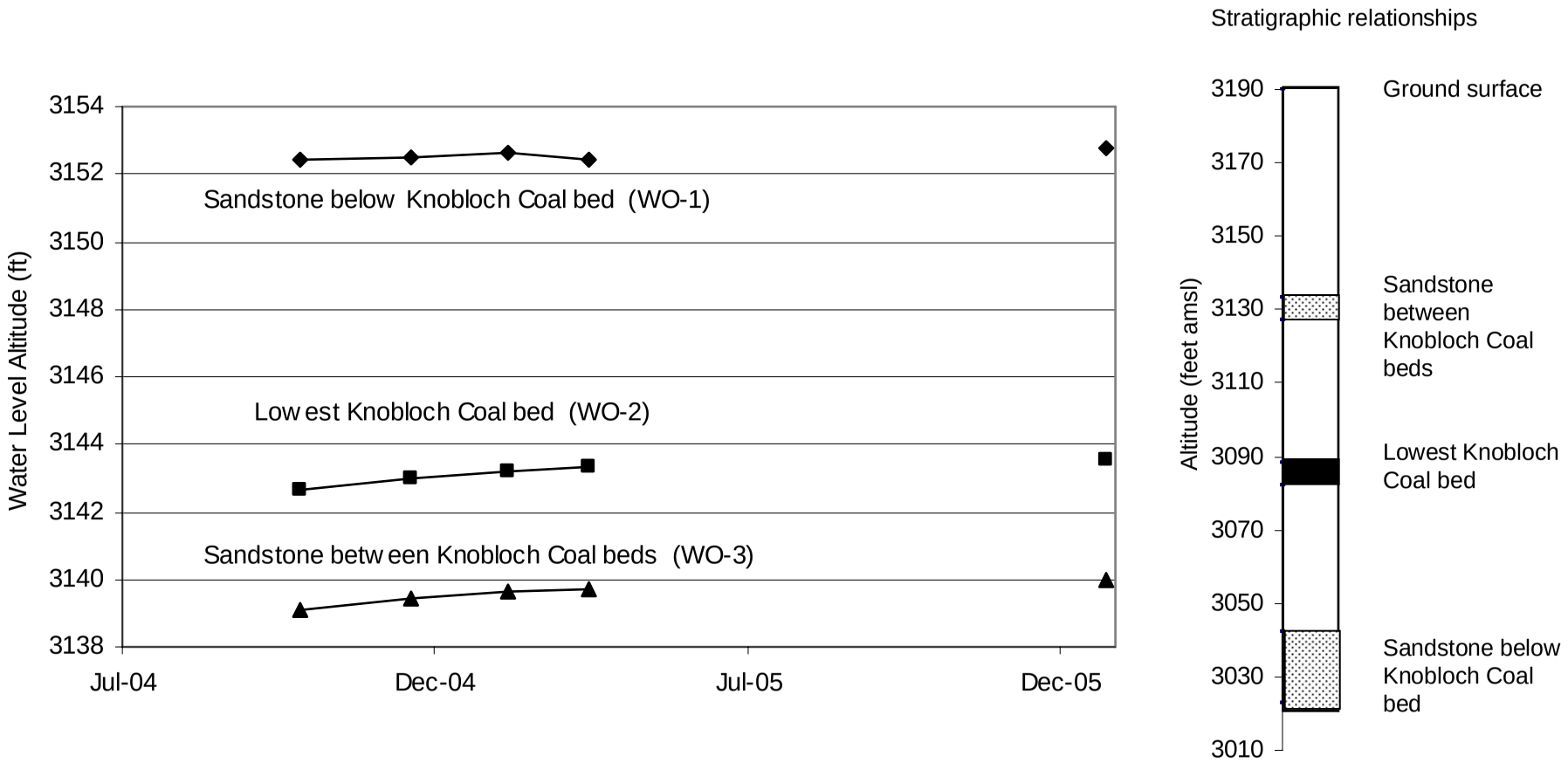

Figure 10. Bedrock aquifers at the Otter creek area have an upward vertical gradient, flowing wells are common in the area.

Note the vertical scales of the stratiographic relationship and the hydrograph are different.

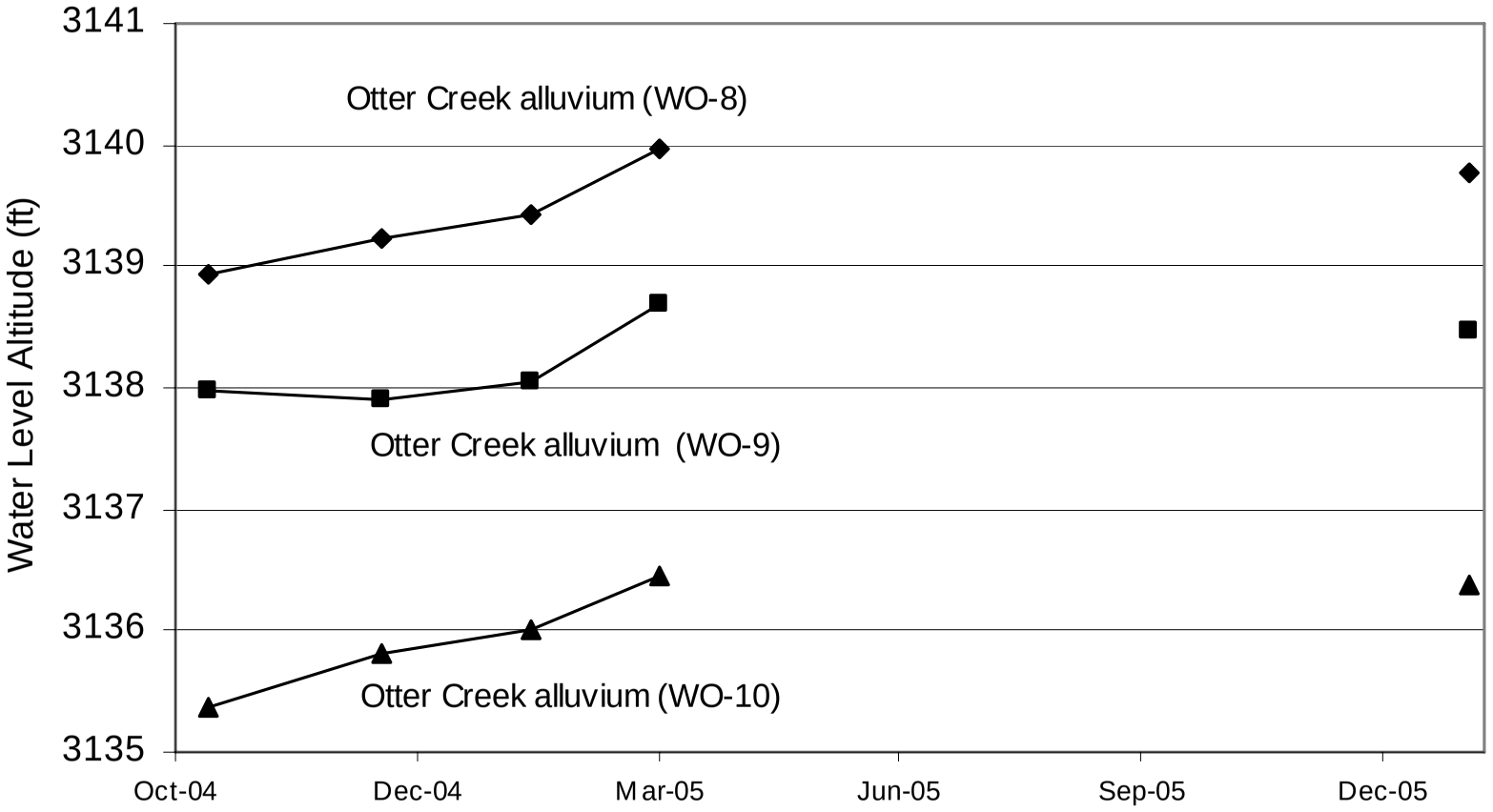

Figure 11. Water-level trends in the alluvium at the Otter Creek site probably relate to weather patterns. The alluvial aquifer appears to receive recharged from the bedrock aquifers in the area, based on the upward vertical gradient.

Water levels in Rosebud Creek alluvium, like most alluvial systems, are directly tied to the surface water levels. The geologic cross section shown on Figure 12 crosses a tributary to the creek and a meander of Rosebud Creek. As shown in Figure 12, ground water flows toward, and provides baseflow to Rosebud Creek (i.e. it is a gaining stream). Data, particularly those from the continuous recorders at the site, are beginning to show the relationships between meteorological conditions, ground-water levels and surface-water flow (Figure 13). Flow data for Rosebud Creek are from the U. S. Geological Survey gaging station near Kirby (station number 06295113) and are available from the web site http://waterdata.usgs.gov/mt/nwis/uv?06295113.

A comparison of the water-level and precipitation data at the RBC-2 site demonstrate part of the effect of transpiration on water table aquifers (Figure 13c). Diurnal fluctuations in the water table reflect the effect of transpiration from the surrounding alfalfa crop. As air temperatures increase, plant growth increases and water consumption increases, which causes a lowered water table. In the evening, as the air temperature decreases, plant stress on the water table decreases and the ground-water level recovers. During September the air temperature drops below the freezing point and a significant raise in the ground-water level occurs, marking the beginning of the fall recharge period. As the alfalfa removes water from the alluvial aquifer, the remaining salt load in the ground water may become more concentrated.

South of Moorhead, ground-water flow through the Powder River alluvium is roughly parallel to the river flow (figures 14 and 15). This site is located on a large meander of the river, and the river likely looses flow to the alluvium on the upgradient end of the meander and gains at the lower end. A stock well (GWIC M:221592) at this location is flowing under artesian pressure, indicating an upward gradient with depth. The depth of the stock well is not known.

Stock water pipeline wells

Pipelines are used by ranchers to provide stock water to range areas that are otherwise underutilized due to a lack of local water resources. A single well may provide water for many miles of pipeline and many stock water tanks. Fifteen pipeline wells on the Ashland Ranger District (Ashland RD) have been inventoried. The locations of these wells are shown on Plate 1. Inventory data and the available completions records are on file in GWIC. Lithologic information is not available for most of these wells.

Total depths reported for these pipeline wells vary from 25 feet to 325 feet, with one-third of the wells being 50 feet or less. Based on locations, depths, and static water levels, 9 wells were determined to be completed in sandstone or coal beds of the Tongue River Member and 6 were completed in alluvium. Measured water levels in wells completed in the Tongue River range from 18 feet to 260 feet deep, and discharge rates for these same wells are reported to range from 5 gpm to 15 gpm. Measured water levels

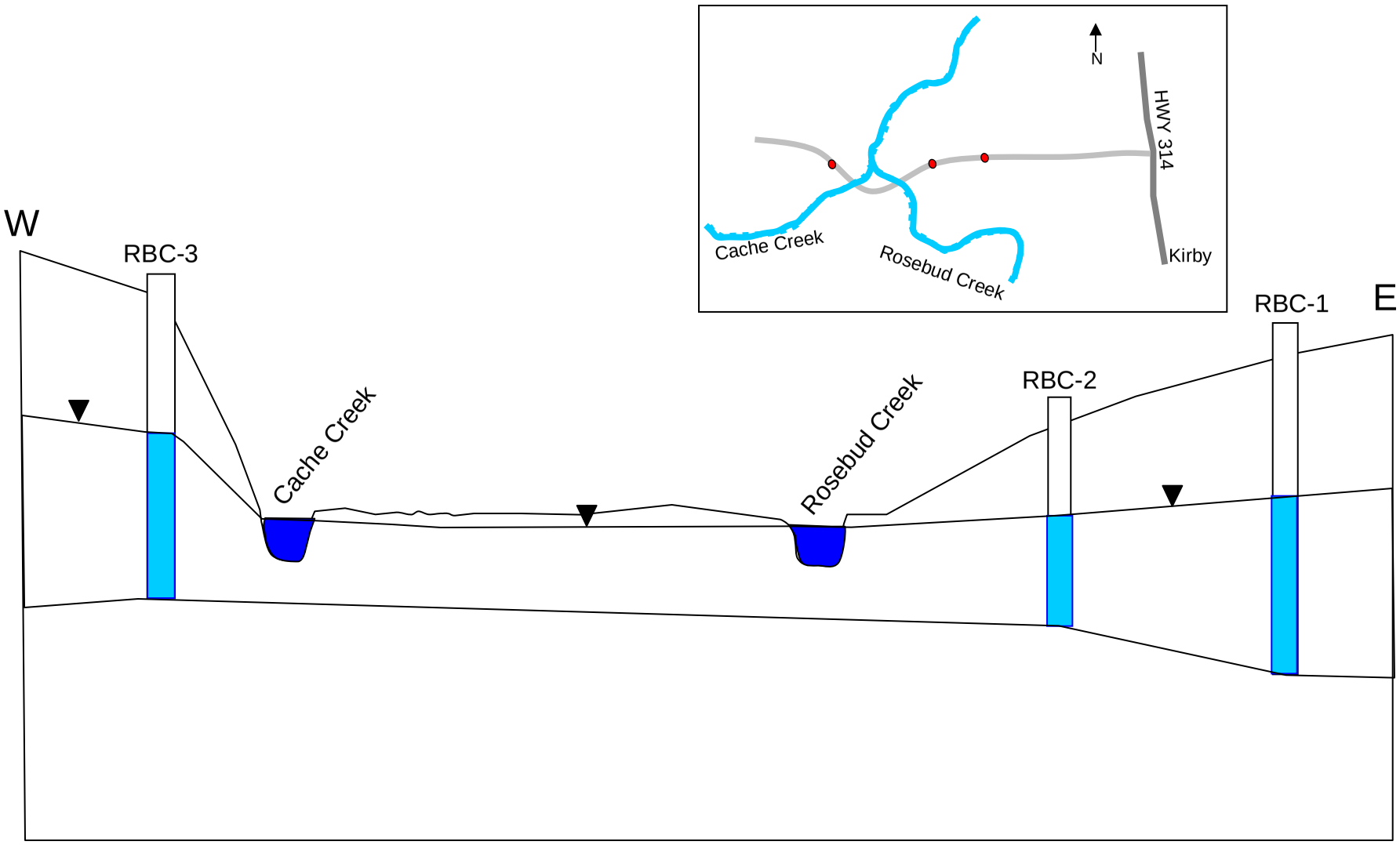

Figure 12. Cross section of the Rosebud creek site located in T06S R39E section 8. Water levels in this alluvial aquifer and surface water levels in Rosebud Creek are closely related. Well water levels are lowest in late summer and highest in early spring. The water levels at RBC-2 shows a correlation with the diurnal effect from the surrounding alfalfa plants. Water levels for this cross section were taken in January 2006.

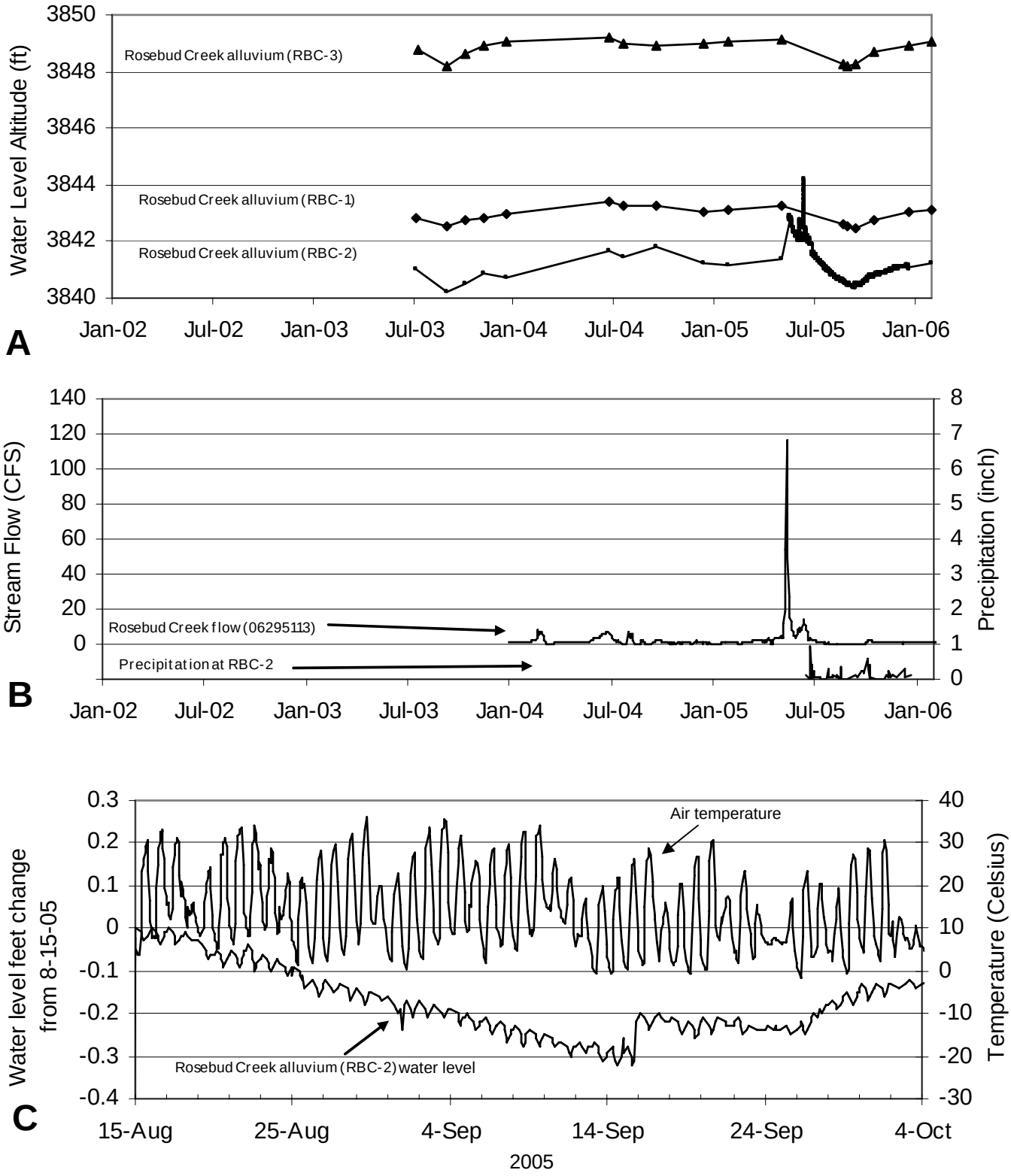

Figure 13. A) Ground-water levels are typically higher during wetter times of the year at the Rosebud Creek alluvium site. B) Rosebud Creek stream flow follows precipitation trends. C) A diurnal drawdown occurs in the aquifer due to the surrounding alfalfa fields as shown by the correlation between water levels and air temperature.

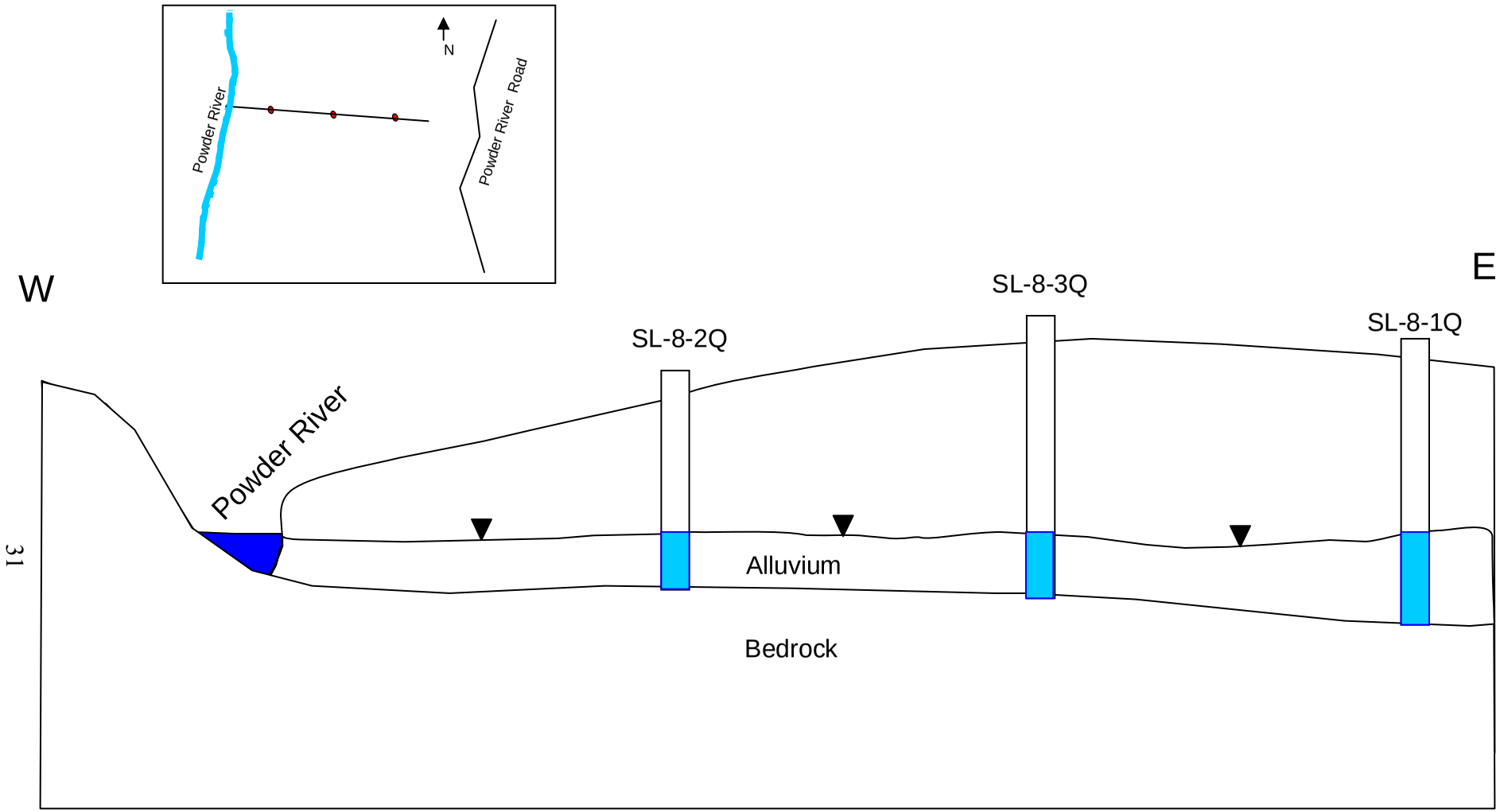

Figure 14. Cross section of alluvial wells south of Moorhead near the Powder River located in T09S R47E section 25. Ground water in the alluvium appear to flow parallel to the river. Water levels for this cross section were taken in January 2006. Vertical exaggeration is 58:1.

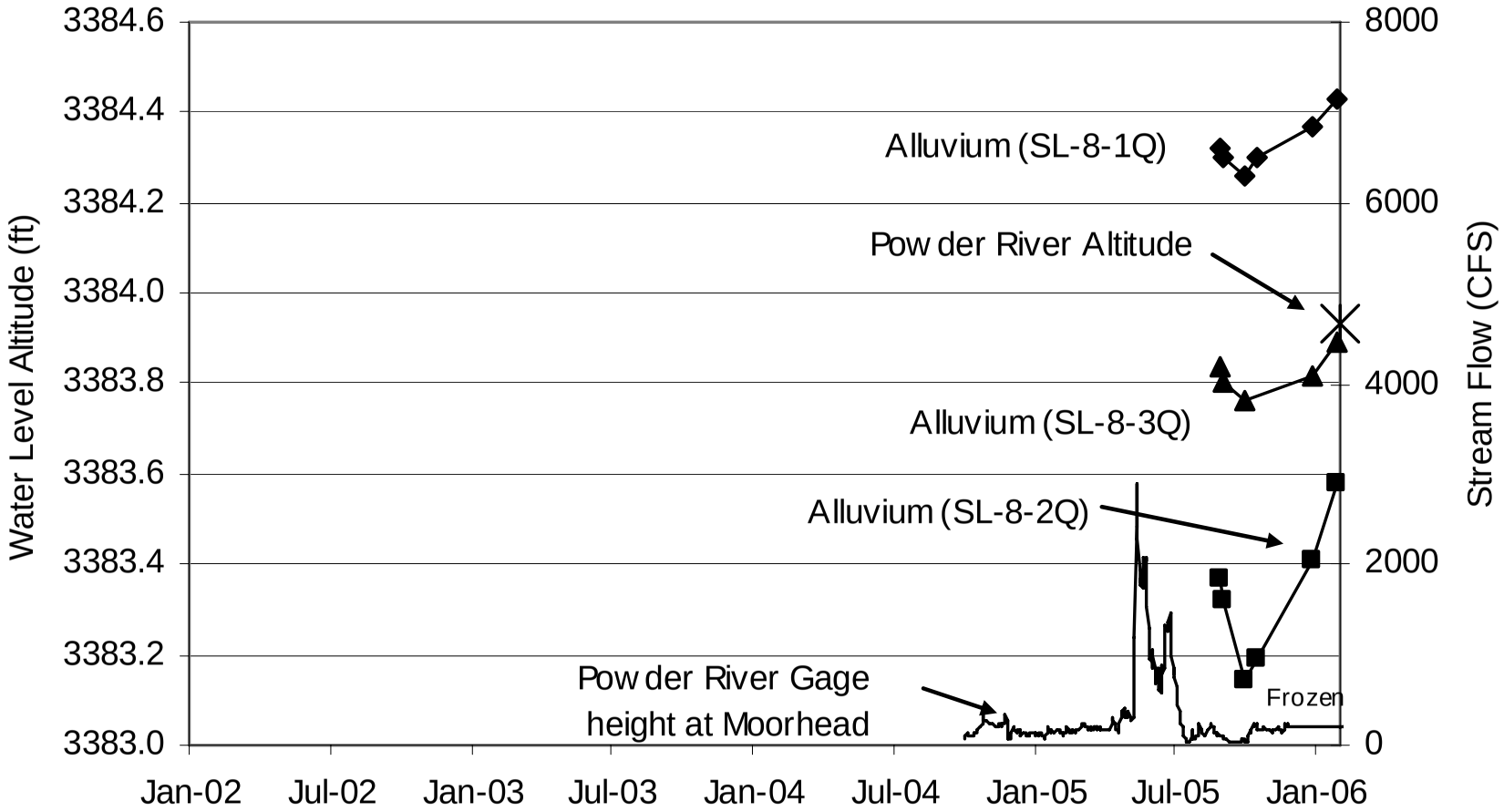

Figure 15. Ground-water flow in the alluvial aquifer at SL-8 site is roughly parallel to the Powder River. The water-level trends also follow surface stream flow trends.

for wells completed in alluvium range from 9 feet to 26 feet, and no discharge rates were reported.

Springs

Seventeen springs within the project area were monitored during 2005. The locations of monitored springs are shown on Plate 1, and data are available in GWIC. Springs are discharge points for ground-water flow systems. For the purpose of this report, local recharge is defined as occurring on ridge tops adjacent to a spring or along the hillside between the spring and the top of the adjacent ridge. Regional recharge originates at more distant locations such as outcrop areas along the edges of the Powder River Basin and flows beneath valleys between the recharge area and the discharge area. If a spring is topographically isolated from the regional flow systems by a valley, it is assumed to be local in origin. Springs located at higher elevations, such as at the base of clinker zones on ridges, are recharged by local ground-water recharge. Springs located low on hillsides or along the floors of major valleys such as Otter Creek may represent regional flow systems or a combination of local and regional recharge. A survey of springs within the northern PRB showed that most springs obtain their water from local flow systems (Wheaton and Donato, 2004). Springs are identified by a local name, or where absent the GWIC number is used.

In the southern portion of the Ashland RD, along Otter Creek, spring 197452 discharges about 1 gpm. The discharge rate at this spring shows some seasonal influence (Figure 16). This spring represents either local ground-water flow or a mixture of regional and local flow systems. The Cook coal is likely the aquifer that supports this spring.

The North Fork Spring is along the southeastern edge of the Ashland RD. This spring shows moderate seasonal influence in discharge rates which are less than 1 gpm (Figure 17). This spring is associated with the Canyon coal and likely represents local ground-water recharge.

Cow Creek Spring, in the south central part of the Ashland RD, is the water supply for the Fort Howes Work Center. A portion of the spring discharge is diverted and flows several miles through a gravity pipeline to Fort Howes. The discharge rate at the Cow Creek Spring has decreased to about 7 gpm (Figure 18), probably in response to a lack of local rainfall over the past few years (Figure 2). This spring flows from clinker which is recharged locally on the ridge above the spring.

In the lower reaches of the Cow Creek watershed, spring 197395 discharges from a sandstone above the Cook coal bed. Discharge from this spring has been measured as high as 7.5 gpm, but since mid-2004 the flow has been between 3 and 4 gpm (Figure 19). The sandstone that supports this spring is locally recharged. Discharge from this spring and subcropping aquifers nearby support a short reach of flowing water in Cow Creek.

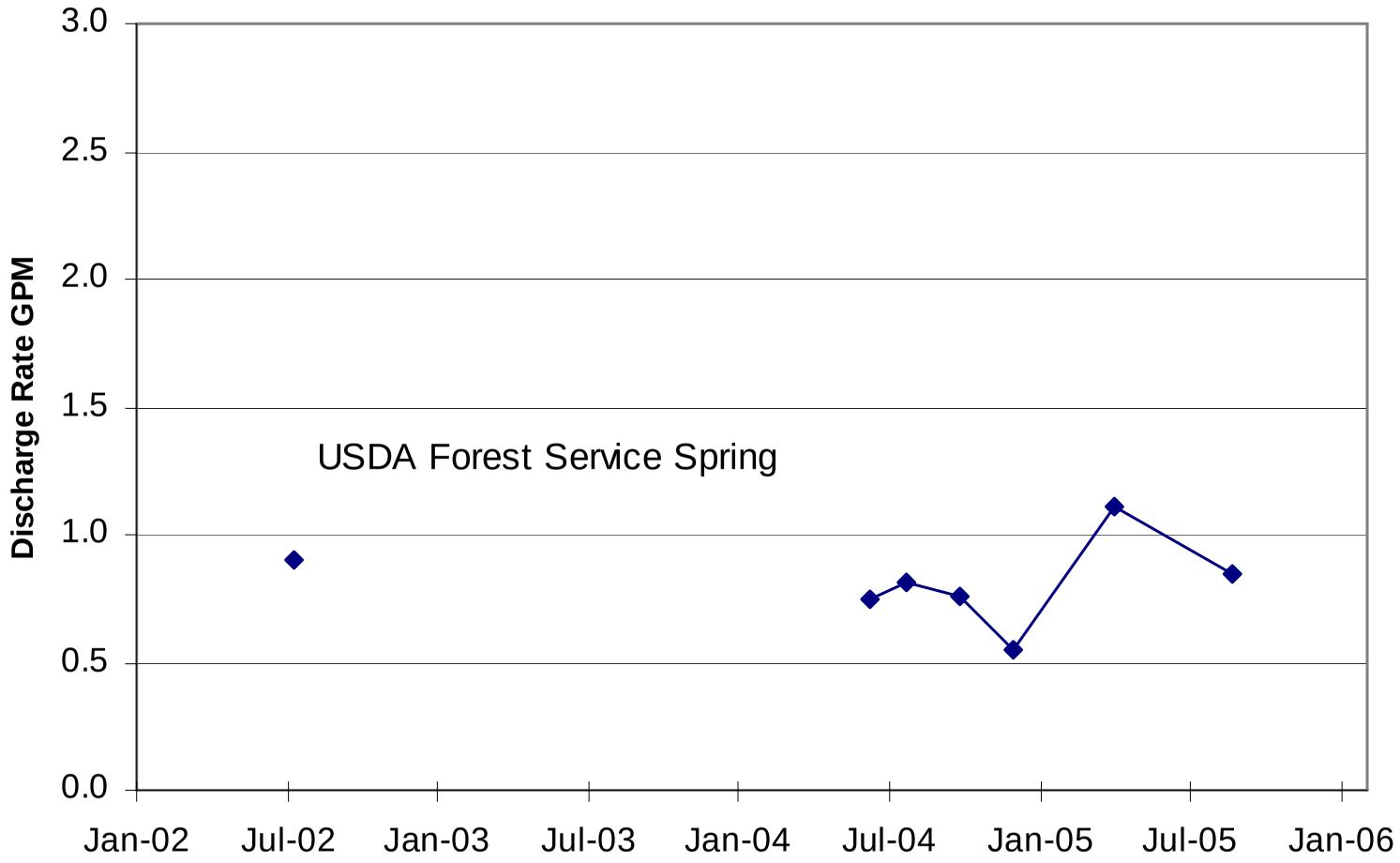

Figure 16. This USDA Forest Service Spring (GWIC M:197452) appears to be a combination of local and regional recharge associated with the Cook Coal aquifer. The spring discharges at about 1 gpm.

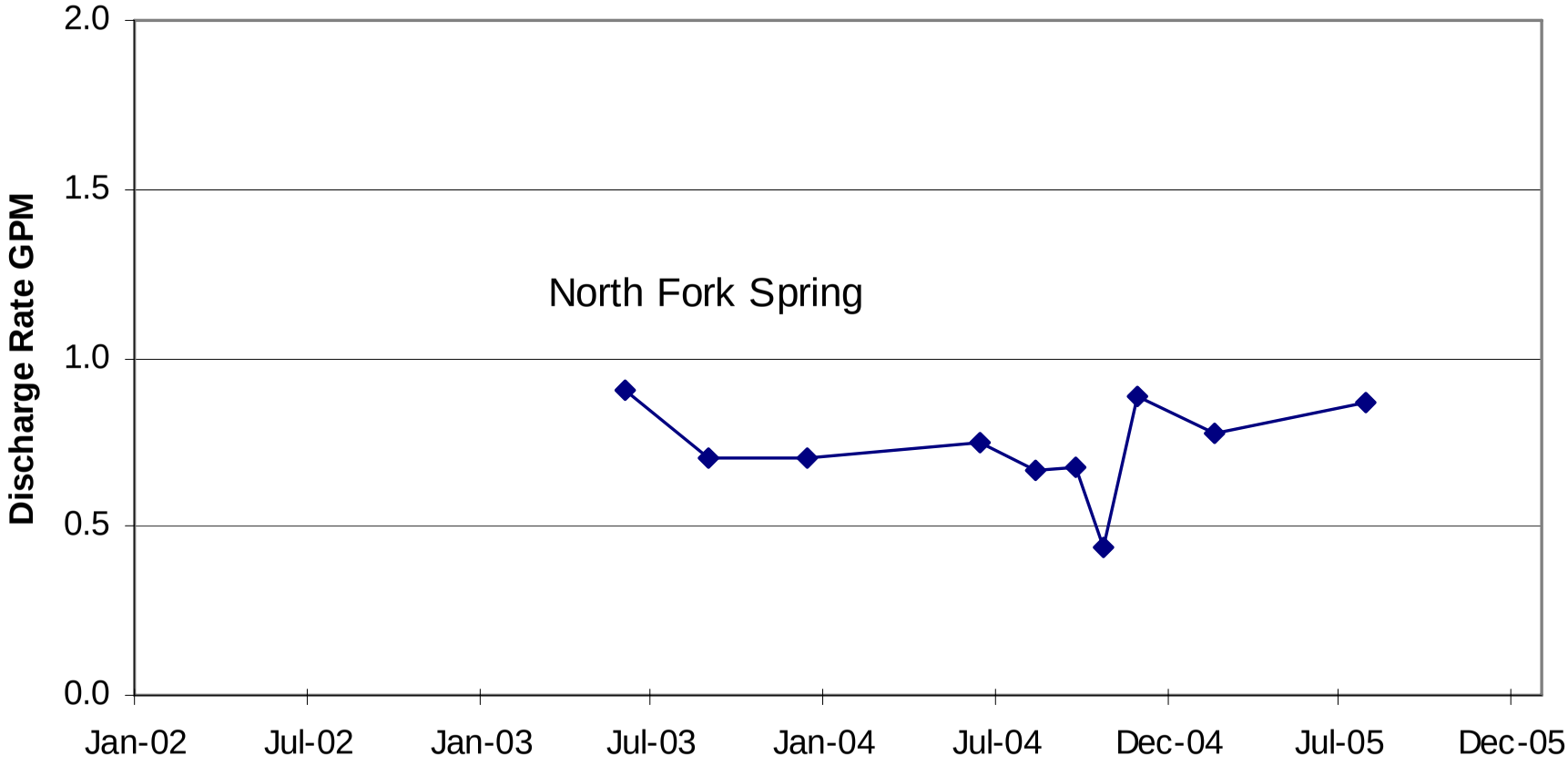

Figure 17. The North Fork spring (GWIC M: 205010) appears to be locally recharged by the Canyon Coal aquifer. The spring discharges less than 1 gpm.

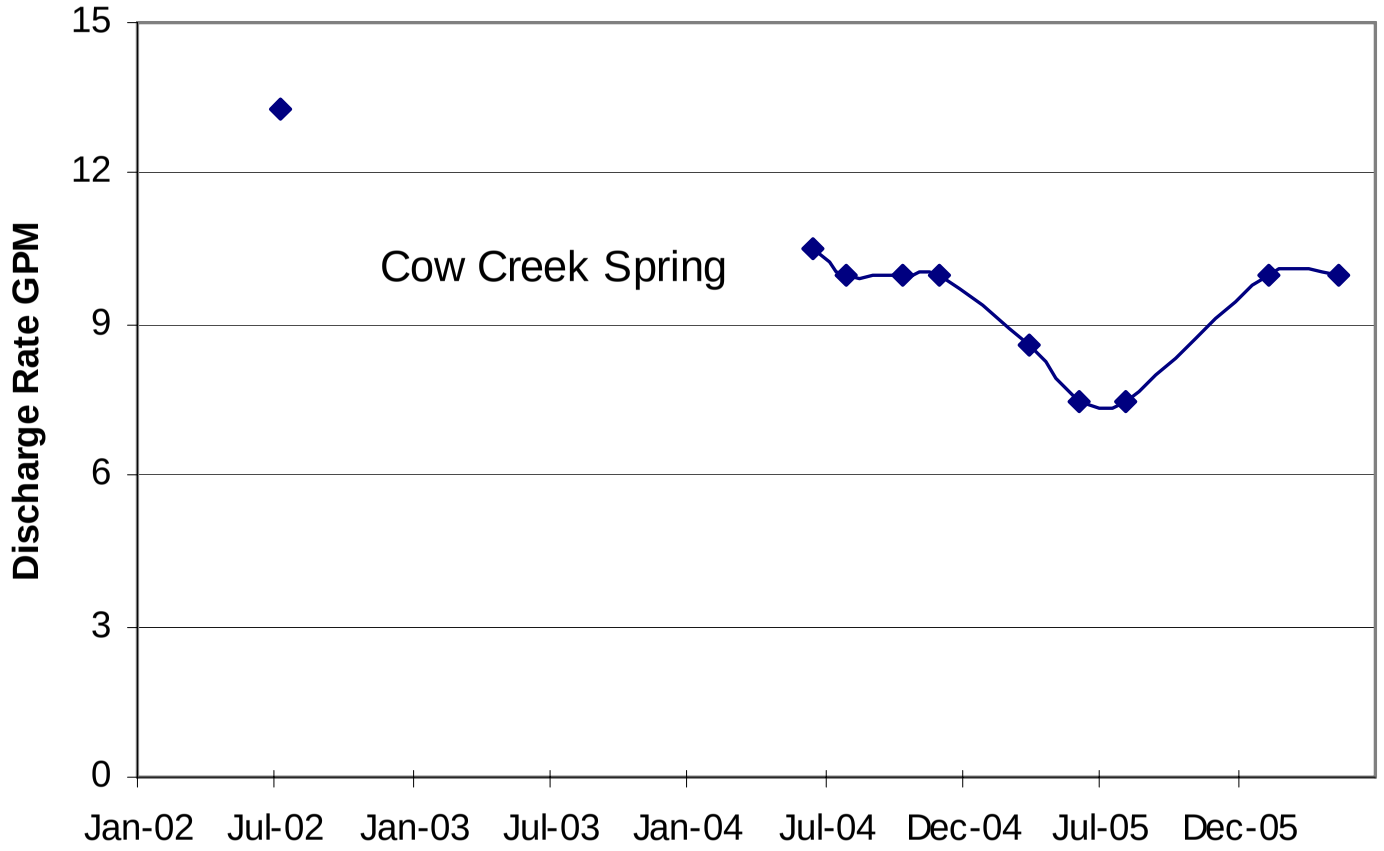

Figure 18. Cow Creek spring (GWIC M:7909) appears to be locally recharged by the clinker ridge above the spring. The spring discharges about 7 gpm.

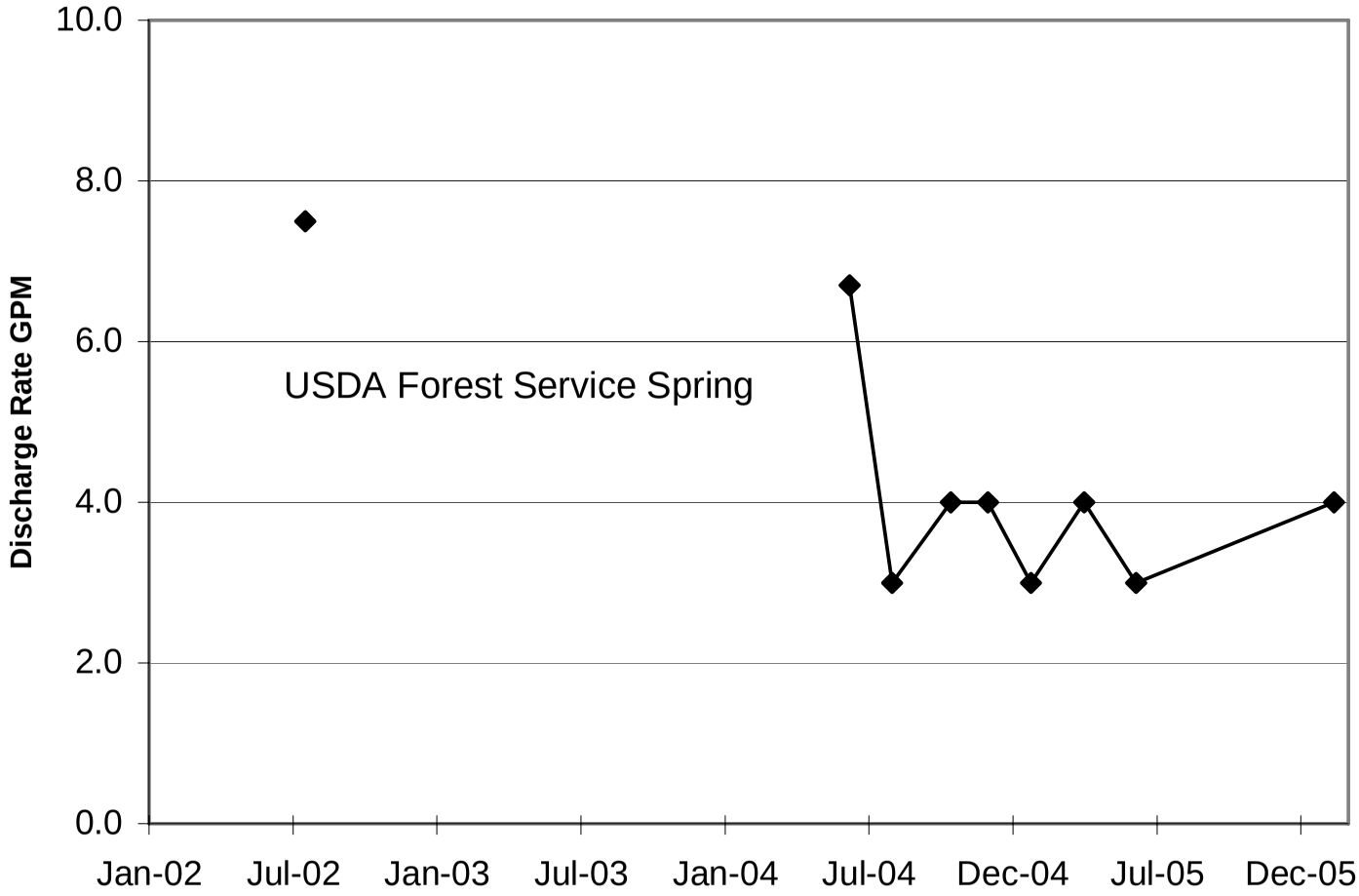

Figure 19. The USDA Forest Service Spring (GWIC M:197395) is locally recharged by the sandstone above the Cook Coal bed. The current discharge rate is around 3 to 4 gpm.

Lemonade Spring is located east of the town of Ashland along U. S. Highway 212. This spring is associated with the Canyon and Ferry coal beds, and probably receives local recharge. Discharge at this spring is between 1 and 1.5 gpm, showing moderate seasonal variations (Figure 20).

In the northern part of the Ashland RD, Bidwell Spring discharges from a local ground-water flow system, below the Canyon and Ferry coal beds. Typical discharge rate for this spring is about 0.5 gpm (Figure 21). An isolated high discharge rate of 2.3 gpm during 2003 may represent a precipitation event.

Ground-water conditions within areas of coalbed-methane production and influence

Hydrostatic pressure in coal aquifers is lowered during coalbed methane production. This may affect water levels in wells, and discharge rates of springs, which obtain their water from the developed coal seams. The magnitude, geographic extent and duration of this drawdown are a primary focus of the regional monitoring program.

Aquifers store and release water by two distinct mechanisms which together make up storativity (S): specific yield (S_y) and specific storage (S_s) ($S=S_y+S_s$). The specific yield of an aquifer is the amount of water that drains from the pore spaces in response to pumping or some other stress. Water stored or released due to specific storage is released in response to the compressibility of the aquifer's mineral skeleton and the pore water. Specific yield is several orders of magnitude greater than specific storage for a given aquifer (Fetter, 1994). Within unconfined, or water table, aquifers the primary means of water release to wells is from specific yield as pore spaces are dewatered, while the effects of specific storage are negligible. Within saturated confined aquifers (such as coal beds in the PRB) specific storage is the primary means of water release as pores are not typically drained and water is not released due to specific yield.

Davis (1984) reported values of specific yield for unconfined coal aquifers in the PRB on the order of 0.003 to 0.03, based on effective porosity measurements. For these values, between 0.003 and 0.03 cubic feet of water would be released by completely draining 1 cubic foot of an unconfined coal bed aquifer. Typical values for specific storage for a confined coal bed aquifer are much less, on the order of 0.00006 (Wheaton and Metesh, 2002). In this case, reducing the hydrostatic pressure in a unit area of a confined coal bed by 1 foot would release 0.00006 cubic feet of water. The two examples of water released are comparable, as each represents a 1-foot change in water level over a 1-square foot area of an aquifer. The difference in the quantities of water released is a function of how the water is released. An unconfined aquifer is dewatered (drained) while the confining pressure is reduced in a confined aquifer which releases water in response to the compressibility of the aquifer's matrix. Removal of water during

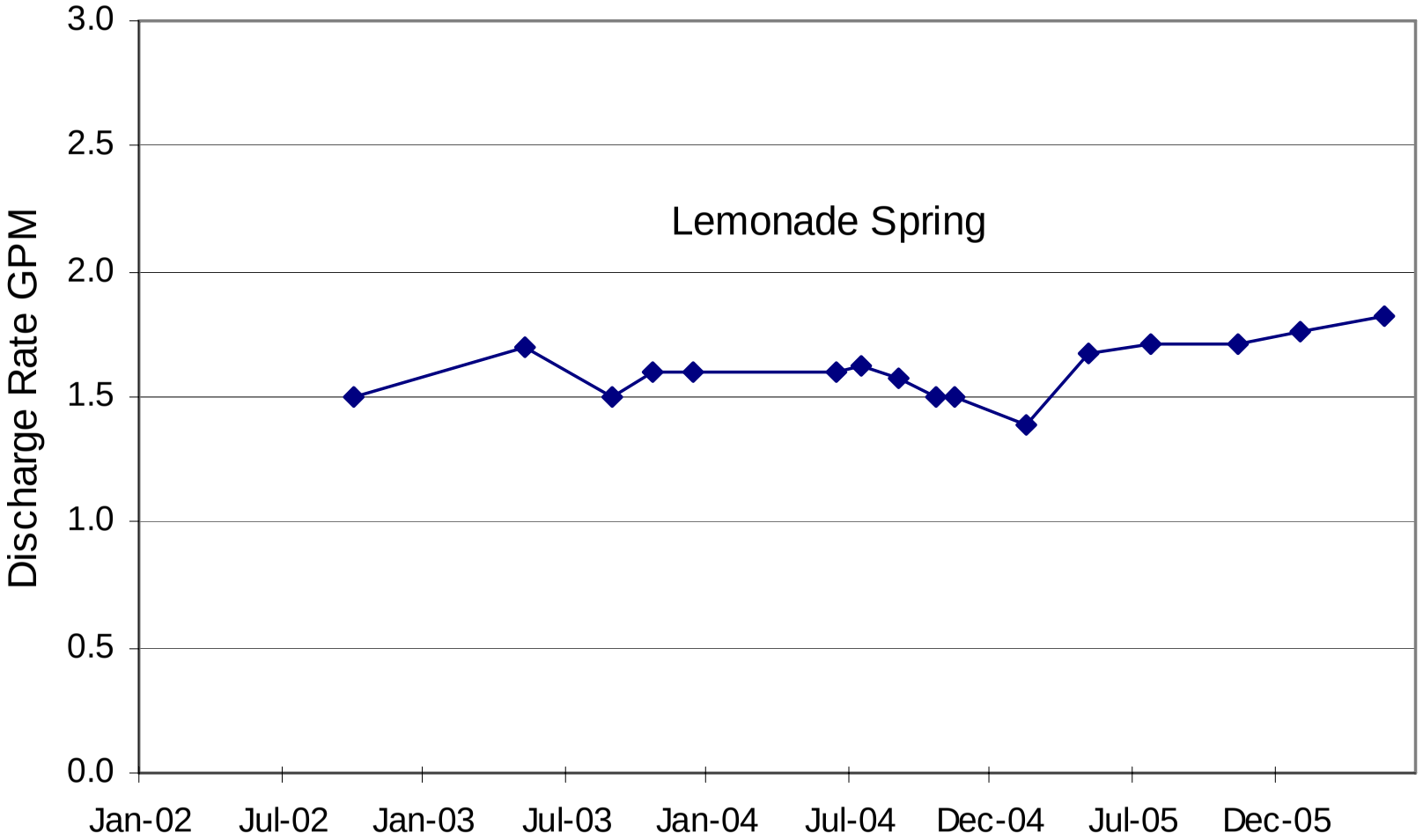

Figure 20. Lemonade Spring (GWIC M:198766) appears to be locally recharged by the Canyon and Ferry coal beds. The spring has a discharge between 1 and 1.5 gpm.

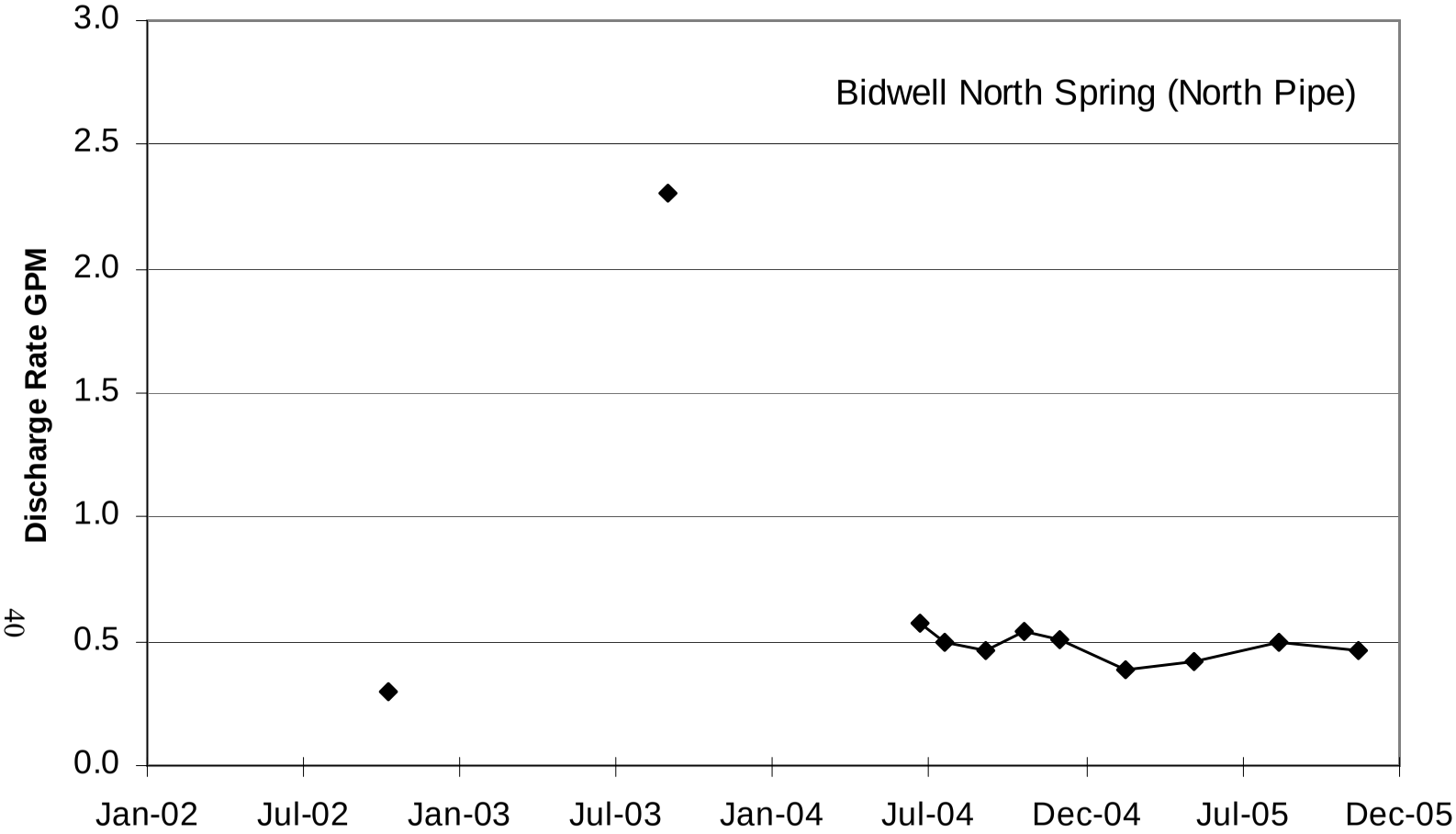

Figure 21. The Bidwell Spring (GWIC as M:198819) appears to be locally recharged by a flow system below the Canyon and Ferry coal beds. The spring discharge rate is about 0.5 gpm. The isolated high discharge in 2003 may represent a precipitation event.

CBM production is intended to reduce the hydrostatic pressure rather than drain the aquifer pores.

Estimated average discharge rates per well are used to predict aquifer-drawdown and water-management impacts from CBM development. The Montana CBM environmental impact statement (U. S. Bureau of Land Management, 2003, page 4-61) and the technical hydrogeology report associated with that analysis (ALL Consulting, 2001) included an estimation of the average water-production rates, per CBM well. The trendline for that estimated water-production rate is shown on Figure 22. In Montana, the first reported CBM production water was in April, 1999 (Montana Board of Oil and Gas Conservation web page http://www.bogc.dnrc.state.mt.us/). Now, with 5 years, 8 months of available production reports, the original water-production rate estimation can be evaluated and updated. The monthly-average water-production rates for all CBM wells in Montana are plotted against normalized months in Figure 22. The early production data (normalized-months 1 through 4) appear to indicate the affects of infrastructure construction and well development. The actual hydrogeologic response of the aquifer to the stress of water production begins, on average, in normalized-month 5. The data set available for Montana CBM wells is continuous for 80 months. The average values for normalized-months 75 through 80 of the data set are questionable because the number of wells with data for each of those months is small and the trend does not follow hydrogeologic concepts. Normalized-month 80, for example, represents only 1 well. A trendline based on normalized-months 5 through 74 shows that the amount of water initially produced from each CBM well is somewhat less than was expected (Figure 22); however, the predicted and observed rates become comparable over time. The area between the two trendlines on Figure 22 represents the difference in the amount of water that has been produced and the amount that was expected to be produced. This reduced quantity of CBM-production water decreases the amount of water that must be managed and it decreases the stress on the aquifers. How well this trend will transfer to other areas of the PRB in Montana is not yet known.

Coal beds in the Powder River Basin are generally separated from other aquifers by shale units. Due to these confining shale units, in most areas water-level drawdown in response to CBM production is expected to be limited to the coal aquifers and not migrate vertically to impact overlying or underlying aquifers. At a few selected locations, overburden and underburden aquifers are monitored for verification of impacts and lack of impacts on water levels.

Water-quality samples are collected from monitoring wells as part of the regional ground-water monitoring program and have been collected during previous projects in southeastern Montana. Water-quality data are available in GWIC for 100 samples from coal bed monitoring wells located in the area where CBM development is probable in southeastern Montana. Summary statistics for these data are presented in Table 2. Based on these data, CBM production water in Montana can generally be expected to have TDS concentrations between about 875 and 1,525 mg/L and SAR values between 34 and 57. Low sulfate concentrations in coal-bed water indicate reducing conditions and are an important tool for CBM exploration. (Van Voast, 2003). The median sulfate value for

the samples included in this summary is 4.5 mg/L, though samples with concentrations as high as 471 mg/L were included in the selected data set.

Ground-water quality in coal seams is not expected to change in response to CBM production. Infiltration of produced water may, however, cause changes in shallow ground-water quality. To monitor the impact, water-quality data are collected in shallow aquifers.

Table 2. Water-quality summary for coal bed aquifers in the portion of the Powder River Basin with coalbed methane potential in Montana.

	Specific Conductance (umhos/cm^2)	pH	Total Dissolved Solids (mg/L)	Sodium Adsorption Ratio	Sulfate (mg/L)
Median	1821	8.14	1201.0	45.8	4.5
Standard Deviation	494	0.40	322.8	11.4	64.4
Minimum	1055	7.45	568.2	11.3	0.0
Maximum	3061	9.36	2028.6	82.4	471.0
Count	100	100	100	100	100

Data source: Montana Ground-Water Information Center, MBMG

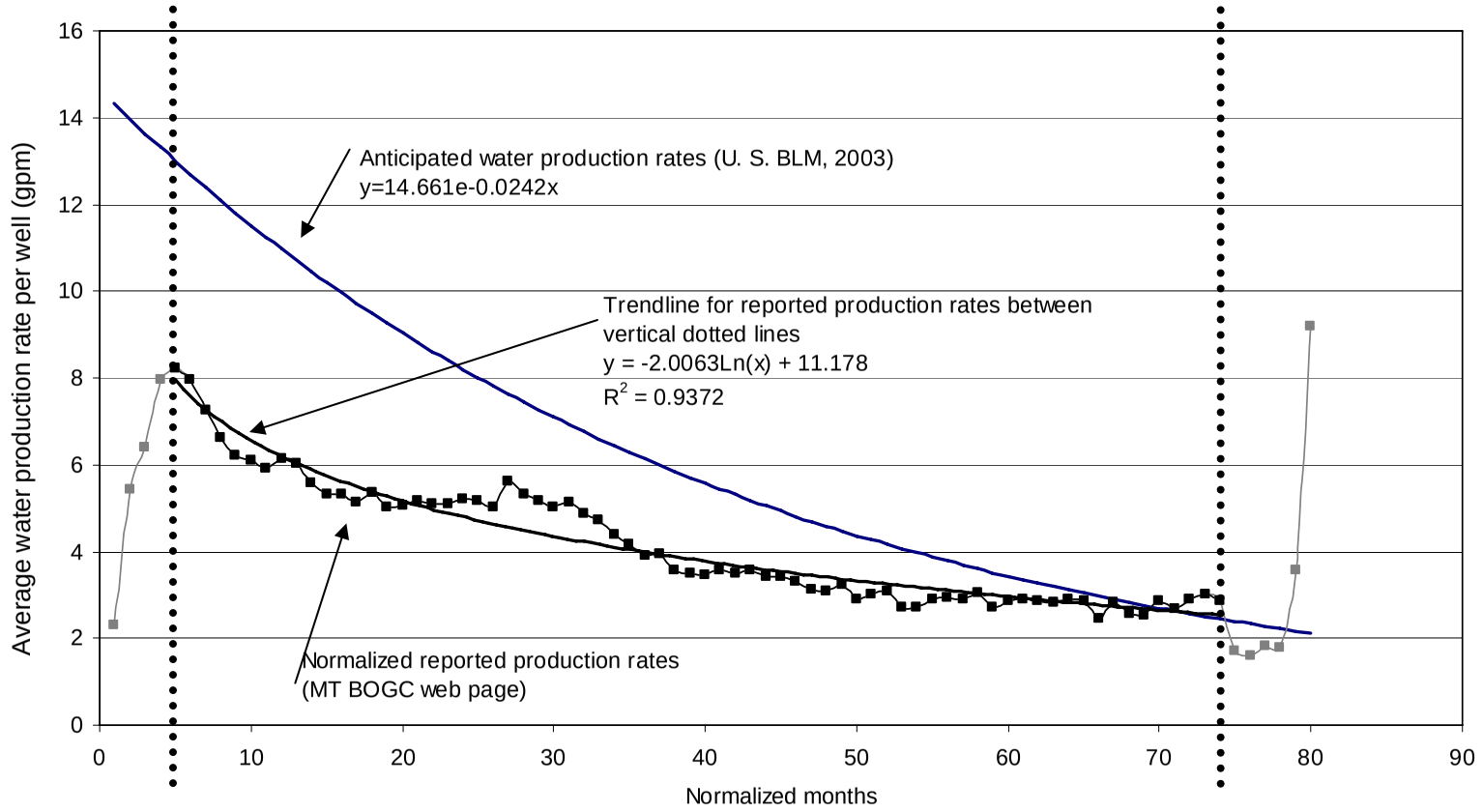

Figure 22. Actual reported water production for CBM wells in Montana have averaged far lower production rates than originally anticipated. Data points on the reported production curve that fall outside the vertical, dotted lines are not included in the trend analysis as they do not represent hydrogeologic response to stress.

CX gas field

Methane-water production

Data from CBM production wells in the CX field (Plate 1) were retrieved from the Montana Board of Oil and Gas Conservation web page (http://www.bogc.dnrc.state.mt.us/). Data for December, 2005 were not available. During 2005, a total of 516 CBM wells produced either water, gas, or both in the CX field. Production is from the Anderson, Dietz, Canyon, Carney, Wall, King, and Flowers-Goodale coal beds (Figure 3). The average water production per well and the total water production per month for all wells are shown on Figure 23. The average water production rate for all wells over the entire year was 3.1 gpm. The highest water production rate for a single well over a one month reporting period was 30.1 gallons per minute (gpm). Average total production rates were least in March at 1,137 gpm, and highest during August at 1,552 gpm. Cumulative water production per month was least in February at 4.9×10^7 gallons and reached the maximum in August at 6.9×10^7 gallons. The total water production for the year was 66.7×10^7 gallons or 8.9×10^7 cubic feet (ft^3), slightly less than reported during 2004 when a total of 439 wells were reported as producing. Along the western edge of the Fidelity project area near the Montana – Wyoming state line some wells are no longer being pumped and others are being pumped at a reduced rate as the methane production rates in this area have declined.

Bedrock aquifer water levels

Water level trends in aquifers that are susceptible to CBM impacts in and adjacent to the CX field are presented in figures 24 through 31. Ground-water levels in this area respond to a combination of precipitation patterns, coal mining, and CBM production. Both coal mining and CBM production have created large areas of lowered ground-water levels in the coal seams.

The CX field covers an area of approximately 20 square miles and the area where a total of 20 feet or more of CBM related drawdown has occurred (Plate 4). Some of the additional CBM wells are located east of MBMG monitoring wells, and drawdown in that area is not measured as part of this study. The locations of active CBM wells at any specific time is not available; however, it appears that drawdown of at least 20 feet has reached a typical distance of about 1 mile beyond the active field in most areas and a maximum distance of about 1.5 miles. Drawdown in other monitored coal seams is similar to that shown for the Dietz coal. Within the regional monitoring program area, more monitoring wells are completed in the Dietz than in other coal seams. Therefore, the best data set to develop a drawdown map is from the Dietz coal. Drawdown was expected to reach 20 feet at a distance of 2 miles after 10 years of CBM production (Wheaton and Metesh, 2002) and a distance of 4 to 5 miles after 20 years (U. S. Bureau of Land Management, 2003, page 4-62). Current measured drawdown is similar to, but

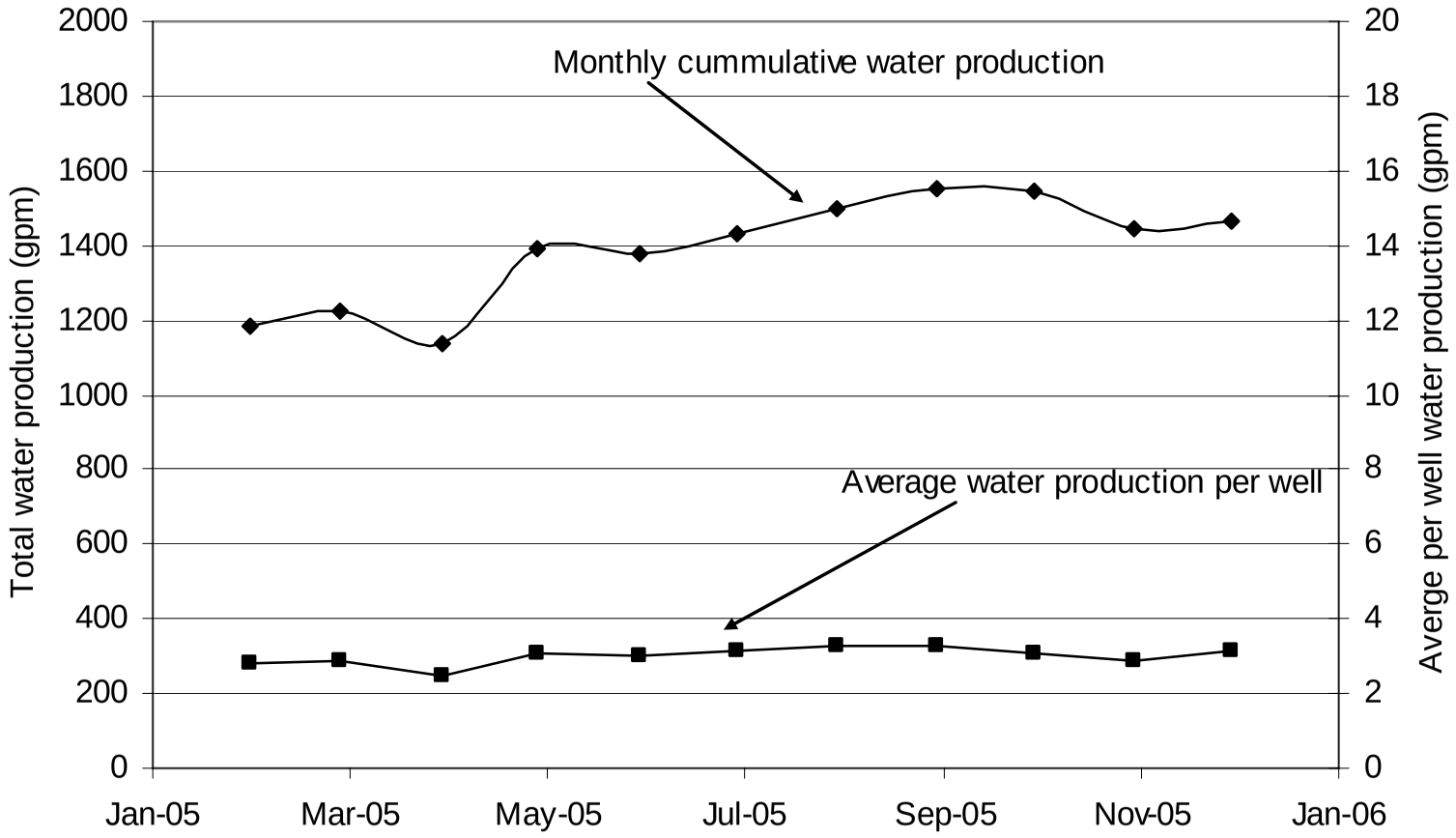

Figure 23. Fidelity's average water production rate for all wells for the entire year was 3.1 gpm.

somewhat less than, expected. These monitoring data support the conclusions reached in the original evaluations of impacts (U. S. Bureau of Land Management, 2003).

Hydrostatic pressure in the combined Anderson and Dietz coal in well WR-34 near the Ash Creek mine declined about 21 feet between 1977 and 1979 due to mine dewatering. The Ash Creek mine pit reached a maximum size of about 5 acres. Pit dewatering maintained a reduced water level until reclamation and recovery began in 1995; baseline conditions were reached in 1998 (Figure 24). Between 2001 and 2003 ground-water levels at this site were lowered to about 150 feet below baseline conditions by CBM production. Since 2003, the water levels have recovered to within 52 feet of baseline conditions. This recovery appears to be due to a reduction in the amount of water pumped in this area by CBM wells. The greater magnitude of drawdown at this well due to CBM development is primarily due to the proximity of, and area affected by, CBM production.

Ground-water level responses due to the Ash Creek mine pit dewatering are also evident at well WR-38 (Figure 25). The water level in this well has dropped about 80 feet in response to CBM production. Well BF-01 is completed in the Ash Creek mine spoils. It is interesting to note that although the mine pit created a water level response in the adjacent coal aquifer, the water level in the spoils has not responded to lowered water levels in the coal due to CBM production.

In southeastern Montana, faults in the Fort Union Formation can be aquitards that limit the aerial extent of drawdown (Van Voast and Reiten, 1988). A series of monitoring wells was installed south of the east Decker mine in the early 1970's to document this effect (Van Voast and Hedges, 1975). Monitoring data (Figure 26) from the Smith (WRE-17) and Anderson (WRE-18) coal seams south of the fault show no response to mining north of the fault; drawdown in response to mining is apparent north of the fault (WRE-19). Methane production south of the fault shows the inverse response as water levels in the Anderson coal (WRE-18) south of the fault have been lowered about 123 feet since 2001 and water levels at WRE-19 north of the fault have not responded to CBM production.

Near the western edge of the CX field, but across a fault from active CBM wells, the Carney (CBM02-2WC) coal began responding to CBM-related drawdown during 2004 (Figure 27). The water level in the Canyon coal (WR-24) at this site has decreased somewhat, which may be a response to CBM production or may be due to long term precipitation patterns. The Roland coal (CBM02-2RC) is stratigraphically higher than the CBM production zones and during 2005 the water level at this well dropped about 8 feet. The cause of the lowered water levels in the Roland coal is not apparent, as CBM production is unlikely to have an affect on this unit.

Near the East Decker mine, water levels respond to coal mining in the Anderson, Dietz 1 and Dietz 2 coals (Figure 28). Drawdown has increased, particularly in the Dietz 2 coal, in response to CBM production in the area. This site provides an example of the increased drawdown in deeper coal aquifers that has been noted in coal mine research

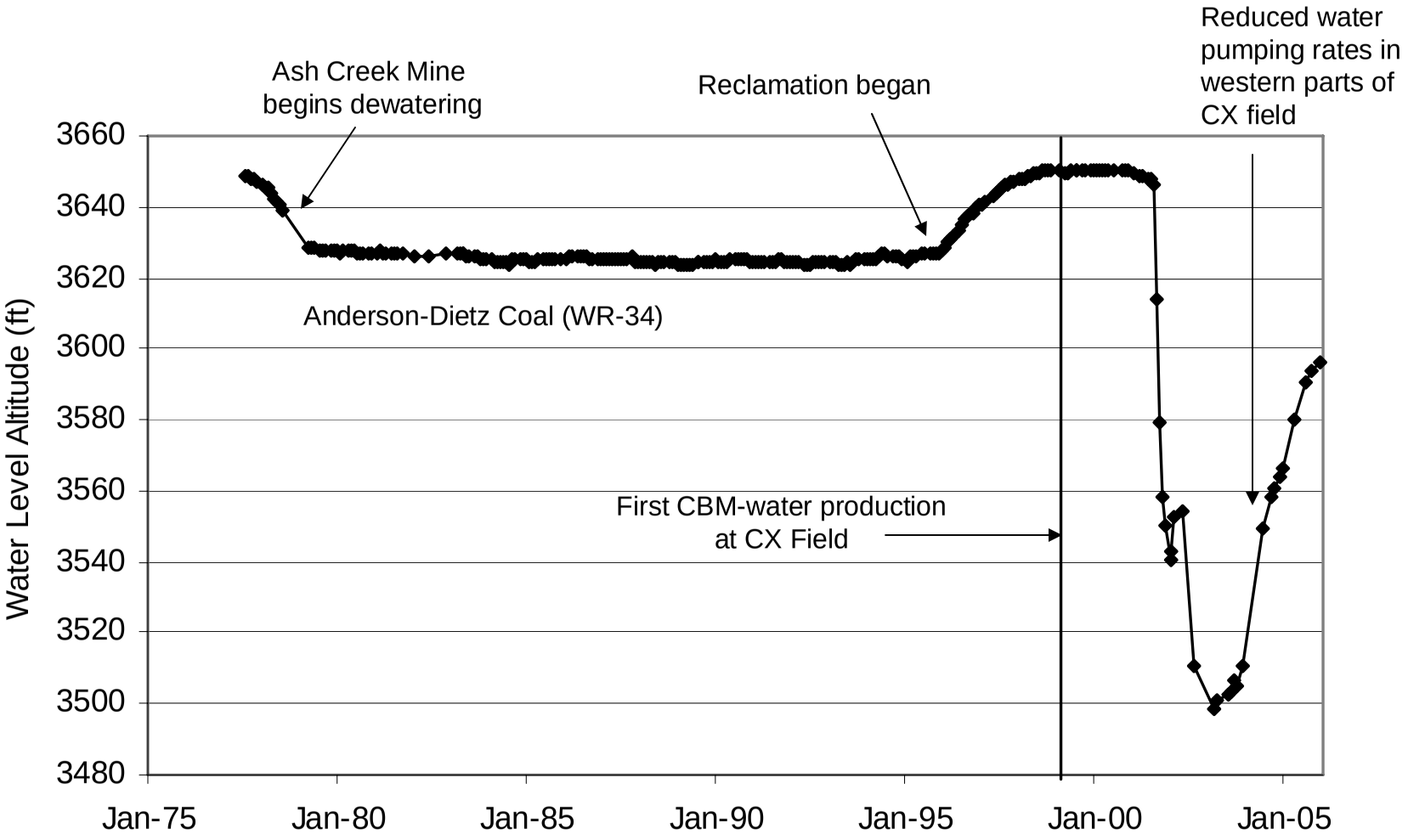

Figure 24. Water levels in the combined Anderson and Dietz coal (WR-34) in the Squirrel Creek area respond to both coal mining and coalbed methane production. The water level recovered during 2004 in response to water production decreases in this portion of the CX field.

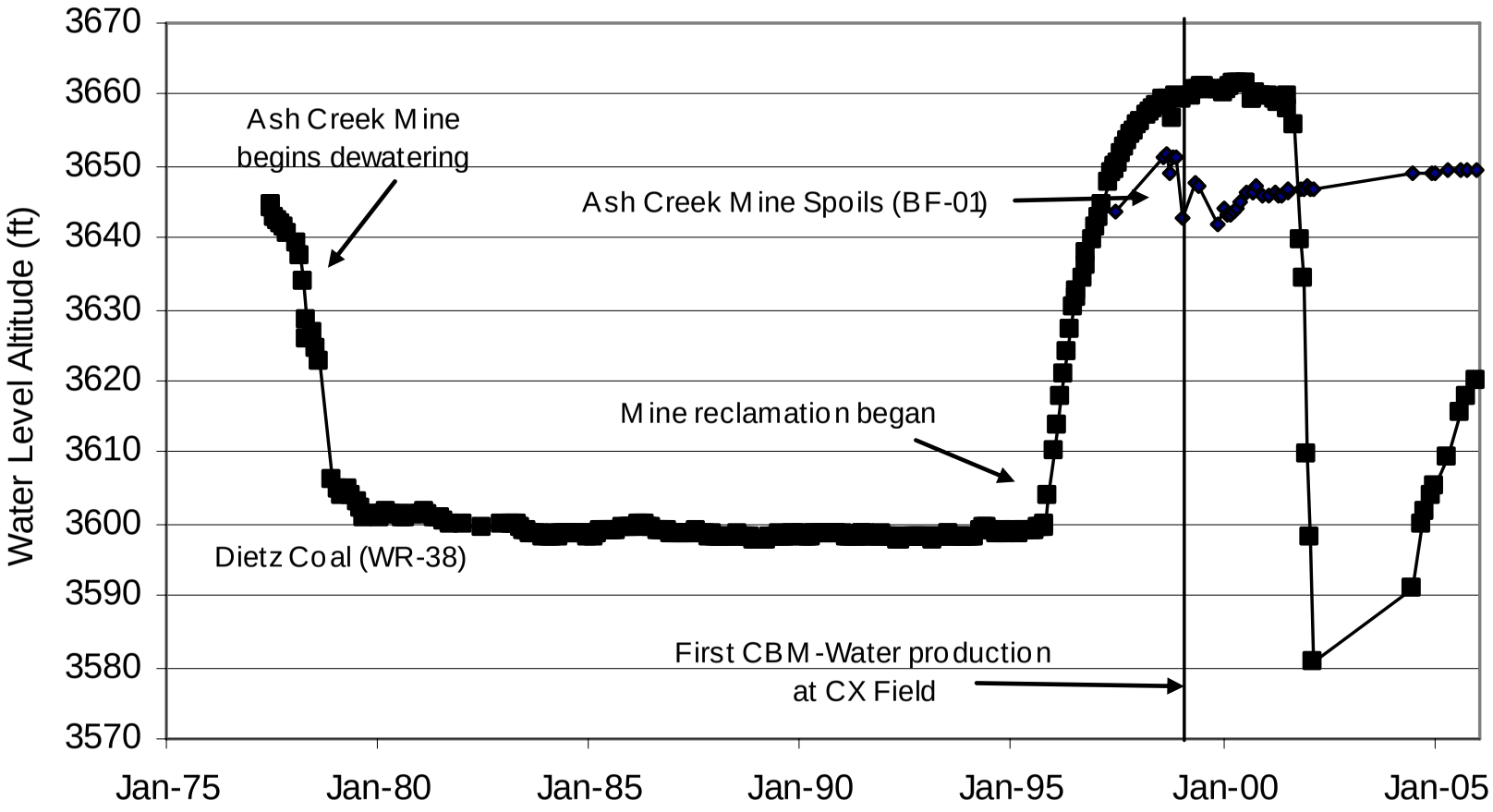

Figure 25. The mine spoils well is being dewatered for CBM production but the water levels show no response to the lowered water levels. However, water levels have decreased by 80 feet in the Dietz Coal in response to the CBM production.

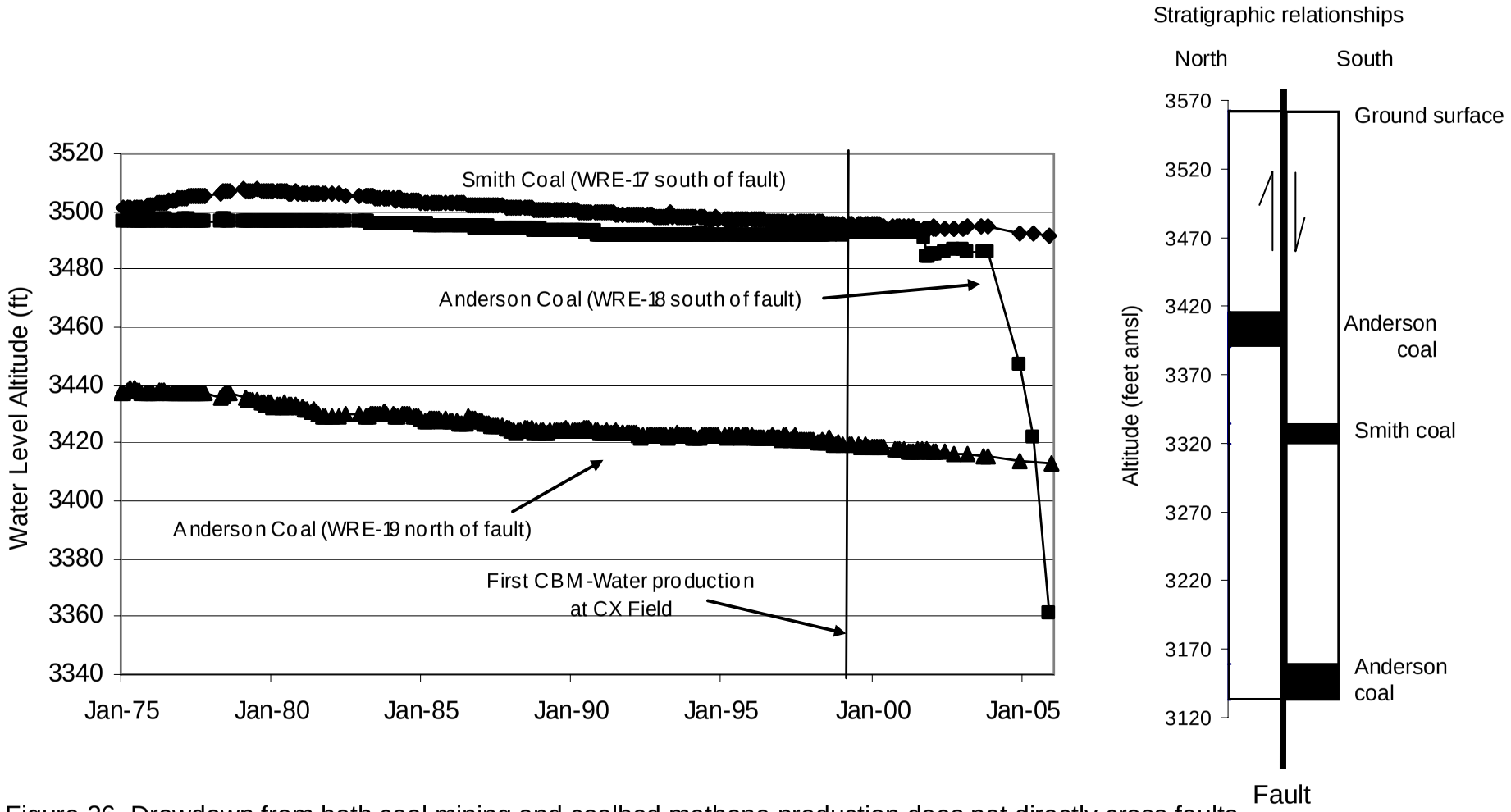

Figure 26. Drawdown from both coal mining and coalbed methane production does not directly cross faults in the project area. Mining has occurred north of this fault since the early 1970's and only minor drawdown has been measured at WRE-18 since the mid-1980's. The pressure reduction has probably migrated around the end of the fault. Coalbed methane production south of the fault is apparent in WRE-18 but not across the fault in WRE-19.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

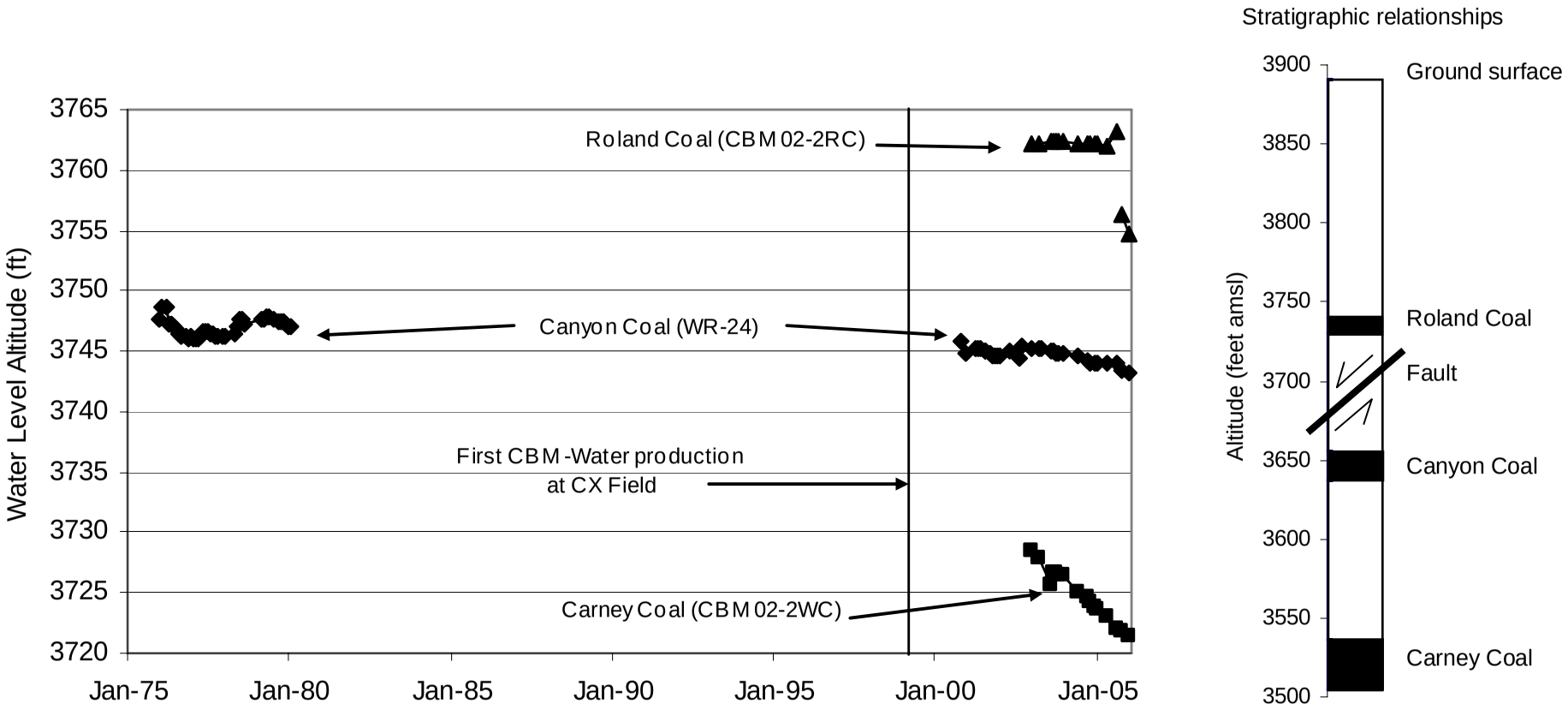

Figure 27. The long-term decrease in water levels in the Canyon Coal is probably related to precipitation patterns. The short period of record for the Carney coal at the CBM02-02 site does not indicate meteorological influence but may be showing the beginning of CBM related drawdown during 2004. The Roland Coal has not been developed for CBM production and the water-level decline is not likely a response to CBM activities.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

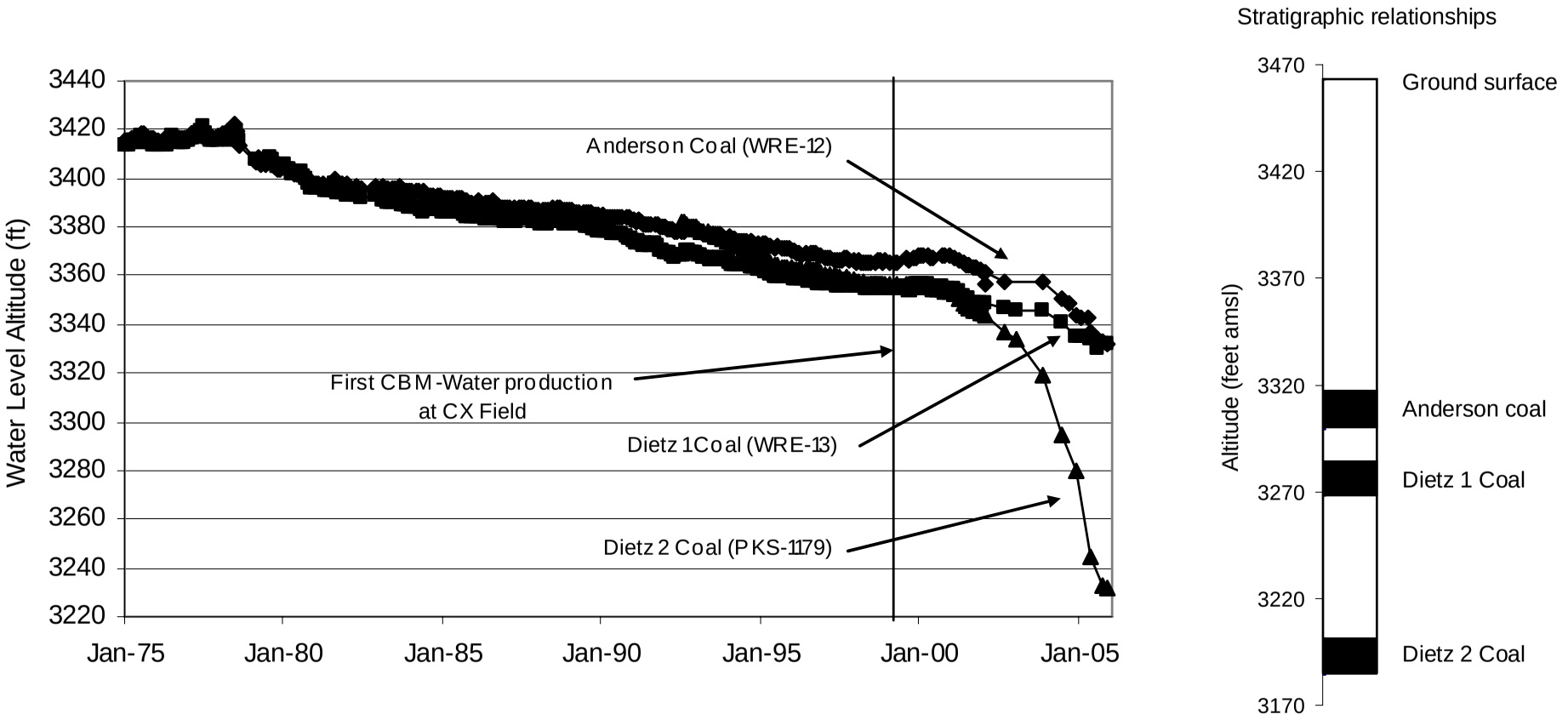

Figure 28. In some locations, the water level response to CBM production in deeper coal seams (PKS-1179) is far greater than in shallower coal seams (WRE-12 and WRE-13). This trend has been noted in coal mining areas also.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

(Van Voast and Reiten, 1988). Note the far greater rate of drawdown in the Dietz 2 coal than in the other coal seams at this site.

Changes in stage in the Tongue River Reservoir affect water levels in aquifers that are connected to it such as the Dietz coal that crops out beneath the reservoir. Water levels in the Dietz coal south of the reservoir show annual responses to the reservoir stage levels, but are more strongly influenced by mining and CBM production (Figure 29). Average reservoir stage is about 3420 ft, which, when compared to the Dietz potentiometric surface, indicates that some water has always seeped from the Tongue River Reservoir to the coal seam, though the rate of seepage is likely increasing due to the increasing gradient between the reservoir and the Dietz potentiometric surface.

Water levels in Anderson overburden in the Squirrel Creek watershed (Figure 30) show possible correlation with precipitation patterns and no drawdown due to either coal mining or CBM production. The deeper overburden aquifer is separated from the Anderson coal by over 50 feet of shale, siltstone and coal which has limited the vertical movement of water in response to mine dewatering (which began in 1972) and CBM water production (which began in 1999). The shallow, water-table aquifer (WR-17A) shows a rapid rise, totaling about 30 feet, in response to infiltration of CBM-production water from an adjacent holding pond. This pond is no longer used to hold CBM production water, and the shallow water table has returned to within 12 feet above baseline. The deeper overburden aquifer (WR-17B) at this site shows no response to the holding pond. The water-level trend of the deeper sandstone aquifer may relate to the local drought conditions.

Alluvial aquifer water levels

Water levels in the Squirrel Creek alluvium show annual variations that are typical for shallow water table aquifers (Figure 31). Since 1999 the alluvial water levels at WR-58 have declined slightly in response to drought conditions. Farther downstream in the CBM production area (WR-52D), the water level in the alluvium increased and is now decreasing to approximate baseline levels. This rise and subsequent fall is likely in response to CBM-production water seepage from nearby infiltration ponds which are no longer in use.

Coal Creek gas field

Methane water production

Data from CBM production wells in the Coal Creek field (Plate 1) were retrieved from the Montana Board of Oil and Gas Conservation web page (http://www.bogc.dnrc.state.mt.us/). Data for December, 2005 were not available. Pinnacle Gas Resources, Inc. is developing the Coal Creek field, north of the Tongue

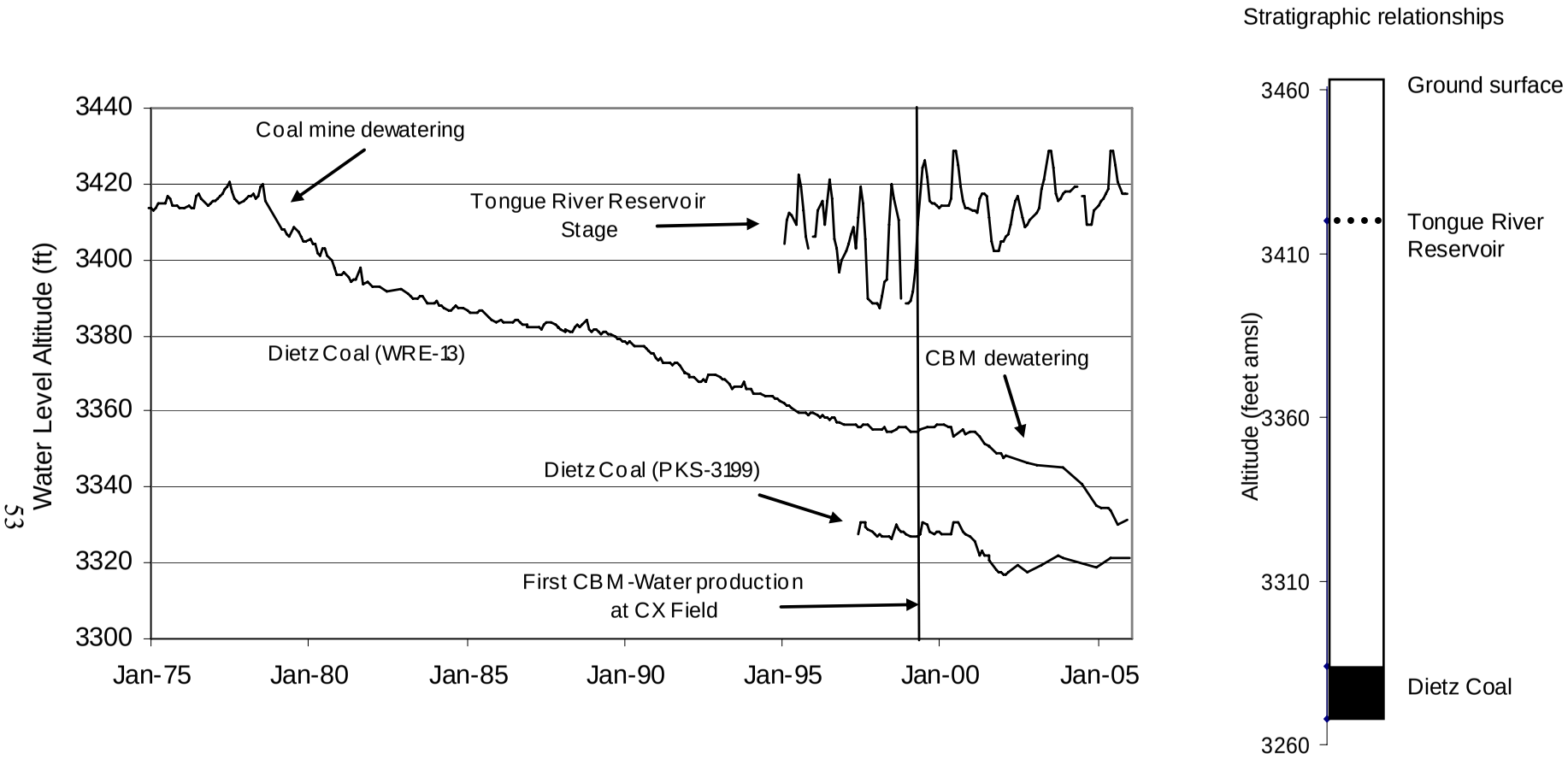

Figure 29. Annual fluctuations of stage level in the Tongue River Reservoir are reflected in water levels in the Dietz coal (WRE-13 and PKS-3199); however, coal mine and CBM influences dominate when present.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

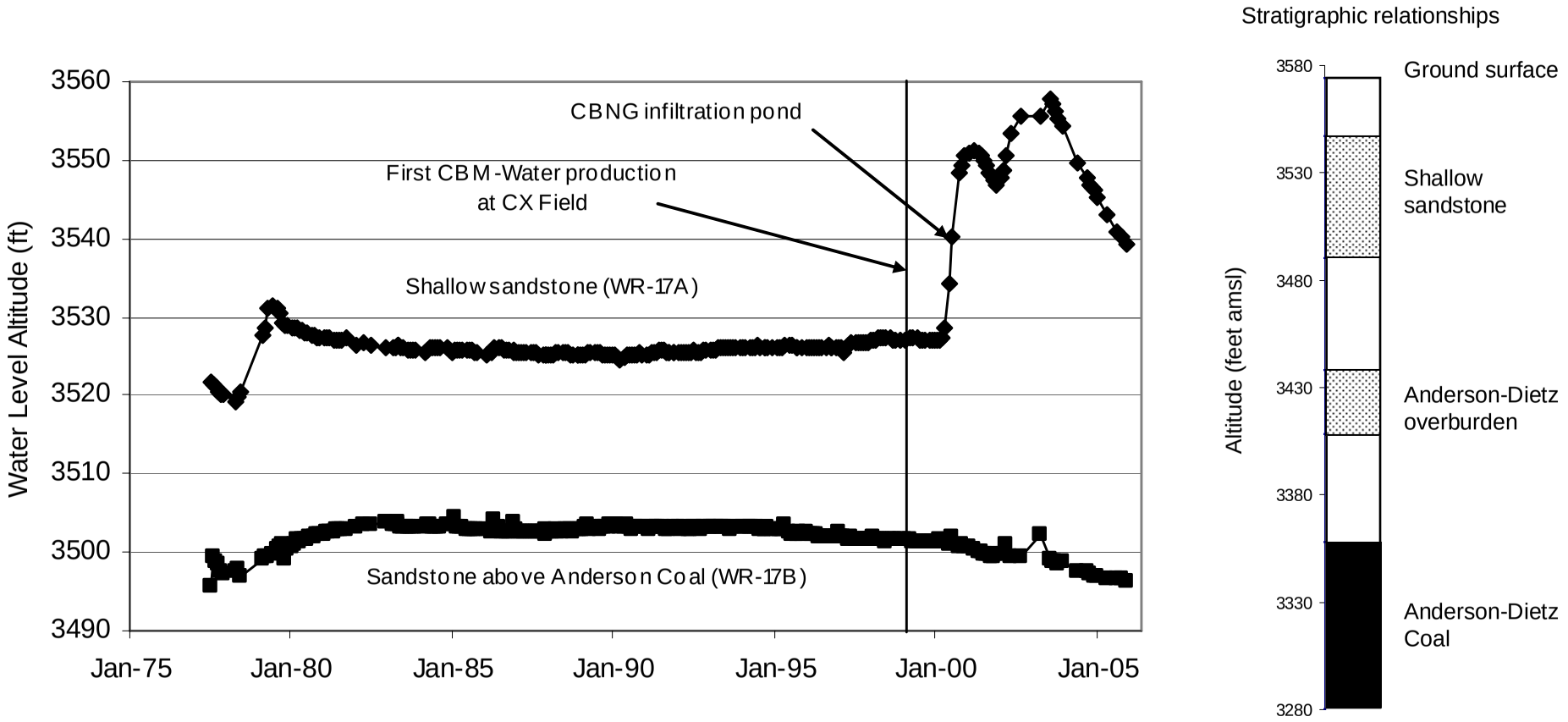

Figure 30. Long-term water-level trends in the Anderson overburden(WR-17A and WR-17B) in the Squirrel Creek area, may relate to precipitation patterns. The rise in water table in 1999 at WR-17A is believed to be in response to infiltration of water from a CBM holding pond. The water level in this aquifer is now dropping as the pond receives less water.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

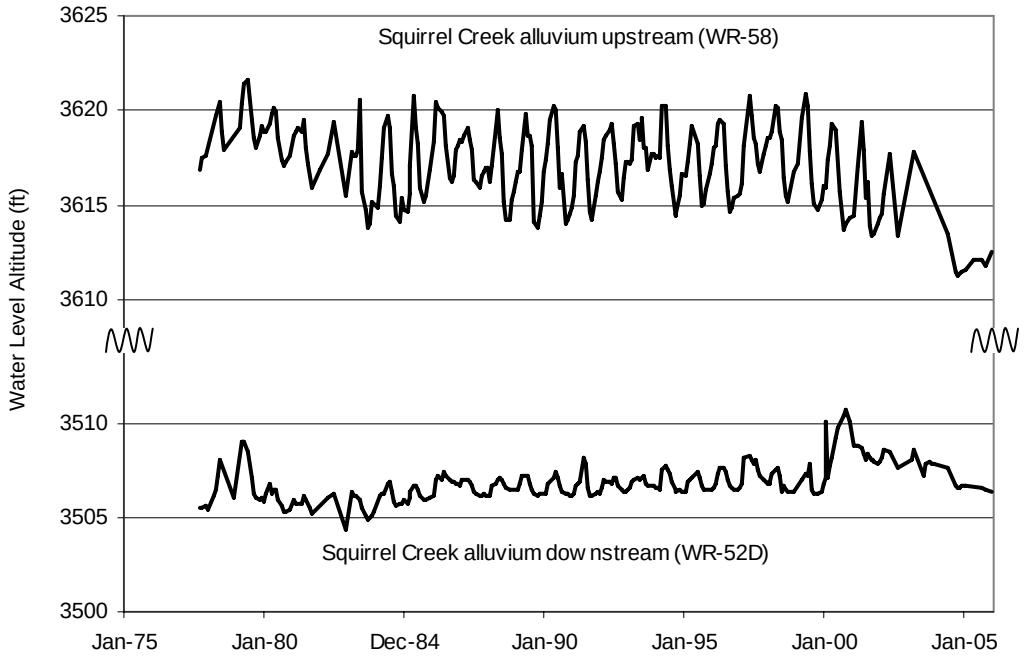

Figure 31. In addition to normal annual cycles, long-term precipitation trends affect water-table levels in the Squirrel Creek alluvium. Upstream of CBM production Squirrel Creek alluvium is not influenced by CBM production (WR-58), but adjacent to CBM production the water level rise since 1999 and fall during 2004 likely relates to infiltration ponds (WR-52D).

Note: The Y axis scale is broken to show better hydrograph detail.

River Reservoir. During 2005, a total of 12 CBM wells produced water in the Coal Creek field, with the first reported production being during April, 2005. Production is from the Wall and Flowers-Goodale coal beds (Figure 3). The average water production per well and the total water production per month for all wells in the field are shown on Figure 32. The average water production rate for all wells over the 9 month production period was 21.5 gpm. The highest water production rate for a single well over a one month reporting period was 40 gpm. Average total production rates were least in May at 155 gpm and highest during November at 281 gpm. Cumulative water production per month was least in February at 2.1×10^6 gallons and reached the maximum in August at 1.1×10^7 gallons. The total water production for the 9-month period was 6.1×10^7 gallons or 8.2×10^6 ft^3.

Bedrock aquifer water levels and quality

Two miles west of the Tongue River and about 4 miles north of the Tongue River Dam, at site CBM02-4 (Plate 1), the water level in the Wall coal has been lowered about 6 feet since April, 2005 in response to water production in the Coal Creek field (Figure 33). The nearest CBM well is about 2.5 miles from site CBM02-4. Water levels in the sandstone overburden wells show no response at this site (Figure 33). No response has been measured in either the overburden sandstone or Canyon coal at the CBM02-7 site, located about 6 miles west of the Coal Creek field (Figure 34).

A water quality sample was collected during 2004 from the Wall coal at CBM02-4WC. The data are available from GWIC and indicate the Wall coal in this area has a TDS concentration of 896 mg/L and a SAR of 68.7.

Hanging Woman Creek gas field

Methane water production

Data for CBM wells in Wyoming are available from the Wyoming Oil and Gas Commission web site (http://wogcc.state.wy.us/). Water production is available as the cumulative volume of water produced from each well. During November, 2004, Nance began pumping water from CBM wells in the Hanging Woman Creek watershed, directly south of the Montana-Wyoming state line (Plate 1). As of December, 2005, a total of 35.1×10^7 gallons of water (4.7×10^7 ft^3) of water had been produced by Nance from a total of 99 wells. Nance is producing CBM from the Anderson, Canyon, Cook and Roberts coal beds (Figure 3).

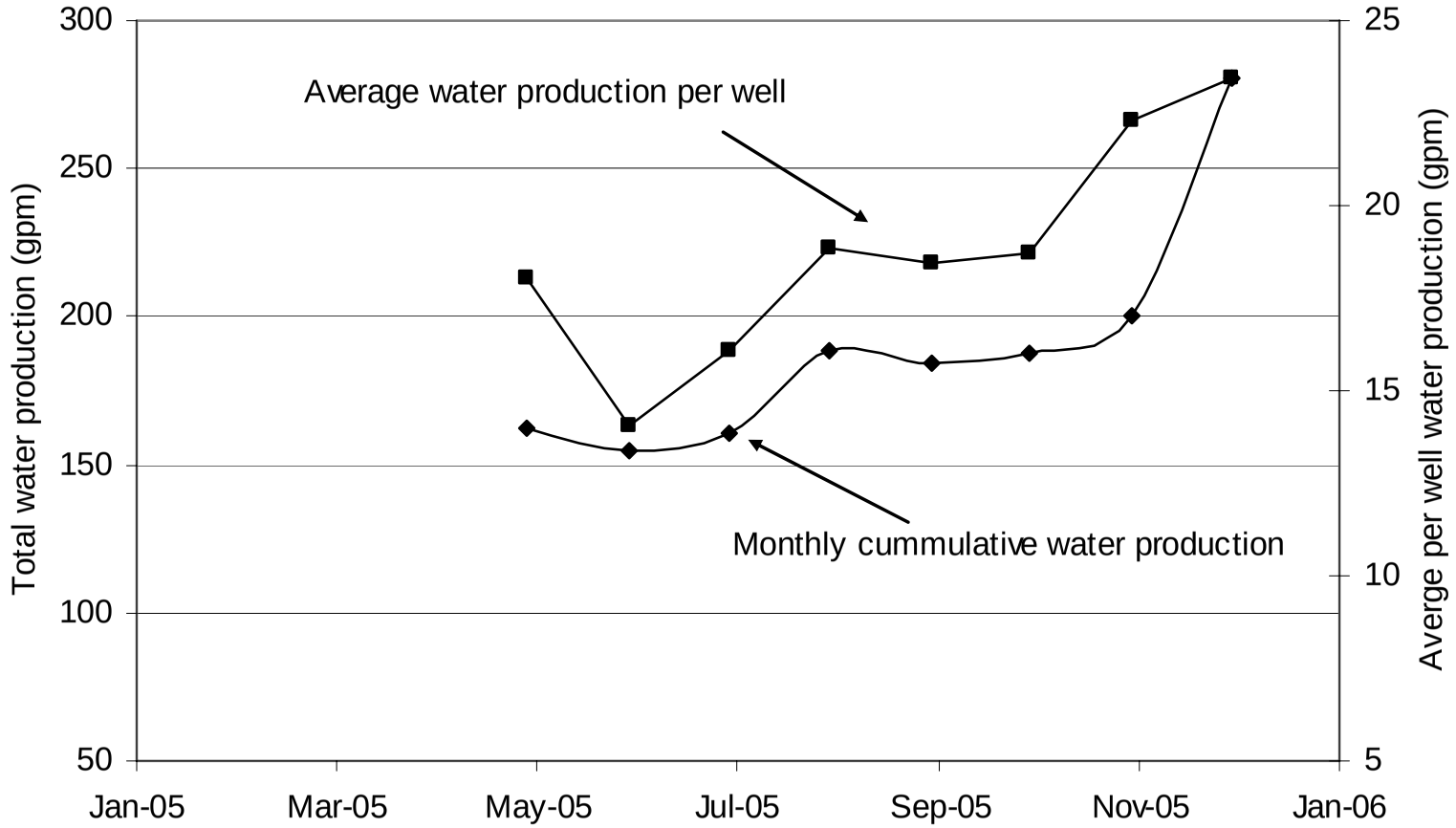

Figure 32. Average water production rate in the Coal Creek field for all wells over a 9 month period was 21.5 gpm.

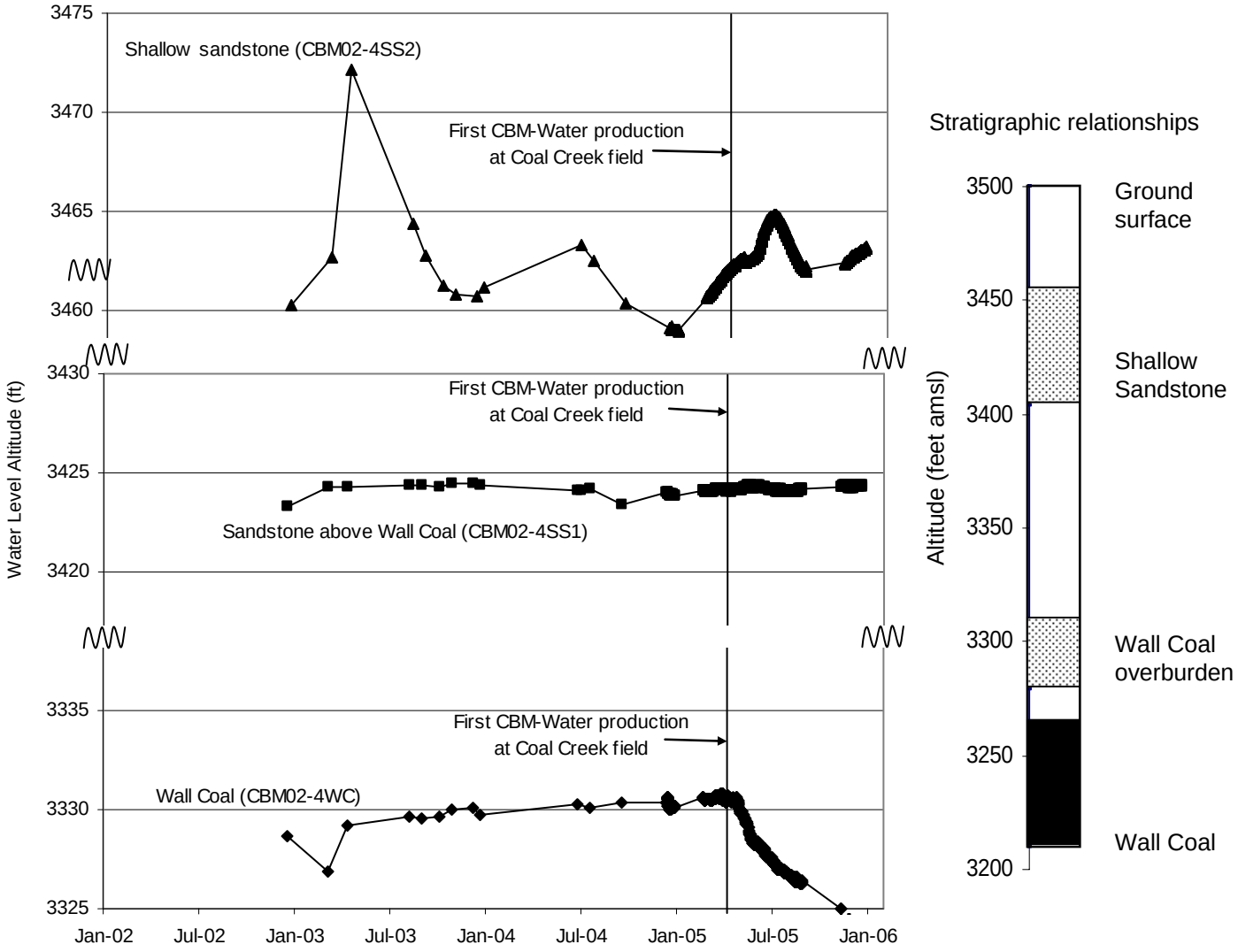

Figure 33. A downward hydraulic gradient is evident between the Canyon underburden sandstone, Wall overburden sandstone, and Wall coal at the CBM02-4 site. Water-level trends in the Wall coal and overburden are probably not related to meteorological patterns while those in the shallower sandstone may be. The water level in the Wall Coal aquifer is beginning to decrease in response to CBM development.

Note: The vertical scales of the stratigraphic relationship and the hydrograph are different. The Y axis scale is broken to show better hydrograph detail.

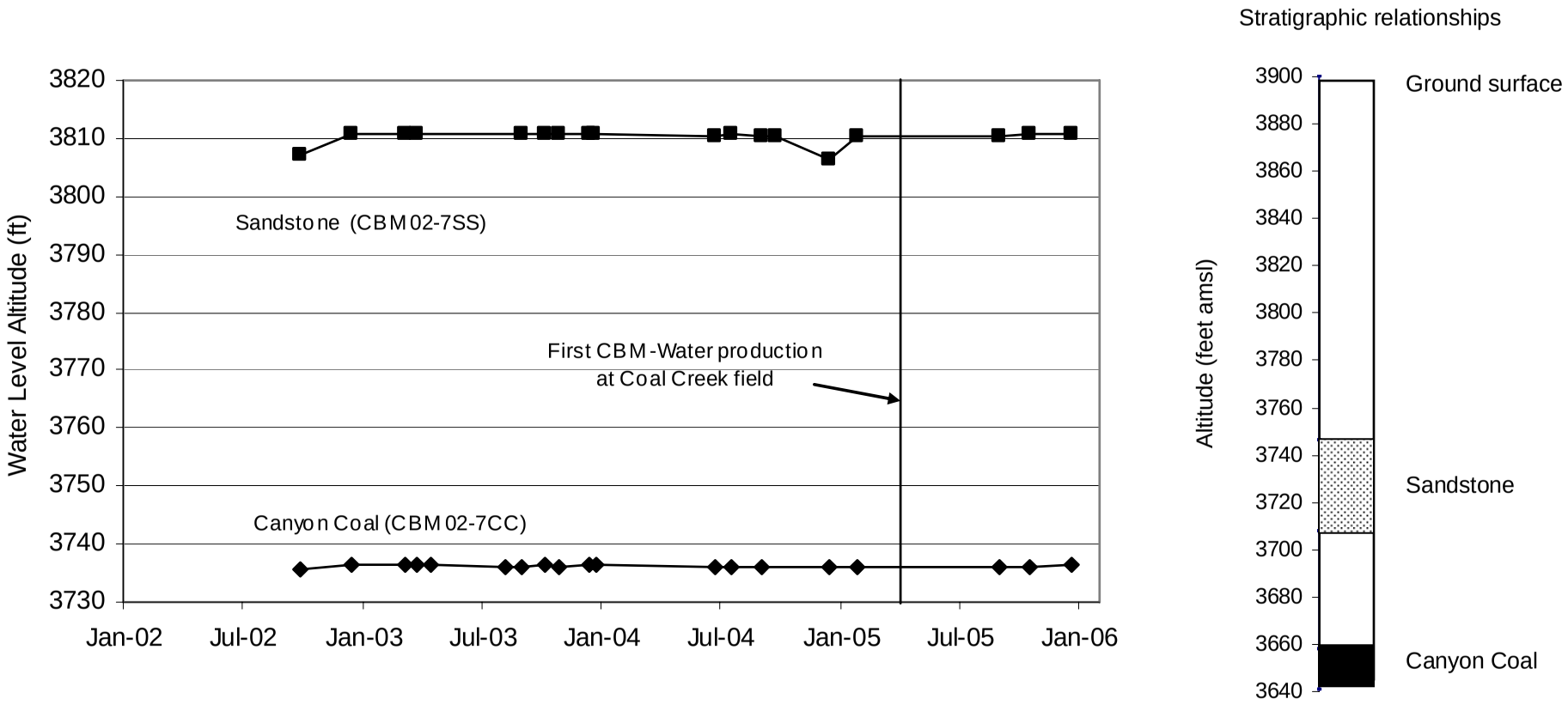

Figure 34. The CBM02-7 site is located about 6 miles west of the Coal Creek CBM field. The water levels for the overburden sandstone and Canyon Coal show no response to CBM pumping in the Coal Creek field.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

Bedrock aquifer water levels and quality

Monitoring well site SL-4 is located about 1-mile north of the nearest CBM well in the Hanging Woman Creek gas field. Wells at this site are completed in the alluvium, Smith and Anderson coal beds (Figure 35). The water level in the Anderson coal has been lowered about 20 feet at this site in response to CBM production (Figure 36). The water level in the Smith coal has also dropped; however the cause of this drop is unclear. Vertical migration of changes in hydrostatic pressure does not seem likely in a short time, and additional monitoring may help explain the changes in the Smith coal.

Six miles west of site SL-4, at monitor site SL-3, the alluvium of North Fork Waddle Creek, an overburden sandstone, the Smith, Anderson and Canyon coals are monitored (Figure 37). Water levels in the overburden, Smith and Anderson coals are not responding to CBM production; however the water level in the Canyon coal has dropped about 22 feet (Figure 38).

Water quality samples from the Anderson and Smith coal at site SL-4 indicate similar chemical concentrations in both aquifers (Appendix D and Plate 3). Total dissolved solids concentrations for the Anderson and Smith coals are 1,201 and 1,237 mg/L, respectively, cation concentrations are dominated by sodium in both coal beds with SAR values of 43 and 38 and SO_4^- concentrations are 7.0 and 19.9 mg/L. These data represent the quality of water that can be expected to be produced with CBM in this area, and indicates that the Smith coal may be a viable methane target to the south where it would be more deeply buried and under greater hydrostatic pressure.

Water quality is very similar in all 4 monitored bedrock aquifers at SL-3. Total dissolved solids concentrations range from 1,122 mg/L to 1,422 mg/L, and the cation concentrations are dominated by sodium with SAR values from 43.1 to 58.7.

Alluvial aquifer water levels and quality

The Hanging Woman Creek alluvium near the state line appears to be hydrologicaly isolated from the Anderson and Smith coal beds (Figure 35). Changes in water levels in the alluvium reflect water table response to precipitation (Figure 39). Alluvial water level changes at SL-3Q (Figure 40) appear to be in response to seasonal weather patterns and not to CBM production as no change in overburden water levels have been detected.

Water quality samples were collected at HWC-86-13 and HWC-86-15 during April and September, 2005 (Appendix D). The baseline TDS concentrations in the alluvial water are very high, between 6,242 mg/L and 8,484 mg/L. The water quality in the alluvium is dominated by sodium and sulfate. There is very little difference between these data and data from samples collected at these wells in 1987 (GWIC).

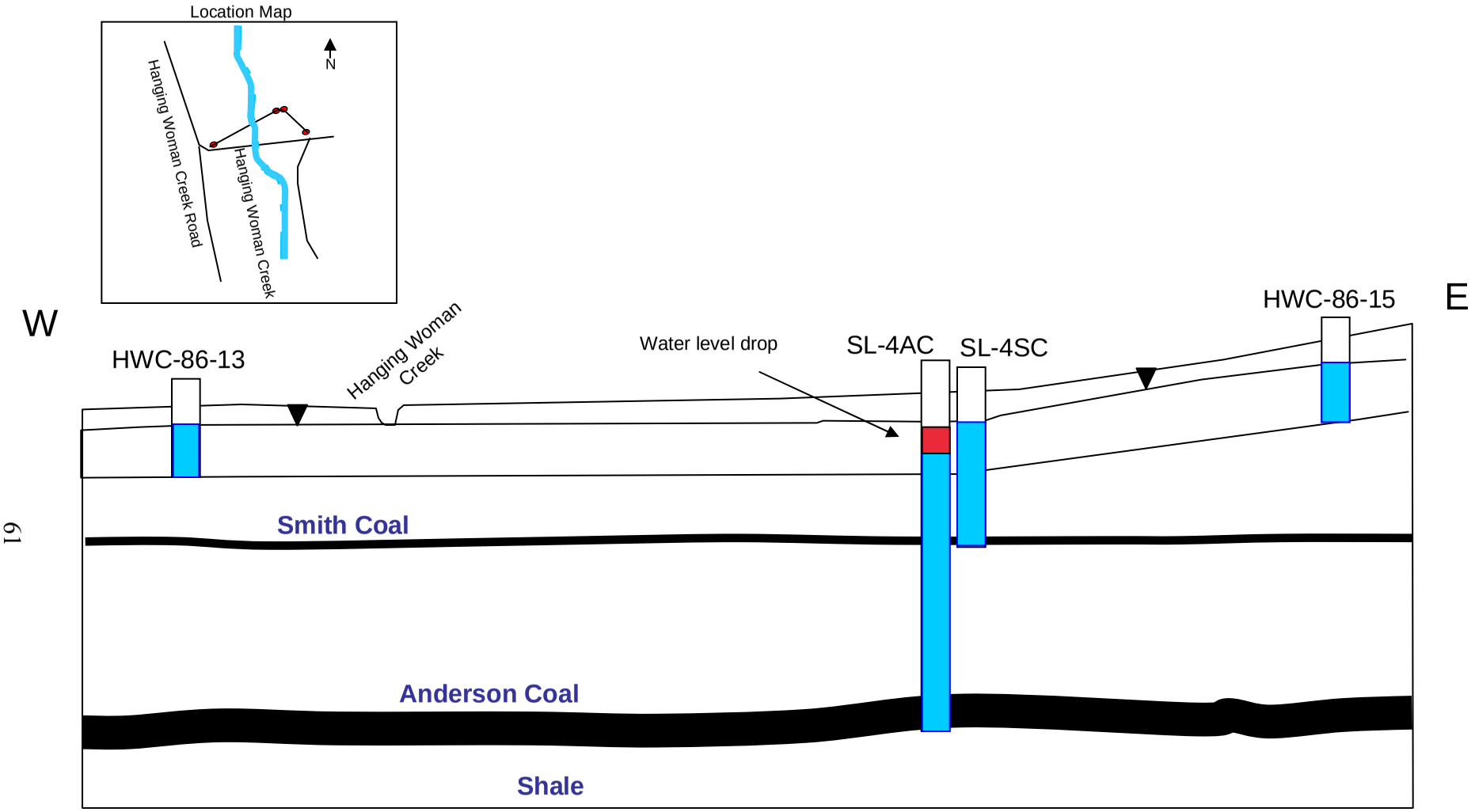

Figure 35. Geological cross section for the alluvium and bedrock wells near the Montana / Wyoming state line on Hanging Women Creek located in T10S R43E section 2. Water levels in the alluvium fluctuate with meteorological changes. Water levels in the Anderson Coal have lowered by about 20ft (shown in cross section) in response to CBM production. These wells are located roughly 1 mile north of the nearest CBM field. Water levels for the cross section were taken in January 2006. Vertical exaggeration is 1.7:1.

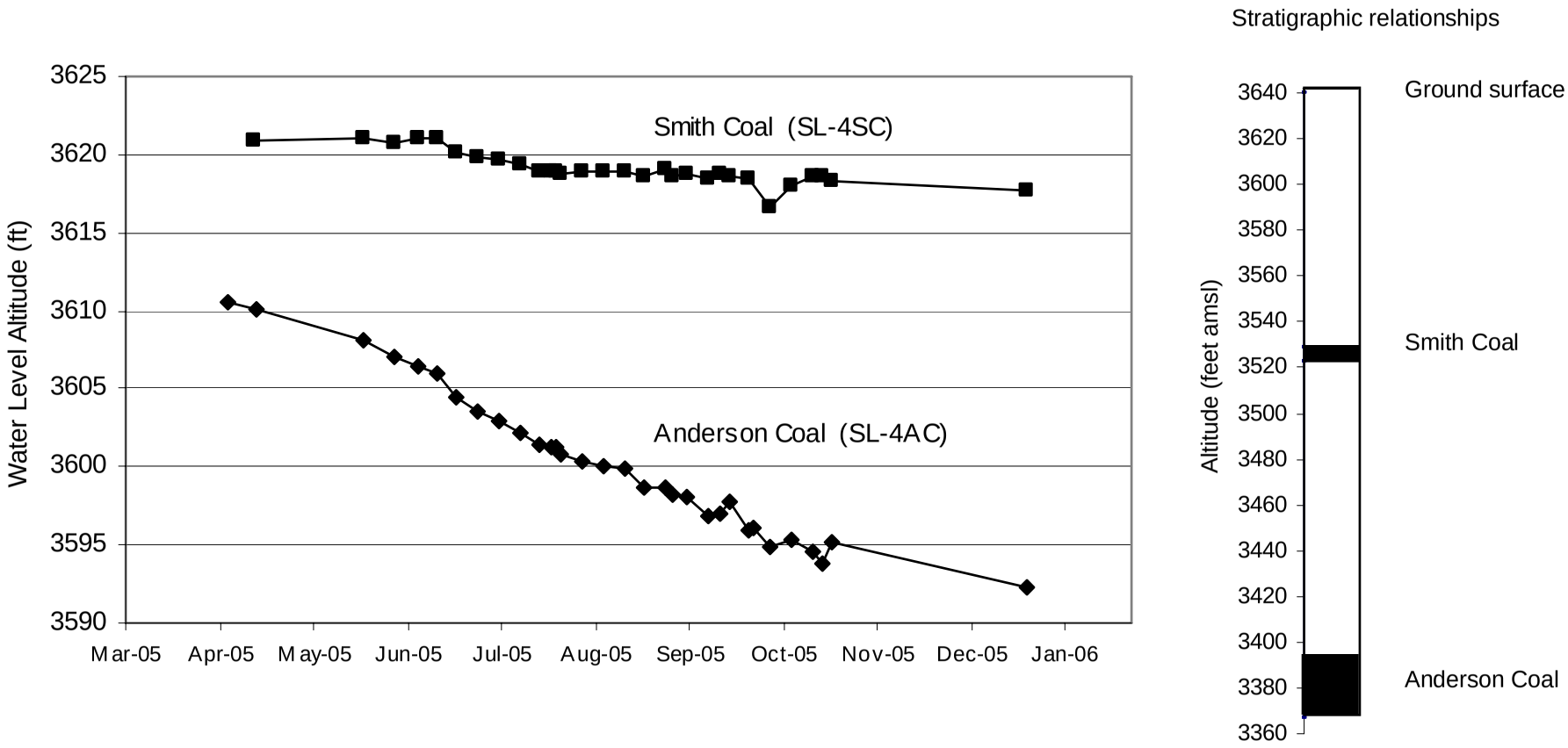

Figure 36. The SL-4 site is located about 1 mile north of the nearest CBM field. Water levels in the Anderson Coal have lowered about 20 feet since April 2005 in response to CBM development. Water levels in the Smith Coal have decreased, to a lesser degree, but a relationship to CBM has not been established. Water production from CBM wells in this field began during November, 2004.

Note the vertical scales of the stratigraphic relationship and the hydrograph are different.

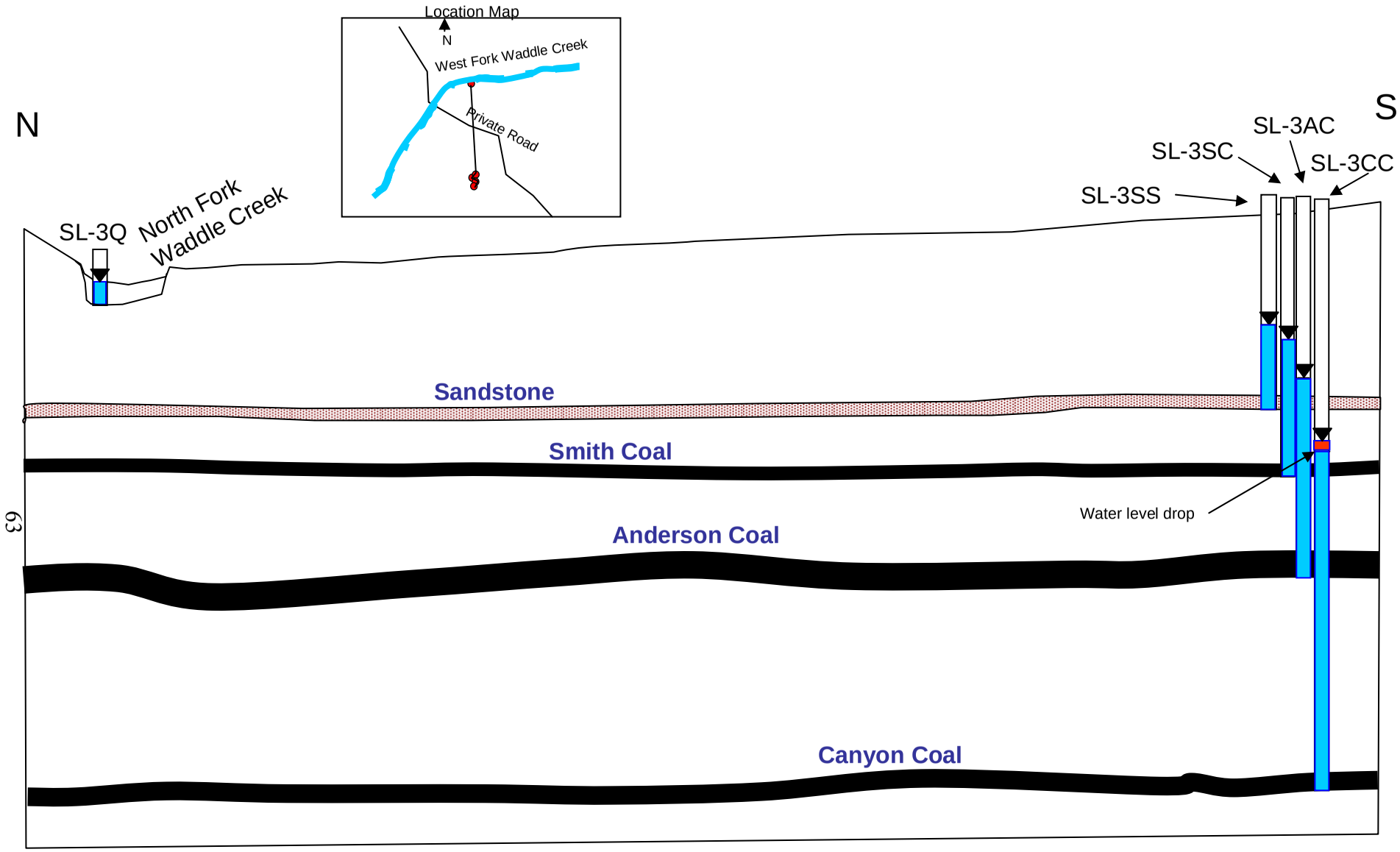

Figure 37. Geologic cross section for alluvium, an overburden sandstone, Smith, Anderson, and Canyon coal beds located at T9S R42E section 36. A downward hydraulic gradient is evident between each of the aquifer zones. The water levels for the cross section were taken in January 2006. Vertical exaggeration is 3.6:1.

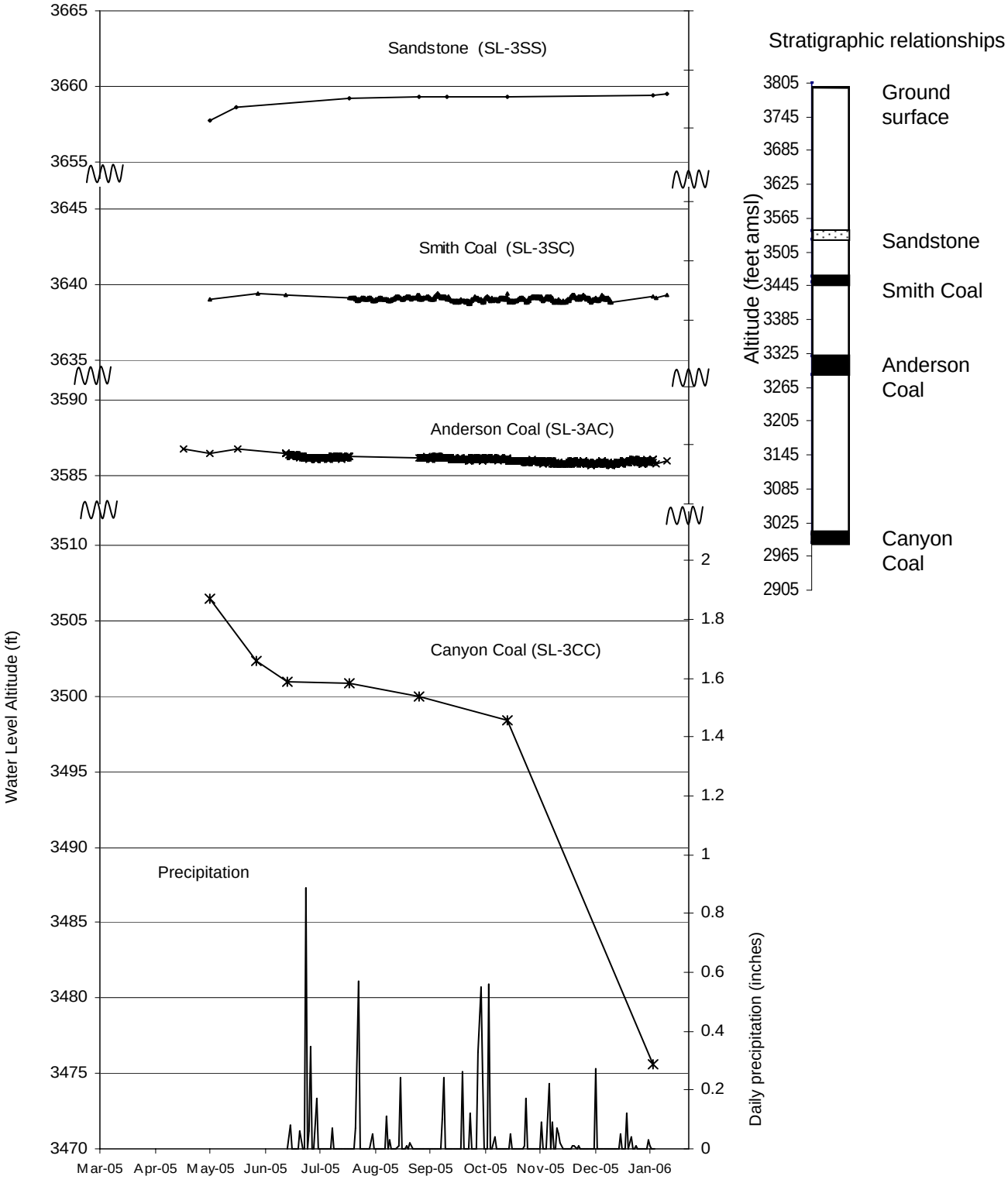

Figure 38. Water levels in the overburden sandstone, Smith, and Anderson coals are not responding to CBM development. However the water level in the Canyon Coal has dropped about 22 feet possibly in response to CBM production.

Note: The vertical scales of the stratigraphic relationship and the hydrograph are different. The Y axis scale is broken to show better hydrograph detail.

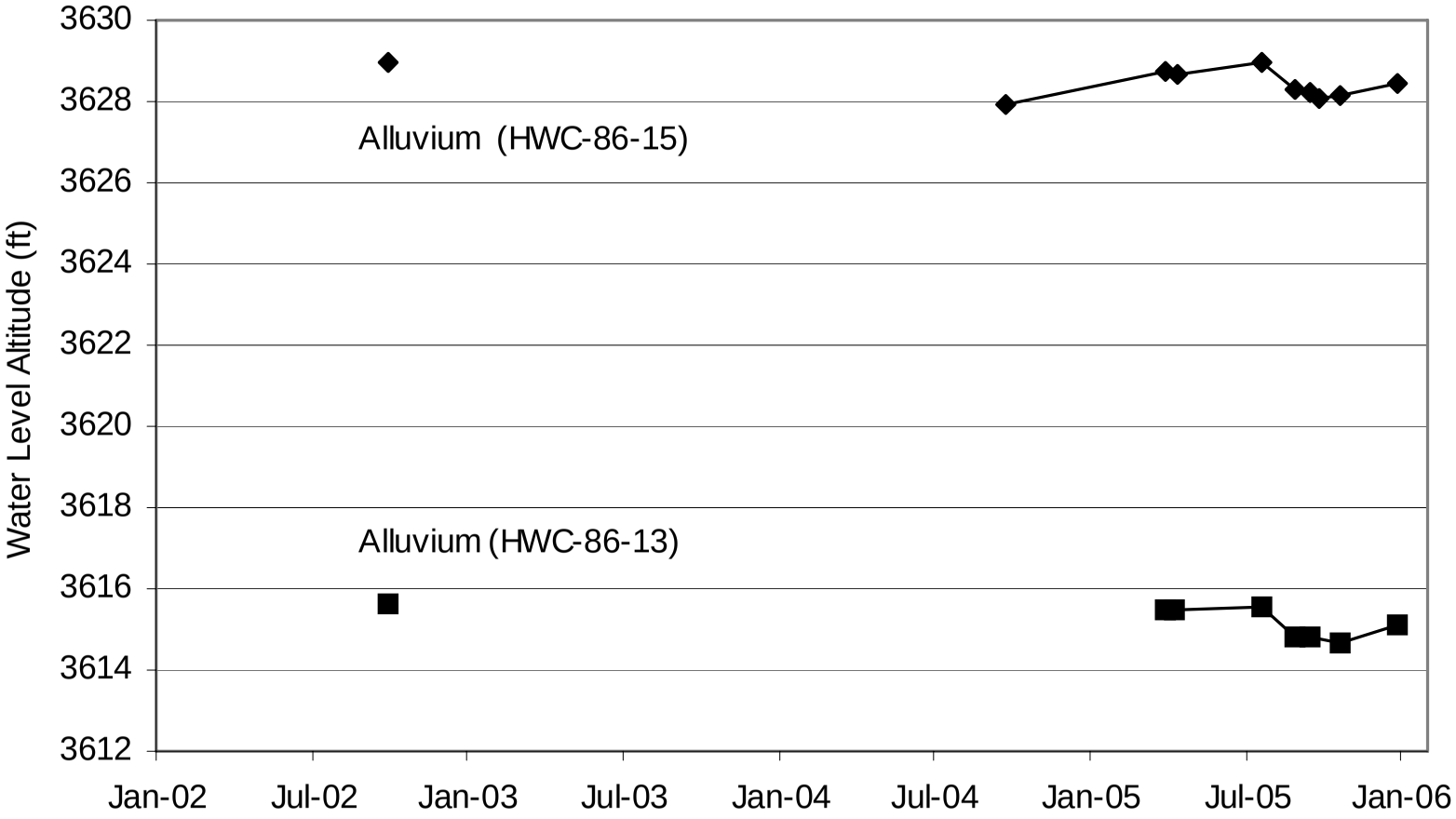

Figure 39. The water level in the alluvial aquifer reflects water table response to meteorological pattern.

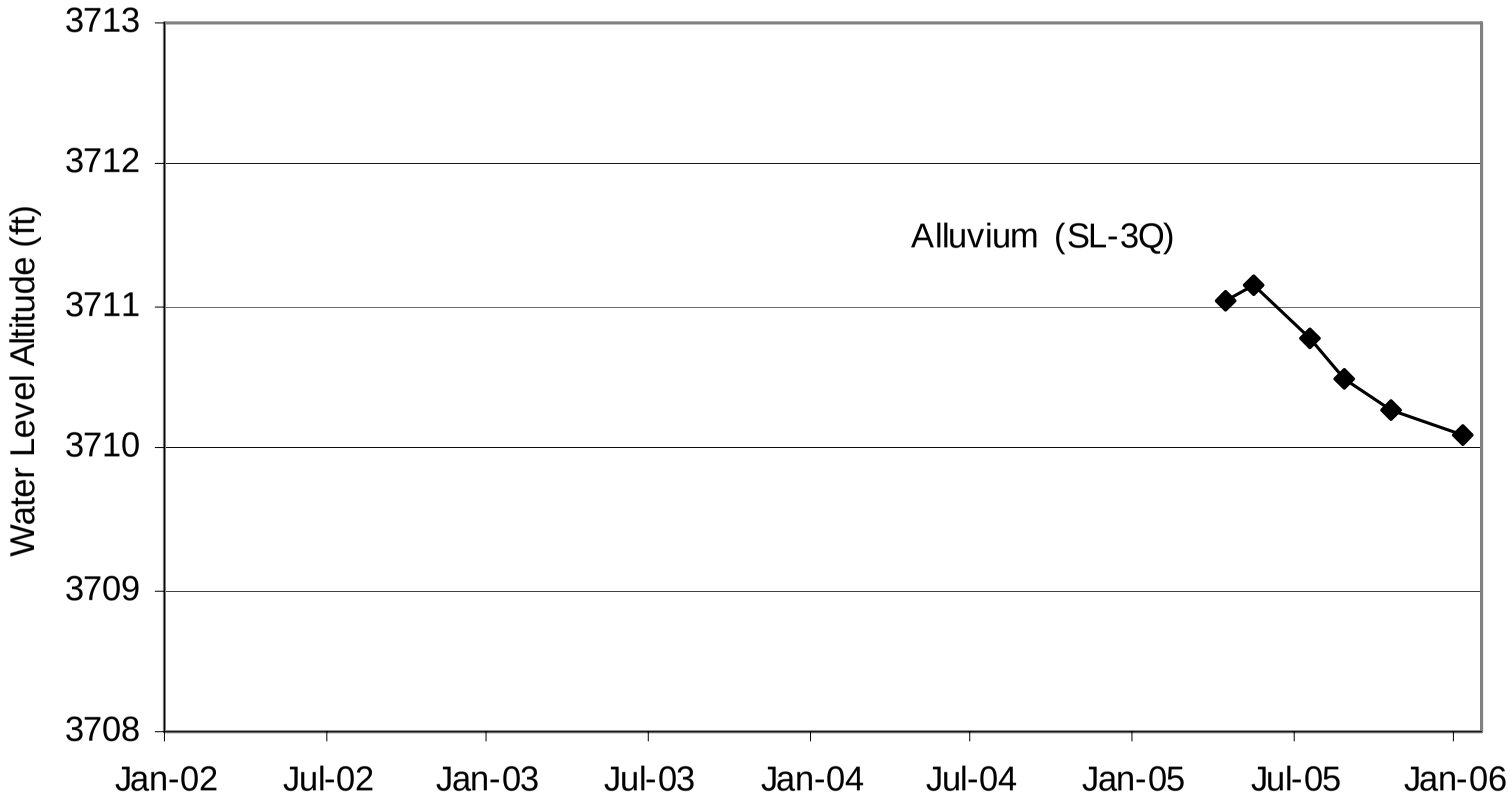

Figure 40. Water levels in the alluvium at site SL-3 appear to be in response to seasonal weather patterns and not to CBM production.

Water quality in the alluvium of North Fork Waddle Creek is similar to that found in Hanging Woman Creek, except concentrations of all constituents were less. Total dissolved solids concentration was 3,461 mg/L and the SAR value was 5.7.

Summary and 2006 monitoring plan

Coalbed methane production continues in the CX field in Montana, and in Wyoming near the state line. Water production has begun in the Coal Creek field. The regional ground-water monitoring network documents baseline conditions outside production areas, changes to the ground-water systems within the area of influence, and the aerial limits of drawdown within the monitored aquifers. Outside the area of influence of CBM production, ground-water conditions reflect normal response to precipitation and the long-term response to coal mining.

Water discharge rates from individual CBM wells in the CX field have been lower than predicted, averaging 3.1 gpm during 2005 from 516 wells. The highest water production rate, averaged over a 1-month period, was 30.1 gpm from one well, and some wells are producing methane without pumping water. Within the CX field, ground-water levels have been drawndown by over 150 feet in the producing coal beds. The actual amount of drawdown in some wells cannot be measured due to methane release from monitoring wells. After 6 years of CBM production, drawdown of up to 20 feet has been measured in the coal seams at a distance of roughly 1 mile and a maximum distance of 1.5 miles outside the production areas. These distances are similar to, but somewhat less than predicted in the Montana CBM environmental impact statement. Water levels in several wells near the Ash Creek mine have raised in response to decreased water production by the gas company in that area. At the Coal Creek field, 6-feet of drawdown during a period of 9 months has been measured at a distance of 2.5 miles from the nearest producing well.

Water from production wells is expected to have TDS concentrations generally between 875 mg/L and 1,525 mg/L. Data collected during 2005 from coal seams where SO_4 concentrations were low support those values with the lowest measured TDS being 1,075 mg/L and the highest measured TDS being 2,029 mg/L. Sodium adsorption ratios in methane bearing coal seams are high, and data collected during 2005 indicate values between 36.8 and 66.3.

Monitoring plans for 2006 are included in Appendix B. During 2006, monitoring sites outside of active production (generally north of township 8 north) will be measured semi-annually or quarterly depending on distance to production and amount of background data collected to date. Near production areas monthly water-level monitoring will continue. Data loggers or continuous recorders will be installed at the Powder River and Otter Creek alluvial sites. Meteorological stations currently deployed

at SL-3, RBC-2 and one near Poker Jim Butte will be maintained. A stream measuring station will be installed on the Ashland Ranger District. Water-quality samples will be collected semi-annually from selected alluvial sites. Monitoring priorities will be adjusted as new areas of production are proposed or developed.

Thorough assessment of hydrogeologic changes associated with CBM production, both impacts and lack of impacts, requires complete sets of CBM-water-production records including mapping-software-compatible locations. As more wells are drilled in Montana, a more efficient method of retrieving CBM data will be required. This need will continue to be addressed during future years.

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Appendix A.

Completion records for wells installed during 2005

MBMG MONITORING WELL SL-2AC

Location Information

GWIC Id:	219125	Source of Data:	REPORT
Location (TRS):	09S 42E 30 BDAC	Latitude (dd):	45.0276
County (MT):	BIG HORN	Longitude (dd):	-106.6358
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3925.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	671.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	340.17	Driller's Name:	J. WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):		Completion Date (m/d/y):	5/25/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125ANCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING

Well Notes: METHANE WAS DETECTED

Hole Diameter Information

From	To	Diameter
0.0	671.0	7.9
647.0	671.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	647.0	5.0				STEEL

Annular Seal Information

From	To	Description
0.0	657.0	CEMENT
645.0	645.0	PACKER
647.0	647.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
647.0	671.0	5.0			PVC

Lithology Information

From	To	Description
0.0	1.5	SOIL, TAN, SANDY, DAMP
1.5	12.0	CLAY, TAN, SILTY
12.0	20.0	SAND, ORANGE-TAN, FINE GRAINED, DRY, ABOUNDANT WHITE CHRISTALS
20.0	28.0	SHALE, MEDIUM GRAY, FIRM
28.0	33.0	SANDSTONE, BROWNISH-TAN, MEDIUM GRAINED, ABOUNDANT GYPSUM
33.0	35.0	SHALE, LIGHT GRAY, SOFT
35.0	39.0	SANDSTONE, LIGHT ORANGE-TAN, DRY
39.0	44.0	SHALE, LIGHT GRAY, FIRM
44.0	62.5	SANDSTONE, GRAY, FINE GRAINED, FRIABLE
62.5	64.5	SHALE, BROWNISH-GRAY, CARBONATIOUS, FIRM
64.5	114.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL SORTED, OCCATIONAL THIN GRAY SHALE STRINGER, 80 TO 90 MEDIUM GRAINED SAND
114.0	120.0	SHALE, DARK GRAY, FIRM, MINOR PYRITE-RICH ZONES
120.0	141.0	SANDSTONE, DARK GRAY, MEDIUM GRAINED, POORLY SORTED, SHALE STRINGERS
141.0	157.0	SANDSTONE, MEDIUM GRAY, VERY FINE TO FINE GRAINED FINING UPWARDS,
157.0	168.0	SHALE, DARK BROWN, FIRM
168.0	181.0	SANDSTONE, MEDIUM GRAY, WELL SORTED, FINE GRINED, SLIGHTLY DAMP, SHALE STRINGER
181.0	184.0	SHALE, GRAY, MEDIUM GRAINED, FIRM
184.0	193.0	COAL, BLACK, DULL, SOFT, (ROLLAND)
193.0	213.0	SHALE, MEDIUM GRAY, FIRM, SILTY NEAR BASE
213.0	241.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL SORTED, POSSIBLE MAKING WATER
241.0	253.0	SHALE, LIGHT GRAY, FIRM
253.0	281.0	SHALE, LIGHT GRAY, FIRM, WITH SANDSTONE STRINGERS
281.0	311.0	SHALE, INTERBEDDED WITH SILTSTONE
311.0	337.0	SILTSTONE, GRAY, SHALEY ZONES
337.0	341.0	SANDSTONE, GRAY, MEDIUM GRAINED
341.0	350.0	SILTSTONE, GRAY, SHALEY
350.0	366.0	SILTSTONE, GRAY
366.0	387.0	SILTSTONE, SHALEY
387.0	389.0	COAL, BLACK, HARD, (SMITH)
389.0	397.0	SHALE, BROWN, SOFT
397.0	423.0	SANDSTONE, GRAY, FINE AND MEDIUM GRAINED, POORLY SORTED
423.0	438.0	SILTSTONE, BROWN, CLAYEY, SOFT

438.0	441.0	SANDSTONE, GRAY, FINE AND MEDIUM GAINED
441.0	451.0	SHALE, LIGHT GRAY, SOFT, VERY SILTY
451.0	496.0	SANDSTONE, GRAY, MEDIUM GRAINED AND FINE GRAINED
496.0	499.0	SHALE, TAN, SOFT
499.0	522.0	COAL, BACK, DULL, HARD, SHALE PARTINGS AT 501.5-504, 506.5-510.5
522.0	524.5	SHALE
524.5	539.0	SANDSTONE
539.0	592.0	SHALE, LIGHT GRAY, SOFT
592.0	610.0	SANDSTONE, LIGHT GRAY, FINE GRAINED
610.0	628.0	SILTSTONE, LIGHT, GRAY
628.0	647.0	SHALE, MEDIUM GRAY, SOME PARTS SILTY
647.0	670.5	COAL, BLACK, HARD, SUBVITRIOUS, (ANDERSON)
670.5	672.0	SANDSTONE, LIGHT GRAY, FINE GRAINED

MBMG MONITORING WELL SL-2CC

Location Information

GWIC Id:	220385	Source of Data:	
Location (TRS):	09S 42E 30 BCBC	Latitude (dd):	45.0273
County (MT):	BIG HORN	Longitude (dd):	-106.6360
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD83
Block:		Altitude (feet):	3920.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	1301.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	441.87	Driller's Name:	PENNACO ENERGY
Pumping Water Level (ft):		Driller License:	
Yield (gpm):		Completion Date (m/d/y):	8/22/1999
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125TGRV 125FRUN 125CNCB
Recovery Time (hrs):		Well/Water Use:	MONITORING

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	950.0	9.9
950.0	971.0	10.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	951.0	7.0				STEEL

Annular Seal Information

From	To	Description
0.0	951.0	CEMENT

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
951.0	971.0	10.5			OPEN HOLE

Lithology Information

From	To	Description
0.0	1.5	SOIL, TAN, SANDY, DAMP
1.5	12.0	CLAY, TAN, SILTY
12.0	20.0	SAND, ORANGE-TAN, FINE GRAINED, DRY, ABOUNDANT WHITE CHRISTALS
20.0	28.0	SHALE, MEDIUM GRAY, FIRM
28.0	33.0	SANDSTONE, BROWNISH-TAN, MEDIUM GRAINED, ABOUNDANT GYPSUM
33.0	35.0	SHALE, LIGHT GRAY, SOFT
35.0	39.0	SANDSTONE, LIGHT ORANGE-TAN, DRY
39.0	44.0	SHALE, LIGHT GRAY, FIRM
44.0	62.5	SANDSTONE, GRAY, FINE GRAINED, FRIABLE
62.5	64.5	SHALE, BROWNISH-GRAY, CARBONATIOUS, FIRM
64.5	114.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL SORTED, OCCATIONAL THIN GRAY SHALE STRINGER, 80 TO 90 MEDIUM GRAINED SAND
114.0	120.0	SHALE, DARK GRAY, FIRM, MINOR PYRITE-RICH ZONES
120.0	141.0	SANDSTONE, DARK GRAY, MEDIUM GRAINED, POORLY SORTED, SHALE STRINGERS
141.0	157.0	SANDSTONE, MEDIUM GRAY, VERY FINE TO FINE GRAINED FINING UPWARDS,
157.0	168.0	SHALE, DARK BROWN, FIRM
168.0	181.0	SANDSTONE, MEDIUM GRAY, WELL SORTED, FINE GRINED, SLIGHTLY DAMP, SHALE STRINGER
181.0	184.0	SHALE, GRAY, MEDIUM GRAINED, FIRM
184.0	193.0	COAL, BLACK, DULL, SOFT, (ROLLAND)
193.0	213.0	SHALE, MEDIUM GRAY, FIRM, SILTY NEAR BASE
213.0	241.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL SORTED, POSSIBLE MAKING WATER
241.0	253.0	SHALE, LIGHT GRAY, FIRM
253.0	281.0	SHALE, LIGHT GRAY, FIRM, WITH SANDSTONE STRINGERS
281.0	311.0	SHALE, INTERBEDDED WITH SILTSTONE
311.0	337.0	SILTSTONE, GRAY, SHALEY ZONES
337.0	341.0	SANDSTONE, GRAY, MEDIUM GRAINED
341.0	350.0	SILTSTONE, GRAY, SHALEY
350.0	366.0	SILTSTONE, GRAY
366.0	387.0	SILTSTONE, SHALEY
387.0	389.0	COAL, BLACK, HARD, (SMITH
389.0	397.0	SHALE, BROWN, SOFT
397.0	423.0	SANDSTONE, GRAY, FINE AND MEDIUM GRAINED, POORLY SORTED
423.0	438.0	SILTSTONE, BROWN, CLAYEY, SOFT

438.0	441.0	SANDSTONE, GRAY, FINE AND MEDIUM GAINED
441.0	451.0	SHALE, LIGHT GRAY, SOFT, VERY SILTY
451.0	496.0	SANDSTONE, GRAY, MEDIUM GRAINED AND FINE GRAINED
496.0	522.0	COAL, BACK, DULL, HARD, SHALE PARTINGS AT 501.5-504, 506.5-510.5
522.0	524.5	SHALE
524.5	539.0	SANDSTONE
539.0	592.0	SHALE, LIGHT GRAY, SOFT
592.0	610.0	SANDSTONE, LIGHT GRAY, FINE GRAINED
610.0	628.0	SILTSTONE, LIGHT, GRAY
628.0	647.0	SHALE, MEDIUM GRAY, SOME PARTS SILTY
647.0	670.5	COAL, BLACK, HARD, SUBVITRIOUS, (ANDERSON)
668.0	780.0	(LOG BELOW 668 FROM PENNACO) CLAY, BLUE GRAY TO GRAY, SOFT TO FIRM
670.5	672.0	SANDSTONE, LIGHT GRAY, FINE GRAINED
780.0	784.0	COAL, BLACK , SOFT TO FIRM, BULKY
784.0	838.0	CLAY, TAN TO LIGHT GRAY, SOFT
838.0	848.0	COAL, SAMPLES 95% + CLAY, TAN TO GRAY, SOFT, GUMMY, SHELLY (DIETZ)
848.0	948.0	CLAY, TAN TO GRAY, SOFT
948.0	974.0	COAL, BLACK, FIRM TO HARD, BULKY (CANYON)
974.0	1046.0	CLAY, GRAY, SOFT,
1048.0	1056.0	COAL (COOK/CARNEY)
1056.0	1246.0	CLAY, LIGHT TO LIGHT GRAY, SOFT TO FIRM,
1246.0	1256.0	EARTHY, VERY COAL, 40% BLACK, SOFT TO FIRM, BRITTLE, ABUNDANT CLAY, GRAY SOFT, (WALL)
1256.0	1301.0	CLAY, GRAY TO TAN, SOFT,

MBMG MONITORING WELL SL-3Q

Location Information

GWIC Id:	219136	Source of Data:	REPORT
Location (TRS):	09S 42E 36 BBAD	Latitude (dd):	45.0161
County (MT):	BIG HORN	Longitude (dd):	-106.5386
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3725.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	40.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	13.96	Driller's Name:	J. WHEATON
Pumping Water Level (ft):	38.00	Driller License:	046
Yield (gpm):	2.00	Completion Date (m/d/y):	4/7/2005
Test Type:	AIR LIFT	Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	110ALVM
Recovery Time (hrs):		Well/Water Use:	MONITORING

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	40.0	7.9

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.9	40.0	4.5				PVC-SCHED 40

Annular Seal Information

From	To	Description
0.0	28.0	BENTONITE CHIPS
28.0	40.0	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
30.0	40.0	4.5			SCREEN-CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	8.0	SOIL, BROWN, SANDY LOAM, DAY
8.0	12.0	GRAVEL, CLINKER, SAND, COAL, DAMP
12.0	18.0	CLAY, TAN-BROWN, SOFT, DAMP
18.0	23.0	GRAVEL, CLINKER, MEDIUM TO COARSE SAND, DAMP
23.0	30.5	CLAY, TAN, SOFT, DAMP
30.5	40.0	GRAVEL, CLINKER AND SAND, TAN UNCONSOLIDATED AND UNSTABLE FIRST WATER SHALE STRINGER 34-35.5
40.0	41.5	CLAY, GREY, SOFT, (BED ROCK)
41.5	45.0	SANDSTONE, GREY MEDIUM TO COURSE GRAINED, CLAY LENSES

MBMG MONITORING WELL SL-3SS

Location Information

GWIC Id:	219617	Source of Data:	REPORT
Location (TRS):	09S 42E 36 DBCB	Latitude (dd):	45.0079
County (MT):	BIG HORN	Longitude (dd):	-106.5313
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3805.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	278.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	145.80	Driller's Name:	J. WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	5.00	Completion Date (m/d/y):	4/26/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125TGRV 125FRUN 125SMOB
Recovery Time (hrs):		Well/Water Use:	MONITORING

Well Notes:

Hole Diameter Information

From	To	Diameter
0.0	278.0	7.9

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	278.0	4.5				PVC

Annular Seal Information

From	To	Description
0.0	260.0	BENTONITE CHIPS
262.0	278.0	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
262.0	278.0	4.5			SCREEN-CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	4.0	SOIL, TAN, SANDY LOAM, DAMP
4.0	10.0	SAND, TAN, FINE LOOSE, DAMP
10.0	16.0	SAND, TAN, VERY FINE LOOSE, MINOR CLAY
16.0	19.0	SAND, TAN, FINE LOOSE, DAMP
19.0	21.5	CLAY, BROWNISH-GRAY, FIRM
21.5	28.0	SHALE, MEDIUM GRAY, FIRM
28.0	36.0	SILTSTONE, LIGHT GRAY, VERY HARD
36.0	40.0	SHALE, MEDIUM GRAY, FIRM
40.0	47.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, SLIGHTLY DAMP
47.0	51.0	SHALE, BROWNISH-GRAY, FIRM
51.0	59.5	COAL, BROWN, SOFT DULL (ROLLAND)
59.5	62.0	SHALE
62.0	68.0	SILTSTONE, GRAY
68.0	78.0	CLAY, GRAY, FIRM
78.0	87.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, DAMP, FRIABLE
87.0	98.0	SHALE, DARK-BROWN, BRITTLE, CARBONATIONS
98.0	106.0	SILTSTONE, MEDIUM GRAY, FRIABLE
106.0	119.0	SHALE, DARK GRAY
119.0	120.5	COAL, BROWN, SOFT
120.5	127.0	SILTSTONE, LIGHT GRAY, SHALEY
127.0	136.0	SANDSTONE, BROWN, VERY FINE GRAINED
136.0	142.0	SHALE, DARK GRAY, FIRM
142.0	159.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
159.0	162.0	SHALE, DARK BROWN, FIRM, CARBONATIONS
162.0	176.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
173.0	176.0	SHALE, INTER-BEDDED WITH COAL
176.0	173.0	SHALE, MEDIUM GRAY, FIRM
176.0	186.0	SILTSTONE, INTER-BEDDED WITH SANDSTONE, GRAY
186.0	197.0	SHALE, MEDIUM GRAY
197.0	206.0	SHALE, INTER-BEDDED WITH SILTSTONE (AT 200 HOLE IS MAKING 1/4 GPM)
206.0	240.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, FRIABLE, INTER-BEDDED WITH GRAY SHALE AT 280 MAKING 7.5 GPM AFTER 30MIN AIR LIFT
240.0	257.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE
257.0	262.0	SILTSTONE
262.0	278.0	SANDSTONE, LIGHT GRAY, FINE GRAINED, WELL SORTED, FRIABLE

MBMG MONITORING WELL SL-3SC

Location Information

GWIC Id:	219138	Source of Data:	REPORT
Location (TRS):	09S 42E 36 DBCB	Latitude (dd):	45.0080
County (MT):	BIG HORN	Longitude (dd):	-106.5313
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3805.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	358.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	165.65	Driller's Name:	J. WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	2.00	Completion Date (m/d/y):	4/29/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125SMCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	METHANE WAS DETECTED.		

Hole Diameter Information

From	To	Diameter
0.0	347.0	7.9
347.0	358.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	347.0	5.0				STEEL

Annular Seal Information

From	To	Description
0.0	347.0	CEMENT
345.0	345.0	PACKER
348.0	348.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
348.0	358.0	2.0			PVC

Lithology Information

From	To	Description
0.0	4.0	SOIL, TAN, SANDY LOAM, DAMP
4.0	10.0	SAND, TAN, FINE LOOSE, DAMP
10.0	16.0	SAND, TAN, VERY FINE LOOSE, MINOR CLAY
16.0	19.0	SAND, TAN, FINE LOOSE, DAMP
19.0	21.5	CLAY, BROWNISH-GRAY, FIRM
21.5	28.0	SHALE, MEDIUM GRAY, FIRM
28.0	36.0	SILTSTONE, LIGHT GRAY, VERY HARD
36.0	40.0	SHALE, MEDIUM GRAY, FIRM
40.0	47.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, SLIGHTLY DAMP
47.0	51.0	SHALE, BROWNISH-GRAY, FIRM
51.0	59.5	COAL, BROWN, SOFT DULL (ROLLAND)
59.5	62.0	SHALE
62.0	68.0	SILTSTONE, GRAY
68.0	78.0	CLAY, GRAY, FIRM
78.0	87.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, DAMP, FRIABLE
87.0	98.0	SHALE, DARK-BROWN, BRITTLE, CARBONATIONS
98.0	106.0	SILTSTONE, MEDIUM GRAY, FRIABLE
106.0	119.0	SHALE, DARK GRAY
119.0	120.5	COAL, BROWN, SOFT
120.5	127.0	SILTSTONE, LIGHT GRAY, SHALEY
127.0	136.0	SANDSTONE, BROWN, VERY FINE GRAINED
136.0	142.0	SHALE, DARK GRAY, FIRM
142.0	159.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
159.0	162.0	SHALE, DARK BROWN, FIRM, CARBONATIONS
162.0	176.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
173.0	176.0	SHALE, INTER-BEDDED WITH COAL
176.0	173.0	SHALE, MEDIUM GRAY, FIRM
176.0	186.0	SILTSTONE, INTER-BEDDED WITH SANDSTONE, GRAY
186.0	197.0	SHALE, MEDIUM GRAY
197.0	206.0	SHALE, INTER-BEDDED WITH SILTSTONE (AT 200 HOLE IS MAKING 1/4 GPM)
206.0	240.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, FRIABLE, INTER-BEDDED WITH GRAY SHALE AT 280 MAKING 7.5 GPM AFTER 30MIN AIR LIFT
240.0	257.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE
257.0	262.0	SILTSTONE
262.0	278.0	SANDSTONE, LIGHT GRAY, FINE GRAINED, WELL SORTED, FRIABLE
278.0	290.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE

290.0	303.0	SHALE, WITH THIN COAL STRINGERS
303.0	310.0	COAL
310.0	318.0	SHALE, BROWN FIRM
318.0	319.0	COAL
319.0	344.5	SHALE, BROWN GRAY, INTER-BEDDED (AT 320 10.9GPM)
344.5	355.0	COAL, BLACK, HARD, SUB-VITREOUS (SMITH)
355.0	358.0	SHALE, LIGHT GRAY TO TANISH GRAY, (AT 360 15GPM)

MBMG MONITORING WELL SL-3AC

Location Information

GWIC Id:	219139	Source of Data:	REPORT
Location (TRS):	09S 42E 36 DBCB	Latitude (dd):	45.0079
County (MT):	BIG HORN	Longitude (dd):	-106.5313
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3805.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	523.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	218.32	Driller's Name:	J. WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	2.00	Completion Date (m/d/y):	4/12/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125ANCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	NO METHANE DETECTED.		

Hole Diameter Information

From	To	Diameter
0.0	490.0	7.9
490.0	517.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	490.0	5.0				STEEL

Annular Seal Information

From	To	Description
0.0	490.0	CEMENT
485.0	485.0	PACKER
490.0	490.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
490.0	517.0	2.0			PVC

Lithology Information

From	To	Description
0.0	4.0	SOIL, TAN, SANDY LOAM, DAMP
4.0	10.0	SAND, TAN, FINE LOOSE, DAMP
10.0	16.0	SAND, TAN, VERY FINE LOOSE, MINOR CLAY
16.0	19.0	SAND, TAN, FINE LOOSE, DAMP
19.0	21.5	CLAY, BROWNISH-GRAY, FIRM
21.5	28.0	SHALE, MEDIUM GRAY, FIRM
28.0	36.0	SILTSTONE, LIGHT GRAY, VERY HARD
36.0	40.0	SHALE, MEDIUM GRAY, FIRM
40.0	47.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, SLIGHTLY DAMP
47.0	51.0	SHALE, BROWNISH-GRAY, FIRM
51.0	59.5	COAL, BROWN, SOFT DULL (ROLLAND)
59.5	62.0	SHALE
62.0	68.0	SILTSTONE, GRAY
68.0	78.0	CLAY, GRAY, FIRM
78.0	87.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, DAMP, FRIABLE
87.0	98.0	SHALE, DARK-BROWN, BRITTLE, CARBONATIONS
98.0	106.0	SILTSTONE, MEDIUM GRAY, FRIABLE
106.0	119.0	SHALE, DARK GRAY
119.0	120.5	COAL, BROWN, SOFT
120.5	127.0	SILTSTONE, LIGHT GRAY, SHALEY
127.0	136.0	SANDSTONE, BROWN, VERY FINE GRAINED
136.0	142.0	SHALE, DARK GRAY, FIRM
142.0	159.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
159.0	162.0	SHALE, DARK BROWN, FIRM, CARBONATIONS
162.0	176.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
173.0	176.0	SHALE, INTER-BEDDED WITH COAL
176.0	173.0	SHALE, MEDIUM GRAY, FIRM
176.0	186.0	SILTSTONE, INTER-BEDDED WITH SANDSTONE, GRAY
186.0	197.0	SHALE, MEDIUM GRAY
197.0	206.0	SHALE, INTER-BEDDED WITH SILTSTONE (AT 200 HOLE IS MAKING 1/4 GPM)
206.0	240.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, FRIABLE, INTER-BEDDED WITH GRAY SHALE AT 280 MAKING 7.5 GPM AFTER 30MIN AIR LIFT
240.0	257.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE
257.0	262.0	SILTSTONE
262.0	278.0	SANDSTONE, LIGHT GRAY, FINE GRAINED, WELL SORTED, FRIABLE
278.0	290.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE

290.0	303.0	SHALE, WITH THIN COAL STRINGERS
303.0	310.0	COAL
310.0	318.0	SHALE, BROWN FIRM
318.0	319.0	COAL
319.0	344.5	SHALE, BROWN GRAY, INTER-BEDDED (AT 320 10.9GPM)
344.5	355.0	COAL, BLACK, HARD, SUB-VITREOUS (SMITH)
355.0	379.0	SHALE, LIGHT GRAY TO TANISH GRAY, (AT 360 15GPM)
379.0	409.0	SILTSTONE, MEDIUM GRAY, VERY SHALEY
409.0	416.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED
416.0	475.0	SHALE, MEDIUM GRAY, VERY FINE INTER-BEDDED SANDSTONE, MEDIUM GRAY
475.0	486.5	SHALE, BROWNISH-GRAY, SOFT
486.5	517.0	COAL, BLACK, HARD VITREOUS, SHALE PARTING AT 506-508 (ANDERSON) (AT 492 OPEN BORE HOLE MAKING 12GPM)
517.0	523.0	SHALE

MBMG MONITORING WELL SL-3CC

Location Information

GWIC Id:	219140	Source of Data:	REPORT
Location (TRS):	09S 42E 36 DBCB	Latitude (dd):	45.0082
County (MT):	BIG HORN	Longitude (dd):	-106.5313
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3805.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	817.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	304.04	Driller's Name:	JOHN WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	0.10	Completion Date (m/d/y):	4/18/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125CNCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	METHANE WAS DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	802.0	7.9
802.0	817.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	802.0	5.0				STEEL

Annular Seal Information

From	To	Description
0.0	802.0	CEMENT
800.0	800.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
802.0	817.0	2.0			PVC

Lithology Information

From	To	Description

0.0	4.0	SOIL, TAN, SANDY LOAM, DAMP
4.0	10.0	SAND, TAN, FINE LOOSE, DAMP
10.0	16.0	SAND, TAN, VERY FINE LOOSE, MINOR CLAY
16.0	19.0	SAND, TAN, FINE LOOSE, DAMP
19.0	21.5	CLAY, BROWNISH-GRAY, FIRM
21.5	28.0	SHALE, MEDIUM GRAY, FIRM
28.0	36.0	SILTSTONE, LIGHT GRAY, VERY HARD
36.0	40.0	SHALE, MEDIUM GRAY, FIRM
40.0	47.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, SLIGHTLY DAMP
47.0	51.0	SHALE, BROWNISH-GRAY, FIRM
51.0	59.5	COAL, BROWN, SOFT DULL (ROLLAND)
59.5	62.0	SHALE
62.0	68.0	SILTSTONE, GRAY
68.0	78.0	CLAY, GRAY, FIRM
78.0	87.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, DAMP, FRIABLE
87.0	98.0	SHALE, DARK-BROWN, BRITTLE, CARBONATIONS
98.0	106.0	SILTSTONE, MEDIUM GRAY, FRIABLE
106.0	119.0	SHALE, DARK GRAY
119.0	120.5	COAL, BROWN, SOFT
120.5	127.0	SILTSTONE, LIGHT GRAY, SHALEY
127.0	136.0	SANDSTONE, BROWN, VERY FINE GRAINED
136.0	142.0	SHALE, DARK GRAY, FIRM
142.0	159.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
159.0	162.0	SHALE, DARK BROWN, FIRM, CARBONATIONS
162.0	176.0	SANDSTONE, GRAY, FINE GRAINED, FRIABLE, DAMP
173.0	176.0	SHALE, INTER-BEDDED WITH COAL
176.0	173.0	SHALE, MEDIUM GRAY, FIRM
176.0	186.0	SILTSTONE, INTER-BEDDED WITH SANDSTONE, GRAY
186.0	197.0	SHALE, MEDIUM GRAY
197.0	206.0	SHALE, INTER-BEDDED WITH SILTSTONE (AT 200 HOLE IS MAKING 1/4 GPM)
206.0	240.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, FRIABLE, INTER-BEDDED WITH GRAY SHALE AT 280 MAKING 7.5 GPM AFTER 30MIN AIR LIFT
240.0	257.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE
257.0	262.0	SILTSTONE
262.0	278.0	SANDSTONE, LIGHT GRAY, FINE GRAINED, WELL SORTED, FRIABLE
278.0	290.0	SANDSTONE, GRAY, TO SHALE, GRAY, SILTY, FINING UPWARD SEQUENCE
290.0	303.0	SHALE, WITH THIN COAL STRINGERS
303.0	310.0	COAL

310.0	318.0	SHALE, BROWN FIRM
318.0	319.0	COAL
319.0	344.5	SHALE, BROWN GRAY, INTER-BEDDED (AT 320 10.9GPM)
344.5	355.0	COAL, BLACK, HARD, SUB-VITREOUS (SMITH)
355.0	379.0	SHALE, LIGHT GRAY TO TANISH GRAY, (AT 360 15GPM)
379.0	409.0	SILTSTONE, MEDIUM GRAY, VERY SHALEY
409.0	416.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED
416.0	475.0	SHALE, MEDIUM GRAY, VERY FINE INTER-BEDDED SANDSTONE, MEDIUM GRAY
475.0	486.5	SHALE, BROWNISH-GRAY, SOFT
486.5	517.0	COAL, BLACK, HARD VITREOUS, SHALE PARTING AT 506-508 (ANDERSON) (AT 492 OPEN BORE HOLE MAKING 12GPM)
517.0	523.0	SHALE
523.0	541.0	SANDSTONE, INTER-BEDDED SHALE
541.0	544.0	SHALE, GRAY, FIRM
544.0	560.0	SANDSTONE, FINING UPWARD
560.0	568.0	SHALE, MEDIUM GRAY
568.0	575.0	SILT
575.0	592.0	SHALE
592.0	595.0	COAL
595.0	623.0	SANDSTONE, GRAY, FINE GRAINED
623.0	629.0	SHALE
629.0	633.0	COAL
633.0	662.0	SHALE, MEDIUM GRAY, WITH SANDSTONE STRINGERS GRAY, FINE GRAINED
662.0	669.0	SHALE, MEDIUM GRAY
669.0	674.0	SANDSTONE, GRAY, MEDIUM GRAINED
674.0	691.0	SANDSTONE, SHALE, UPWARD FINING
691.0	696.0	SANDSTONE, GRAY, MEDIUM GRAINED
696.0	708.0	SHALE, MEDIUM GRAY, SOFT
708.0	728.0	SILTSTONE, SHALE, GRAY
728.0	734.0	COAL, BLACK, BRITTLE
734.0	740.0	SHALE, GRAY, MEDIUM FIRM
740.0	743.0	SANDSTONE, MEDIUM GRAY 30GPM
743.0	750.0	SILTSTONE
750.0	754.0	SHALE, GRAY
754.0	768.0	SANDSTONE, GRAY, VERY FINE, SHALEY
768.0	795.0	SANDSTONE, GRAY, MEDIUM GRAINED, WELL ROUNDED, LOOSE
795.0	802.0	SHALE, FIRM
802.0	817.0	COAL, BLACK, HARD, VITREOUS, (CANYON)
817.0	817.6	SHALE

MBMG MONITORING WELL SL-4SC

Location Information

GWIC Id:	219141	Source of Data:	REPORT
Location (TRS):	10S 43E 02 ABAA	Latitude (dd):	45.0031
County (MT):	BIG HORN	Longitude (dd):	-106.4243
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3640.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	120.40	How Drilled:	AIR ROTARY
Static Water Level (ft):	19.17	Driller's Name:	JOHN WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	2.00	Completion Date (m/d/y):	4/7/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125SMCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	NO METHANE DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	120.4	7.9

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	120.4	4.5				PVC

Annular Seal Information

From	To	Description
0.0	107.0	BENTONITE
107.0	120.4	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
110.5	116.5	4.5			SCREEN-CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	1.5	SOIL, TAN, SANDY LOAM
1.5	15.0	SOIL, BROWN CLAY
15.0	59.0	SAND, BROWN, LOOSE WITH CLAY AND GRAVEL ZONES
59.0	63.0	CLAY
63.0	67.0	COAL (WADDLE)
67.0	78.0	SHALE, DARK, GRAYISH-BROWN, SOFT
78.0	85.5	SHALE, LIGHT GREENISH-GRAY, SOFT (AT 80FT 6GPM, QAL IS SEALED OUT BY SURFACE CASING MOST WATER IS FROM COAL AT 65FT)
85.5	105.0	SHALE, MEDIUM GRAY, SILT, STRINGERS
105.0	111.0	SHALE BROWN SOFT
111.0	117.0	COAL (SMITH)
117.0	120.4	SHALE, MEDIUM GRAY, FIRM, (AT 120 MAKING 12 GPM SC 4790 TEMP 9.9)

MBMG MONITORING WELL SL-4AC

Location Information

GWIC Id:	219169	Source of Data:	REPORT
Location (TRS):	10S 43E 02 ABAA	Latitude (dd):	45.0031
County (MT):	BIG HORN	Longitude (dd):	-106.4244
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3640.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	279.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	30.48	Driller's Name:	JOHN WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	2.00	Completion Date (m/d/y):	4/1/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125ANCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	NO METHANE DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	249.0	7.9
249.0	279.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.0	249.0	5.0				STEEL
249.0	279.0	2.0				PVC

Annular Seal Information

From	To	Description
0.0	249.0	CEMENT
249.0	249.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
249.0	279.0	2.0			PVC

Lithology Information

From	To	Description
0.0	1.5	SOIL, TAN, SANDY LOAM
1.5	15.0	SOIL, BROWN CLAY
15.0	59.0	SAND, BROWN, LOOSE WITH CLAY AND GRAVEL ZONES
59.0	63.0	CLAY
63.0	67.0	COAL (WADDLE)
67.0	78.0	SHALE, DARK, GRAYISH-BROWN, SOFT
78.0	85.5	SHALE, LIGHT GREENISH-GRAY, SOFT (AT 80FT 6GPM, QAL IS SEALED OUT BY SURFACE CASING MOST WATER IS FROM COAL AT 65FT)
85.5	105.0	SHALE, MEDIUM GRAY, SILT, STRINGERS
105.0	111.0	SHALE BROWN SOFT
111.0	117.0	COAL (SMITH)
117.0	128.0	SHALE, MEDIUM GRAY, FIRM, (AT 120 MAKING 12 GPM SC 4790 TEMP 9.9)
128.0	158.0	SHALE, GRAY, MINOR SILTSTONE
158.0	172.0	SANDSTONE, LIGHT GRAY, VERY FINE, TIGHT
172.0	175.0	SHALE, GRAY
175.0	197.0	SILTSTONE, "AT 180 OPEN HOLE 15GPM SC 3915 TEMP 10.3"
197.0	200.0	SANDSTONE, GRAY, VERY FINE GRAINED
200.0	219.0	SILTSTONE
219.0	242.0	SHALE, MEDIUM BROWN, FIRM
242.0	247.0	SILTSTONE
247.0	249.0	SHALE, GRAY
249.0	273.0	COAL (ANDERSON) MAKING 2GPM
273.0	279.0	SHALE, LIGHT GRAY

MBMG MONITORING WELL SL-5AC

Location Information

GWIC Id:	219927	Source of Data:	REPORT
Location (TRS):	09S 44E 36 ABBD	Latitude (dd):	45.0119
County (MT):	BIG HORN	Longitude (dd):	-106.2714
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3810.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	223.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	131.24	Driller's Name:	J WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	1.00	Completion Date (m/d/y):	6/6/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125ANCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	METHANE WAS DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	223.0	7.9

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	198.0	4.5				PVC-SCHED 40

Annular Seal Information

From	To	Description
0.0	196.0	BENTONITE
196.0	223.0	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
198.0	223.0	4.5			SCREEN-

					CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	7.0	SOIL, TAN, CLAY LOAM, DAMP
7.0	16.0	CLAY AND VERY FINE GRAINED SAND, TAN DRY
16.0	19.0	CLAY, GRAY, SOFT
19.0	24.0	SAND, TAN, VERY FINE GRAINED, LOOSE, AND GRAY SOFT CLAY, DRY
24.0	29.0	SAND, ORANGE-TAN, FINE GRAINED, DAMP
29.0	48.0	SAND, LIGHT TAN-GRAY, MEDIUM GRAINED, DAMP
48.0	49.5	COAL, DARK BROWN, SOFT
49.5	62.0	SHALE, MEDIUM GRAY, SOFT, PLATEY
62.0	74.0	SANDSTONE, LIGHT GRAY, VERY FINE GRAINED, DRY
74.0	111.0	SHALE, MEDIUM GRAY, FIRM
111.0	124.0	SILTSTONE, LIGHT GRAY, DAMP
124.0	127.0	SHALE, MEDIUM GRAY, FIRM
127.0	143.0	SILTSTONE AND VERY FINE SANDSTONE, GRAY, LOOSE
143.0	146.0	SHALE, GRAY, FIRM
146.0	159.0	SANDSTONE, GRAY, VERY FINE GRAINED, MAKING SOME WATER
159.0	164.0	SILTSTONE, GRAY, SHALEY
164.0	174.0	SANDSTONE, GRAY, VERY FINE GRAINED, MAKING SOME WATER
174.0	198.0	SHALE, MEDIUM BROWN, FIRM
198.0	223.0	COAL, BLACK, HARD, DULL, MAKING ABOUT 1 GPM (ANDERSON)

MBMG MONITORING WELL SL-5DC

Location Information

GWIC Id:	219929	Source of Data:	REPORT
Location (TRS):	09S 44E 36 ABBD	Latitude (dd):	45.0119
County (MT):	BIG HORN	Longitude (dd):	-106.2714
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3810.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	322.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	168.23	Driller's Name:	J WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	0.70	Completion Date (m/d/y):	6/3/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125DICB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	METHANE WAS DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	312.0	7.9
312.0	322.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	312.5	5.0				STEEL
311.0	322.0	2.0				PVC

Annular Seal Information

From	To	Description
0.0	312.0	CEMENT
308.0	308.0	PACKER
311.0	311.0	PACKER
316.0	316.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
311.5	314.0	2.0			PVC
316.5	322.0	2.0			PVC

Lithology Information

From	To	Description
0.0	7.0	SOIL, TAN, CLAY LOAM, DAMP
7.0	16.0	CLAY AND VERY FINE GRAINED SAND, TAN DRY
16.0	19.0	CLAY, GRAY, SOFT
19.0	24.0	SAND, TAN, VERY FINE GRAINED, LOOSE, AND GRAY SOFT CLAY, DRY
24.0	29.0	SAND, ORANGE-TAN, FINE GRAINED, DAMP
29.0	48.0	SAND, LIGHT TAN-GRAY, MEDIUM GRAINED, DAMP
48.0	49.5	COAL, DARK BROWN, SOFT
49.5	62.0	SHALE, MEDIUM GRAY, SOFT, PLATEY
62.0	74.0	SANDSTONE, LIGHT GRAY, VERY FINE GRAINED, DRY
74.0	111.0	SHALE, MEDIUM GRAY, FIRM
111.0	124.0	SILTSTONE, LIGHT GRAY, DAMP
124.0	127.0	SHALE, MEDIUM GRAY, FIRM
127.0	143.0	SILTSTONE AND VERY FINE SANDSTONE, GRAY, LOOSE
143.0	146.0	SHALE, GRAY, FIRM
146.0	159.0	SANDSTONE, GRAY, VERY FINE GRAINED, MAKING SOME WATER
159.0	164.0	SILTSTONE, GRAY, SHALEY
164.0	174.0	SANDSTONE, GRAY, VERY FINE GRAINED, MAKING SOME WATER
174.0	198.0	SHALE, MEDIUM BROWN, FIRM
198.0	223.0	COAL, BLACK, HARD, DULL, MAKING ABOUT 1 GPM (ANDERSON)
223.0	227.0	SHALE, BROWNISH GRAY, SOFT
227.0	230.0	SANDSTONE, TAN, VERY FINE GRAINED
230.0	235.0	SHALE, GRAY, FIRM
235.0	249.0	SANDSTONE, TAN, VERY FINE GRAINED
249.0	255.0	SHALE, GRAY, FIRM
255.0	285.0	SILTSTONE, GRAY, SHALEY WITH DEPTH
285.0	305.0	SANDSTONE, GRAY, FINE GRAINED
305.0	311.5	SHALE, LIGHT BROWN, SOFT
311.5	322.0	COAL, BLACK, HARD, DULL, MAKING SOME WATER, SHALE STRINGER 312 TO 315 (DIETZ)

MBMG MONITORING WELL SL-5CC

Location Information

GWIC Id:	220076	Source of Data:	REPORT
Location (TRS):	09S 44E 36 ABBD	Latitude (dd):	45.0119
County (MT):	BIG HORN	Longitude (dd):	-106.2715
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3810.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	430.50	How Drilled:	AIR ROTARY
Static Water Level (ft):	180.41	Driller's Name:	J WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	6.00	Completion Date (m/d/y):	6/10/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	Not Reported
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	METHANE WAS DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	408.0	7.9
408.0	430.5	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	408.0	5.0				STEEL
408.0	411.0	2.0				PVC

Annular Seal Information

From	To	Description
0.0	408.0	CEMENT
406.0	406.0	PACKER
411.0	411.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
411.0	430.5	2.0			PVC

Lithology Information

From	To	Description
0.0	7.0	SOIL, TAN, CLAY LOAM, DAMP
7.0	16.0	CLAY AND VERY FINE GRAINED SAND, TAN DRY
16.0	19.0	CLAY, GRAY, SOFT
19.0	24.0	SAND, TAN, VERY FINE GRAINED, LOOSE, AND GRAY SOFT CLAY, DRY
24.0	29.0	SAND, ORANGE-TAN, FINE GRAINED, DAMP
29.0	48.0	SAND, LIGHT TAN-GRAY, MEDIUM GRAINED, DAMP
48.0	49.5	COAL, DARK BROWN, SOFT
49.5	62.0	SHALE, MEDIUM GRAY, SOFT, PLATEY
62.0	74.0	SANDSTONE, LIGHT GRAY, VERY FINE GRAINED, DRY
74.0	111.0	SHALE, MEDIUM GRAY, FIRM
111.0	124.0	SILTSTONE, LIGHT GRAY, DAMP
124.0	127.0	SHALE, MEDIUM GRAY, FIRM
127.0	143.0	SILTSTONE AND VERY FINE SANDSTONE, GRAY, LOOSE
143.0	146.0	SHALE, GRAY, FIRM
146.0	159.0	SANDSTONE, GRAY, VERY FINE GRAINED, MAKING SOME WATER
159.0	164.0	SILTSTONE, GRAY, SHALEY
164.0	174.0	SANDSTONE, GRAY, VERY FINE GRAINED, MAKING SOME WATER
174.0	198.0	SHALE, MEDIUM BROWN, FIRM
198.0	223.0	COAL, BLACK, HARD, DULL, MAKING ABOUT 1 GPM (ANDERSON)
223.0	227.0	SHALE, BROWNISH GRAY, SOFT
227.0	230.0	SANDSTONE, TAN, VERY FINE GRAINED
230.0	235.0	SHALE, GRAY, FIRM
235.0	249.0	SANDSTONE, TAN, VERY FINE GRAINED
249.0	255.0	SHALE, GRAY, FIRM
255.0	285.0	SILTSTONE, GRAY, SHALEY WITH DEPTH
285.0	305.0	SANDSTONE, GRAY, FINE GRAINED
305.0	311.5	SHALE, LIGHT BROWN, SOFT
311.5	322.0	COAL, BLACK, HARD, DULL, MAKING LESS THAN 1 GPM, SHALE STRINGER 312 TO 315 (DIETZ)
322.0	326.0	SHALE, GRAY, FIRM
326.0	328.0	SANDSTONE, LIGHT GRAY, VERY FINE GRAINED, SHALEY
334.0	337.0	SANDSTONE, LIGHT GRAY, VERY FINE GRAINED, SHALEY
337.0	396.0	SILTSTONE, GRAY, SHALEY NEAR TOP
346.0	334.0	SHALE, GRAY, FIRM
396.0	401.0	SANDSTONE, GRAY, VERY FINE GRAINED
401.0	407.0	SHALE, GRAY, FIRM
407.0	408.0	COAL
408.0	410.3	SHALE, DARK BROWN AND GRAY, CARBONACEOUS
410.3	430.5	COAL BLACK HARD MAKING ABOUT 6 GPM (CANYON)

MBMG MONITORING WELL SL-6AC

Location Information

GWIC Id:	220062	Source of Data:	REPORT
Location (TRS):	09S 45E 36 ABBB	Latitude (dd):	45.0148
County (MT):	BIG HORN	Longitude (dd):	-106.1514
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	4220.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	492.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	377.89	Driller's Name:	JOHN WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	0.10	Completion Date (m/d/y):	6/23/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125ANCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	NO METHANE DETECTED		

Hole Diameter Information

From	To	Diameter
0.0	474.0	7.9
474.0	492.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	474.0	5.0				STEEL
474.0	492.0	2.0				PVC

Annular Seal Information

From	To	Description
0.0	474.0	CEMENT
470.0	470.0	PACKER
490.0	490.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
474.0	488.0	2.0			PVC
490.0	492.0	2.0			PVC

Lithology Information

From	To	Description
0.0	2.0	SOIL, LIGHT TAN, SANDY LOAM, DAMP
2.0	7.0	SOIL, DARK RED-BROWN, CLAY LOAM, DAMP
7.0	12.0	CLAY, LIGHT TAN AND DARK BROWN, DAMP
12.0	24.0	SANDSTONE, LIGHT TAN, VERY FINE GRAINED, LOOSE, SLIGHTLY DAMP
24.0	26.0	COAL, DARK BROWN, DULL, SOFT, DRY
26.0	35.0	SHALE, LIGHT GREEN-GRAY, SOFT
35.0	40.0	SANDSTONE, TAN, FINE GRAINED, DAMP
40.0	46.0	SILTSTONE, GRAY
46.0	49.0	COAL, DARK BROWN, DULL, SOFT
49.0	60.0	SHALE, BROWN AND BROWN-GRAY, SOFT
60.0	63.0	SANDSTONE, VERY HARD, POOR RETURNS
63.0	71.0	SHALE, MEDIUM GRAY
71.0	77.0	COAL, DARK BROWN, DULL, SOFT (ARVADA)
77.0	82.0	SHALE, MEDIUM BROWN-GRAY, CARBONACEOUS, SOFT
82.0	87.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL SORTED, DAMP
87.0	109.0	SHALE, MEDIUM GRAY, FIRM, MINOR SANDSTONE STRINGERS
109.0	117.0	SANDSTONE, MEDIUM GRAY, MEDIUM GRAINED, WELL SORTED
117.0	123.0	SHALE, MEDIUM GRAY, FIRM
123.0	136.0	COAL, BLACK, DULL, FIRM, BROWN SHALE PARTING 132-134, (ROLAND)
136.0	141.0	SHALE, GRAY, FIRM
141.0	146.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, POORLY SORTED, DAMP
146.0	164.0	SHALE, MEDIUM BROWN-GRAY AND GRAY, WITH SANDSTONE STRINGER
164.0	176.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, VERY SHALEY, DAMP
176.0	193.0	SHALE, MEDIUM GRAY, FIRM
193.0	210.0	SILTSTONE, DARK GRAY AND GRAY -BROWN, FINE GRAINED, POORLY SORTED, INTER-BEDED WITH GRAY SHALE
210.0	225.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL ROUNDED AND SORTED, MAKING ABOUT 7 GPM
225.0	235.0	SHALE, DARK GRAY, FIRM WITH DARK GRAY SILTSTONE
235.0	241.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED
241.0	256.0	SHALE, BROWN-GRAY, FIRM
256.0	259.0	COAL, BLACK, HARD, VITREOUS (WADDLE)
259.0	262.0	SHALE, BROWN-GRAY, BRITTLE
262.0	279.0	SILTSTONE, GRAY, VERY SHALEY
279.0	286.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED

286.0	295.0	SILTSTONE, GRAY
295.0	318.0	SHALE, MEDIUM BROWN-GRAY, FIRM GRADING DOWNWARD TO BROWN-GRAY, SHALEY SILTSTONE
318.0	320.0	COAL
320.0	336.0	SHALE, GRAY, SOFT
336.0	337.0	SANDSTONE, MEDIUM GRAY, FINE GAINED, SHALEY
337.0	339.0	SHALE, MEDIUM GRAY, FIRM
339.0	372.0	SANDSTONE, GRAY, FINE GRAINED, VERY HARD
372.0	377.0	SILTSTONE, GRAY, SHALEY
377.0	380.0	SANDSTONE, GRAY, FINE GRAINED
380.0	400.0	SHALE, MEDIUM GRAY, FIRM
400.0	404.0	SANDSTONE, GRAY, FINE GRAINED
404.0	419.0	SILTSTONE, GRAY, SHALEY
419.0	434.0	SHALE, GRAY, FIRM
434.0	443.0	SANDSTONE, GRAY, FINE GRAINED
443.0	472.0	SHALE, GRAY, SILTY, FIRM
472.0	492.0	COAL, BLACK, HARD, SLIGHTLY VITREOUS, SHALE STRINGER 487-490 (ANDERSON)

MBMG MONITORING WELL SL-6CC

Location Information

GWIC Id:	220064	Source of Data:	REPORT
Location (TRS):	09S 45E 36 ABBB	Latitude (dd):	45.0148
County (MT):	BIG HORN	Longitude (dd):	-106.1513
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	4220.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	685.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	521.89	Driller's Name:	JOHN WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	0.50	Completion Date (m/d/y):	6/17/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	125CNCB 125TGRV 125FRUN
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	RELEASING FREE METHANE		

Hole Diameter Information

From	To	Diameter
662.0	685.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	662.0	5.0				STEEL
662.0	685.0	2.0				PVC

Annular Seal Information

From	To	Description
0.0	662.0	CEMENT
660.0	660.0	PACKER
669.0	669.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
662.0	666.0	2.0			PVC
669.0	685.0	2.0			PVC

Lithology Information

From	To	Description
0.0	2.0	SOIL, LIGHT TAN, SANDY LOAM, DAMP
2.0	7.0	SOIL, DARK RED-BROWN, CLAY LOAM, DAMP
7.0	12.0	CLAY, LIGHT TAN AND DARK BROWN, DAMP
12.0	24.0	SANDSTONE, LIGHT TAN, VERY FINE GRAINED, LOOSE, SLIGHTLY DAMP
24.0	26.0	COAL, DARK BROWN, DULL, SOFT, DRY
26.0	35.0	SHALE, LIGHT GREEN-GRAY, SOFT
35.0	40.0	SANDSTONE, TAN, FINE GRAINED, DAMP
40.0	46.0	SILTSTONE, GRAY
46.0	49.0	COAL, DARK BROWN, DULL, SOFT
49.0	60.0	SHALE, BROWN AND BROWN-GRAY, SOFT
60.0	63.0	SANDSTONE, VERY HARD, POOR RETURNS
63.0	71.0	SHALE, MEDIUM GRAY
71.0	77.0	COAL, DARK BROWN, DULL, SOFT (ARVADA)
77.0	82.0	SHALE, MEDIUM BROWN-GRAY, CARBONACEOUS, SOFT
82.0	87.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL SORTED, DAMP
87.0	109.0	SHALE, MEDIUM GRAY, FIRM, MINOR SANDSTONE STRINGERS
109.0	117.0	SANDSTONE, MEDIUM GRAY, MEDIUM GRAINED, WELL SORTED
117.0	123.0	SHALE, MEDIUM GRAY, FIRM
123.0	136.0	COAL, BLACK, DULL, FIRM, BROWN SHALE PARTING 132-134, (ROLAND)
136.0	141.0	SHALE, GRAY, FIRM
141.0	146.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, POORLY SORTED, DAMP
146.0	164.0	SHALE, MEDIUM BROWN-GRAY AND GRAY, WITH SANDSTONE STRINGER
164.0	176.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, VERY SHALEY, DAMP
176.0	193.0	SHALE, MEDIUM GRAY, FIRM
193.0	210.0	SILTSTONE, DARK GRAY AND GRAY -BROWN, FINE GRAINED, POORLY SORTED, INTER-BEDED WITH GRAY SHALE
210.0	225.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, WELL ROUNDED AND SORTED, MAKING ABOUT 7 GPM
225.0	235.0	SHALE, DARK GRAY, FIRM WITH DARK GRAY SILTSTONE
235.0	241.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED
241.0	256.0	SHALE, BROWN-GRAY, FIRM
256.0	259.0	COAL, BLACK, HARD, VITREOUS (WADDLE)
259.0	262.0	SHALE, BROWN-GRAY, BRITTLE
262.0	279.0	SILTSTONE, GRAY, VERY SHALEY
279.0	286.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED

286.0	295.0	SILTSTONE, GRAY
295.0	318.0	SHALE, MEDIUM BROWN-GRAY, FIRM GRADING DOWNWARD TO BROWN-GRAY, SHALEY SILTSTONE
318.0	320.0	COAL
320.0	336.0	SHALE, GRAY, SOFT
336.0	337.0	SANDSTONE, MEDIUM GRAY, FINE GAINED, SHALEY
337.0	339.0	SHALE, MEDIUM GRAY, FIRM
339.0	372.0	SANDSTONE, GRAY, FINE GRAINED, VERY HARD
372.0	377.0	SILTSTONE, GRAY, SHALEY
377.0	380.0	SANDSTONE, GRAY, FINE GRAINED
380.0	400.0	SHALE, MEDIUM GRAY, FIRM
400.0	404.0	SANDSTONE, GRAY, FINE GRAINED
404.0	419.0	SILTSTONE, GRAY, SHALEY
419.0	434.0	SHALE, GRAY, FIRM
434.0	443.0	SANDSTONE, GRAY, FINE GRAINED
443.0	472.0	SHALE, GRAY, SILTY, FIRM
472.0	492.0	COAL, BLACK, HARD, SLIGHTLY VITREOUS, SHALE STRINGER 488-490 (ANDERSON)
492.0	533.0	SHALE, GRAY, SOFT
533.0	536.0	SILTSTONE, GRAY
536.0	539.0	SHALE, GRAY
539.0	542.0	SANDSTONE, GRAY, FINE GRAINED
542.0	578.0	SHALE, MEDIUM GRAY, FIRM, SANDSTONE STRINGERS
578.0	585.0	COAL, BLACK, DULL (DIETZ)
585.0	597.0	SHALE, GRAY
597.0	615.0	SANDSTONE, GRAY, FINE GRAINED, SHALE STRINGERS
615.0	626.0	SHALE, GRAY, FIRM
626.0	645.0	SANDSTONE, GRAY, SHALEY
645.0	660.0	SHALE, MEDIUM GRAY, FIRM
660.0	686.0	COAL, BLACK, HARD, DULL, SHALE STRINGER 667-669 (CANYON)
686.0	700.0	SHALE, POOR RETURNS, OPEN HOLE IS MAKING 15 GPM, AND IS PRODUCING METHANE

MBMG MONITORING WELL SL-7CC

Location Information

GWIC Id:	220069	Source of Data:	REPORT
Location (TRS):	09S 46E 36 BBBB	Latitude (dd):	45.0147
County (MT):	BIG HORN	Longitude (dd):	-106.0392
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	4173.00
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	515.00	How Drilled:	AIR ROTARY
Static Water Level (ft):	455.95	Driller's Name:	J. WHEATON
Pumping Water Level (ft):		Driller License:	046
Yield (gpm):	1.00	Completion Date (m/d/y):	7/8/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	Not Reported
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:	RELEASING FREE METHANE.		

Hole Diameter Information

From	To	Diameter
0.0	499.0	7.9
499.0	515.0	4.5

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	499.0	5.0				STEEL
499.0	515.0	2.0				PVC

Annular Seal Information

From	To	Description
0.0	499.0	CEMENT
496.0	496.0	PACKER
499.0	499.0	PACKER

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
499.0	515.0	2.0			PVC

From	To	Description
0.0	1.0	SOIL, TAN, SAND, VERY SLIGHTLY DAMP
1.0	15.0	SAND, LIGHT TAN, VERY FINE GRAINED, SLIGHTLY DAMP
15.0	31.0	SHALE, LIGHT OLIVE-TAN AND DARK GRAY, SOFT
31.0	36.0	SANDSTONE, MEDIUM GRAY, MEDIUM GRAINED, WELL ROUNDED, DAMP
36.0	41.0	SHALE, DARK BROWN-GRAY, FIRM
41.0	47.0	SILTSTONE, GRAY
47.0	50.0	SHALE, DARK BROWN-GRAY, FIRM
50.0	71.0	SANDSTONE, MEDIUM GRAY, VERY FINE GRAINED, SLIGHTLY DAMP
71.0	74.0	SHALE, DARK GRAY, FIRM
74.0	85.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, POORLY SORTED
85.0	89.0	SHALE, MEDIUM GRAY, FIRM
89.0	106.0	SHALE, DARK GRAY, FIRM
106.0	114.0	SANDSTONE, DARK BROWN, STAINED, VERY FINE GRAINED, DRY
114.0	119.0	SHALE, DARK BROWN, CARBONACEOUS, SOFT, BRITTLE
119.0	135.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, VERY SLIGHTLY DAMP
135.0	139.0	SHALE, MEDIUM GRAY AND DARK BROWN, FIRM
139.0	153.0	SANDSTONE, MEDIUM BROWN-GRAY, FINE GRAINED, WELL SORTED, DAMP
153.0	155.0	SHALE, DARK GRAY, FIRM
155.0	161.0	SILTSTONE, GRAY
161.0	175.0	SANDSTONE, MEDIUM BROWN-GRAY, MEDIUM GRAINED, WELL SORTED, DAMP, MINOR SHALE STRINGERS
175.0	179.0	SHALE, MEDIUM GRAY
179.0	190.0	SANDSTONE, MEDIUM GRAY, FINE GRAINED, IMPROVED SORTING UP SECTION, MAKING VERY LITTLE WATER
190.0	209.0	SHALE, MEDIUM GRAY, FIRM
209.0	229.0	SANDSTONE AND SILTSTONE, GRAY, INCREASING GRAIN SIZE UP SECTION
229.0	233.0	SHALE, MEDIUM GRAY, FIRM
233.0	257.0	SHALE, MEDIUM GRAY, MINOR SANDSTONE NEAR TOP
257.0	273.0	SANDSTONE, GRAY, FINE GRAINED
273.0	292.0	SHALE, MEDIUM GRAY, MINOR SANDSTONE NEAR TOP
292.0	298.0	SANDSTONE, GRAY, FINE GRAINED
298.0	302.0	SHALE, MEDIUM GRAY, FIRM
302.0	307.0	SANDSTONE, GRAY, VERY FINE GRAINED
307.0	328.0	SHALE, MEDIUM BROWN-GRAY, SOFT
328.0	356.0	COAL, BLACK, HARD, SUB-VITREOUS (ANDERSON) SHALE PARTINGS 341-342, 351.5-353
356.0	370.0	SHALE, MEDIUM GRAY, FIRM

370.0	378.0	SHALE, MEDIUM GRAY-BROWN, FIRM
378.0	401.0	SANDSTONE, LIGHT GRAY, MEDIUM GRAINED, WELL ROUNDED
401.0	412.0	SHALE, MEDIUM GRAY, FIRM
412.0	419.5	COAL, BLACK, DULL, BRITTLE (DIETZ)
419.5	429.0	SHALE, MEDIUM GRAY, FIRM
429.0	437.0	SILTSTONE, GRAY, HARD
437.0	445.0	SHALE, LIGHT GRAY, FIRM
445.0	450.0	SILTSTONE, GRAY, HARD
450.0	465.0	SANDSTONE, LIGHT GRAY, FINE GRAINED
465.0	486.0	SHALE, MEDIUM GRAY, SOFT
486.0	488.5	SHALE, MEDIUM GRAY-BROWN, SOFT
488.5	515.0	COAL, BLACK, HARD, SUB-VITREOUS (CANYON) SHALE PARTING 494.5-498, PRODUCING SIGNIFICANT METHANE
515.0	517.0	SHALE, LIGHT GRAY, SOFT
517.0	525.0	SILTSTONE, GRAY

MBMG MONITORING WELL SL-8-1Q

Location Information

GWIC Id:	220851	Source of Data:	REPORT
Location (TRS):	09S 47E 25 DDDB	Latitude (dd):	45.0176
County (MT):	POWDER RIVER	Longitude (dd):	-105.8998
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3396.70
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	19.00	How Drilled:	
Static Water Level (ft):	12.00	Driller's Name:	
Pumping Water Level (ft):		Driller License:	
Yield (gpm):	1.00	Completion Date (m/d/y):	8/26/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	110ALVM
Recovery Time (hrs):		Well/Water Use:	MONITORING

Well Notes:

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	19.0	2.0				PVC

Annular Seal Information

From	To	Description
1.0	11.0	BENTONITE
11.0	19.0	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
14.0	19.0	2.0		20 SLOT	SCREEN-CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	10.0	SAND, TAN, MEDIUM GRAINED, MODERATELY SORTED, WELL ROUNDED
10.0	14.0	SAND, COARSE, WITH GRAVEL, AND COAL CHIPS, COARSE GRAINED, MODERATELY SORTED, MODERATELY ROUND, DAMP
14.0	20.0	GRAVEL AND SAND, WET, CLINKER, SANDSTONE, QUARTZITE, UP TO 3 INCH GRAVEL
20.0	21.0	CLAY, BROWN-GREY, VERY SOFT, WET
21.0	28.0	CLAY AND SILT, BLUE-GREY, SILTY, WET

MBMG MONITORING WELL SL-8-2Q

Location Information

GWIC Id:	220857	Source of Data:	REPORT
Location (TRS):	09S 47E 25 DCDB	Latitude (dd):	45.0182
County (MT):	POWDER RIVER	Longitude (dd):	-105.9052
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3394.12
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	13.80	How Drilled:	
Static Water Level (ft):	12.27	Driller's Name:	
Pumping Water Level (ft):		Driller License:	
Yield (gpm):	0.30	Completion Date (m/d/y):	8/26/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	110ALVM
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:			

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	13.8	2.0				PVC

Annular Seal Information

From	To	Description
1.0	8.0	BENTONITE
8.0	13.8	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
9.8	13.8	2.0		20 SLOT	SCREEN-CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	1.0	SAND, TAN, MEDIUM GRAINED, MODERATLY SORTED, SUB ROUNDED, DAMP
1.0	2.0	SAND WITH SILT, TAN, VERY FINE GRAINED, MEDIUM SORTED, SUB ROUNDED, DAMP
2.0	3.0	SAND, BROWN, MEDIUM GRAINED, SUB ROUNDED, DAMP
3.0	5.0	SAND, BROWN, MEDIUM GRAINED, SUB ROUNDED, DAMP
5.0	6.0	STREAM DEPOSITED COAL, BRITTLE, DULL, DAMP
6.0	6.5	GRAVEL, BROWN SAND, GRAVEL UP TO 2 INCHES
6.5	10.0	SAND, BROWN, MEDIUM GRAINED, SUB ROUNDED, DAMP
10.0	12.0	GRAVEL, SATURATION AT 12FEET
12.0	13.0	SAND, BROWN, MEDIUM GRAINED, SUB ROUNDED, DAMP
13.0	15.0	COAL, CRUMBLY, DULL, DAMP, SILT, BROWN, DRY

MBMG MONITORING WELL SL-8-3Q

Location Information

GWIC Id:	220859	Source of Data:	REPORT
Location (TRS):	09S 47E 25 DDCB	Latitude (dd):	45.0177
County (MT):	POWDER RIVER	Longitude (dd):	-105.9028
DNRC Water Right:		Geomethod:	NAV-GPS
PWS Id:		Datum:	NAD27
Block:		Altitude (feet):	3398.46
Lot:		Certificate of Survey:	
Addition:		Type of Site:	WELL

Well Construction and Performance Data

Total Depth (ft):	19.00	How Drilled:	
Static Water Level (ft):	15.95	Driller's Name:	
Pumping Water Level (ft):		Driller License:	
Yield (gpm):	1.00	Completion Date (m/d/y):	8/26/2005
Test Type:		Special Conditions:	
Test Duration:		Is Well Flowing?:	
Drill Stem Setting (ft):		Shut-In Pressure:	
Recovery Water Level (ft):		Geology/Aquifer:	110ALVM
Recovery Time (hrs):		Well/Water Use:	MONITORING
Well Notes:			

Hole Diameter Information

No Hole Diameter Records currently in GWIC.

Casing Information[1]

From	To	Dia	Wall Thickness	Pressure Rating	Joint	Type
-1.5	19.0	2.0				PVC

Annular Seal Information

From	To	Description
1.0	12.0	BENTONITE
12.0	19.0	GRAVEL PACK

Completion Information[1]

From	To	Dia	# of Openings	Size of Openings	Description
14.0	19.0	2.0		20 SLOT	SCREEN-CONTINUOUS-PVC

Lithology Information

From	To	Description
0.0	1.0	SAND, TAN FINE GRAINED, DRY
1.0	2.0	SAND, TAN FINE GRAINED, DRY
2.0	5.0	SAND, TAN, FINE GRAINED, MODERATELY ROUNDED
5.0	6.0	SAND, TAN, FINE GRAINED, DAMP, MODERATELY ROUNDED
6.0	6.5	GRAVEL AND SAND, TAN, FINED TO MEDIUM GRAINED, GRAVEL OF VARIOUS SIZES, DAMP
6.5	14.0	BOTTOM OF GRAVEL AND SAND
14.0	22.0	SAND, CLAY, DARK BROWN, WET
22.0	28.0	CLAY, LIGHT GREY, DAMP, SILTY AT BOTTOM, DRY

Appendix B

Site details, water-level data and 2006 monitoring plan
for ground-water monitoring wells

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	GWIC ID	Longitude	Latitude	Town-ship	Range	Section	Tract
5072B	157879	-106.49040	45.73930	01S	42E	24	ACBB
5072C	157882	-106.49050	45.73940	01S	42E	24	ACBB
5080B	157883	-106.51260	45.71990	01S	42E	26	DCBA
5080C	157884	-106.51260	45.72000	01S	42E	26	DCBA
LISCOM WELL	94661	-106.03230	45.77820	01S	46E	3	DBAA
COYOTE WELL	94666	-106.05050	45.75240	01S	46E	16	AACC
WHITETAIL RANGER STATION	183564	-105.97580	45.64040	02S	47E	19	CDCA
EAST FORK WELL	100472	-106.16420	45.59350	03S	45E	10	BACB
SCHOOL HOUSE PIPELINE WELL	205088	-106.00360	45.56370	03S	46E	23	AAAC
LEMONADE PIPELINE WELL	205081	-105.92670	45.54530	03S	47E	28	ACAC
DRY CREEK PIPELINE WELL	223927	-106.33550	45.48410	04S	44E	17	CCBC
WO-14	210094	-106.18490	45.51830	04S	45E	4	BDDB
WO-15	7573	-106.18550	45.51860	04S	45E	4	BDDB
WO-16	7574	-106.18610	45.51580	04S	45E	4	CAAC
NEWELL PIPELINE WELL	7589	-106.21430	45.47270	04S	45E	19	DADD
OC-28	207101	-106.19280	45.47170	04S	45E	21	CCBD
10 MILE CREEK PIPELINE WELL	223879	-106.11220	45.44000	04S	46E	31	CBBD
NC02-4	223243	-106.73110	45.40800	05S	40E	13	ADAB
NC02-1	223238	-106.84640	45.36080	05S	40E	31	BDCC
NC02-6	223237	-106.84640	45.36080	05S	41E	14	BDCD
NC02-3	223242	-106.69170	45.40440	05S	41E	17	ADBD
NC02-2	223240	-106.50440	45.40300	05S	42E	14	ADDC
NC02-5	223236	-106.56030	45.39860	05S	42E	16	CCAB
CBM02-8KC	203697	-106.54730	45.36890	05S	42E	28	DDAC
CBM02-8SS	203699	-106.54720	45.36880	05S	42E	28	DDAC
CBM02-8DS	203700	-106.54700	45.36870	05S	42E	28	DDAC
CBM02-8FG	203701	-106.54710	45.36880	05S	42E	28	DDAC
NANCE PROPERTIES INC	183560	-106.42050	45.43870	05S	43E	4	AAAB
P-5	223954	-106.46470	45.41710	05S	43E	8	BCCA
WA-9	223951	-106.43390	45.42270	05S	43E	9	ABBB
P-10	223955	-106.43530	45.41170	05S	43E	9	CDAA
WA-2	223952	-106.46210	45.40200	05S	43E	17	BCDD
IB-2	207096	-106.43720	45.39300	05S	43E	21	BBDB
MK-4	207097	-106.43630	45.39190	05S	43E	21	BBDC
NM-4	207098	-106.43610	45.39160	05S	43E	21	BCAB
WL-2	207099	-106.43580	45.39190	05S	43E	21	BBDC
WA-7	214354	-106.43470	45.39330	05S	43E	21	BABC
PADGET CREEK PIPELINE WELL	103155	-106.29400	45.39390	05S	44E	22	BBBD
77-26	7755	-106.18390	45.43520	05S	45E	4	ABCC
CHROMO PIPELINE	205092	-106.19570	45.43800	05S	45E	5	AAAA
WO-8	7770	-106.14110	45.39220	05S	45E	23	ABCA
WO-9	7772	-106.14190	45.39250	05S	45E	23	ABCA
WO-10	7775	-106.14300	45.39250	05S	45E	23	ABCB
WO-5	7776	-106.13860	45.39220	05S	45E	23	ABDA
WO-6	7777	-106.13860	45.39220	05S	45E	23	ABDA
WO-7	7778	-106.13860	45.39220	05S	45E	23	ABDA
WO-1	7780	-106.14940	45.39470	05S	45E	23	BBAA
WO-2	7781	-106.14940	45.39470	05S	45E	23	BBAA

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	GWIC ID	Longitude	Latitude	Town-ship	Range	Section	Tract
WO-3	7782	-106.14940	45.39470	05S	45E	23	BBAA
WO-11	215085	-106.14330	45.39270	05S	45E	23	ABCC
NC05-1	226919	-106.47690	45.41060	05S	46E	7	C
WATT PIPELINE WELL	205087	-106.06660	45.38030	05S	46E	21	CDCD
SKINNER GULCH PIPELINE WELL	183565	-105.91710	45.42750	05S	47E	3	BCCD
SPRING CREEK PIPELINE WELL	205082	-105.95380	45.38830	05S	47E	20	ACAC
RBC-1	207064	-106.98360	45.33270	06S	39E	8	CAAA
RBC-2	207066	-106.98440	45.33270	06S	39E	8	CAAA
RBC-3	207068	-106.98680	45.33310	06S	39E	8	BDCD
CBM02-1KC	203646	-106.96710	45.31860	06S	39E	16	DBCA
CBM02-1BC	203655	-106.96710	45.31860	06S	39E	16	DBCA
CBM02-1LC	203658	-106.96710	45.31860	06S	39E	16	DBCA
20-LW	191139	-106.78010	45.33910	06S	40E	1	CDDC
22-BA	191155	-106.69540	45.34840	06S	41E	3	BADD
28-W	191163	-106.72920	45.32110	06S	41E	16	BBCC
32-LW	191169	-106.70980	45.29550	06S	41E	21	DDDC
HWC86-9	7903	-106.50270	45.29660	06S	43E	19	DACD
HWC86-7	7905	-106.50330	45.29580	06S	43E	19	DDBA
HWC86-8	7906	-106.50300	45.29610	06S	43E	19	DDBA
CBM02-4WC	203680	-106.78020	45.17980	07S	40E	36	CDDC
CBM02-4SS1	203681	-106.78030	45.17980	07S	40E	36	CDDC
CBM02-4SS2	203690	-106.78030	45.17980	07S	40E	36	CDDC
HWCQ-2	214096	-106.50090	45.19130	07S	43E	32	AAAA
HWCQ-1	214097	-106.50050	45.19120	07S	43E	32	AAAA
PIPELINE WELL 7(PL-1W) LOHOF	144969	-106.30740	45.23540	07S	44E	14	ABD
TOOLEY CREEK WELL	105007	-106.26970	45.21530	07S	45E	19	CAAA
DICK FLETCHER PIPELINE WELL	223883	-106.16550	45.22260	07S	45E	24	ABAB
INDIAN CREEK PIPELINE WELL	224006	-106.07540	45.24760	07S	46E	10	AADA
STEWART PIPELINE WELL	224007	-106.06850	45.24380	07S	46E	11	BDCA
TAYLOR CREEK PIPELINE WELL	223890	-105.99280	45.22130	07S	47E	21	BBCC
634	184225	-107.07280	45.14220	08S	38E	17	DADD
634A	184226	-107.08830	45.14220	08S	38E	17	DADD
625	184223	-107.05220	45.11330	08S	38E	28	DADB
625A	184224	-107.05220	45.11330	08S	38E	28	DADB
CBM02-7CC	203693	-106.89060	45.18010	08S	39E	1	AAAA
CBM02-7SS	203695	-106.89060	45.17990	08S	39E	1	AAAA
CBM02-3CC	203676	-106.96080	45.13920	08S	39E	16	BAAA
CBM02-3DC	203678	-106.96070	45.13910	08S	39E	16	BAAA
WR-21	8074	-106.97910	45.08770	08S	39E	32	DBBC
PKS-3204	166351	-106.82990	45.10670	08S	40E	28	ADA
PKS-3203	166358	-106.83020	45.10680	08S	40E	28	ADA
CBM03-10AC	203703	-106.60450	45.11410	08S	42E	29	ADAD
CBM03-10SS	203704	-106.60450	45.11410	08S	42E	29	ADAD
HWC-86-2	8101	-106.48270	45.13500	08S	43E	17	DDCA
HWC-86-5	8103	-106.48220	45.13410	08S	43E	17	DDDC
HWC-01	8107	-106.48660	45.13380	08S	43E	20	DDDD
HC-24	8118	-106.47470	45.12970	08S	43E	21	BDBB
HC-01	207143	-106.47500	45.13140	08S	43E	21	BBDA

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	GWIC ID	Longitude	Latitude	Town-ship	Range	Section	Tract
FC-01	8140	-106.51660	45.10250	08S	43E	31	BBDA
FC-02	8141	-106.51660	45.10250	08S	43E	31	BBDA
CBM03-11AC	203705	-106.36320	45.17930	08S	44E	5	BBBB
CBM03-11DC	203707	-106.36410	45.17930	08S	44E	5	BBBB
CBM03-11CC	203708	-106.36470	45.17930	08S	44E	5	BBBB
BC-06	8191	-106.21000	45.13870	08S	45E	16	DBCB
BC-07	8192	-106.21000	45.13870	08S	45E	16	DBCB
CBM03-12COC	203709	-106.21210	45.13520	08S	45E	16	DBCB
75-23	191634	-106.20110	45.09660	08S	45E	34	BDBC
WR-23	8347	-106.99050	45.09220	09S	38E	1	AADC
SH-624	184222	-107.09170	45.07250	09S	38E	7	DADB
SHEPA-01	8352	-107.04610	45.06910	09S	38E	10	CCAA
SHEPA-02	8353	-107.04610	45.06910	09S	38E	10	CCAA
YA-114	207075	-107.05430	45.04610	09S	38E	21	ADBD
YA-105	207076	-107.05270	45.04650	09S	38E	21	ACAC
391	8368	-107.03200	45.04130	09S	38E	22	DADC
YA-109	192874	-107.03120	45.04070	09S	38E	22	DADC
388	8371	-107.02050	45.03910	09S	38E	23	CDAD
TA-100	207080	-107.00900	45.04790	09S	38E	23	BBCC
396	8372	-107.00880	45.04910	09S	38E	24	BBBC
TA-101	207081	-107.00900	45.04820	09S	38E	24	BBCC
TA-102	207083	-107.00760	45.04860	09S	38E	24	BBCB
394	8377	-107.00750	45.03300	09S	38E	25	BCBA
422	8379	-107.00610	45.02610	09S	38E	25	CBDC
395	8387	-107.06180	45.03610	09S	38E	26	ABAB
424	8396	-107.03910	45.03270	09S	38E	27	ACBB
WR-58	8412	-106.91220	45.04080	09S	39E	14	DDBD
WR-58D	8413	-106.91380	45.03940	09S	39E	14	DDCC
WR-58A	132903	-106.91230	45.04030	09S	39E	14	DDBD
WR-58C	132905	-106.91230	45.03840	09S	39E	14	DDCD
WR-19	8417	-106.95050	45.05250	09S	39E	16	AABA
WR-20	8419	-106.95050	45.05250	09S	39E	16	AABA
WR-54A	8428	-106.89020	45.01470	09S	39E	25	DADB
WR-53A	8430	-106.88880	45.01220	09S	39E	25	DDAA
WR-24	8436	-106.98770	45.02020	09S	39E	29	BBDD
WR-31	130476	-106.98630	45.01630	09S	39E	29	CBAA
WR-30	132908	-106.98740	45.01650	09S	39E	29	CBAB
CBM02-2WC	203669	-106.98840	45.02070	09S	39E	29	BBDC
CBM02-2RC	203670	-106.98890	45.01850	09S	39E	29	BCBD
WR-33	8441	-106.97580	45.00660	09S	39E	32	ACAA
WR-27	8444	-106.96580	45.00080	09S	39E	33	DBBD
WR-45	8446	-106.95380	44.99660	09S	39E	33	DDCC
WR-44	8447	-106.95220	44.99660	09S	39E	33	DDCD
WR-42	8451	-106.95020	44.99660	09S	39E	33	DDDD
WR-34	132909	-106.97020	45.00150	09S	39E	33	CBBB
WR-41	186195	-106.94980	44.99500	09S	39E	34	CCCC
WRE-02	132910	-106.77560	45.07120	09S	40E	1	DBCC
WRN-10	8456	-106.80940	45.07330	09S	40E	3	DABA

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	GWIC ID	Longitude	Latitude	Town-ship	Range	Section	Tract
WRN-11	123798	-106.80940	45.07330	09S	40E	3	DABA
WRN-15	8461	-106.82750	45.06380	09S	40E	9	AADD
DS-05A	8471	-106.83380	45.05550	09S	40E	9	DCAB
WRE-09	8500	-106.77410	45.03970	09S	40E	13	DCBC
WRE-10	8501	-106.77410	45.03830	09S	40E	13	DCCB
WRE-11	8504	-106.77360	45.03830	09S	40E	13	DCCD
PKS-3202	166359	-106.79810	45.04510	09S	40E	14	CAA
PKS-3201	166362	-106.79710	45.04370	09S	40E	14	CAA
PKS-3200	166370	-106.79690	45.04400	09S	40E	14	CAA
PKS-3199	166388	-106.79660	45.04430	09S	40E	14	CAA
PKS-3198	166389	-106.79640	45.04460	09S	40E	14	CAA
DS-02A	8574	-106.81660	45.04160	09S	40E	15	DBCC
WR-29R	166761	-106.81530	45.04650	09S	40E	15	ACCD
WR-55A	8651	-106.88630	45.03020	09S	40E	19	CBBD
WRE-12	8687	-106.80380	45.03110	09S	40E	23	BCCD
WRE-13	8692	-106.80440	45.03110	09S	40E	23	BCCD
PKS-1179	132973	-106.80400	45.03140	09S	40E	23	CBBB
WRE-16	8698	-106.76970	45.03520	09S	40E	24	AACB
WRE-18	121669	-106.76830	45.03470	09S	40E	24	AACD
WRE-20	122767	-106.77160	45.03690	09S	40E	24	ABAB
WRE-19	123797	-106.77360	45.03690	09S	40E	24	ABBA
WRE-21	132958	-106.77300	45.03860	09S	40E	24	ABAB
WRE-17	132959	-106.76830	45.03470	09S	40E	24	AACD
WR-17B	8706	-106.86410	45.02160	09S	40E	29	BBAC
WR-51A	8709	-106.86220	45.01860	09S	40E	29	BDCB
WR-52B	8710	-106.86270	45.01470	09S	40E	29	CACB
WR-17A	123796	-106.86410	45.02160	09S	40E	29	BBAC
WR-52C	132960	-106.86290	45.01640	09S	40E	29	CABC
WR-52D	132961	-106.86160	45.01640	09S	40E	29	CABD
WR-59	122766	-106.85260	45.00500	09S	40E	32	ACAD
WRE-25	123795	-106.73330	45.06830	09S	41E	5	DCCA
WRE-24	130475	-106.73330	45.06880	09S	41E	5	DCCA
WRE-27	8721	-106.73910	45.05860	09S	41E	8	CABC
WRE-28	8723	-106.73910	45.05860	09S	41E	8	CABC
WRE-29	8726	-106.74110	45.05860	09S	41E	8	CBAD
SL-2AC	219125	-106.63580	45.02760	09S	42E	30	BDAC
SL-2CC	220385	-106.63600	45.02730	09S	42E	30	BCBC
SL-3Q	219136	-106.53860	45.01610	09S	42E	36	BBAD
SL-3SC	219138	-106.53130	45.00800	09S	42E	36	DBCB
SL-3AC	219139	-106.53130	45.00790	09S	42E	36	DBCB
SL-3CC	219140	-106.53130	45.00820	09S	42E	36	DBCB
SL-3SS	219617	-106.53130	45.00790	09S	42E	36	DBCB
CC -1	8754	-106.46460	45.08750	09S	43E	4	ABDD
CC-4	8757	-106.46590	45.08740	09S	43E	4	ABDD
CC-3	8758	-106.46540	45.08640	09S	43E	4	ACAA
HWC-38	8777	-106.40170	45.07230	09S	43E	12	ADBB
HWC-37	189802	-106.40170	45.07230	09S	43E	12	ADBB
HWC-39	189838	-106.40040	45.07130	09S	43E	12	ADBD

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Site Name	GWIC ID	Longitude	Latitude	Town-ship	Range	Section	Tract
HWC-17	8778	-106.41330	45.05700	09S	43E	13	BCAA
HWC-6	198465	-106.40930	45.05360	09S	43E	13	CAAA
HWC-10	190902	-106.46950	45.04440	09S	43E	21	BADA
HWC-11 TR-77	190904	-106.46960	45.04440	09S	43E	21	BADA
HWC-15	8782	-106.44680	45.04120	09S	43E	22	ACCA
HWC-29B	8796	-106.39690	45.06880	09S	44E	7	BBCC
SL-5AC	219927	-106.27140	45.01190	09S	44E	36	ABBD
SL-5DC	219929	-106.27140	45.01190	09S	44E	36	ABBD
SL-5CC	220076	-106.27150	45.01190	09S	44E	36	ABBD
DH 75-102	190897	-106.18720	45.08000	09S	45E	3	ACDD
SL-5ALQ	223801	-106.25790	45.01290	09S	45E	31	BBA
SL-6AC	220062	-106.15140	45.01480	09S	45E	36	ABBB
SL-6CC	220064	-106.15130	45.01480	09S	45E	36	ABBB
AMAX NO. 110	8835	-106.11530	45.06990	09S	46E	8	BACC
UOP-09	8846	-106.05780	45.07200	09S	46E	11	BBBA
UOP-10	8847	-106.05780	45.07200	09S	46E	11	BBBA
CBM03-13OC	203710	-106.05720	45.07220	09S	46E	11	BBBA
SL-7CC	220069	-106.03920	45.01470	09S	46E	36	BBBB
SL-8-1Q	220851	-105.89980	45.01760	09S	47E	25	DDDB
SL-8-2Q	220857	-105.90520	45.01820	09S	47E	25	DCDB
SL-8-3Q	220859	-105.90280	45.01770	09S	47E	25	DDCB
SL-8-4Q	220860	-105.89880	45.02020	09S	47E	25	DADA
FULTON GEORGE *NO.6	8863	-105.86280	45.08070	09S	48E	5	ACDD
FULTON GEORGE	183563	-105.87090	45.06370	09S	48E	8	CABC
HWC 86-13	8888	-106.42620	45.00200	10S	43E	2	ABCA
HWC 86-15	198489	-106.42350	45.00250	10S	43E	2	AABC
SL-4SC	219141	-106.42430	45.00310	10S	43E	2	ABAA
SL-4AC	219169	-106.42440	45.00310	10S	43E	2	ABAA
WR-38	122769	-106.96500	44.99380	37N	63E	23	BBCB
WR-39	122770	-106.95550	44.99520	37N	63E	23	ABBC
WR-48	132716	-106.96500	44.99330	37N	63E	23	BBCB
BF-01	161749	-106.96670	44.98970	58N	84W	22	ACCC

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	County	Land-surface altitude (feet)	Aquifer
5072B	ROSEBUD	3160.0	ROSEBUD COAL
5072C	ROSEBUD	3160.0	ROSEBUD COAL OVERBURDEN
5080B	ROSEBUD	3260.0	KNOBLOCH COAL
5080C	ROSEBUD	3260.0	KNOBLOCH OVERBURDEN
LISCOM WELL	POWDER RIVER	3275.0	FORT UNION FORMATION
COYOTE WELL	POWDER RIVER	3294.0	FORT UNION FORMATION
WHITETAIL RANGER STATION	POWDER RIVER	4045.0	FORT UNION FORMATION
EAST FORK WELL	POWDER RIVER	3210.0	TONGUE RIVER FORMATION
SCHOOL HOUSE PIPELINE WELL	POWDER RIVER	3345.0	ALLUVIUM
LEMONADE PIPELINE WELL	POWDER RIVER	3605.0	ALLUVIUM
DRY CREEK PIPELINE WELL	POWDER RIVER	3050.0	TONGUE RIVER FORMATION
WO-14	POWDER RIVER	3010.0	ALLUVIUM
WO-15	POWDER RIVER	3022.0	ALLUVIUM
WO-16	POWDER RIVER	3040.0	ALLUVIUM
NEWELL PIPELINE WELL	POWDER RIVER	3290.0	TONGUE RIVER FORMATION
OC-28	POWDER RIVER	3171.0	KNOBLOCH COAL
10 MILE CREEK PIPELINE WELL	POWDER RIVER	3210.0	TONGUE RIVER FORMATION
NC02-4	BIG HORN	3940.0	
NC02-1	BIG HORN	4440.0	
NC02-6	ROSEBUD	3510.0	
NC02-3	ROSEBUD	3740.0	
NC02-2	ROSEBUD	3220.0	
NC02-5	ROSEBUD	3400.0	
CBM02-8KC	ROSEBUD	3262.3	KNOBLOCH COAL
CBM02-8SS	ROSEBUD	3262.2	KNOBLOCH UNDERBURDEN
CBM02-8DS	ROSEBUD	3260.5	FLOWERS-GOODALE OVERBURDEN
CBM02-8FG	ROSEBUD	3260.6	FLOWERS-GOODALE COAL
NANCE PROPERTIES INC	ROSEBUD	3035.0	ALLUVIUM
P-5	ROSEBUD	3062.0	ALLUVIUM
WA-9	ROSEBUD	3047.6	ALLUVIUM
P-10	ROSEBUD	3066.9	ANDERSON-DIETZ 1 COAL BED
WA-2	ROSEBUD	3068.5	ALLUVIUM
IB-2	ROSEBUD	3191.6	KNOBLOCH UNDERBURDEN
MK-4	ROSEBUD	3195.3	KNOBLOCH COAL
NM-4	ROSEBUD	3195.3	NANCE COAL
WL-2	ROSEBUD	3187.6	KNOBLOCH COAL
WA-7	ROSEBUD	3179.0	ALLUVIUM
PADGET CREEK PIPELINE WELL	ROSEBUD	3385.0	TONGUE RIVER FORMATION
77-26	POWDER RIVER	3284.0	KNOBLOCH COAL
CHROMO PIPELINE	POWDER RIVER	3295.0	TONGUE RIVER FORMATION
WO-8	POWDER RIVER	3155.0	ALLUVIUM
WO-9	POWDER RIVER	3150.0	ALLUVIUM
WO-10	POWDER RIVER	3145.0	ALLUVIUM
WO-5	POWDER RIVER	3160.0	KNOBLOCH UNDERBURDEN
WO-6	POWDER RIVER	3160.0	LOWER KNOBLOCH COAL
WO-7	POWDER RIVER	3160.0	ALLUVIUM
WO-1	POWDER RIVER	3190.0	KNOBLOCH UNDERBURDEN
WO-2	POWDER RIVER	3188.0	LOWER KNOBLOCH COAL

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	County	Land-surface altitude (feet)	Aquifer
WO-3	POWDER RIVER	3186.0	KNOBLOCH OVERBURDEN
WO-11	POWDER RIVER	3145.0	ALLUVIUM
NC05-1	ROSEBUD	3170.0	
WATT PIPELINE WELL	POWDER RIVER	3295.0	ALLUVIUM
SKINNER GULCH PIPELINE WELL	POWDER RIVER	3730.0	TONGUE RIVER FORMATION
SPRING CREEK PIPELINE WELL	POWDER RIVER	3630.0	TONGUE RIVER FORMATION
RBC-1	BIG HORN	3854.7	ALLUVIUM
RBC-2	BIG HORN	3849.4	ALLUVIUM
RBC-3	BIG HORN	3859.9	ALLUVIUM
CBM02-1KC	BIG HORN	3980.3	KNOBLOCH COAL
CBM02-1BC	BIG HORN	3983.9	BREWSTER-ARNOLD COAL
CBM02-1LC	BIG HORN	3981.8	LOCAL COALS
20-LW	BIG HORN	3940.0	WALL COAL
22-BA	ROSEBUD	3530.0	BREWSTER-ARNOLD COAL
28-W	ROSEBUD	3715.0	WALL COAL
32-LW	ROSEBUD	3530.0	WALL COAL
HWC86-9	ROSEBUD	3170.0	ALLUVIUM
HWC86-7	ROSEBUD	3170.0	ALLUVIUM
HWC86-8	ROSEBUD	3170.0	ALLUVIUM
CBM02-4WC	BIG HORN	3500.0	WALL COAL
CBM02-4SS1	ROSEBUD	3500.0	WALL COAL OVERBURDEN
CBM02-4SS2	BIG HORN	3500.0	CANYON UNDERBURDEN
HWCQ-2	ROSEBUD	3340.0	ALLUVIUM
HWCQ-1	ROSEBUD	3340.0	ALLUVIUM
PIPELINE WELL 7(PL-1W) LOHOF	ROSEBUD	3850.0	TONGUE RIVER FORMATION
TOOLEY CREEK WELL	POWDER RIVER	3755.0	FORT UNION FORMATION
DICK FLETCHER PIPELINE WELL	POWDER RIVER	3395.0	ALLUVIUM
INDIAN CREEK PIPELINE WELL	POWDER RIVER	3515.0	ALLUVIUM
STEWART PIPELINE WELL	POWDER RIVER	3540.0	ALLUVIUM
TAYLOR CREEK PIPELINE WELL	POWDER RIVER	3910.0	TONGUE RIVER FORMATION
634	BIG HORN	4480.5	DIETZ COAL
634A	BIG HORN	4481.2	ANDERSON COAL
625	BIG HORN	4186.6	DIETZ COAL
625A	BIG HORN	4186.7	ANDERSON COAL
CBM02-7CC	BIG HORN	3900.0	CANYON COAL
CBM02-7SS	BIG HORN	3900.0	CANYON OVERBURDEN
CBM02-3CC	BIG HORN	3920.0	CANYON COAL
CBM02-3DC	BIG HORN	3920.0	DIETZ COAL
WR-21	BIG HORN	3890.0	DIETZ 1 AND DIETZ COALS COMBINED
PKS-3204	BIG HORN	3500.0	ANDERSON-DIETZ 1 COAL BED
PKS-3203	BIG HORN	3500.0	CANYON COAL
CBM03-10AC	BIG HORN	4130.0	ANDERSON COAL
CBM03-10SS	BIG HORN	4130.0	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
HWC-86-2	BIG HORN	3460.0	ALLUVIUM
HWC-86-5	BIG HORN	3455.0	ALLUVIUM
HWC-01	BIG HORN	3530.0	CANYON COAL
HC-24	BIG HORN	3500.0	CANYON OVERBURDEN
HC-01	BIG HORN	3457.0	ALLUVIUM

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	County	Land-surface altitude (feet)	Aquifer
FC-01	BIG HORN	3735.0	ANDERSON COAL
FC-02	BIG HORN	3735.0	DIETZ COAL
CBM03-11AC	BIG HORN	3950.0	ANDERSON COAL
CBM03-11DC	BIG HORN	3950.0	DIETZ COAL
CBM03-11CC	BIG HORN	3950.0	CANYON COAL
BC-06	POWDER RIVER	3715.0	CANYON COAL
BC-07	POWDER RIVER	3715.0	CANYON OVERBURDEN
CBM03-12COC	POWDER RIVER	3715.0	COOK COAL
75-23	POWDER RIVER	3780.0	CANYON COAL
WR-23	BIG HORN	3960.0	DIETZ 1 AND DIETZ COALS COMBINED
SH-624	BIG HORN	4644.7	ANDERSON-DIETZ 1 COAL BED
SHEPA-01	BIG HORN	4138.6	ANDERSON-DIETZ 1 AND 2 COALS
SHEPA-02	BIG HORN	4138.5	DIETZ COAL
YA-114	BIG HORN	4000.0	ALLUVIUM
YA-105	BIG HORN	4015.0	ALLUVIUM
391	BIG HORN	3987.0	DIETZ 1 AND DIETZ COALS COMBINED
YA-109	BIG HORN	3830.0	ALLUVIUM
388	BIG HORN	3975.0	DIETZ COAL
TA-100	BIG HORN	3900.0	ALLUVIUM
396	BIG HORN	3939.0	ANDERSON-DIETZ 1 AND 2 COALS
TA-101	BIG HORN	3910.0	ALLUVIUM
TA-102	BIG HORN	3910.0	ALLUVIUM
394	BIG HORN	3909.0	DIETZ COAL
422	BIG HORN	3917.0	DIETZ COAL
395	BIG HORN	3900.0	DIETZ COAL
424	BIG HORN	3972.0	CANYON COAL
WR-58	BIG HORN	3631.3	ALLUVIUM
WR-58D	BIG HORN	3627.4	ALLUVIUM
WR-58A	BIG HORN	3631.4	ALLUVIUM
WR-58C	BIG HORN	3632.6	ALLUVIUM
WR-19	BIG HORN	3835.4	DIETZ 1 AND DIETZ COALS COMBINED
WR-20	BIG HORN	3835.3	ANDERSON COAL
WR-54A	BIG HORN	3631.2	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WR-53A	BIG HORN	3607.9	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WR-24	BIG HORN	3777.2	CANYON COAL
WR-31	BIG HORN	3895.2	ANDERSON COAL
WR-30	BIG HORN	3894.6	DIETZ 1 AND DIETZ COALS COMBINED
CBM02-2WC	BIG HORN	3792.0	CARNEY COAL
CBM02-2RC	BIG HORN	3890.0	ROLAND COAL
WR-33	BIG HORN	3732.3	ANDERSON-DIETZ 1 CLINKER AND COAL
WR-27	BIG HORN	3672.0	ANDERSON-DIETZ 1 AND 2 COALS
WR-45	BIG HORN	3638.2	ALLUVIUM
WR-44	BIG HORN	3636.9	ALLUVIUM
WR-42	BIG HORN	3636.7	ALLUVIUM
WR-34	BIG HORN	3772.1	ANDERSON-DIETZ 1 AND 2 COALS
WR-41	BIG HORN	3642.7	ALLUVIUM
WRE-02	BIG HORN	3456.8	ALLUVIUM
WRN-10	BIG HORN	3433.3	DIETZ 2 COAL

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	County	Land-surface altitude (feet)	Aquifer
WRN-11	BIG HORN	3436.8	ANDERSON-DIETZ 1 CLINKER AND COAL
WRN-15	BIG HORN	3499.8	DIETZ 2 COAL
DS-05A	BIG HORN	3505.5	DIETZ 2 COAL
WRE-09	BIG HORN	3510.7	DIETZ 2 COAL
WRE-10	BIG HORN	3518.5	DIETZ COAL
WRE-11	BIG HORN	3508.9	ANDERSON COAL
PKS-3202	BIG HORN	3438.0	ALLUVIUM
PKS-3201	BIG HORN	3438.0	CANYON COAL
PKS-3200	BIG HORN	3438.0	DIETZ 2 COAL
PKS-3199	BIG HORN	3439.0	DIETZ COAL
PKS-3198	BIG HORN	3440.0	ANDERSON COAL
DS-02A	BIG HORN	3430.0	DIETZ 2 COAL
WR-29R	BIG HORN	3461.0	ANDERSON-DIETZ 1 CLINKER AND COAL
WR-55A	BIG HORN	3591.1	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WRE-12	BIG HORN	3463.2	ANDERSON COAL
WRE-13	BIG HORN	3462.6	DIETZ COAL
PKS-1179	BIG HORN	3458.0	DIETZ 2 COAL
WRE-16	BIG HORN	3550.5	ANDERSON COAL
WRE-18	BIG HORN	3573.1	ANDERSON COAL
WRE-20	BIG HORN	3519.4	ANDERSON COAL
WRE-19	BIG HORN	3520.3	ANDERSON COAL
WRE-21	BIG HORN	3529.4	ANDERSON COAL
WRE-17	BIG HORN	3561.9	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WR-17B	BIG HORN	3574.7	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WR-51A	BIG HORN	3541.3	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WR-52B	BIG HORN	3518.8	ALLUVIUM
WR-17A	BIG HORN	3573.9	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
WR-52C	BIG HORN	3530.0	ALLUVIUM
WR-52D	BIG HORN	3529.3	ALLUVIUM
WR-59	BIG HORN	3470.1	ALLUVIUM
WRE-25	BIG HORN	3549.4	ANDERSON COAL
WRE-24	BIG HORN	3552.1	DIETZ COAL
WRE-27	BIG HORN	3523.8	ANDERSON COAL
WRE-28	BIG HORN	3525.2	DIETZ COAL
WRE-29	BIG HORN	3523.3	DIETZ 2 COAL
SL-2AC	BIG HORN	3925.0	ANDERSON COAL
SL-2CC	BIG HORN	3920.0	CANYON COAL
SL-3Q	BIG HORN	3725.0	ALLUVIUM
SL-3SC	BIG HORN	3805.0	SMITH COAL
SL-3AC	BIG HORN	3805.0	ANDERSON COAL
SL-3CC	BIG HORN	3805.0	CANYON COAL
SL-3SS	BIG HORN	3805.0	SMITH COAL OVERBURDEN
CC -1	BIG HORN	3520.0	ALLUVIUM
CC-4	BIG HORN	3511.0	ALLUVIUM
CC-3	BIG HORN	3521.0	ALLUVIUM
HWC-38	BIG HORN	3586.0	ALLUVIUM
HWC-37	BIG HORN	3578.0	ALLUVIUM
HWC-39	BIG HORN	3591.0	ALLUVIUM

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	County	Land-surface altitude (feet)	Aquifer
HWC-17	BIG HORN	3610.0	ANDERSON COAL
HWC-6	BIG HORN	3595.0	DIETZ COAL
HWC-10	BIG HORN	3610.0	DIETZ COAL
HWC-11 TR-77	BIG HORN	3615.0	ANDERSON COAL
HWC-15	BIG HORN	3600.0	ANDERSON COAL
HWC-29B	BIG HORN	3620.0	ANDERSON COAL
SL-5AC	BIG HORN	3810.0	ANDERSON COAL
SL-5DC	BIG HORN	3810.0	DIETZ COAL
SL-5CC	BIG HORN	3810.0	CANYON COAL
DH 75-102	POWDER RIVER	3815.0	ANDERSON-DIETZ 1 COAL BED
SL-5ALQ	POWDER RIVER	3810.0	ALLUVIUM
SL-6AC	BIG HORN	4220.0	ANDERSON COAL
SL-6CC	BIG HORN	4220.0	CANYON COAL
AMAX NO. 110	POWDER RIVER	3965.0	DIETZ COAL
UOP-09	POWDER RIVER	3929.0	CANYON COAL
UOP-10	POWDER RIVER	3930.0	CANYON OVERBURDEN
CBM03-13OC	POWDER RIVER	3931.0	OTTER COAL
SL-7CC	BIG HORN	4173.0	CANYON COAL
SL-8-1Q	POWDER RIVER	3396.7	ALLUVIUM
SL-8-2Q	POWDER RIVER	3394.1	ALLUVIUM
SL-8-3Q	POWDER RIVER	3398.5	ALLUVIUM
SL-8-4Q	POWDER RIVER	3398.3	ALLUVIUM
FULTON GEORGE *NO.6	POWDER RIVER	3380.0	TONGUE RIVER FORMATION
FULTON GEORGE	POWDER RIVER	3360.0	ALLUVIUM
HWC 86-13	BIG HORN	3640.0	ALLUVIUM
HWC 86-15	BIG HORN	3630.0	ALLUVIUM
SL-4SC	BIG HORN	3640.0	SMITH COAL
SL-4AC	BIG HORN	3640.0	ANDERSON COAL
WR-38	SHERIDAN	3692.9	DIETZ 1 AND DIETZ COALS COMBINED
WR-39	SHERIDAN	3666.0	ANDERSON-DIETZ 1 AND 2 COALS
WR-48	SHERIDAN	3693.8	ANDERSON COAL
BF-01	SHERIDAN	3680.0	COAL MINE SPOILS BANK

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude	Comments
5072B	109.0	2.0	2/22/2006	35.61	3124.4	
5072C	106.0	0.3	2/22/2006	29.25	3130.8	
5080B	88.5	1.3	2/22/2006	46.70	3213.3	
5080C	110.0	0.3	2/22/2006	35.66	3224.3	
LISCOM WELL	135.0	10.0	9/27/2005	98.37	3176.6	
COYOTE WELL	190.0	5.0	9/27/2005	134.86	3159.1	
WHITETAIL RANGER STATION	60.0		1/11/2006	41.29	4003.7	
EAST FORK WELL	193.0	5.0	1/11/2006	129.49	3080.5	
SCHOOL HOUSE PIPELINE WELL	50.4		2/3/2006	24.98	3320.0	
LEMONADE PIPELINE WELL	27.5		2/3/2006	11.22	3593.8	
DRY CREEK PIPELINE WELL	78.2		2/3/2006	64.17	2985.8	
WO-14	66.0		2/25/2006	4.37	3005.6	
WO-15	63.0	12.0	1/26/2006	8.53	3013.5	
WO-16	61.0	3.7	1/26/2006	22.74	3017.3	
NEWELL PIPELINE WELL	325.0	5.0				
OC-28			1/29/2006	68.81	3102.2	
10 MILE CREEK PIPELINE WELL			1/26/2006	72.76	3137.2	
NC02-4	380.0		8/24/2005	200.26	3739.7	
NC02-1	680.5		6/6/2005	624.70	3815.3	
NC02-6	360.0		8/25/2005	238.61	3271.4	
NC02-3	353.0		8/24/2005	181.98	3558.0	
NC02-2	420.0		6/16/2005	106.90	3113.1	
NC02-5	376.0		8/25/2005	262.69	3137.3	
CBM02-8KC	208.0	1.0	1/27/2006	157.98	3104.3	
CBM02-8SS	224.0	10.0	1/27/2006	160.06	3102.1	
CBM02-8DS	446.0	0.3	1/27/2006	102.24	3158.3	
CBM02-8FG	480.4	0.5	1/27/2006	101.96	3158.7	
NANCE PROPERTIES INC	20.0		1/11/2006	10.24	3024.8	
P-5						
WA-9			10/25/1980	11.70	3138.0	
P-10						
WA-2			10/25/1980	45.20	3145.0	
IB-2	245.0		12/22/2005	119.53	3072.1	
MK-4	188.0		12/22/2005	119.65	3075.7	
NM-4	294.0		12/22/2005	120.14	3075.2	
WL-2	199.0		12/22/2005	117.30	3070.3	
WA-7			12/22/2005	55.15	3123.8	
PADGET CREEK PIPELINE WELL	135.0	10.0	2/3/2006	74.68	3310.3	
77-26	216.8	3.6	1/26/2006	145.32	3138.7	
CHROMO PIPELINE			1/29/2006	223.25	3071.8	
WO-8	33.0	12.0	1/26/2006	15.23	3139.8	
WO-9	45.0	21.8	1/26/2006	11.53	3138.5	
WO-10	41.4		1/26/2006	8.63	3136.4	
WO-5	192.0	20.4	1/26/2006	16.97	3143.0	
WO-6	82.0	7.0	1/26/2006	24.27	3135.7	
WO-7	40.0	29.0	1/26/2006	26.58	3133.4	
WO-1	172.0	8.0	1/26/2006	37.26	3152.7	
WO-2	112.0	19.0	1/26/2006	44.46	3143.5	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude	Comments
WO-3	66.0	17.8	1/26/2006	46.05	3140.0	
WO-11	38.5		1/26/2006	8.81	3136.2	
NC05-1	780.0					
WATT PIPELINE WELL	46.0		1/26/2006	21.42	3273.6	
SKINNER GULCH PIPELINE WELL	167.0		1/26/2006	49.50	3680.5	
SPRING CREEK PIPELINE WELL	50.0		1/26/2006	16.27	3613.7	
RBC-1	26.8		1/31/2006	11.60	3843.1	
RBC-2	16.9		1/31/2006	8.21	3841.2	
RBC-3	24.6		1/31/2006	10.77	3849.1	
CBM02-1KC	417.0	0.5	1/31/2006	172.82	3807.5	
CBM02-1BC	255.5	5.0	1/31/2006	101.02	3882.8	
CBM02-1LC	366.0	2.0	1/31/2006	144.13	3837.6	
20-LW	253.0	0.2	2/2/2006	93.94	3846.1	
22-BA	262.0	0.4	8/30/2005	110.10	3419.9	
28-W	144.0	1.3	2/2/2006	109.87	3605.1	
32-LW	51.0	0.2	2/2/2006	37.48	3492.5	
HWC86-9	44.0		2/2/2006	10.44	3159.6	
HWC86-7	71.0		2/2/2006	8.98	3161.0	
HWC86-8	67.0		2/2/2006	9.47	3160.5	
CBM02-4WC	291.0	0.2	12/23/2005	175.87	3324.1	
CBM02-4SS1	221.0	5.0	12/23/2005	75.73	3424.3	
CBM02-4SS2	96.6	30.0	12/23/2005	36.83	3463.2	
HWCQ-2	19.0		2/2/2006	11.83	3328.2	
HWCQ-1	19.5		2/2/2006	11.87	3328.1	
PIPELINE WELL 7(PL-1W) LOHOF	225.0	15.0	2/3/2006	133.53	3716.5	
TOOLEY CREEK WELL	110.0	12.0	1/11/2006	37.11	3717.9	
DICK FLETCHER PIPELINE WELL	42.0		1/26/2006	11.79	3383.2	
INDIAN CREEK PIPELINE WELL	24.3		2/3/2006	16.76	3498.2	
STEWART PIPELINE WELL	25.1		2/3/2006	20.54	3519.5	
TAYLOR CREEK PIPELINE WELL	150.0		1/26/2006	122.84	3787.2	
634	348.0	12.0	12/5/2001	156.11	4324.4	
634A	159.1		12/5/2001	113.81	4367.4	
625	186.0		1/13/2006	48.18	4138.4	
625A	90.6		1/13/2006	54.76	4131.9	
CBM02-7CC	263.4	1.5	12/22/2005	163.77	3736.2	
CBM02-7SS	190.3	5.0	12/22/2005	89.40	3810.6	
CBM02-3CC	376.4	0.3	12/22/2005	301.12	3618.9	
CBM02-3DC	235.0	0.1	12/22/2005	184.69	3735.3	
WR-21	206.0	4.0	1/13/2006	57.40	3832.6	
PKS-3204	82.0		12/10/2005	73.37	3426.6	
PKS-3203	201.0		12/10/2005	121.60	3378.4	
CBM03-10AC	560.0	0.3	12/22/2005	531.11	3598.9	
CBM03-10SS	462.0	1.0	12/22/2005	372.30	3757.7	
HWC-86-2	50.0		12/22/2005	19.62	3440.4	
HWC-86-5	33.0		12/22/2005	14.45	3440.6	
HWC-01	232.0	7.5	12/28/2005	87.89	3442.1	
HC-24	150.0	7.1	10/20/2005	52.72	3447.3	
HC-01	19.7	17.0	10/20/2005	11.39	3445.6	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude	Comments
FC-01	133.0	0.0	8/31/2005	129.04	3606.0	
FC-02	260.0		8/31/2005	240.63	3494.4	
CBM03-11AC	211.0	1.0	12/18/2005	155.71	3794.3	
CBM03-11DC	271.0	0.2	12/18/2005	227.76	3722.2	
CBM03-11CC	438.0	1.5	12/18/2005	382.22	3567.8	
BC-06	188.0	4.6	12/18/2005	89.05	3626.0	
BC-07	66.0	0.8	12/18/2005	41.96	3673.0	
CBM03-12COC	351.0	3.0	12/18/2005	166.43	3548.6	
75-23	247.0		12/18/2005	130.20	3649.8	
WR-23	322.0	6.0	1/13/2006	84.04	3876.0	
SH-624	435.1		12/14/2003	348.02	4296.7	
SHEPA-01	295.0	15.0	2/6/1980	92.39	4046.2	
SHEPA-02	98.0	5.0	2/6/1980	59.00	4079.5	
YA-114			1/6/2006	13.51	3986.5	
YA-105			1/6/2006	11.14	4003.9	
391	175.0		1/6/2006	61.10	3925.9	
YA-109	43.8		12/23/2005	37.72	3792.3	
388	190.0		1/6/2006	81.01	3894.0	
TA-100			1/13/2006	13.94	3886.1	
396	280.0	25.0	1/13/2006	56.81	3882.2	
TA-101			1/13/2006	15.81	3894.2	
TA-102			1/13/2006	21.09	3888.9	
394	242.0	5.0	1/6/2006	90.22	3818.8	
422	187.0		1/6/2006	122.12	3794.9	
395	299.0	15.0	1/6/2006	62.38	3837.6	
424	109.0	2.5	2/6/1980	-5.59	3977.6	
WR-58	55.0	21.0	12/28/2005	18.73	3612.6	
WR-58D	27.0	15.0	12/28/2005	18.87	3608.5	
WR-58A	24.0	8.0	12/28/2005	18.73	3612.6	
WR-58C	23.0	2.0	12/28/2005	22.84	3609.7	
WR-19	305.0	20.0	12/28/2005	140.24	3695.2	
WR-20	166.0	15.0	12/28/2005	115.33	3720.0	
WR-54A	211.0	1.0	12/28/2005	127.92	3503.3	
WR-53A	187.0		12/28/2005	110.04	3497.9	
WR-24	146.0		12/23/2005	34.02	3743.2	
WR-31	316.0	2.0	12/23/2005	182.32	3712.9	
WR-30	428.0	5.0	12/23/2005	200.47	3694.1	
CBM02-2WC	290.0	10.0	12/23/2005	70.62	3721.4	
CBM02-2RC	159.0	1.0	12/23/2005	135.36	3754.6	
WR-33	165.0		12/23/2005	51.92	3680.4	
WR-27	363.0	25.0	12/23/2005	132.51	3539.5	
WR-45	64.0	30.0	10/19/2005	11.30	3626.9	
WR-44	64.0	30.0	10/19/2005	11.05	3625.9	
WR-42	66.0	30.0	10/19/2005	10.76	3625.9	
WR-34	522.0		12/23/2005	176.10	3596.0	
WR-41	40.0	1.0	10/19/2005	18.09	3624.6	
WRE-02	79.0		1/6/2006	35.45	3421.4	
WRN-10	79.0	3.4	12/10/2005	28.49	3404.8	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude	Comments
WRN-11	50.0		12/10/2005	33.94	3402.9	
WRN-15	140.0		1/5/2006	115.01	3384.8	
DS-05A	166.0	5.0	1/5/2006	136.83	3368.7	
WRE-09	232.0		1/6/2006	213.95	3296.8	
WRE-10	183.0		1/6/2006	173.17	3345.3	
WRE-11	127.0		1/6/2006	95.51	3413.4	
PKS-3202	60.0	5.0	12/28/2005	37.63	3400.4	
PKS-3201	390.0	50.0	12/28/2005	159.43	3278.6	
PKS-3200	242.0	20.0	12/28/2005	157.27	3280.7	
PKS-3199	165.0	20.0	12/28/2005	117.89	3321.1	
PKS-3198	112.0		12/28/2005	82.32	3357.7	
DS-02A	150.0		1/5/2006	44.37	3385.6	
WR-29R	72.0		12/10/2005	46.03	3415.0	
WR-55A	72.0		12/28/2005	45.14	3546.0	
WRE-12	172.0		12/10/2005	130.92	3332.3	
WRE-13	206.0		12/10/2005	130.93	3331.7	
PKS-1179	282.0	5.0	12/10/2005	226.42	3231.6	
WRE-16	458.0		12/10/2005	69.69	3480.8	
WRE-18	445.0		12/10/2005	211.79	3361.3	
WRE-20	120.0		1/6/2006	106.19	3413.2	
WRE-19	140.0		1/6/2006	107.29	3413.0	
WRE-21	130.0		1/6/2006	112.71	3416.7	
WRE-17	250.0		12/10/2005	69.92	3492.0	
WR-17B	160.0		12/28/2005	78.37	3496.3	
WR-51A	187.0		12/28/2005	30.97	3510.3	
WR-52B	55.0	59.7	12/28/2005	5.69	3513.1	
WR-17A	88.0		12/28/2005	34.56	3539.3	
WR-52C	62.0	20.0	12/28/2005	19.21	3510.8	
WR-52D	40.0	1.0	12/28/2005	22.95	3506.4	
WR-59	34.0	10.0	12/28/2005	9.42	3460.7	
WRE-25	114.5		1/6/2006	61.07	3488.3	
WRE-24	154.0	20.0	1/6/2006	68.45	3483.7	
WRE-27	77.0	0.5	1/6/2006	48.87	3474.9	
WRE-28	153.0		1/6/2006	66.10	3459.1	
WRE-29	217.0		1/6/2006	129.46	3393.8	
SL-2AC	671.0		1/6/2006	374.21	3550.8	
SL-2CC	1301.0		1/6/2006	470.82	3449.2	
SL-3Q	40.0	2.0	1/12/2006	14.91	3710.1	
SL-3SC	358.0	2.0	1/20/2006	165.71	3639.3	
SL-3AC	523.0	2.0	1/20/2006	219.10	3585.9	
SL-3CC	817.0	0.1	1/12/2006	329.44	3475.6	
SL-3SS	278.0	5.0	1/20/2006	145.54	3659.5	
CC -1	28.0	4.2	12/28/2005	14.44	3505.6	
CC-4	25.0	4.8	12/28/2005	-27.36	3538.4	
CC-3	34.5	4.6	12/28/2005	-14.79	3535.8	
HWC-38	40.5		1/13/2006	21.02	3565.0	
HWC-37	32.0		1/13/2006	11.51	3566.5	
HWC-39	39.0		1/13/2006	26.82	3564.2	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude	Comments
HWC-17	82.0	6.9	1/13/2006	20.89	3589.1	
HWC-6	151.6		1/13/2006	69.15	3525.9	
HWC-10	229.0		12/28/2005	94.87	3515.1	
HWC-11 TR-77	135.0	8.0	12/28/2005	13.49	3601.5	
HWC-15	129.0	10.0	1/13/2006	12.32	3587.7	
HWC-29B	92.0		1/13/2006	45.96	3574.0	
SL-5AC	223.0	1.0	1/13/2006	132.11	3677.9	
SL-5DC	322.0	0.7	1/13/2006	167.98	3642.0	
SL-5CC	430.5	6.0	1/13/2006	180.43	3629.6	
DH 75-102	153.6	6.0	12/18/2005	20.90	3794.1	
SL-5ALQ	35.0		9/16/2005	14.85	3795.2	
SL-6AC	492.0	0.1	12/9/2005	374.80	3845.2	
SL-6CC	685.0	0.5	11/17/2005	521.75	3698.3	59 PSI SHUT IN
AMAX NO. 110	240.0	1.4	1/11/2005	166.66	3798.3	
UOP-09	261.5	0.8	1/27/2006	153.27	3775.7	
UOP-10	207.3	4.4	1/27/2006	141.47	3788.5	
CBM03-13OC	500.0	1.5	1/27/2006	383.64	3547.4	
SL-7CC	515.0	1.0	10/20/2005	456.92	3716.1	16 PSI SHUT IN
SL-8-1Q	19.0	1.0	1/27/2006	12.27	3384.4	
SL-8-2Q	13.8	0.3	1/27/2006	10.54	3383.6	
SL-8-3Q	19.0	1.0	1/27/2006	14.57	3383.9	
SL-8-4Q	17.0		1/27/2006	15.34	3383.0	
FULTON GEORGE *NO.6	410.0	4.0	1/11/2006	16.19	3363.8	
FULTON GEORGE	30.0	1.0	1/11/2006	19.95	3340.1	
HWC 86-13	53.0	3.9	12/28/2005	11.58	3628.4	
HWC 86-15	62.5	30.0	12/28/2005	14.88	3615.1	
SL-4SC	120.4	2.0	12/28/2005	22.28	3617.7	
SL-4AC	279.0	2.0	12/28/2005	47.73	3592.3	
WR-38	286.0	3.8	12/23/2005	72.78	3620.1	
WR-39	312.0		10/19/2005	99.65	3566.4	
WR-48	167.0		12/23/2005	46.03	3647.8	
BF-01	125.0		12/23/2005	30.41	3649.6	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	2006 planned SWL monitoring	2006 planned QW sample collection
5072B	BURGWA	
5072C	BURGWA	
5080B	BURGWA	
5080C	BURGWA	
LISCOM WELL	BURGWA	
COYOTE WELL	BURGWA	
WHITETAIL RANGER STATION	BURGWA	
EAST FORK WELL	SEMI-ANNUAL	
SCHOOL HOUSE PIPELINE WELL	SEMI-ANNUAL	
LEMONADE PIPELINE WELL	QUARTERLY	
DRY CREEK PIPELINE WELL		
WO-14	MONTHLY	
WO-15	MONTHLY	SEMI-ANNUAL
WO-16	MONTHLY	
NEWELL PIPELINE WELL		
OC-28	QUARTERLY	
10 MILE CREEK PIPELINE WELL		
NC02-4	NC	
NC02-1	NC	
NC02-6	NC	
NC02-3	NC	
NC02-2	NC	
NC02-5	NC	
CBM02-8KC	SEMI-ANNUAL	
CBM02-8SS	SEMI-ANNUAL	
CBM02-8DS	SEMI-ANNUAL	
CBM02-8FG	SEMI-ANNUAL	
NANCE PROPERTIES INC	BURGWA	
P-5	MONTHLY	
WA-9	MONTHLY	
P-10	MONTHLY	
WA-2	MONTHLY	SEMI-ANNUAL
IB-2	SEMI-ANNUAL	
MK-4	SEMI-ANNUAL	
NM-4	SEMI-ANNUAL	
WL-2	SEMI-ANNUAL	
WA-7	SEMI-ANNUAL	
PADGET CREEK PIPELINE WELL		
77-26	QUARTERLY	
CHROMO PIPELINE	SEMI-ANNUAL	
WO-8	MONTHLY	
WO-9	MONTHLY	
WO-10	MONTHLY	ONE-TIME
WO-5	MONTHLY	
WO-6	MONTHLY	
WO-7	MONTHLY	
WO-1	MONTHLY	
WO-2	MONTHLY	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	2006 planned SWL monitoring	2006 planned QW sample collection
WO-3	MONTHLY	
WO-11	MONTHLY	
NC05-1	NC	
WATT PIPELINE WELL	SEMI-ANNUAL	
SKINNER GULCH PIPELINE WELL	BURGWA	
SPRING CREEK PIPELINE WELL	QUARTERLY	
RBC-1	MONTHLY	
RBC-2	MONTHLY	
RBC-3	MONTHLY	
CBM02-1KC	MONTHLY	
CBM02-1BC	MONTHLY	
CBM02-1LC	MONTHLY	
20-LW	SEMI-ANNUAL	
22-BA	SEMI-ANNUAL	
28-W	SEMI-ANNUAL	
32-LW	SEMI-ANNUAL	
HWC86-9	MONTHLY	
HWC86-7	MONTHLY	SEMI-ANNUAL
HWC86-8	MONTHLY	
CBM02-4WC	MONTHLY	
CBM02-4SS1	MONTHLY	
CBM02-4SS2	MONTHLY	
HWCQ-2	QUARTERLY	
HWCQ-1	QUARTERLY	
PIPELINE WELL 7(PL-1W) LOHOF	QUARTERLY	
TOOLEY CREEK WELL	BURGWA	
DICK FLETCHER PIPELINE WELL		
INDIAN CREEK PIPELINE WELL		
STEWART PIPELINE WELL		
TAYLOR CREEK PIPELINE WELL	QUARTERLY	
634	SEMI-ANNUAL	
634A	SEMI-ANNUAL	
625	QUARTERLY	
625A	QUARTERLY	
CBM02-7CC	MONTHLY	
CBM02-7SS	MONTHLY	
CBM02-3CC	MONTHLY	
CBM02-3DC	MONTHLY	
WR-21	MONTHLY	
PKS-3204	MONTHLY	
PKS-3203	MONTHLY	
CBM03-10AC	MONTHLY	
CBM03-10SS	MONTHLY	
HWC-86-2	MONTHLY	
HWC-86-5	MONTHLY	
HWC-01	MONTHLY	
HC-24	QUARTERLY	
HC-01	QUARTERLY	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	2006 planned SWL monitoring	2006 planned QW sample collection
FC-01	QUARTERLY	
FC-02	QUARTERLY	
CBM03-11AC	QUARTERLY	
CBM03-11DC	QUARTERLY	
CBM03-11CC	QUARTERLY	
BC-06	SEMI-ANNUAL	
BC-07	SEMI-ANNUAL	
CBM03-12COC	SEMI-ANNUAL	
75-23	SEMI-ANNUAL	
WR-23	MONTHLY	
SH-624	QUARTERLY	
SHEPA-01	MONTHLY	
SHEPA-02	MONTHLY	
YA-114	MONTHLY	
YA-105	MONTHLY	
391	MONTHLY	
YA-109	MONTHLY	
388	QUARTERLY	
TA-100	MONTHLY	
396	MONTHLY	
TA-101	MONTHLY	
TA-102	MONTHLY	
394	MONTHLY	
422	QUARTERLY	
395	QUARTERLY	
424	QUARTERLY	
WR-58	MONTHLY	
WR-58D	MONTHLY	
WR-58A	MONTHLY	
WR-58C		
WR-19	MONTHLY	
WR-20	MONTHLY	
WR-54A	MONTHLY	
WR-53A	MONTHLY	
WR-24	MONTHLY	
WR-31	MONTHLY	
WR-30	MONTHLY	
CBM02-2WC	MONTHLY	
CBM02-2RC	MONTHLY	
WR-33	MONTHLY	
WR-27	MONTHLY	
WR-45	MONTHLY	
WR-44	MONTHLY	
WR-42	MONTHLY	
WR-34	MONTHLY	
WR-41	MONTHLY	
WRE-02	QUARTERLY	
WRN-10	MONTHLY	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	2006 planned SWL monitoring	2006 planned QW sample collection
WRN-11	MONTHLY	
WRN-15	QUARTERLY	
DS-05A	QUARTERLY	
WRE-09	QUARTERLY	
WRE-10	QUARTERLY	
WRE-11	QUARTERLY	
PKS-3202	QUARTERLY	
PKS-3201	QUARTERLY	
PKS-3200	QUARTERLY	
PKS-3199	QUARTERLY	
PKS-3198	QUARTERLY	
DS-02A	QUARTERLY	
WR-29R	MONTHLY	
WR-55A	MONTHLY	
WRE-12	MONTHLY	
WRE-13	MONTHLY	
PKS-1179	MONTHLY	
WRE-16	MONTHLY	
WRE-18	MONTHLY	
WRE-20	QUARTERLY	
WRE-19	QUARTERLY	
WRE-21	QUARTERLY	
WRE-17	MONTHLY	
WR-17B	MONTHLY	
WR-51A	MONTHLY	
WR-52B	MONTHLY	
WR-17A	MONTHLY	
WR-52C	MONTHLY	
WR-52D	MONTHLY	
WR-59	MONTHLY	SEMI-ANNUAL
WRE-25	QUARTERLY	
WRE-24	QUARTERLY	
WRE-27	QUARTERLY	
WRE-28	QUARTERLY	
WRE-29	QUARTERLY	
SL-2AC	MONTHLY	
SL-2CC	MONTHLY	
SL-3Q	MONTHLY	
SL-3SC	MONTHLY	
SL-3AC	MONTHLY	
SL-3CC	MONTHLY	
SL-3SS	MONTHLY	
CC -1	QUARTERLY	
CC-4	QUARTERLY	
CC-3	QUARTERLY	
HWC-38	SEMI-ANNUAL	
HWC-37	SEMI-ANNUAL	
HWC-39	SEMI-ANNUAL	

Appendix B. Site details, water-level data, and 2006 monitoring schedule for ground-water monitoring wells

Site Name	2006 planned SWL monitoring	2006 planned QW sample collection
HWC-17	QUARTERLY	
HWC-6	QUARTERLY	
HWC-10	MONTHLY	
HWC-11 TR-77	MONTHLY	
HWC-15	MONTHLY	
HWC-29B	SEMI-ANNUAL	
SL-5AC	MONTHLY	
SL-5DC	MONTHLY	
SL-5CC	MONTHLY	
DH 75-102	SEMI-ANNUAL	
SL-5ALQ	MONTHLY	ONE-TIME
SL-6AC	MONTHLY	
SL-6CC	MONTHLY	
AMAX NO. 110	SEMI-ANNUAL	
UOP-09	SEMI-ANNUAL	
UOP-10	SEMI-ANNUAL	
CBM03-13OC	SEMI-ANNUAL	
SL-7CC	QUARTERLY	
SL-8-1Q	MONTHLY	
SL-8-2Q	MONTHLY	
SL-8-3Q	MONTHLY	SEMI-ANNUAL
SL-8-4Q	MONTHLY	
FULTON GEORGE *NO.6	BURGWA	
FULTON GEORGE	BURGWA	
HWC 86-13	MONTHLY	SEMI-ANNUAL
HWC 86-15	MONTHLY	SEMI-ANNUAL
SL-4SC	MONTHLY	
SL-4AC	MONTHLY	
WR-38	MONTHLY	
WR-39	MONTHLY	
WR-48	MONTHLY	
BF-01	MONTHLY	

Appendix C

Site details, flow data and 2006 monitoring plans for monitored springs

Appendix C. Site details, discharge data, and 2006 monitoring schedule for monitored springs.

GWIC ID	Site name	Longitude	Latitude	Township	Range	Section	Tract	County
7909	COW CREEK 1 SPRING	-106.25010	45.30790	06S	45E	20	ABBC	ROSEBUD
197243	MOUTH OF HARRIS CREEK	-106.68370	45.21070	07S	41E	23	CCAB	ROSEBUD
197247	SOUTH FORK HARRIS CREEK	-106.60530	45.16420	08S	42E	5	DDDB	BIG HORN
197391	UPPER ANDERSON CREEK SPRING	-106.67810	45.13610	08S	41E	14	BBDD	BIG HORN
197395	197395	-106.18500	45.29530	06S	45E	23	DCDC	POWDER RIVER
197452	ALKALI SPRING	-106.15010	45.19140	07S	46E	31	BACD	POWDER RIVER
197607	UPPER FIFTEEN MILE SPRING	-105.93720	45.39200	05S	47E	16	DCDC	POWDER RIVER
198766	LEMONADE SPRING	-105.92550	45.54550	03S	47E	28	ACAA	POWDER RIVER
198777	EAST FORK SPRING	-105.99100	45.63370	02S	46E	25	ACBA	POWDER RIVER
198811	FRARY SPRING	-105.96310	45.59050	03S	47E	7	AADC	POWDER RIVER
198819	BIDWELL SPRING NORTH PIPE	-105.96280	45.64040	02S	47E	19	CCCC	POWDER RIVER
199568	HEDUM SPRING	-106.07100	45.28230	06S	46E	26	CDBA	POWDER RIVER
199589	ROCK JOB SPRING	-106.19890	45.34200	06S	45E	3	DADD	POWDER RIVER
199600	ANNIVERSARY SPRING	-105.99660	45.66380	02S	46E	13	BACD	POWDER RIVER
204954	STOCKER DRAW SPRING	-106.39490	45.20900	07S	44E	19	CDCC	ROSEBUD
204956	CLARK DRAW 1 SPRING	-106.40960	45.21110	07S	43E	24	CADA	ROSEBUD
204957	CLARK DRAW 2 SPRING	-106.41470	45.21620	07S	43E	24	BCAA	ROSEBUD
205004	HAGEN 2 SPRING	-106.26880	45.34500	06S	45E	6	ACDC	POWDER RIVER
205010	NORTH FORK SPRING	-105.87360	45.29960	06S	48E	20	BDCA	POWDER RIVER
205011	JOE ANDERSON SPRING	-105.95470	45.27150	06S	47E	34	CABA	POWDER RIVER
205034	WATER GAP SPRING	-105.85940	45.22990	07S	48E	17	AADB	POWDER RIVER
205041	SCHOOL HOUSE SPRING	-106.00810	45.19440	07S	47E	32	BABA	POWDER RIVER
205049	CHIPMUNK SPRING	-106.36110	45.21200	07S	44E	21	CCBB	ROSEBUD
210421	THREE MILE SPRING	-106.80030	45.18940	07S	40E	35	BDAC	BIG HORN
211316	LOWER FIRST CREEK SPRING	-106.18160	45.30890	06S	45E	14		ROSEBUD
223695	MOORHEAD CAMPGROUND SPRING	-105.87730	45.05420	09S	48E	17	BCBB	POWDER RIVER
223877	EAST FORK HANGING WOMAN CREEK	-106.40410	45.29090	06S	43E	25	ABDD	ROSEBUD
199572	DEADMAN SPRING	-105.87430	45.29030	06S	48E	29	BABB	POWDER RIVER
223687	ROSEBUD CREEK RBC-4	-106.98630	45.33320	06S	39E	8	C	BIG HORN
223869	POKER JIM MET STATION	-106.31638	45.30981	06S	44E	23	BB	ROSEBUD

Appendix C. Site details, discharge data, and 2006 monitoring schedule for monitored springs.

GWIC ID	Spring source lithology	Nearest overlying coal bed association to spring	Spring recharge origin	Altitude	Spring yield (gpm)	Spring yield date	2006 planned flow monitoring	2006 planned QW sample collection
7909	CLINKER	ANDERSON/DIETZ	LOCAL	3945	10	2/11/2006	QUARTERLY	
197243		WALL	REGIONAL	3241	0.4	7/23/2002	MONTHLY	
197247		ANDERSON	REGIONAL	3690	0.6	6/19/2002	MONTHLY	
197391		ANDERSON	REGIONAL & LOCAL	3665	0.3	6/18/2002	MONTHLY	
197395	SANDSTONE	COOK	LOCAL	3515	4	2/11/2006	QUARTERLY	
197452	COAL	COOK	LOCAL	3470	1.1	3/30/2005	MONTHLY	
197607	COLLUVIUM	PAWNEE	LOCAL	3805	0.6	1/26/2006	QUARTERLY	
198766		CANYON/FERRY	LOCAL	3660	1.8	2/3/2006	QUARTERLY	
198777		CANYON/FERRY	LOCAL	3845	0.4	11/14/2005	QUARTERLY	
198811		CANYON/FERRY	LOCAL	3710	2.1	11/14/2005	QUARTERLY	
198819		CANYON/FERRY	LOCAL	3940	0.5	11/14/2005	QUARTERLY	
199568	SANDSTONE	COOK	LOCAL	3680	0.6	7/30/2005	QUARTERLY	
199589	SANDSTONE	CANYON	LOCAL	3750	0.6	2/11/2006	QUARTERLY	
199600		CANYON/FERRY	LOCAL	3545	0.8	8/13/2005	QUARTERLY	
204954	SANDSTONE	ANDERSON/DIETZ	LOCAL	3775	6.7	4/24/2003	QUARTERLY	
204956	CLINKER	ANDERSON/DIETZ	LOCAL	3800	1.2	12/1/2004	QUARTERLY	
204957	SANDSTONE	ANDERSON/DIETZ	LOCAL	3700	1.4	12/1/2004	QUARTERLY	
205004	CLINKER	ANDERSON/DIETZ	LOCAL	3890	0.6	2/11/2006	QUARTERLY	
205010		CANYON	LOCAL	3960	0.9	7/30/2005	QUARTERLY	
205011		ANDERSON/DIETZ	LOCAL	4050	0.7	7/30/2005	QUARTERLY	
205034	COLLUVIUM	KNOBLOCH	REGIONAL	3640	0.7	7/21/2004	QUARTERLY	
205041	SANDSTONE	CANYON	LOCAL	3735	0.9	8/21/2005	QUARTERLY	
205049	SANDSTONE	ANDERSON/DIETZ	LOCAL	3670	0.6	10/20/2003	QUARTERLY	
210421		DIETZ	LOCAL	3620	12.5	6/9/2003		
211316	COAL AND SANDSTONE	PAWNEE	REGIONAL	3500	0.4	2/11/2006	QUARTERLY	
223695	SANDSTONE	PAWNEE	REGIONAL	3400	1.6	1/27/2006	MONTHLY	ONCE
223877		OTTER	REGIONAL & LOCAL	3475	20	11/10/2005	MONTHLY	
199572	SANDSTONE	CANYON	LOCAL	3940	0.6	9/12/2002	QUARTERLY	
223687				3840.95			MONTHLY	
223869								

Appendix D

Ground-water quality data collected during 2005

Appendix D. Ground-water quality data collected during 2005.

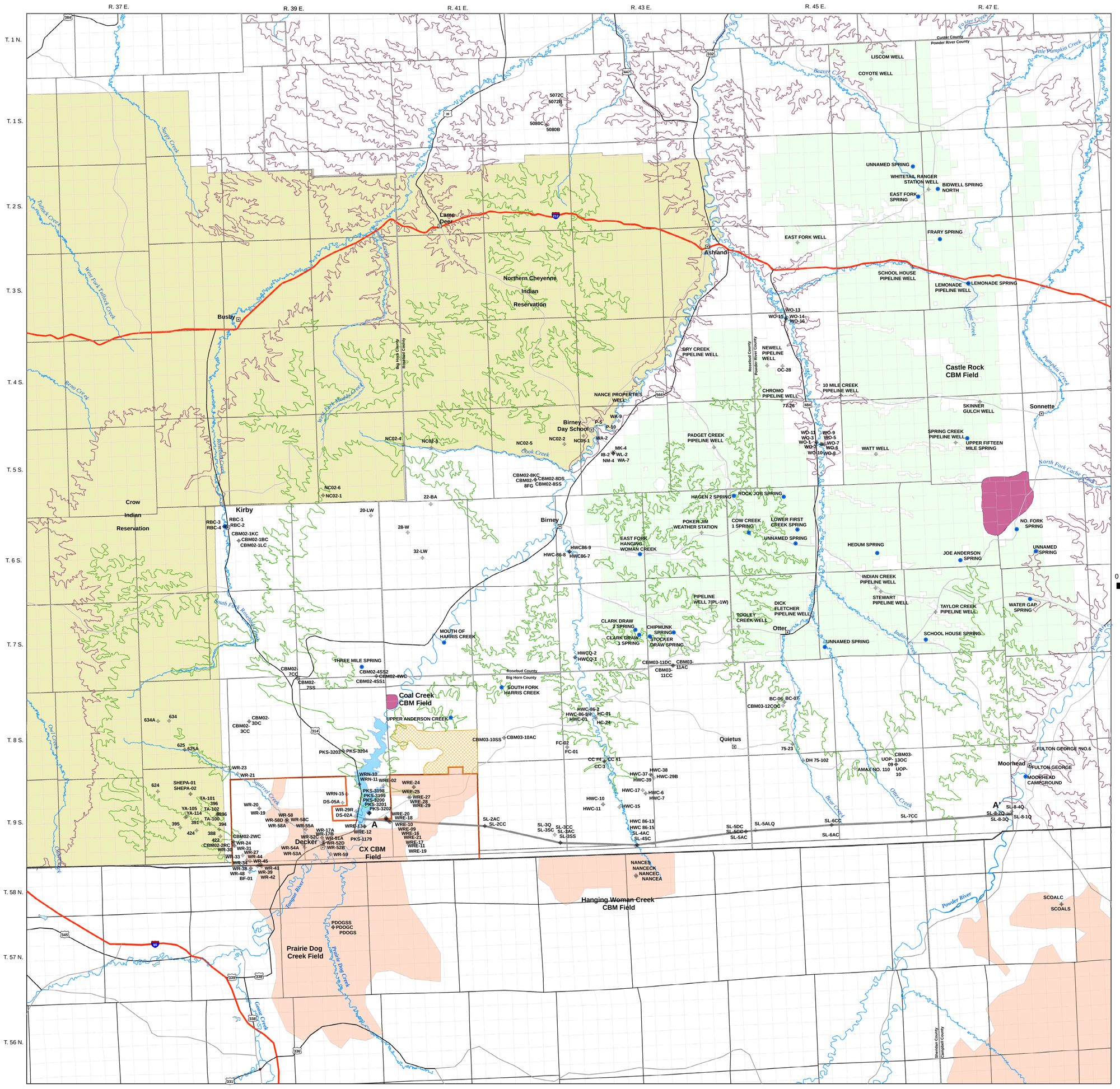
Gwic Id	Site Name	Sample	Latitude	Longitude	Location (TRS)	County	State	Site Type	Depth (feet)	Agency	Sample Date
183564	USDA FOREST SERVICE - WHITETAIL RANGER STATION	2005Q0459	45.6404	-105.9758	02S47E19CDCA	POWDER RIVER	MT	WELL	60	MBMG	4/26/2005
183565	USDA FOREST SERVICE - SKINNER GULCH WELL	2005Q0457	45.4275	-105.9171	05S47E03BCCD	POWDER RIVER	MT	WELL	167	MBMG	4/26/2005
207066	RBC-2	2005Q0521	45.3327	-106.9844	06S39E08CAAA	BIG HORN	MT	WELL	16.9	MBMG	5/18/2005
203708	CBM03-11CC	2005Q0366	45.1793	-106.3647	08S44E05BBBB	BIG HORN	MT	WELL	438	MBMG	2/4/2005
203707	CBM03-11DC	2005Q0363	45.1793	-106.3641	08S44E05BBBB	BIG HORN	MT	WELL	271	MBMG	2/4/2005
203705	CBM03-11AC	2005Q0365	45.1793	-106.3632	08S44E05BBBB	BIG HORN	MT	WELL	211	MBMG	2/3/2005
203709	CBM03-12COC	2005Q0436	45.1352	-106.2121	08S45E16DBCB	POWDER RIVER	MT	WELL	351	MBMG	4/15/2005
203703	CBM03-10AC	2005Q0364	45.1141	-106.6045	08S42E29ADAD	BIG HORN	MT	WELL	560	MBMG	2/2/2005
203704	CBM03-10SS	2005Q0367	45.1141	-106.6045	08S42E29ADAD	BIG HORN	MT	WELL	462	MBMG	2/2/2005
183563	FULTON GEORGE	2005Q0455	45.0637	-105.8709	09S48E08CABC	POWDER RIVER	MT	WELL	30	MBMG	4/26/2005
219125	SL-2AC	2005Q0588	45.0276	-106.6358	09S42E30BDAC	BIG HORN	MT	WELL	671	MBMG	6/21/2005
220857	SL-8-2Q	2006Q0360	45.0182	-105.9052	09S47E25DCDB	POWDER RIVER	MT	WELL	13.8	MBMG	9/30/2005
220859	SL-8-3Q	2006Q0362	45.0177	-105.9028	09S47E25DDCB	POWDER RIVER	MT	WELL	19	MBMG	9/30/2005
221592	MONTANA STATE LAND FLOWING WELL - IP-22	2006Q0359	45.0177	-105.9003	09S47E25DDBD	POWDER RIVER	MT	WELL		MBMG	9/30/2005
220851	SL-8-1Q	2006Q0363	45.0176	-105.8998	09S47E25DDDB	POWDER RIVER	MT	WELL	19	MBMG	9/30/2005
219136	SL-3Q	2005Q0520	45.0161	-106.5386	09S42E36BBAD	BIG HORN	MT	WELL	40	MBMG	5/20/2005
220062	SL-6AC	2006Q0042	45.0148	-106.1514	09S45E36ABBB	BIG HORN	MT	WELL	492	MBMG	7/14/2005
220064	SL-6CC	2006Q0041	45.0148	-106.1513	09S45E36ABBB	BIG HORN	MT	WELL	685	MBMG	7/14/2005
220076	SL-5CC	2006Q0035	45.0119	-106.2715	09S44E36ABBD	BIG HORN	MT	WELL	430.5	MBMG	7/5/2005
219927	SL-5AC	2005Q0587	45.0119	-106.2714	09S44E36ABBD	BIG HORN	MT	WELL	223	MBMG	6/23/2005
219929	SL-5DC	2005Q0589	45.0119	-106.2714	09S44E36ABBD	BIG HORN	MT	WELL	322	MBMG	6/24/2005
219140	SL-3CC	2005Q0585	45.0082	-106.5313	09S42E36DBCB	BIG HORN	MT	WELL	817	MBMG	6/16/2005
219138	SL-3SC	2005Q0586	45.008	-106.5313	09S42E36DBCB	BIG HORN	MT	WELL	358	MBMG	6/15/2005
219139	SL-3AC	2005Q0584	45.0079	-106.5313	09S42E36DBCB	BIG HORN	MT	WELL	523	MBMG	6/15/2005
219617	SL-3SS	2005Q0519	45.0079	-106.5313	09S42E36DBCB	BIG HORN	MT	WELL	278	MBMG	5/17/2005
219169	SL-4AC	2005Q0441	45.0031	-106.4244	10S43E02ABAA	BIG HORN	MT	WELL	279	MBMG	4/13/2005
219141	SL-4SC	2005Q0440	45.0031	-106.4243	10S43E02ABAA	BIG HORN	MT	WELL	120.4	MBMG	4/12/2005
198489	HWC 86-15	2005Q0437	45.0025	-106.4235	10S43E02AABC	BIG HORN	MT	WELL	62.52	MBMG	4/11/2005
198489	HWC 86-15	2006Q0358	45.0025	-106.4235	10S43E02AABC	BIG HORN	MT	WELL	62.52	MBMG	9/27/2005
8888	HWC 86-13	2005Q0435	45.002	-106.4262	10S43E02ABCA	BIG HORN	MT	WELL	53	MBMG	4/12/2005
8888	HWC 86-13	2006Q0361	45.002	-106.4262	10S43E02ABCA	BIG HORN	MT	WELL	53	MBMG	9/27/2005

Gwic Id	Water Temperature (c)	Field pH	Field specific conductance	Lab	Lab pH	Lab specific conductance	Procedure	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Sodium absorption ratio	Potassium (mg/l)	Iron (mg/l)	Manganese (mg/l)	Silica (mg/l)
183564	6.8	8.74	1310	MBMG	7.30	708	DISSOLVED	48.3	53.3	19.4	0.46	7.8	0.025	0.04	14.7
183565	9.5	8.33	2390	MBMG	8.07	3660	DISSOLVED	75.3	63.2	781.0	16.05	9.5	3.24	0.065	7.84
207066	9.5	7.50		MBMG	7.82	918	DISSOLVED	69.0	67.2	43.3	0.89	9.2	0.976	0.307	27.8
203708	15.8	7.59	3022	MBMG	7.87	2960	DISSOLVED	5.7	3.5	814.0	66.28	5.5	0.064	<0.005	8.1
203707	13.0	7.83	4422	MBMG	8.01	4220	DISSOLVED	13.8	10.3	1058.0	52.51	7.1	0.095	0.166	9.92
203705	18.0	7.44	4680	MBMG	7.76	4500	DISSOLVED	48.3	36.6	1064.0	28.11	10.2	0.084	0.082	11.6
203709	14.3	8.56	2010	MBMG	8.22	2090	DISSOLVED	4.0	2.2	546.0	54.52	3.4	0.036	0.017	7.51
203703	15.1	7.95	3023	MBMG	7.94	2990	DISSOLVED	7.8	4.2	765.0	54.84	8.5	0.968	0.043	10.9
203704	13.5	8.11	4252	MBMG	8.18	4080	DISSOLVED	16.0	30.9	1009.0	33.96	10.0	0.106	0.017	7.53
183563	7.4	8.05	1560	MBMG	7.54	2310	DISSOLVED	236.0	139.0	197.0	2.52	16.3	1.52	0.139	15.9
219125	18.5	7.94	2720	MBMG	8.25	2660	DISSOLVED	6.8	3.9	717.0	54.48	6.9	0.711	0.028	9.25
220857				MBMG	7.52	3150	DISSOLVED	391.0	110.0	396.0	4.56	9.7	0.1	2.16	12.2
220859				MBMG	7.58	2590	DISSOLVED	326.0	90.3	286.0	3.61	10.2	4.05	0.721	12.1
221592				MBMG	8.43	892	DISSOLVED	2.4	0.6	249.0	37.15	1.7	0.098	0.005	5.18
220851				MBMG	7.68	2640	DISSOLVED	281.0	129.0	304.0	3.77	12.7	2.56	1.2	13
219136	12.4	6.94	3660	MBMG	7.41	3810	DISSOLVED	285.0	215.0	520.0	5.66	6.9	1.63	0.586	10.8
220062	15.1	8.63	2220	MBMG	8.58	2150	DISSOLVED	7.9	5.3	565.0	38.14	8.4	0.016	0.024	9.05
220064	17.3	7.72	2232	MBMG	7.69	2130	DISSOLVED	8.8	3.9	576.0	40.65	19.5	0.01	0.015	11.4
220076	16.6	8.21	2030	MBMG	8.24	1935	DISSOLVED	5.1	3.3	556.0	47.09	3.8	0.023	0.005	8.19
219927	17.9	8.03	2220	MBMG	8.10	2100	DISSOLVED	7.4	4.9	527.0	36.80	3.8	0.029	0.02	10.3
219929	15.9	8.46	1826	MBMG	8.51	1798	DISSOLVED	4.5	2.6	452.0	42.27	3.6	0.015	0.008	8.36
219140	18.8	8.72	2500	MBMG	8.80	2420	DISSOLVED	4.4	2.2	605.0	58.74	11.8	0.021	0.016	7.26
219138	15.9	8.29	1990	MBMG	8.23	1883	DISSOLVED	5.7	3.2	517.0	43.12	4.7	0.053	0.012	10.1
219139	17.7	8.02	2290	MBMG	7.80	2130	DISSOLVED	5.8	3.3	567.0	46.76	4.9	0.026	0.025	8.58
219617	13.1	8.16	1340	MBMG	8.12	1782	DISSOLVED	4.9	2.4	480.0	44.18	3.4	<0.005	0.005	8.09
219169	13.6	8.74	1970	MBMG	8.70	1910	DISSOLVED	5.2	2.7	488.0	43.15	5.6	0.018	0.01	5.23
219141	12.5	8.14	1870	MBMG	8.16	1874	DISSOLVED	6.7	3.8	498.0	38.25	3.5	0.007	0.003	7.15
198489	10.1	7.15	7270	MBMG	7.94	7010	DISSOLVED	460.0	447.0	1389.0	11.06	12.4	8.08	1.98	13.7
198489				MBMG	7.48	7050	DISSOLVED	495.0	496.0	1481.0	11.26	13.6	9.45	2.12	9.08
8888	10.5	7.09	6020	MBMG	7.31	6120	DISSOLVED	356.0	305.0	1105.0	10.38	12.2	5.98	2.08	13.1
8888				MBMG	7.50	6090	DISSOLVED	380.0	330.0	1311.0	11.88	13.1	7.19	2.27	8.65

Gwic Id	Bicarbonate (mg/l)	Carbonate (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	Nitrate (mg/l)	Flouride (mg/l)	Orthophosphate (mg/l)	Silver (ug/l)	Aluminum (ug/l)	Arsenic (ug/l)	Boron (ug/l)	Barium (ug/l)	Beryllium (ug/l)	Bromide (ug/l)	Cadmium (ug/l)	Cobalt (ug/l)
183564	428.5	0	34.4	3.02	<0.5 P	1.49	<0.05	<1	<10	1.13	257	82.6	<2	67	<1	<2
183565	533.1	0	1670	<10.0	<2.5 P	<1.0	<1.0	<5	<30	<5	113	<10	<2	<1000	<1	<2
207066	565	0	80.3	2.99	<0.5 P	0.33	<0.05	<5	<30	<5	110	79.8	<2	<50	<1	<2
203708	2351	0	<25	33.6	<0.5	<0.5	<0.5	<5	<150	<5	<150	499	<10	<0.5	<5	<10
203707	1540.9	0	1151	27.7	<2.5	<0.5	<0.5	<10	<300	<10	<300	50.5	<20	<0.5	<10	<20
203705	1781.2	0	1239	28.3	<2.5	<0.5	<0.5	<10	<300	<10	<300	24.3	<20	<0.5	<10	<20
203709	1504.7	0	<2.5	18.7	11.8 P	0.198	0.07	<5	<30	<5	<150	235	<2	<50	<1	<2
203703	2141	0	<25	34.5	<0.5	<0.5	<0.5	<5	445	<5	<150	444	<10	<0.5	<5	<10
203704	1229.8	0	1327	26	<2.5	<0.5	<0.5	<10	<300	21.6	<300	<20	<20	<0.5	<10	<20
183563	379.4	0	1192	12.1	<2.5 P	<0.5	<0.5	<5	<30	<5	169	28.7	<2	<500	<1	<2
219125	1676.3	0	<2.5	18.4	0.789 P	<1.0	<0.05	<1	<10	<1	91.7	527	<2	77	<1	<2
220857	467.3	0	1483	210	<2.5 P	3.36	<1.0	<5	168	<5	<150	18.6	<10	<1000	<5	<10
220859	398.5	0	1164	137	<2.5 P	2.49	<1.0	<5	<30	6.7	<150	25	<10	<1000	<5	<10
221592	556.3	8.7	<2.5	15.3	<0.5 P	0.941	<0.050	<1	<30	<1	68.5	90.8	<2	86	<1	<2
220851	400.2	0	1370	25.4	<2.5 P	2.41	<1.0	<5	<30	<5	136	34.3	<2	<1000	<1	2.38
219136	503	0	2173	<25	<2.5 P	<2.5	<2.5	<5	<50	<5	<150	<10	<10	<2500	<5	<10
220062	1273.7	44.4	128	19.1	2.06 P	<0.05	<0.05	<5	<30	<5	<150	124	<2	<50	<1	<2
220064	1482.3	0	77.6	25.7	<0.10 P	<0.05	<0.05	<5	<30	<5	<150	133	<2	51	<1	<2
220076	1288.32	15.2	<2.5	15.2	<0.5 P	0.096	<0.05	<1	<10	<1	96.8	266	<2	<50	<1	<2
219927	1145.6	0	124	37.3	<0.5 P	<0.5	<0.5	<1	<10	<1	64.7	160	<2	<500	<1	<2
219929	1133.99	16.2	10.4	18.7	<0.5 P	<1.0	<0.05	<1	<10	<1	67.4	169	<2	<50	<1	<2
219140	1386	41.2	<25	67.5	<0.5 P	<0.5	<0.5	<1	10.9	<1	120	149	<2	<500	<1	<2
219138	1106.1	0	<25	36	<0.5 P	<0.5	<0.5	<1	<10	<1	65.6	279	<2	<500	<1	<2
219139	1439.6	0	4.43	22.9	<0.5 P	1.05	0.052	<1	<10	<1	42.3	324	<2	<1000	<1	<2
219617	1235	0	<2.5	13.9	5.71 P	0.736	<0.05	<1	<10	1.25	61.5	186	<2	89.8	<1	<2
219169	1274.9	31.6	6.95	26.3	1.22 P	<0.05	<0.05	<5	<30	<5	44.5	167	<2	<50	<1	<2
219141	1379.8	0	19.9	17.9	<0.5 P	<0.05	0.119	<5	<30	<5	<150	195	<10	<50	<5	<10
198489	1177.6	0	5549	14.2	<5.0 P	8.53	<1.0	<10	354	<10	<300	<20	<20	<1000	<10	<20
198489	922.3	0	5221	<50.0	<5 0 P	7.57	<5.0	<10	369	<100	<300	<20	<20	<5000	<10	<20
8888	762.5	0	4058	<10.0	<1.0 P	8.76	<1.0	<10	349	<10	<300	<20	<20	<1000	<10	<20
8888	840.6	0	4288	<25.0	<5.0 P	6.6	<2.5	<10	346	<10	<300	<20	<20	<2500	<20	<10

Gwic Id	Chromium (ug/l)	Copper (ug/l)	Lithium (ug/l)	Molybdenum (ug/l)	Nickel (ug/l)	Lead (ug/l)	Antimony (ug/l)	Selenium (ug/l)	Strontium (ug/l)	Titanium (ug/l)	Thallium (ug/l)	Uranium (ug/l)	Vanadium (ug/l)	Zinc (ug/l)	Zirconium (ug/l)	Total Dissolved Solids
183564	3.5	7.21	61.9	<10	<2	2.12	<2	<1	1560	<1	<5	1.78	<5	50.2	<2	394
183565	<10	<5	148	<10	<2	<10	<10	<5	2172	<1	<25	<2.5	<10	7.6	<2	2873
207066	<10	<5	50.1	<10	<2	<10	<10	<5	1133	<1	<25	<2.5	<10	2.42	<2	580
203708	<10	<10	154	<50	<10	<10	<10	<5	541	<50	<25	<3	<25	36.5	<10	2029
203707	<20	<20	183	<100	<20	<20	<20	<10	922	<10	<50	<5	<50	125	<20	3037
203705	<20	<20	278	<100	<20	<20	<20	<10	2840	<10	<50	<5	<50	80.1	<20	3316
203709	<10	<5	78.4	<10	<2	<10	<10	<5	212	<1	<25	<3	<25	<10	<2	1335
203703	<10	11.4	214	<50	<10	<10	<10	<5	595	14	<25	<3	<25	346	<10	1887
203704	<20	<20	229	<100	<20	<20	<20	<10	1375	<10	<50	<5	<50	<20	<20	3032
183563	<10	<5	91.3	<10	<2	<10	<10	<5	2481	<1	<25	26.1	<10	95.6	<2	1997
219125	12.9	9.04	182	<10	3.76	<2	<2	2.33	496	<1	<5	<0.5	<5.0	10.4	<2	1589
220857	<10	<10	48.9	<50	<10	<10	<10	<5	2915	<5	<25	15.1	<25	<10	<10	2848
220859	<10	<10	43.4	<50	<2	<10	<10	<5	2264	<1	<25	20.8	<25	<10	<2	2229
221592	2.02	2.47	18.1	<10	<2	<2	<2	1.96	74.5	<1	<5	<0.5	<5	<2	<2	558
220851	<10	<5	70.2	<10	3.64	<10	<10	<5	2466	<1	<25	14.2	<10	<10	3.31	2338
219136	<10	<10	157	<50	11.4	<10	<10	<5	5118	<10	<25	5.12	<25	12.7	<20	3461
220062	<10	<10	85	15.7	<2	<10	<10	<5	242	<1	<25	<2.5	<25	9.74	<2	1417
220064	11.8	<5	112	21.6	<2	<10	<10	<5	227	<1	<25	<2.5	<25	<2	<2	1453
220076	4.34	5.8	95.9	<10	<2	<2	<2	1.94	213	<1	<5	<0.5	<5	5.98	<2	1242
219927	6.85	6.18	66.6	<10	<2	<2	<2	1.9	286	<1	<5	<0.5	<5	12.3	<2	1279
219929	4.75	5.2	62.5	<10	<2	<2	<2	1.63	178	<1	<5	<0.5	<5	<2	<2	1075
219140	7.46	7.27	157	17.6	<2	<2	<2	2.51	359	<1	<5	<0.5	<5	17.9	<2	1422
219138	4.99	5.93	88.9	<10	<2	<2	<2	2.89	305	<1	<5	<0.5	<5	53.7	<2	1122
219139	3.06	2.45	109	<10	<2	<2	<2	1.38	336	<1	<5	<0.5	<5	83.7	<2	1327
219617	5.79	13.1	63.6	<10	<2	<2	<2	2.35	214	<1	<5	<0.5	<5	18.6	<2	1128
219169	<10	<5	76	<50	<2	<10	<10	<5	188	<1	<25	<3	<10	<2	<2	1201
219141	<10	<10	61.4	<50	<10	<10	<10	<5	225	<1	<25	<3	<25	<10	<2	1237
198489	<20	<20	237	<100	<20	<20	<20	<10	7407	<10	<50	38.8	<50	22.5	<20	8484
198489	<100	<50	253	<100	<20	<20	<20	<10	7708	<10	<50	41.9	<50	<20	<20	8190
8888	<20	<20	216	<100	<20	<20	<20	<10	5911	<10	<50	18.8	<50	<20	<20	6242
8888	<20	<20	224	<100	<20	<20	<20	<10	6071	<10	<50	20.6	<50	<20	<20	6761

Plate 1. Locations of monitoring sites and Anderson and Knobloch coal outcrops.



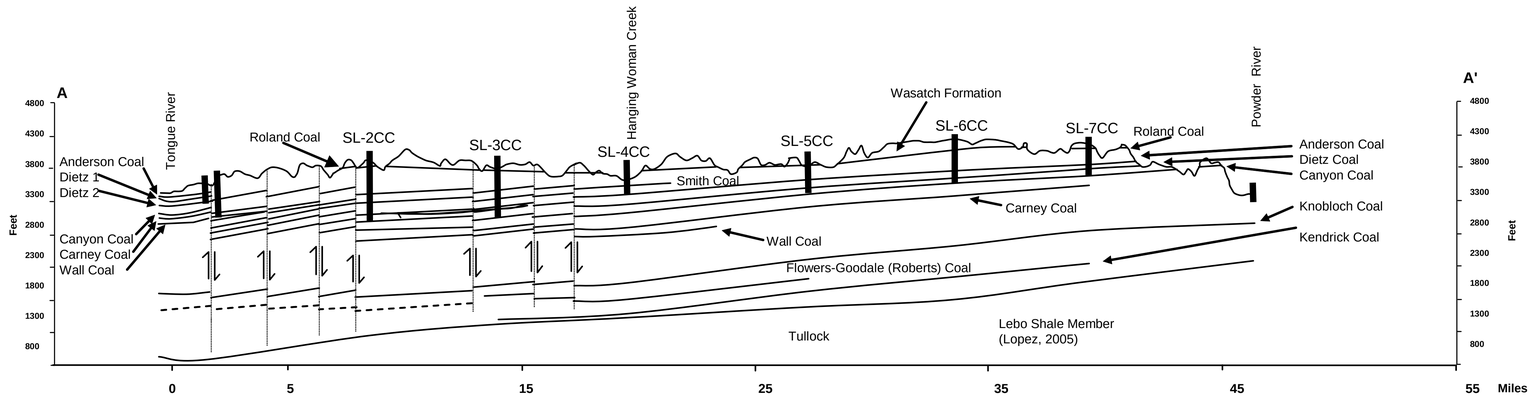
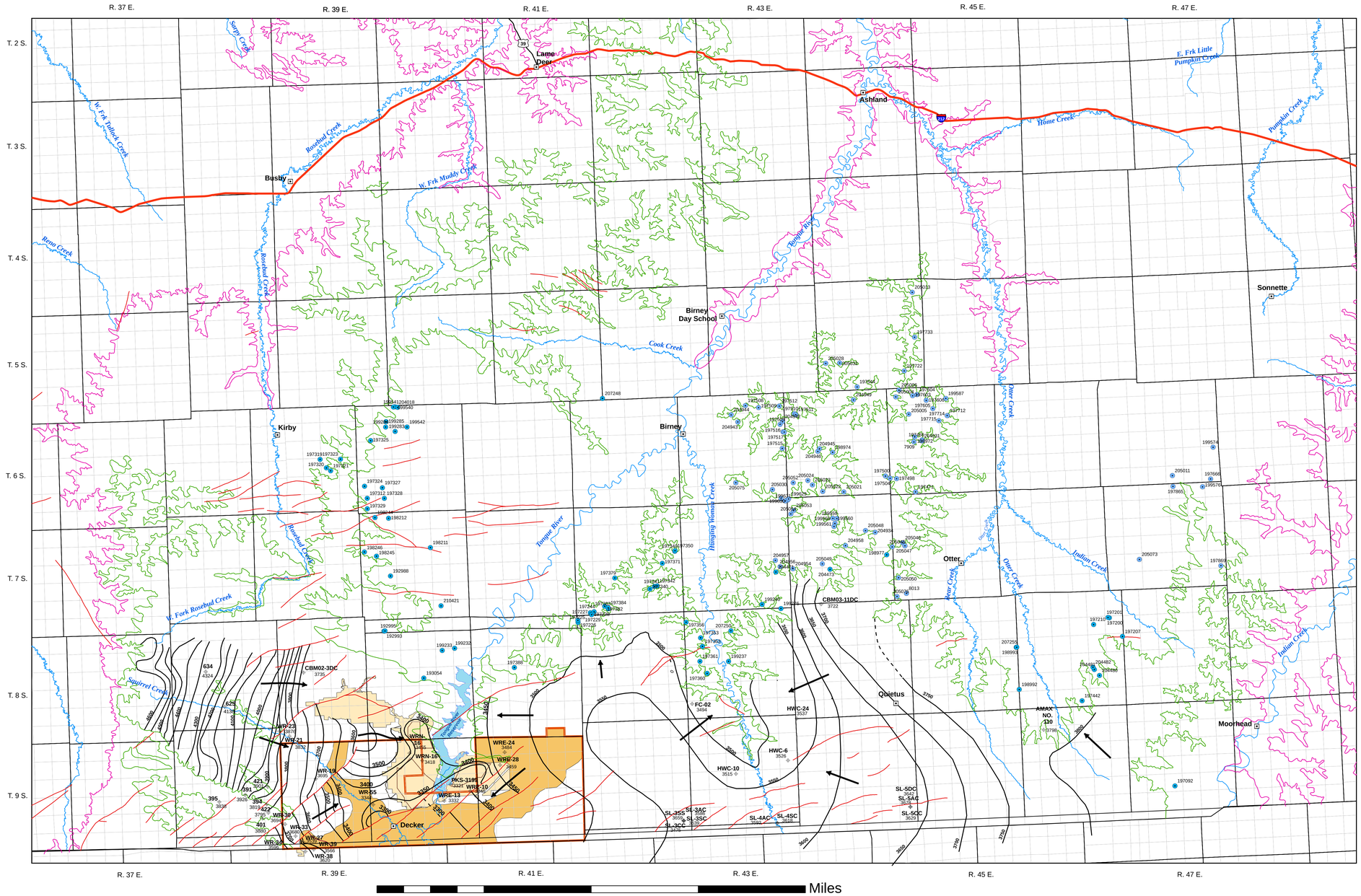


Plate 2. Potentiometric surface for the Dietz coal bed in the southern portion of the Powder River Basin, Montana.



Explanation

- Potentiometric surface, dashed where inferred (in ranges 37 and 38 east, modified from Hedges and others, 1998)
- Approximate direction of ground-water flow
- WR-39 / 3566 — Well name, water-level altitude (ft) (11/2005, 12/2005, 1/2006)
- 197319 — Spring with Dietz coal bed association; GWIC Identifier Number
- Anderson coal outcrop
- Knobloch coal outcrop
- Faults
- Mine area, includes active, permitted and reclaimed
- Mine pit boundary
- CX CBM exploration field
- CBM production or exploration area (12/31/2005)

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Plate 3. Water quality samples collected during the 2005 field season.

Explanation

- Water quality samples 2005
- Stiff diagram showing sodium, chloride, calcium, bicarbonate, magnesium, and sulfate in alluvial formation.
- Stiff diagram showing sodium, chloride, calcium, bicarbonate, magnesium, and sulfate in sandstone formation.
- Stiff diagram showing sodium, chloride, calcium, bicarbonate, magnesium, and sulfate in coal formation.
- Stiff diagram showing sodium, chloride, calcium, bicarbonate, magnesium, and sulfate in coal formation producing methane.
- Anderson coal outcrop
- Knobloch coal outcrop
- Custer National Forest

0 2.5 5 10 Miles

N W E S

R. 37 E. R. 39 E. R. 41 E. R. 43 E. R. 45 E. R. 47 E.

T. 1 N. T. 1 S. T. 2 S. T. 3 S. T. 4 S. T. 5 S. T. 6 S. T. 7 S. T. 8 S. T. 9 S.

Carter County
Powder River County
Rosebud County
Big Horn County

Tongue River
Beaver Creek
Little Pumpkin Creek
Pumpkin Creek
Greenleaf Creek
Rosebud Creek
Sarpy Creek
Tullock Creek
Home Creek
W. Frk Muddy Creek
Reno Creek
Cook Creek
Otter Creek
Honeyroot Woman Creek
South Fork Rosebud Creek
Squirrel Creek
Indian Creek
Bear Creek
Powder River

Lame Deer
Ashland
Busby
Kirby
Birney
Birney Day School
Otter
Quietus
Decker
Sonnette
Moorhead

WHITETAIL RANGER STATION
2005Q0459

SKINNER GULCH WELL
2005Q0457

RBC-2
2005Q0521

CBM03-11DC
2005Q0363

CBM03-11AC
2005Q0365

CBM03-11CC
2005Q0366

CBM03-12COC
2005Q0436

CBM03-10SS
2005Q0367

CBM03-10AC
2005Q0364

HWC 86-13
2006Q0361

HWC 86-15
2006Q0358

SL-2AC
2005Q0588

SL-3SS
2005Q0519

SL-3Q
2005Q0520

SL-4SC
2005Q0440

SL-4AC
2005Q0441

SL-5AC
2005Q0587

SL-5CC
2006Q0035

SL-5DC
2005Q0589

SL-6AC
2006Q0042

SL-6CC
2006Q0041

SL-3SC
2005Q0586

SL-3CC
2005Q0585

SL-3AC
2005Q0584

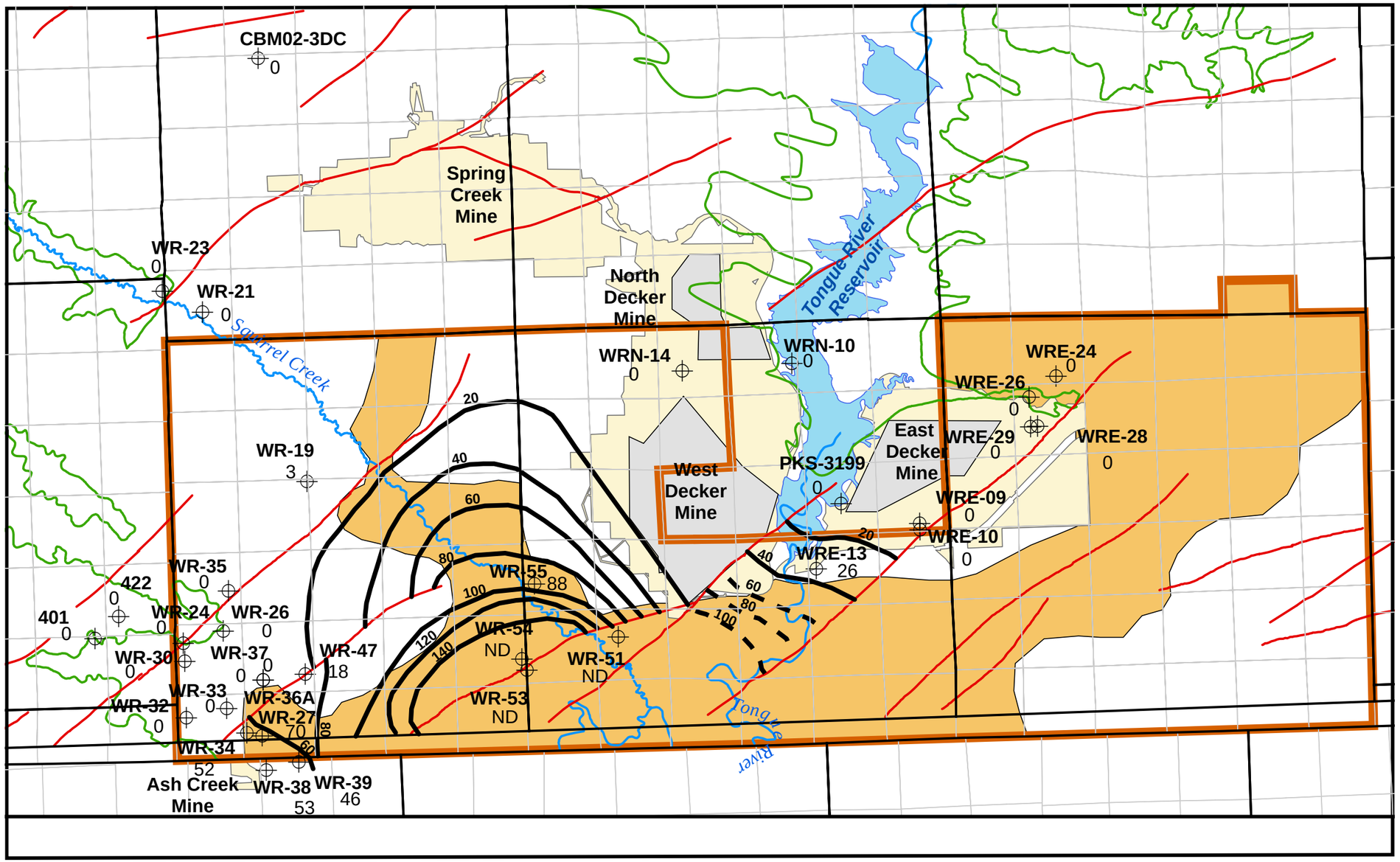
SL-8-2Q
2006Q0360

SL-8-3Q
2006Q0362

SL-8-1Q
2006Q0363

IP-22
2006Q0359

Plate 4. CBM-related drawdown for the Dietz coal bed near Decker, Montana.



Explanation

- WRE-13 / 26 — Monitoring well; Change in water level due to CBM production in feet (11/2005, 12/2005, 1/2006)
- Drawdown related to CBM production (ft)
- Estimated drawdown (ft)
- Faults
- Anderson coal outcrop
- Mine area, includes active, permitted and reclaimed
- Mine pit area
- CBM production or exploration field (12/31/2005)
- CX coal exploration field

N
W
E
S