MBMG Open-File Report 707

2017 Annual Coalbed-Methane Regional Groundwater Monitoring Report: Powder River Basin, Montana

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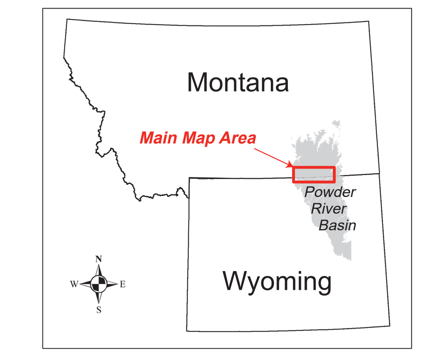
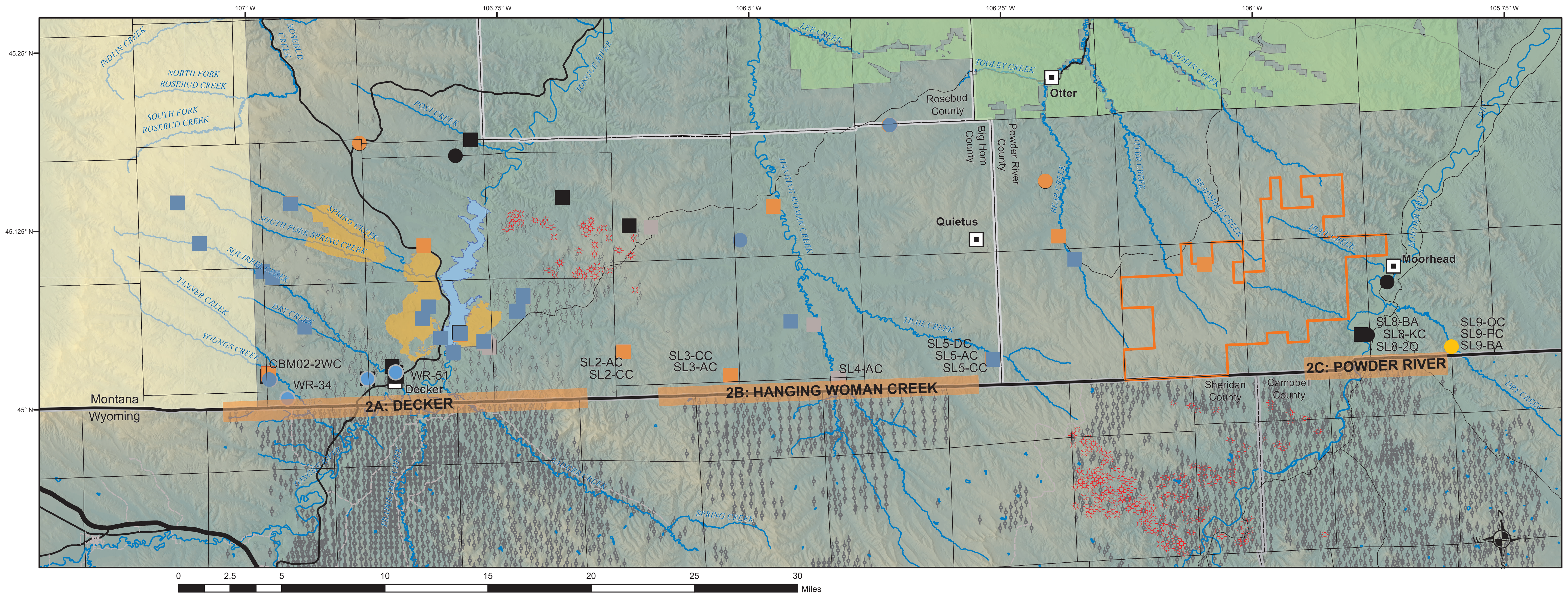
2018





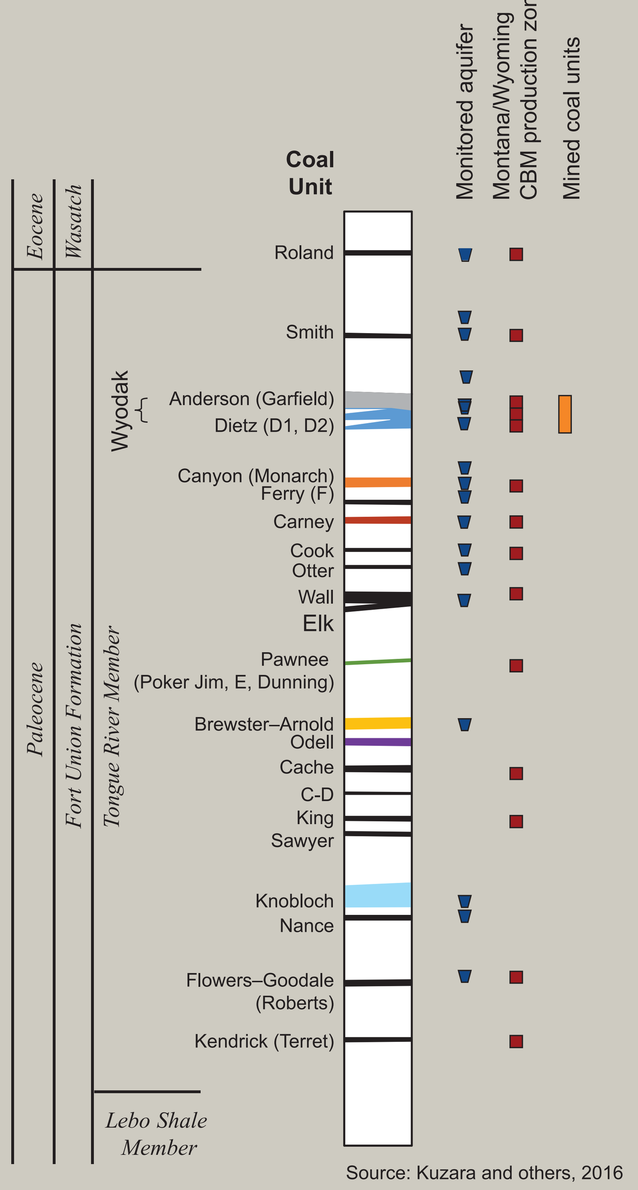


Figure 1. The source of economically produced CBM in Montana is Tertiary Fort Union Formation coal. CBM has been produced from most of the named coals in Montana and Wyoming (red squares). Groundwater monitoring by the MBMG overlaps most of these produced aquifers (blue trapezoids). Coal unit colors indicate the corresponding hydrographs in figure 2.

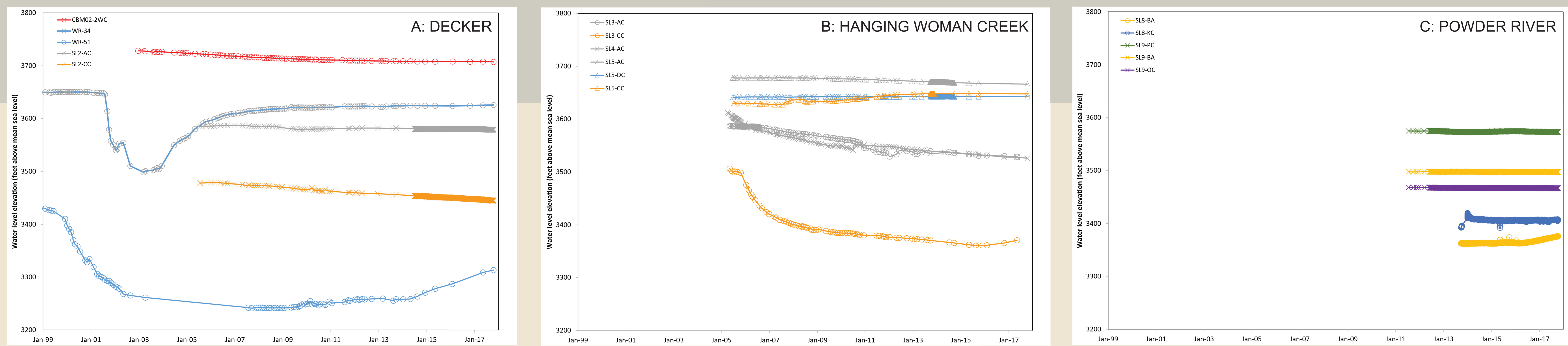


Figure 2. Coal aquifer groundwater levels have responded in a variety of ways to CBM production in Montana and Wyoming based in upon distance from devlepment and geologic structure. Hydrographs (GWIC, 2018) presented here compare the coal aquifer responses within parts of the basin along the state line (indicated on map, above). Hydrograph color corresponds to the coal-aquifer color in figure 1.

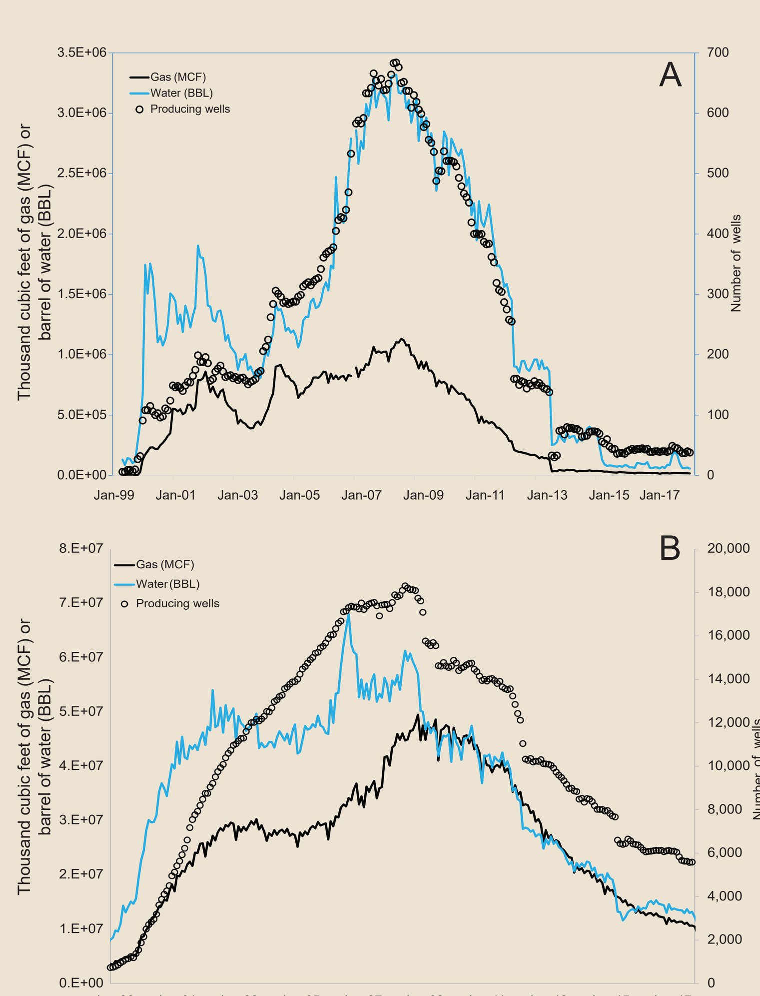


Figure 3. In 2008, coalbed-methane production peaked in the Powder River Basin in Montana at approximately 700 wells (A) and Wyoming at approximately 19,000 wells (B). Production in Montana stabilized at a new, lower rate in 2016. Wyoming's production continues to decrease at an overall slower rate than in Montana. Note different Y-axis scales on A and B.

Maps may be obtained from:
Publications Office
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http://mbmg.mtech.edu

Introduction

In Montana, coalbed methane (CBM) has been commercially produced from the Powder River Basin since 1999, primarily from the coal-rich Fort Union Formation (fig. 1). Methane is adsorbed on coal through weak bonding and water pressure. Pumping groundwater from coalbeds reduces water pressure and allows methane to desorb and be collected (Meredith and others, 2012). Coalbed-methane development occurs near the two large open-cut coal mines in the Decker, Montana area. Both forms of resource development require pumping groundwater and therefore are sources of groundwater-level drawdown. The Montana Bureau of Mines and Geology (MBMG) monitors groundwater drawdown in these coal aquifers, and potential water-quality changes, because these aquifers are widely used throughout the area for domestic purposes and stock water.

The regional coalbed methane groundwater-monitoring network has been active in the Montana portion of the Powder River Basin for the past 15 years. The CBM network is complementary to the coal-mine monitoring program started by the U.S. Bureau of Land Management (BLM) and the MBMG in 1969. The purposes of the network are:

(1) document baseline hydrogeologic conditions in current and prospective areas of coal and CBM development in southeastern Montana;
(2) quantify changes and lack of change in groundwater quantity and quality that occur in response to coal-energy production; and
(3) evaluate predictive tools to improve their capacity to assess magnitude of water-level drawdown and recovery time (Kuzara and others, 2016).

The monitoring program continues to support the BLM, MBMG, Montana Department of Natural Resources and Conservation, the Coalbed Methane Protection Program, landowners, and others to understand impacts and recovery, evaluate modeling predictions, and aid environmental analyses and permitting decisions. The network includes monitoring wells installed in response to actual and potential coal mining and CBM production, as well as "control" wells located outside zones of development.

Groundwater Monitoring along the State Line

Coal-aquifer groundwater levels along the Montana–Wyoming state line have responded to varying degrees to CBM production (figs. 2A, B, C) based, primarily, upon their proximity to development. For example, sites SL3 and SL4 (fig. 2B) are near CBM development along Hanging Woman Creek and the Anderson coal water levels (gray hydrographs) have been lowered by over 50 ft. In contrast, in sites further from development such as SL2 (fig. 2A) and SL5 (fig. 2B), the Anderson coal water levels have declined approximately 10 ft.

CBM production in both Montana and Wyoming has been decreasing over the past 10 years (fig. 3). The MBMG first documented groundwater-level recovery in 2003. Recovery was in response to discontinuation or reduction of production in some CBM fields. The rate of recovery is affected by multiple factors, such as the proximity to producing CBM wells, intensity of CBM development, and other significant groundwater withdrawals such as coal mine dewatering. Site-specific aquifer characteristics—including the extent of faulting and the amount, timing, and location of recharge—also affect groundwater recovery rates. The time required for water levels to recover to near-baseline conditions is difficult to estimate precisely, but based on the measured recovery trends, recovery will occur over decades. Some groundwater levels began increasing in 2003 (WR-34; fig. 2A), after CBM production was reduced in the CX field. Other sites began recovery in 2014 (WR-51; fig. 2A) or 2016 (SL3-CC; fig. 2B), as production slowed in Wyoming. Initial recovery is not observed in some wells, e.g., Anderson coal water levels in wells SL4-AC and SL5-AC (fig. 2B), despite shut-in of almost all of the state line CBM wells in 2015.

Coal aquifer groundwater levels monitored along the Powder River at sites SL8 and SL9 (fig. 2C) were minimally perturbed by CBM production in Wyoming since monitoring began in 2011 and 2013, respectively. However, water levels in the Brewster–Arnold coal near the Powder River (SL8-BA; fig. 2C) are increasing, which may indicate drawdown prior to 2011 or may reflect climatic influences. Continued monitoring at these locations may help identify the cause of these trends.

Computer modeling completed in 2002 that simulated groundwater response to CBM development (Wheaton and Metesh, 2002) indicated that water levels would initially recover rapidly as CBM production decreased, with recovery slowing as the water levels approached the original static level. The water levels in CBM-impacted coal aquifers are generally recovering slower than models predicted, indicating models relied on incomplete or incorrect assumptions about groundwater recharge. Wheaton and Metesh (2002) included recharge from vertical leakage from streams and overlying rock units in model construction; however, vertical hydraulic conductivity has not been quantified in the Powder River Basin and is an important unknown quantity in models constructed for the Fort Union aquifers. Field observations show the potential both for and against a measureable component of vertical groundwater flow. Van Voast and Reiten (1988) showed coal aquifer drawdown passing beneath Squirrel Creek alluvial wells without vertical transmission of drawdown. However, nested well monitoring site WR-17 may be showing migration of drawdown from the Anderson–Dietz coal (well WR-17) to an overlying sandstone aquifer (well WR-17B) (Kuzara and others, 2015). While model predictions fit some recovery curves well (e.g., WR-34), groundwater responses measured at sites SL4 and SL5 indicate that future modeling should carefully consider the inclusion of vertical recharge.

In an effort to facilitate the completion and evaluation of future extractive-energy permits and associated modeling efforts, the MBMG compiled relevant geologic information into groundwater-modeling-compatible spreadsheets. These digital files are available from the MBMG and the BLM. The available geologic records from MBMG water-well and coal databases were evaluated for geologic detail and location accuracy. Borehole information (fig. 4) was gathered for Townships 9 and 10 South from west of Decker (Range 38 East) to east of Moorhead (Range 48 East). Two levels of geologic detail were prepared: one focusing on just the coal (displayed in fig. 4) and one where all geologic layer information was maintained but nomenclature—which varies greatly between logs—was standardized. This dataset will give future modelers a standardized foundation to begin the modeling process.

2018 Monitoring Plan

The current monitoring well network of 124 wells will be visited on a semi-annual basis. There are 47 water-level data loggers installed in monitoring wells, 10 of which were installed in 2017. Semiannual groundwater samples will be collected from well SL8-2Q, which is downgradient from Wyoming CBM production. All monitoring results including water levels, field measurements, and geochemical analysis are available on the Groundwater Information Center Database (MBMG, 2018). Additional water-level data loggers will be installed, and additional groundwater samples collected, as funding allows.

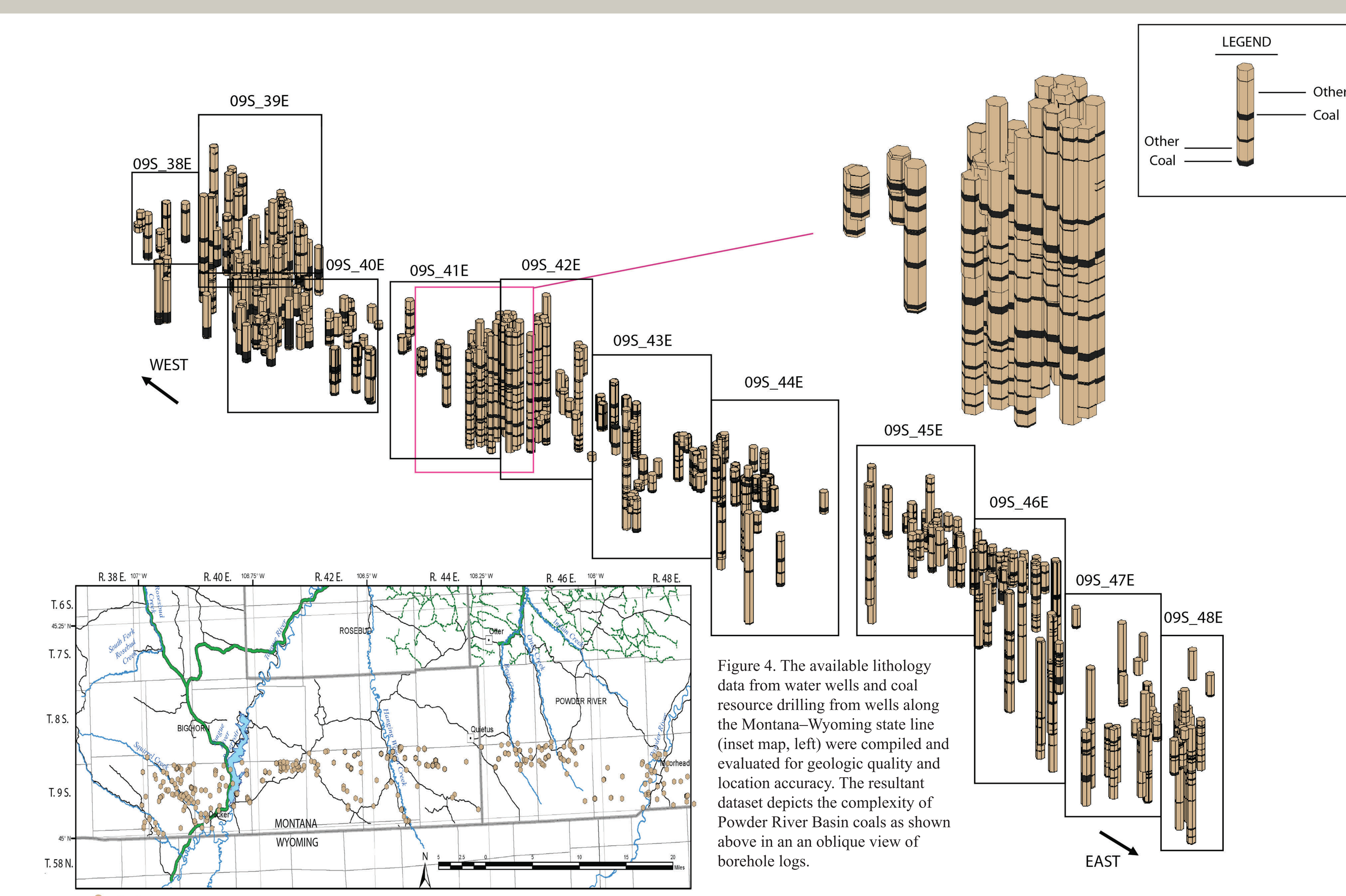

Figure 4. The available lithology data from water wells and coal resource drilling from wells along the Montana–Wyoming state line (inset map, left) were compiled and evaluated for geologic quality and location accuracy. The resultant dataset depicts the complexity of Powder River Basin coals as shown above in an an oblique view of borehole logs.

References

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