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Task 1D Report for the Powder River Basin Coal Review Current Environmental Conditions

ES.1.0 Executive Summary

This Task 1D Report for the Powder River Basin (PRB) Coal Review describes the existing environmental conditions in the Wyoming PRB study area, with the exception of air quality, water resources, and social and economic conditions (which are presented in standalone Task 1 reports) and cultural resources, which is addressed in the Bureau of Land Management (BLM) Cultural Class I Regional Overview - Buffalo Field Office. The descriptions of current environmental conditions in this report are based on published and unpublished information; information obtained from local, state, and federal agencies and industrial companies; and a compilation of past and present actions in the Wyoming PRB developed for the Task 2 Report for the PRB Coal Review (AECOM 2011). The past and present actions summarized in the Task 2 report include surface coal mines (currently 13 are active in the Wyoming PRB study area), oil and gas development, power plants, railroads, coal technology facilities, major transmission lines, other mines, major pipelines, reservoirs, and other industrial and non-industrial developments. Descriptions of the past and present activities identified in the Task 2 report were based on the most recent data available as of the end of base year 2008.

For the purpose of this study, the Wyoming PRB study area comprises all of Campbell County, all of Sheridan and Johnson counties, less the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the Thunder Basin National Grasslands (TBNG), which is administered by the United States (U.S.) Forest Service (FS). State and private lands also are included in the study area. The area of potential effect for the physical, biological, and human resources analyzed in this study varies by resource and in some cases extends outside of this study area, as appropriate.

ES.2.0 Current Conditions

ES.2.1 Topography, Geology, Minerals, and Paleontological Resources

The study area for topography, geology, minerals, and paleontological resources generally includes all or portions of Campbell, Johnson, Sheridan, and Converse counties. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area. It should be noted that some historical predictions of mineral production were analyzed in project areas defined differently from this study area. Some information concerning the mineral production history occurred outside of the defined study area; however, this information is presented because of the relevance to the study area. In addition, certain aspects of general geology (stratigraphy, structural geology) are discussed for the entire PRB, including Montana.

ES.2.1.1 Topography, Geology, and Minerals

The Phase I description of existing conditions in the Wyoming PRB study area for topography, geology, and minerals has been updated based on information from the Wyoming Oil and Gas Conservation Commission (WOGCC) on-line production data, public BLM documents, IHS Energy Services™ (IHS) well data, Wyoming State Geological Survey and United States Geological Survey (USGS) publications, other published documents, and the past and present action descriptions presented in the Task 2 Report for the PRB Coal Review (AECOM 2011). The description of existing conditions in the Wyoming PRB study area for paleontological resources reflects changes in BLM guidance and policy (BLM 2007, 2008b) and passage of the Paleontological Resources Preservation Act of 2009 (BLM 2012).

The PRB is located within the Upper Missouri Basin Broken Lands physiographic subprovince that includes northeastern Wyoming and eastern Montana to the Canadian border (USGS 1970). The topography generally is of low to moderate relief with occasional buttes and mesas (Radbruch-Hall et al. 1980). The general topographic gradient slopes down gently from southwest to northeast, with elevations ranging from 5,000 to 6,000 feet above mean sea level (amsl) on the southern and western portions of the basin to less than 4,000 feet amsl on the north and northeast along the Montana state line. The major drainages in the basin include the Tongue, Powder, Belle Fourche, and Cheyenne rivers. Most of the drainages in the area are intermittent and have flows during high precipitation events or during periods of snowmelt. The drainages are part of the upper Missouri River Valley drainage basin.

The PRB contains Phanerozoic rocks (younger than Precambrian) over 17,000 feet in thickness. These rocks range in age from Cambrian to Tertiary. In addition, there are unconsolidated alluvial and surficial deposits. Most of the rocks older than Tertiary outcrop along edges of the Wyoming PRB study area and also are found in the subsurface of the basin or are exposed along the margins of the basin. Unconsolidated Quaternary deposits consist of alluvium, terraces, colluvium, gravels, and pediments (Love and Christiansen 1985). Alluvial deposits generally are associated with alluvial valleys of the major rivers and tributaries.

The PRB is one of a number of structural basins in Wyoming and the Rocky Mountain area that were formed during the Laramide Orogeny. The basin is asymmetric with a structural axis that generally trends northwest to southeast along the western side of the basin (Flores et al. 1999). From the eastern margin of the basin, the rocks dip from 2 to 5 degrees to the structural axis. From the western edge of the basin, the rocks generally dip approximately 20 to 25 degrees to the axis of the basin. In addition to the major structural elements that define the basin, there are a number of folds on the western and southern margins of the basin. Much of the basin has very little internal structure, and the large area of west-dipping rocks east of the basin axis contains few, if any, major folds or dislocations.

Landslide occurrence is greatest along the Powder River in Johnson and Sheridan counties and along the Little Powder River north of Gillette (BLM 2003a). Slope instability also can occur in surface mine highwalls.

Earthquakes and subsidence do not present a hazard in the PRB based on the lack of active faults in the study area; the low risk of ground shaking in the region if a maximum credible earthquake were to occur; and lack of evidence of subsidence or other geologic hazards in association with coal bed natural gas (CBNG) production.

Most of the coal resources of the basin are found in the Fort Union and Wasatch formations. Although coals are present in the Wasatch Formation, they are not as economically important as the coals in the Fort Union Formation. The Tongue River Member of the Fort Union Formation contains most of the economically important coal zones. A number of coal seams have been identified and mapped in the Wyoming portion of the PRB. Coal stratigraphy is complex because of the nature of the environments in which coal was originally deposited. The Wyodak-Anderson coal has been mined in over 20 mines in the PRB (Stricker and Ellis 1999). Coal quality data from the Wyodak-Anderson coal indicate that the coal is subbituminous, generally low sulfur, and has low concentrations of metallic constituents. The low sulfur nature of the coal has made it valuable because of its cleaner burning characteristics for power generation. Often utilities will blend PRB coal with higher sulfur coals in order to achieve air quality emissions compliance.

Over the past 20 years, conventional oil and gas development in the Wyoming PRB study area has been at a lower rate than CBNG development. Approximately 2,145 conventional wells were drilled from 1990 to 2008. These include 1,105 development oil wells, 693 wildcat (exploration) wells, and 347 service wells of various types (injection, disposal, source water, and observation wells). The only significant discovery has been the African Swallow Field, discovered in 2000, which produced over 1 million barrels of oil and nearly 17.5 billion cubic feet (Bcf) of gas from two wells as of the end of base year 2008 (WOGCC 2010).

As of the end of base year 2008, there were approximately 3,060 productive conventional oil and gas wells in the Wyoming PRB study area and 784 inactive wells (WOGCC 2010). The annual oil and gas production slowly declined between 2003 and 2008, with 10.5 million barrels and 21.2 Bcf produced, respectively, in 2008.

From 1987 to 2003, the total cumulative CBNG production from PRB coals was over 1.2 trillion cubic feet, and the total cumulative water production was approximately 2.3 billion barrels (AECOM 2011). Annual CBNG production increased rapidly from 1999 through 2002 and started to level off in 2003. Annual water production also increased between 1999 and 2002, but started to decrease slightly in 2003. In 2003, the average CBNG production was over 900 million cubic feet per day (MMcfpd). CBNG production appeared to have peaked at 977 MMcfpd in October 2003 (AECOM 2008). Average daily production dropped slightly and leveled off from 2004 to mid-2006. However, as of the end of base year 2008, CBNG production had rebounded and peaked at 548 Bcf, with cumulative gas production at 3.2 TCF and cumulative water production at 5.5 billion barrels (WOGCC 2010). In 2008 there were approximately 20,000 active CBNG wells, with a total annual gas production of approximately 531 Bcf (AECOM 2011).

Surface coal mining alters the topography in mining areas by causing changes in slope, lowering the general land surface, and changing the physical nature of the surficial materials and overburden. The topography is affected only where mining occurs. Oil and gas exploration and development alter the landscape through leveling the land surface for drilling pads and cutting and filling during road construction. Oil and gas development affects topography to a much lesser degree than coal mining; however, it is more widespread than coal mining.

Other mineral resources in the Wyoming PRB study area include uranium, bentonite, aggregates (clinker, sand, and gravel), and leonardite (a form of lignite). Uranium is found in the Wasatch,

Fort Union, and Lance formations. There are three defined uranium districts in the PRB: Pumpkin Buttes, Southern Powder River, and Kaycee (BLM 2003b). Numerous uranium mining sites were present in these districts, but were mined out or not considered economically viable. As of 2008, uranium was produced via the in situ leach method in the Southern Powder River district at Smith Ranch and Highland/Morton Ranch (BLM 2009). Annual uranium production in 2008 was 1.2 million pounds, all from the Smith Ranch-Highland uranium in situ recovery facility in Converse County (Wyoming Department of Revenue 2010). Bentonite mines in the Kaycee Mining District, located in Johnson and Natrona counties, produced an average of approximately 354,000 tons per year from 1988 to 2008, for a total of approximately 7.4 million tons; over 6.0 million tons of bentonite was produced in Johnson County (Wyoming Department of Revenue 2010). Aggregate production in 2008 was approximately 5.7 million tons (AECOM 2011). In 2008, 54,162 tons of leonardite was produced from mines in west-central Converse County.

ES.2.1.2 Paleontological Resources

The BLM has adopted the Potential Fossil Yield Classification (PFYC) system to identify and classify fossil resources on federal lands (BLM 2007). Paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability of finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources. The PFYC system is a way of classifying geologic units based on the relative abundance of vertebrate fossils or scientifically significant fossils (plants, vertebrates, and invertebrates) and their sensitivity to adverse impacts. Within the PFYC system, geologic units are classified as Class 1 through Class 5b, with a higher class number indicating higher fossil occurrence potential.

There are 45 mapped geologic units in the Wyoming PRB study area. Many of the geologic formations exposed at the surface within the study area are exposed only along the margins of the PRB. The most widely distributed units are the Wasatch and Fort Union formations. With the exception of the Lance Formation and Pierre Shale, which are present on the surface in the northeastern corner of the Wyoming PRB study area, the older formations outcrop in the western portion of the basin. However, in the vicinity of the coal mines and CBNG activity in the eastern portion of the basin, these formations occur at depth. Within the study area, the highly fossiliferous White River Formation (Class 5) occurs only on Pumpkin Buttes in southwestern Campbell County.

The main body of the Wasatch Formation (Class 3a) is the most geographically widespread formation in the Wyoming PRB study area and comprises approximately 57 percent of the surface in the study area. The Wasatch Formation in the PRB has yielded fewer occurrences of important fossils than in other basins in Wyoming. While not ranked as high as the main body of the Wasatch Formation as in other basins, the Class 3a rating does not diminish its potential for important fossils. The Class 5 Kingsbury Conglomerate and Moncrief members of the Wasatch Formation, which outcrop in isolated areas along the north-western margin of the Wyoming PRB study area, have a higher potential for fossil occurrence.

The Fort Union Formation (Class 3) is the second most prevalent formation, covering approximately 35 percent of the surface in the Wyoming PRB study area. This formation contains locally abundant fossil vertebrates, invertebrates, and plants, and displays an important time interval during the early Tertiary evolution of mammals.

ES.2.2 Soils and Alluvial Valley Floors

ES.2.2.1 Soils

The study area for soils and alluvial valley floors (AVFs) includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. This includes all or portions of 18 subwatersheds (fourth order). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

The most extensive soils in the Wyoming PRB study area are Entisols, which are recent soils occurring mainly on sloping topography where geologic erosion outpaces soil profile development or organic matter accumulation. They generally are low in plant nutrients and commonly have clay textures. Aridisols occur on extensive areas of gently sloping to nearly level, more stable, topography. These soils commonly have low to moderate organic matter content and plant nutrients in the surface layer. They also have moderate to strong structural development within the surface and subsoil layers. This generally means that carbonates and salts generally have been leached by water to depths of 1 to 2 feet or more. This produces a more fertile rooting zone, particularly when soil textures are loamy rather than sandy or clayey.

Mollisols and fluvial soils also occur to a minor extent within the Wyoming PRB study area. Mollisols are the most fertile and have higher levels of organic matter and nutrients, particularly in the surface layer. These soils are the best source of soil for reclaiming disturbance areas. Fluvial soil types are found on gently sloping to nearly level drainage bottoms. Fluvial soils vary considerably in fertility, depending on the source of alluvium. Fluvial soils typically are low in salts and sodium, tend to be very fertile, and are the most productive in the basin.

Soil baseline characterization is based on Soil Survey Geographic (SSURGO) database review and analyses. SSURGO is the most detailed level of county soil mapping done by the Natural Resources Conservation Service (NRCS). Based on the order 3 soil survey data for each county, areas with severe wind and water erosion hazards, high compaction potential, severe shrink swell potential, poor revegetation potential (based on high or low pH, high salinity, and sodicity), and prime or otherwise valuable agricultural soils were identified in the basin as follows:

- Steep slopes in the Wyoming PRB study area primarily occur along the southwestern corner of Johnson County and in small scattered areas throughout the basin.
- Soils that are prone to wind erosion primarily occur in the southern portion of the Wyoming PRB study area.
- Water erosion prone soils occur along the western portions of the basin. Severe water erosion hazard soils also occur along the north-eastern border of the basin, as well as scattered areas along the Powder River.
- Soils with high shrink/swell potential occur along the northern and western borders of the basin, on both sides of the Powder River, down the center of Johnson County, in the eastern portion and entire southern half of Campbell County, and in scattered areas of Converse County.
- Droughty soils are scattered throughout the Wyoming PRB study area.
- Soils with limited reclamation potential are scattered in isolated areas throughout the Wyoming PRB study area except in southern Campbell County.
- Prime farmland soils in the Wyoming PRB study area primarily are located along the floodplains of the Powder River in southern Johnson County and in scattered locations in Sheridan County.

Based on Geographic Information System (GIS) analysis, as of the end of base year 2008, the existing development-related soil disturbance in the Wyoming PRB study area was approximately 217,647 acres, of which approximately 67,242 acres of disturbance was related to coal mining activity. The primary soil associations impacted as a result of coal mining activity are shown in **Table ES.2.2-1**.

Table ES.2.2-1 Existing Soil Disturbance in the Wyoming PRB Study Area

Subwatershed	Total Cumulative Disturbance[1,2]	Coal Mine-related Disturbance[1]
Antelope Creek	30,282	16,295
Clear Creek	6,582	0
Crazy Woman Creek	2,298	0
Dry Fork Cheyenne River	3,088	0
Lightning Creek	3,850	0
Little Bighorn River	107	0
Little Missouri River	275	0
Little Powder River	24,993	7,874
Middle North Platte River	1,045	0
Middle Powder River	827	0
Middle Fork Powder River	6,399	0
North Fork Powder River	0	0
Salt Creek	809	0
South Fork Powder River	653	0
Upper Belle Fourche River	56,214	21,702
Upper Cheyenne River	26,295	21,371
Upper Powder River	43,259	0
Upper Tongue River	10,671	0
Total	**217,647**	**67,242**

[1] Based on GIS analysis of existing development-related disturbance as of the end of base year 2008.

[2] Inclusive of coal mine-related disturbance.

Source: NRCS 2012.

ES.2.2.2 Alluvial Valley Floors

AVFs consist of unconsolidated stream-laid deposits where water availability is sufficient for subirrigation or flood irrigation activities (Public Law 95-87). The Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LDQ) administers the AVF regulations for coal mining activities in Wyoming. Because their presence can restrict mining activities, AVFs must be identified before leasing and mining can proceed. Coal mine-related impacts to designated AVFs generally are not permitted if the AVF is determined to be significant to agriculture. Conversely, if the AVF is determined not to be significant to agriculture, or if the permit to affect the AVF was issued prior to the effective Surface Mining Control and Reclamation Act date, the AVF can be disturbed during mining but must be restored to essential hydrologic function during reclamation. Currently identified AVFs are described for all coal mines in the Wyoming PRB study area, based on individual mine State Decision Documents.

As discussed in the Task 2 report (AECOM 2011), the coal mines have been grouped into four areas based on geographic distribution within the basin, including: 1) Subregion 1, mines near Gillette and extending to the north; 2) Subregion 2, mines south of Gillette and north of Wright; 3) Subregion 3, mines east of Wright and extending to the south into the northern part of Converse County; and 4) Subregion 4, former mines northeast of Sheridan to the Wyoming/Montana state line.

AVF areas were identified on mines in Subregion 1 including the Buckskin Mine, Eagle Butte Mine, Dry Fork Mine (former Fort Union Mine portion), and Rawhide Mine permit areas. AVFs were not identified on the Wyodak Mine permit area or on the Hay Creek II amendment area of the Buckskin Mine. Mine plan and reclamation features to prevent long-term impacts and the maintenance of essential hydrologic function for declared AVF areas are contained in various sections of each mine's permit document.

AVF areas were identified on mines in Subregion 2 including the Belle Ayr Mine, Caballo Mine, and Caballo Rojo portion of the Cordero-Rojo Mine. No AVFs were identified on the Cordero portion of the Cordero-Rojo Mine, or on the Coal Creek permit area. For the two lease by applications (LBAs) leased after 2008, only the Belle Ayr North LBA tract (leased to the Belle Ayr Mine) has a designated AVF. No identified AVFs or no official AVF determination has been made by WDEQ/LQD, to date, for two additional LBA tracts for which leasing is pending.

AVFs were identified on mines in Subregion 3 including the Antelope Mine, Black Thunder Mine, Jacobs Ranch Mine, and North Antelope/Rochelle Mine. No AVFs were identified on the North Rochelle Mine or the former Dave Johnston Mine, which is located to the southwest of Subregion 3. For the four LBAs leased after 2008, one AVF was determined to be insignificant to farming by WDEQ/LQD. The three remaining LBAs, as well as three LBA tracts for which leasing is pending, had no identified AVFs or official AVF determination made by the WDEQ/LQD to date.

AVFs were identified in the permit areas for all of the former surface coal mines in Subregion 4, including the former Public Service Company of Oklahoma's Ash Creek Mine, Big Horn Coal Mine, and the Welch No.1 North Mine. These mines are in final reclamation or have been reclaimed, with all awaiting final bond release. There are no recently leased or pending LBAs in the Wyoming portion of Subregion 4.

ES.2.3 Vegetation Including Wetlands and Riparian Areas

The study area for vegetation (including wetlands and riparian areas) includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. This includes all or portions of 18 subwatersheds (fourth order). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

ES.2.3.1 General Vegetation

The Wyoming PRB study area is characterized as a mosaic of general vegetation types, which include prairie grasslands, shrublands, forested areas, and riparian areas. These broad categories often represent several vegetation types that are similar in terms of dominant species and ecological importance. Northwest Regional Gap Analysis (NWReGAP) Project resources generated by the USGS were used to identify specific vegetation types within the Wyoming PRB study area. Sixteen vegetation types were identified, of which 12 primarily consist of native vegetation and are collectively classified as rangeland. These rangeland vegetation types include short- and mixed-grass prairie, sagebrush shrubland, saline shrubland, other shrubland, coniferous forest, deciduous forest, aspen, stabilized dunelands, forested riparian, herbaceous riparian, wet meadow, and wetland/fen. The remaining vegetation types support limited or non-native vegetation and include agricultural, urban/disturbed, barren, and open water.

The short- and mixed-grass prairie vegetation community accounted for approximately 31 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This vegetation community is a combination of low, medium, and high herbaceous rangeland types that occur on a wide variety of landforms. Within the PRB study area, short- and mixed-grass prairie areas are most common along the eastern foothills of the Big Horn Mountains and sporadically occur throughout much of the northern and central portions of the Wyoming PRB study area.

The sagebrush shrubland vegetation community accounted for approximately 53 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This vegetation community includes a combination of sparse, moderately dense, and dense Wyoming big sagebrush crown closure with a variety of understory grasses and forbs. Sagebrush shrubland is widely distributed and occupies a large portion of the Wyoming PRB study area. Sagebrush shrublands occur throughout the Wyoming PRB study area, except in the Big Horn Mountains and associated foothills. Larger, more contiguous tracts of sagebrush occur in the northeastern, central, and eastern portions of the Wyoming PRB study area.

The saline shrubland vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This vegetation community typically occurs in saline soils and as a mosaic of multiple communities, with open to moderately dense shrublands. Occurrences often are surrounded by mixed salt desert scrub or big sagebrush shrublands. The herbaceous layer may be present but scattered. Within the Wyoming PRB study area, saline shrublands are dispersed along floodplains, areas with seeps or perched water tables, and along shale badlands.

The other shrubland vegetation type accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This vegetation type is composed of two distinct shrub-dominate plant communities: mountain-mahogany shrubland and mixed foothill shrubland. The mountain-mahogany shrubland community is the largest component of this vegetation type and has two species-dominated sub-classes. The first sub-class occurs primarily in the foothills of the Big Horn Mountains in southwestern Johnson County and is dominated by curl-leaf mountain mahogany. The second sub-class occurs in the southern portion of the Wyoming PRB study area and is dominated by true mountain mahogany. The two mountain mahogany shrubland sub-classes occur on poorly developed soils derived from sandstone, limestone, and shale (Knight 1994). The mixed foothill shrubland component of the other shrubland vegetation type is intermingled among the mountain mahogany communities. This community is dominated by mountain big sagebrush.

The coniferous forest vegetation community accounted for approximately 4 percent of the pre-disturbance vegetation in the Wyoming PRB study area. The species found in this vegetation community tend to form associations based on elevation, exposure, and soil moisture. Typically, these species are segregated according to elevation. Juniper and pine forests tend to be lower in elevation, while spruce and fir forests occur at higher elevations. This vegetation community occurs primarily along the western edge of the Wyoming PRB study area, where the upper-elevation conifer species are more common and in the northeastern corner where the lower elevation species are more common.

The deciduous forest vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This community is dominated by bur oak and is found in upland areas in the northern portion of the Western Great Plains. It often occurs as small to large patches on buttes, escarpments, and in foothill zones, usually on northerly-facing slopes. Historically, a higher cover of grass species occurred as these stands were more open due to more frequent fires. Few good examples of this community likely remain because of past timber harvesting and heavy grazing. Where it occurs at elevations above 3,000 feet, ponderosa pine woodlands are likely adjacent. This vegetation community occurs primarily in the western portion of the Wyoming PRB study area at the base of the Big Horn Mountains, on foothills, and drainageways.

The aspen vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. Aspen communities typically occur in depressions, ravines, valley bottoms, or on the lee sides of ridges. Aspen seedlings are intolerant of drier conditions; therefore, this community distribution typically is dictated by the availability of soil moisture. The understory of the aspen vegetation community has greater productivity and species diversity than any other forested upland vegetation type in the Wyoming PRB study area (Mueggler 1985). Quaking aspen is the dominant species in the aspen vegetation community. Many stands of aspen are a seral (i.e., transitional) community that would have conifers of various ages growing within them. In the Wyoming PRB, this vegetation type is limited to the Big Horn Mountains.

The stabilized dunelands vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. Stabilized dunes typically occur in basins, valleys, and plains. This community is composed of a mosaic of migrating, bare dunes; anchored dunes with sparse to moderately dense vegetation (less than 10 to 30 percent canopy cover); and stabilized dunes. Stabilized duneland is defined by the presence of migrating dunes or, where the dunes are entirely anchored or stabilized, evidence that the substrate is eolian and not residual, the vegetation is early- or mid-seral, and the substrate is likely to become actively migrating again with disturbance or increased aridity. Substrates are usually eolian sand, but small dunes composed of silt and clay downwind from playas in the Wyoming Basins (which usually support greasewood vegetation) also are included. Species occupying these environments often are adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppes, and occasionally woodlands. This vegetation community occurs in the southwestern portion of the Wyoming PRB study area within Converse County and in small patchy areas throughout the study area.

The agricultural vegetation type accounted for approximately 4 percent of the vegetation cover in the Wyoming PRB study area. This land cover type is defined as croplands, pasture, or hay fields that have been plowed or planted. These areas also may include wooded or shrubby draws and riparian areas. Agricultural areas are most common along the eastern edge of the Big Horn Mountains, along the major drainages, and near Wright and Gillette.

The urban/disturbed category accounted for approximately 2 percent of the surface area in the Wyoming PRB study area. This category includes lands covered by homes, businesses, streets, and a portion of the unvegetated surface mining areas. It is most common around cities and towns and along the eastern edge of the Wyoming PRB study area where many coal mines are located.

The barren category accounted for approximately 2 percent of the surface area in the Wyoming PRB study area. This cover type includes rock outcrops, roads, sandbars, eroded gullies, and areas with less than 10 percent ground cover and perennial snow and ice areas, as defined by the NWReGAP. It occurs as small, scattered areas throughout the Wyoming PRB study area, and as several large blocks in the southwestern portion of the study area.

The water category accounted for less than 1 percent of the surface area in the Wyoming PRB study area. This category includes lakes, ponds, streams, and open water in wetlands, as defined by the NWReGAP, and is scattered throughout the Wyoming PRB study area.

Wetland and riparian areas are highly important water-related features in the arid landscape of northeastern Wyoming. Wetland and riparian areas occur throughout the Wyoming PRB study area in all 18 subwatersheds and typically are restricted to the lands immediately surrounding major and minor rivers, streams, creeks, draws, topographical depressions, lakes, and ponds. Four riparian and wetland vegetation types have been identified in the Wyoming PRB study area, including forested riparian, herbaceous riparian, wet meadow, and wetland/fen.

The forested riparian vegetation community accounted for approximately 2 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This vegetation community is characterized by a variety of deciduous and coniferous tree species that occur along riparian areas. Coniferous forested riparian areas are rare, occurring only in the foothills of the Big Horn Mountains along the western edge of the Wyoming PRB study area. Deciduous forested riparian areas are much more common and occur throughout the Wyoming PRB study area.

The herbaceous riparian vegetation community accounted for approximately 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. Herbaceous riparian vegetation is similar to the wet meadow vegetation type and often occurs in similar environments. Herbaceous riparian communities occur throughout the Wyoming PRB study area, with most occurrences associated with streams, rivers, and other aquatic habitats.

The wet meadow vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. This vegetation community is dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows as defined by NWReGAP. Wet meadow is a grassland vegetation community that typically occurs on fine textured soils in valley bottoms where the water table is high enough to saturate the soil during a portion of the growing season. In addition, this vegetation community commonly occurs where springs emerge, along reservoirs, and in irrigated pastures (Knight 1994). Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. Within the Wyoming PRB study area, wet meadow habitats are widely distributed and tend to exist as island habitats surrounded by dominant plant communities such as grasslands or shrublands. Wet meadows are more common in the northern and western portions of the Wyoming PRB study area than in the southern and eastern portions.

The wetland/fen vegetation community accounted for less than 1 percent of the pre-disturbance vegetation in the Wyoming PRB study area. The fen community occurs infrequently throughout the Rocky Mountains. It is confined to specific environments defined by groundwater discharge, soil chemistry, and peat accumulation of at least 1.3 feet. This system includes extreme rich fens and iron fens, both being quite rare. Fens form at low points in the landscape or near slopes where groundwater intercepts the soil surface. Groundwater inflows maintain a fairly constant water level year-round, with water at or near the surface most of the time. Constant high water levels lead to accumulation of organic material. In addition to peat accumulation and perennially saturated soils, the extreme rich and iron fens have distinct soil and water chemistry, with high levels of one or more minerals, such as calcium, magnesium, or iron. The surrounding landscape may be ringed with other wetland systems (e.g., riparian shrublands) or a variety of upland systems from grasslands to forests. These systems are isolated to the lower foothills along the eastern edge of the Big Horn Mountains along the western edge of the Wyoming PRB study area.

Closed depression wetlands occur more frequently than fens. This community is typified by upland depressional basins with an impermeable layer such as dense clay and hydric soils. These wetlands generally depend on precipitation and local runoff for replenishment. They can be saline, causing both the shallow lakes and depressions and the surrounding areas to be more brackish. Species richness varies considerably. These communities are small and scattered throughout the Wyoming PRB study area within potholes, around seeps and springs, and along perennial streams and rivers.

Based on GIS analysis, as of the end of base year 2008, the existing development-related disturbance to vegetation communities (less riparian and wetland vegetation) in the study area was 155,509 acres, of which 20,877 acres of disturbance was related to coal mining activity (**Table ES.2.3-1**). The primary vegetation communities impacted as a result of coal mine development have included sagebrush shrublands and short- and mixed-grass prairie. Based on GIS analysis, as of the end of base year 2008, the existing development-related disturbance to wetland, wet meadow, and riparian areas in the study area was 6,429 acres, of which 1,407 acres of disturbance was related to coal mining activity (**Table ES.2.3-1**). The primary wetland/riparian communities impacted as a result of coal mine development have included wetland/fen communities. As of the end of base year 2008, approximately 39 percent of previously disturbed vegetation had been permanently reclaimed. Specific to the coal mines, approximately 32 percent of the vegetation disturbance had been permanently reclaimed. It is assumed that the species composition on the reclaimed land is different than surrounding undisturbed lands, particularly in regard to the percent of woody shrub species during the early years following reclamation.

Table ES.2.3-1 Existing Vegetation Disturbance in the Wyoming PRB Study Area

Vegetation Community	Total Cumulative Disturbance[1,2]	Coal Mine-related Disturbance[1]
Short and Mixed-grass Prairie	57,863	7,140
Sagebrush Shrublands	89,331	12,447
Saline Shrubland	830	11
Other Shrublands	79	33
Coniferous Forest	958	15
Deciduous Forest	1	0
Aspen	4	0
Stabilized Dunelands	64	0
Agricultural	6,380	1,231
Urban/Disturbed	47,323	41,756
Barren	4,843	2,568
Forest Riparian	2,852	293
Herbaceous Riparian	1,994	151
Wet Meadow	0	0
Wetland/Fen	1,583	963
Water	3,543	633
Total[3]	**217,647**	**67,242**

[1] Based on GIS analysis of existing development-related disturbance as of the end of base year 2008.

[2] Inclusive of coal mine-related disturbance.

[3] Slight differences in totals may be due to rounding.

Source: USGS 2010.

ES.2.3.2 Invasive and Non-native Species

Once established, invasive and non-native plant species can outcompete and eventually replace native species, thereby reducing forage productivity and the overall vigor of existing native plant communities. Noxious weeds occur throughout the Wyoming PRB study area. Their occurrence, distribution, and density are variable and influenced by many factors, including disturbance type and frequency, climatic conditions, soil conditions, and local management efforts. Noxious weed lists are maintained by the Wyoming Weed and Pest Council and by county weed and pest districts. A total of 45 noxious weed species and invasive species of concern are known to occur in the Wyoming PRB study area. Although data relative to known occurrences of noxious weeds in the Wyoming PRB study area are scarce, the actual occurrence potential is assumed to be commensurate with the type and frequency of disturbance and the site-specific reclamation and weed control measures that currently are or would be implemented.

ES.2.3.3 Special Status Species

A total of 16 special status plant species were identified as potentially occurring within the Wyoming PRB study area, including two federally threatened species, six BLM sensitive species, and eight FS sensitive

species. No Wyoming Game and Fish Department (WGFD) sensitive species were identified in the Wyoming PRB study area. Occurrence potential was evaluated for each species based on its habitat requirements and/or known distribution. **Table ES.2.3-2** lists the BLM and FS sensitive species and their associated habitats.

Ute ladies'-tresses orchid (*Spiranthes diluvialis*) currently is listed as federally threatened (USFWS 2012b). A petition to delist this species and initiate a 5-year review was issued by the U.S. Fish and Wildlife Service (USFWS) in 2004 (69 Federal Register 60605-60607), and a rangewide status review was completed in 2005 (Fertig et al. 2005). The final ruling is pending. This species currently is known from western Nebraska, southeastern Wyoming, north-central Colorado, northeastern and southern Utah, east-central Idaho, southwestern Montana, and central Washington. In Wyoming, the Ute ladies'-tresses orchid is known from the western Great Plains in Converse, Goshen, Laramie, and Niobrara counties. Rangewide, the Ute ladies'-tresses orchid occurs primarily on moist, sub-irrigated or seasonally flooded soils in valley bottoms, gravel bars, old oxbows, or floodplains bordering springs, lakes, rivers, or perennial streams at elevations between 1,780 and 6,800 feet (Fertig 2000). In Wyoming, this species is known from four occurrences, all discovered between 1993 and 1997 (Fertig et al. 2005). The only population known to occur within the Wyoming PRB study area is located in Converse County, along a tributary of Antelope Creek. The BLM Casper Field Office administers the land at this location. The number of individual plants observed in this population between 1994 and 2004 varied from 0 to 35 (Fertig et al. 2005).

The blowout penstemon (*Penstemon haydeni*) is listed as federally endangered (USFWS 2012a). The plant's current known range in Wyoming consists of the Ferris Dunes area in northwestern Carbon County, where the plant is restricted to two habitat types: steep, northwest facing slopes of active sand dunes with less than 5 percent vegetative cover; and north-facing sandy slopes on the lee side of active blowouts with 25 to 40 percent vegetative cover (USFWS 2012a). Blowouts are formed as strong winds deposit sands from the windward side of a dune to the leeward side and create a sparsely vegetated crater-like depression. Known populations in Wyoming are found between 6,680 and 7,440 feet amsl. This species also is suspected to occur on the Thunder Basin National Grasslands based on the occurrence of potentially suitable habitat (USFWS 2012a).

Table ES.2.3-2 BLM and FS Sensitive Plant Species (2012)

Common Name	Scientific Name	BLM[1]	FS[1]	Habitat Association[2]/ Elevational Range	Habitat
Laramie columbine	*Aquilegia laramiensis*	S	--	RO 6,250- 8,000 feet amsl	Often found in shady crevices of north-facing granite boulders and on cliffs with pockets of rich soil.
Limber pine	*Pinus flexilis*	L	--	LIM 4900-12,000 feet amsl	Often found in open forests in the sub alpine to alpine zones and in semi-arid areas on dry rocky ridges and windswept peaks. In Wyoming, it grows mainly on soils derived from limestone or sandstone and is notably absent on adjacent granitic substrates.
Porter's sagebrush (Porter's wormwood)	*Artemisia porteri*	D	--	GL 5,300- 6,500 feet amsl	Occupies sparsely vegetated badlands of ashy or tufaceous mudstones and clay slopes. In the northern Wind River Basin, this species is found in semi-barren, low desert shrub communities on dry, whitish, ashy-clay hills, gravelly-clay flats, and shaley erosional gullies of the Wagon Bed Formation.
Many-stemmed spider-flower (slender spiderflower)	*Cleome multicaulis*	S	--	GL 5,860 feet amsl	Occupies whitish, alkali-rich, strongly hydrogen-sulfide scented soils that border shallow, spring-fed playa lakes or dried lakebeds. Populations are most abundant on damp, but not flooded, flats bordering playa lakes. This species also may be present in lower numbers on clayey dunes surrounding alkaline lakes. Small patches also may occur in dry alkaline depressions.

Table ES.2.3-2 BLM and FS Sensitive Plant Species (2012)

Common Name	Scientific Name	BLM[1]	FS[1]	Habitat Association[2]/ Elevational Range	Habitat
Williams' wafer-parsnip (Williams' spring parsley)	*Cymopterus williamsii*	S	--	RO 6,000-8,300 feet amsl	Occupies open, south or east-facing ridge tops and upper slopes with exposed limestone outcrops or talus. Suitable soils tend to be thin, sandy, and often restricted to small cracks or pockets in limestone bedrock. Barren rock can provide up to 50 percent of the total cover.
Laramie false-sagebrush (Laramie chickensage)	*Sphaeromeria simplex*	V	--	PJ, LIM, MS 7,200-8,760 feet amsl	Occupies gentle slopes or rims of dry, rocky limestone-sandstone "pebble plains" in wind-scoured openings.
Barr's milkvetch	*Astragalus barrii*	--	D	GL, MS 3,700-5,700 feet amsl	A cushion plant in badland islands in grassland matrix. Occupies eroded ridge tops, calcareous, zeolite, bentonite influenced soils, upper and midslope, more often on north and east aspects. Needs a pollinator.
Iowa moonwort	*Botrychium campestre*	--	S	GL, MS 3,700-5,000 and 10,800 feet amsl	Native species are found in unplowed prairies with thatch or disturbance (due to grazing), loess prairies, dunes; sandy soils along railroad tracks, calcareous soils underlain by: limestone, Pierre Shale, Laramie Formation, and calcareous sedimentary rocks. This species is associated with little blue stem.
Foxtail sedge	*Carex alopecoidea*	--	S	RIP 5,600-5,900 feet amsl	Wet meadows, streamside, *Carex* willow communities.
Prairie dodder	*Cuscuta plattensis*	--	S	GL, SS 4,200-4,900 feet amsl	Annual, rootless, twining, parasitic herb found on sand prairie hills parasitizing Psoralea, Ambrosia, Grindelia, Solidago, and Helianthus spp.

Table ES.2.3-2 BLM and FS Sensitive Plant Species (2012)

Common Name	Scientific Name	BLM[1]	FS[1]	Habitat Association[2]/ Elevational Range	Habitat
Elliptic spike rush	*Eleocharis elliptica*	--	S	RIP 6,200 to 7,250 feet amsl	Associated with thermal seeps/ springs and stock ponds.
Visher's buckwheat (Dakota buckwheat)	*Eriogonum visheri*	--	V	GL, MS 1,900-3,000 feet amsl	Occurs in badland islands in a grassland matrix; needs a pollinator.
Common twinpod	*Physaria didymocarpa* var. *lanata*	--	S	GL, PP, WT 3,300-9,000 feet amsl	Occurs in the PRB on sandstone outcrops, redbed clay (clinker or scoria)-shale slopes, calcareous substrates, and road cuts on open, shrub-dominated slopes, sometimes in association with a sparse cover of ponderosa pine and Rocky Mountain juniper.
American cranberrybush (highbush cranberry)	*Viburnum opulus var. americanum*	--	S	RIP 4,200-4,950 feet amsl	Occurs in wetlands, fens, marshes, moist woods, and thickets in association with paper birch.

[1] S = Suspected; D = Documented; DH = Documented historically; L = Likely; V = Vicinity; (D) = Documented/not concern (the Medicine Bow-Routt National Forests and Thunder Basin National Grassland).

[2] AL = Alpine; AQ = Aquatic; AS = Aspen; B = Blowout (in sand); CON = Mix conifer forest; FEN = Peatfen or mire; FM = Forest meadow; GL = Grassland; LIM = Limber pine; LPP = Lodgepole pine; MS = Mountain shrub; PJ = Pinyon pine/juniper; PP = Ponderosa pine; RIP = Riparian; RO = Rock/cliff/cave/canyon/mines; S = Sand; SF = Spruce/fir; TU = Tundra; WET = Wetland; WSSS = Windswept short scrub; WT = Woodland thicket.

Sources: Anderson and Cariveau 2003; BLM 2012; Fertig 2000; Steele 2012; U.S. Department of Agriculture 2012; Wyoming Natural Diversity Database (WYNDD) 2012.

ES.2.4 Wildlife, Fisheries, and Habitat-related Values

The study area for wildlife, fisheries, and related habitat values includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. This includes all or portions of 18 subwatersheds (fourth order). It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

ES.2.4.1 Wildlife

ES.2.4.1.1 General Wildlife

A substantial amount of wildlife habitat has been impacted by past and present activities in the Wyoming PRB study area. These disturbances include, but are not limited to, agriculture, mining, roads, railroads, urban areas, oil and gas well development, power plants, and other energy-related development. Key issues for wildlife, fisheries, and related habitat values in the Wyoming PRB study area as a result of energy-related and mineral development can be classified as temporary and long-term. Potential temporary impacts arise from habitat removal and disturbance associated with a project's development and operation (e.g., coal mines, CBNG wells, etc.) and would cease upon project completion and reclamation in a given area. Potential long-term impacts consist of permanent changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success, and habitat disturbance related to longer term projects (e.g., power plant facilities, rail lines, etc.). Direct impacts to wildlife populations as a result of development could include limited direct mortalities, habitat loss or alteration, habitat fragmentation, and animal displacement. Indirect impacts could include increased noise, additional human presence, and the potential for increased vehicle-related mortalities. The severity of both temporary and long-term impacts would depend on factors such as the sensitivity of the species impacted, seasonal use patterns, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate).

Considerable research has been conducted regarding the effects of habitat fragmentation on wildlife populations that are caused by a variety of human activities, including energy-related development. Habitat fragmentation from facilities such as roads, well pads, mines, pipelines, and electrical power lines can result in the direct loss of potential wildlife habitat. Other effects from habitat fragmentation, such as increased noise, increased human presence, dispersal of noxious and invasive weed species, and dust deposition from unpaved road traffic can extend well beyond the surface disturbance boundary. These effects result in overall changes in habitat quality, habitat loss, increased animal displacement, reductions in local wildlife populations, and changes in species composition. However, the severity of these effects on terrestrial wildlife depends on factors such as sensitivity of the species, seasonal use, type and timing of project activities, and physical parameters (e.g., topography, cover, forage, and climate). The following section examines the effects to various groups of species determined from available literature.

Table ES.2.3-1 summarizes the existing development-related disturbance to vegetation communities as of the end of base year 2008. Based on this GIS analysis, the existing development-related disturbance to associated wildlife habitats in the Wyoming PRB study area totaled 217,647 acres, of which 67,242 acres of disturbance was related to coal mining activities. The primary habitats impacted as a result of coal mine development have included mixed grass and short-grass prairies and sagebrush shrublands. Lesser amounts of coniferous forest, riparian/wetland, and aquatic habitats also have been disturbed. As of the end of base year 2008, approximately 39 percent of previously disturbed wildlife habitat had been permanently reclaimed. Specific to coal mines, approximately 32 percent of the previously disturbed wildlife habitat had been permanently reclaimed (AECOM 2011b).

Big game species that are expected to occur in suitable habitats throughout the Wyoming PRB study area include pronghorn, white-tailed deer, mule deer, elk, and moose. The Wyoming PRB study area includes the following crucial and severe ranges for big game species: crucial winter yearlong and

severe winter range for pronghorn, crucial winter and crucial winter yearlong range for mule deer, crucial winter and crucial winter yearlong range for elk, and crucial yearlong and crucial winter yearlong range for moose. No crucial or severe ranges have been identified within the Wyoming PRB study area for white-tailed deer. These and other seasonal ranges are presented below for each species. No big game migration corridors are recognized by the WGFD in this area. Big game range data for this study were obtained from the WGFD (2012a).

Of the 14 pronghorn antelope herd units that are entirely or partially within the Wyoming PRB study area, the overall population trend of 9 of these has been stable to increasing. Five herd units exhibited a decreasing trend. This most likely was a result of lower fawn ratios, harsh winter conditions, disease, and increased harvest (WGFD 2012c). Extensive on-going and planned future energy development were considered potential management concerns for some herd units. For example, increased road density, loss of vegetation, and increased human presence has the potential to adversely affect herd units subject to CBNG development (WGFD 2012c).

White-tailed deer population trends have been stable or increasing within the Wyoming PRB study area. Increasing population levels can be accredited to the inaccessibility of habitat in the northwestern part of the Wyoming PRB study area, which impedes hunting and urbanization.

Overall, the mule deer population trend is decreasing in the Wyoming PRB study area. No herd units have demonstrated increasing population trends. Specific details on impacts to mule deer populations are unknown; however, it is suspected that increased road density, loss of vegetation, and increased human presence may cause stress to the herd units in areas that are subject to considerable development.

Elk in the Wyoming PRB study area are exhibiting an increasing population trend. Herd units that have experienced drastic growth have done so as a result of lack of access for hunting, low predation rates, and herd management strategies. Similar to mule deer, increased road density, loss of vegetation, and increased human presence have the potential to negatively affect elk herds.

There is little suitable moose habitat within the Wyoming PRB study area. Based on seasonal range maps from the WGFD, moose primarily are restricted to areas along the study area's western boundary in the Big Horn Mountains. This population appears to be stable. As of the end of base year 2008, there was no disturbance to moose habitat as a result of energy-related development, agriculture, or urban development within the Wyoming PRB study area.

Raptor species migrate through and forage in all habitats present in the Wyoming PRB study area. Nesting habitat includes trees, cliffs, grassland, mammal burrows, and manmade structures. In the Wyoming PRB study area, breeding habitat is relatively limited for raptor species that nest exclusively in trees or on cliffs. In addition, wooded riparian areas may provide winter roost habitat for bald eagles. A total of 6,905 raptor nests occur within the Wyoming PRB study area, representing at least 19 species. An additional 2,729 raptor nests occur within the Wyoming PRB study area for which the species is not known.

Several species of upland game birds may occur within the Wyoming PRB study area, including ring-necked pheasant, gray partridge, chukar, wild turkey, mourning dove, greater sage-grouse, and sharp-tailed grouse (WGFD 2009). The greater sage-grouse is discussed under special status species. Mourning doves are abundant in a variety of habitats that occur in the Wyoming PRB study area. Both the gray partridge and ring-necked pheasant occur locally near agricultural lands and along river bottomland. Wild turkeys occur locally in ponderosa pine and shrubby or forested riparian areas. None of these species, with the exception of the greater sage-grouse, is specifically monitored or managed other than through normal hunting seasons.

Suitable waterfowl habitats within the Wyoming PRB study area include major rivers, streams, creeks, draws, lakes, and ponds. These features provide stopover habitats for migrating waterfowl, as well as

breeding habitats. As of the end of base year 2008, approximately 98 percent of the CBNG-produced water in the Wyoming PRB study area was discharged to on-channel impoundments/ephemeral drainages or headwater reservoirs/off-channel impoundments (approximately 69,700 and 13,100 acre-feet, respectively) (AECOM 2011a). Most of the CBNG discharge water is lost through infiltration (72 to 80 percent), evaporation, or evapotranspiration (AECOM 2011b). Although much of this water evaporates or infiltrates, substantial quantities remain on the surface and have resulted in the expansion of wetlands, stock ponds, and reservoirs, potentially increasing waterfowl breeding and foraging habitats. Produced water in some parts of the Wyoming PRB study area is disposed of in containment reservoirs, which also may provide waterfowl habitats, although in many cases appropriate vegetative cover and foraging areas have not developed around these reservoirs. It is possible for salts to accumulate in some CBNG water containment reservoirs. As water evaporates, salinity increases and may result in mass production of salt-tolerant invertebrates such as brine shrimp, a major food source attractive to birds (Pennak 1989; Tribbey 1988). Waterfowl mortalities resulting from salt crystallization and/or toxicity have been documented in hypersaline wetlands in North Dakota and California, where sodium concentrations exceeding 17,000 milligrams per liter (mg/L) were reported and alternative freshwater sources were not available nearby (Gordus et al. 2002; Windingstad et al. 1987). Similarly, in Canada, lake concentrations of sodium in excess of 30,900 mg/L were reported to cause mortality in some Canada geese. Moving salt-stressed geese to freshwater resulted in full recovery (Wobeser and Howard 1987).

The median sodium concentration of Fort Union Formation CBNG-produced water is 270 mg/L (BLM 2003a). If sodium concentrations are maintained below 17,000 mg/L in the evaporation ponds, the potential for adverse effects to waterfowl would be minimal. Further, presence of freshwater sources within the study area, including the Upper Tongue River; Upper, Middle, and Little Powder Rivers; and Crazy Woman Creek, would decrease the potential for sodium toxicity to migratory waterfowl (Kantrud and Stewart 1977; Swanson et al. 1983).

A wide variety of migratory birds utilize the Wyoming PRB study area during migration or the breeding season, potentially utilizing all habitat types. Few data are available on population numbers of these species; however, Breeding Bird Survey (BBS) data (Sauer et al. 2011) can be used to determine population trends in a geographic area. There are 20 active BBS routes in the Wyoming PRB study area, for a total of approximately 430.6 miles. This number of BBS routes is too few to support statistically valid estimates of population. Even at the state scale, estimates for many species are not statistically robust (Sauer et al. 2011). Loss and degradation of habitats likely has occurred, as has disturbance-related effects to individual birds resulting from construction and production activities. In areas of concentrated development, the breeding density of some species may have been reduced due to these and other effects. Species that are specific to grassland and shrub-steppe habitats, and that are sensitive to disturbance and habitat fragmentation, likely have been the most affected.

ES.2.4.1.2 Special Status Wildlife Species

Impacts to special status species have paralleled those discussed above for wildlife. One federal candidate species, 28 FS sensitive species, 24 BLM sensitive species, and 38 WGFD species of greatest conservation need were identified as potentially occurring in the Wyoming PRB study area.

Federally Listed and Federal Candidate Species. The greater sage-grouse is a native game bird closely tied to sagebrush-dominated landscapes in the western U.S. and Canada. Since 1986, greater sage-grouse populations have stabilized and even increased in some areas. However, there is still concern over the long-term viability of the species because of continuing loss and fragmentation of habitat, as well as new threats, such as the West Nile virus (Connelly et al. 2004). A more recent study by Taylor et al. (2012) evaluated both the effects of oil and gas development on the greater sage-grouse population in northeastern Wyoming and the current viability of the population. The greater sage-grouse population has experienced an 82 percent decline within the oil and gas fields (Walker et al. 2007). Small populations of greater sage-grouse are vulnerable to extirpation by a catastrophic event (Soule and

Mills 1998), and the effect of a West Nile virus outbreak-year alone could cut a population by more than half (Taylor et al. 2012).

On March 5, 2010, the USFWS determined that the greater sage-grouse warranted protection under the Endangered Species Act; however, proposing the species for protection was precluded by the need to take action on other species facing more immediate and severe extinction threats, so the greater sage-grouse was added to the candidate species list. Conservation efforts for this species in Wyoming currently are coordinated by the WGFD in cooperation with the USFWS, BLM, and regional greater sage-grouse working groups.

Greater sage-grouse core population areas have been identified as areas with the highest breeding densities as well as areas important for connectivity between populations. The core and connectivity habitats in the Wyoming PRB study area cover 1,071,648 and 283,734 acres, respectively, which accounts for approximately 17 percent of the total study area. The WGFD has identified a total of 295 active leks throughout the Wyoming PRB study area; energy-related disturbance occurs within the 2.0-mile protection buffer of 258 of these active leks.

Forest Service Sensitive Species. The 28 FS sensitive species identified as potentially occurring in the Wyoming PRB study area include 5 mammals, 22 birds, and 1 amphibian. In addition to the federally listed greater sage-grouse, these include Townsend's big-eared bat, spotted bat, fringed myotis, black-tailed prairie dog, swift fox, American bittern, trumpeter swan, mountain plover, long-billed curlew, black tern, bald eagle, northern harrier, northern goshawk, ferruginous hawk, peregrine falcon, western yellow billed cuckoo, short-eared owl, western burrowing owl, Lewis' woodpecker, olive-sided flycatcher, loggerhead shrike, grasshopper sparrow, sage sparrow, Brewer's sparrow, McCown's longspur, chestnut-collared longspur, and northern leopard frog.

Wyoming BLM Sensitive Species. The 24 BLM sensitive species identified as potentially occurring in the Wyoming PRB study area include 6 mammals, 16 birds, and 2 amphibians. Those not already listed as federal or FS sensitive species that are expected to occur in suitable habitats throughout the PRB study area include the long-eared myotis, white-faced ibis, sage thrasher, Baird's sparrow, and Columbia spotted frog.

ES.2.4.2 Fisheries

ES.2.4.2.1 General Fisheries

The study area for fisheries consists of perennial streams and standing water environments (ponds, lakes, and reservoirs) within 18 fourth order watersheds (subwatersheds) in the Wyoming PRB. The subwatersheds are part of eight basins: Powder River, Little Powder River, Tongue River, Belle Fourche River, Cheyenne River, North Platte River, Little Bighorn River, and Little Missouri River. Fish resources within the Wyoming PRB study area include a mixture of coldwater and warmwater species. Species that are managed by the WGFD include game or sport fish and special status species. Eighteen game fish species representing five families (sturgeons, trout, perches, catfishes, and sunfishes/bass) occur in one or more of the subwatersheds.

The Powder River and its tributaries support 28 known fish species of which 20 are native. Most of these species are tolerant of widely fluctuating environmental conditions, such as turbidity, salinity, and water temperature. The common species in the river include flathead chub, sturgeon chub, goldeye, river carpsucker, stonecat, common carp, longnose dace, and channel catfish. The game species in the Powder River and its tributaries include black bullhead, channel catfish, stonecat, smallmouth bass, rock bass, green sunfish, sauger, and walleye. Although rare, the shovelnose sturgeon also has been reported in the Powder River. Trout species such as brook trout and brown trout are found in the headwaters of the Crazy Woman Creek, Middle Fork Powder River, North Fork Powder River, Salt Creek, South Fork Powder River, Upper Powder River, Willow Creek, and Sanchez Creek. Standing waters in the Powder River Basin mainly consist of relatively small (less than 10 acres) reservoirs and

farm ponds. Various trout species, channel catfish, and largemouth bass are the primary stocked species. Since 1995, most of the stocking has been done by private landowners.

The Little Powder River drainage basin contains the entire Little Powder River subwatershed. Flowing water in this basin is restricted to three stream reaches, all of which are on private land. The Little Powder River and a short reach of the Dry Fork Little Powder River below its confluence with Moyer Springs Creek are perennial. The only coldwater habitat in the drainage is Moyer Springs Creek, a 0.5-mile reach of stream that contains a wild brook trout population. There is no perennial water in any of the other tributary streams in the drainage. Only one small standing lake, Weston Reservoir (Little Powder Reservoir) is suitable for game fish and is on accessible public land (Stewart 1996). The predominant habitat types are runs and pools. Streambanks typically are unstable with little or no vegetation. Warmwater game fish species that occur in stream segments with more persistent flow include brown bullhead, channel catfish, green sunfish, and largemouth bass. Fish numbers are limited due to the relatively small size of the stream segments and low water levels.

The waterbodies in the Upper Tongue River consist of headwater tributary streams, mainstem portion of the Upper Tongue River, and privately owned ponds. Habitat quality varies throughout the subwatershed. Although coldwater habitat is provided in the headwater tributaries, an absence or scarcity of deep pools in some of the streams limits the development of larger fish (Stewart 1995). Irrigation diversions reduce flows on many streams and form barriers downstream of Interstate 90 (I-90) that impede seasonal upstream fish movements. Game fish species include the Snake River cutthroat trout and Yellowstone cutthroat trout, as well as the rainbow, brown, and brook trout, which inhabit headwater tributaries. The lower portion of the Upper Tongue River also supports sauger and smallmouth bass (Stewart 1995). Some of the ponds contain warmwater game species such as the brown bullhead, channel catfish, green sunfish, white crappie, and rock bass.

Most of the streams in the Upper Belle Fourche River subwatershed are unsuitable for coldwater fish due to higher water temperatures. None of the streams located in the Upper Belle Fourche subwatershed support self-sustaining trout populations. Habitat for warmwater fish also is limited as a result of water diversions and the relatively small size of the waterbodies (McDowell 1996a). Runs are the dominant habitat type throughout the drainage (McGree et al. 2011). Undercut banks and woody debris were largely absent, overhanging vegetation typically was sparse, and aquatic vegetation usually was absent or sparse. Private farm ponds and reservoirs represent the primary type of warmwater habitat. Limited information is available for fish occurrence in the privately-owned waterbodies. Game fish species likely inhabiting many of the ponds and reservoirs include the black bullhead and green sunfish (McDowell 1996a). The Belle Fourche River below Keyhole Reservoir is dominated by native nongame fish species but also contains game species such as channel catfish and smallmouth bass.

Subwatersheds in the Cheyenne River Basin include Antelope Creek, Upper Cheyenne River, Dry Fork Cheyenne River, and Lightning Creek. Approximately 45 percent of the basin is located on public land managed by the BLM, FS, or the state (Bradshaw 1996b). However, most of the bottomland and riparian areas of the Cheyenne River are privately owned. Streams in these subwatersheds are considered unsuitable by the WGFD as a result of intermittent flows and relatively high summer water temperatures. Runs and pools are the most abundant habitat types (McGree et al. 2011). Undercut banks, overhanging cover, and woody debris largely were absent at the survey sites. Leafy spurge, Russian olive, and tamarisk were found along the mainstem portion of the Cheyenne River. Standing waters in the basin consist of reservoirs and ponds, most of which are less than 10 surface acres. The WGFD stocks privately owned farm ponds based on their potential to support game fish species and accessibility to public fishing. Green sunfish and black bullhead are known to be abundant in some waterbodies (Bradshaw 1996b). Channel catfish and largemouth bass may be present in low numbers in some waterbodies.

The Middle North Platte River subwatershed is contained within a small portion of this basin (northwest corner) and includes watercourses such as Sage Creek and Sand Creek. The area on the north side of the North Platte River is arid with typical plains streams (Deromedi 1996). The streams within this basin

generally are small, and flows are intermittent or low throughout the year (Deromedi 1996). They flow through low-gradient sandy and silty soils that generally are not suitable habitat for game fish species.

Within the Wyoming PRB study area, the Little Bighorn subwatershed contains a few perennial streams such as Elkhorn, Gay, East Pass, West Pass, Twin, and East Twin creeks. The Little Bighorn River basin is a tributary to the Yellowstone River and historical range for native Yellowstone cutthroat trout (McDowell 1996b). Because of the remoteness of part of the drainage basin, especially the West Fork of the Little Bighorn River Basin, fishery surveys have been limited, and data are lacking to evaluate the presence of endemic populations of Yellowstone cutthroat trout (McDowell 1996b). Various trout species occur in Elkhorn, East Pass, and West Pass creeks (McDowell 1996b; WGFD 2003). Flow in Twin Creek, a tributary to East Pass Creek, is insufficient to support trout.

The majority of the Little Missouri Basin is contained within Crook County except for some very small sections in Campbell County. These small sections within Campbell County comprise the portion of the Little Missouri River subwatershed within the Wyoming PRB study area. Small stock water ponds and irrigation reservoirs in the Hattie Creek, Switzer Draw, Cracker Creek, and Flat Creek drainages provide the majority of fisheries habitat (McDowell 1996c). The WGFD listed the majority of the waterbodies in this drainage basin as unsuitable for sustaining a fishery (McDowell 1996c).

ES.2.4.2.2 Special Status Fish Species

Nine fish species that potentially occur in the Wyoming PRB study area subwatersheds have special status designations. No federally listed, proposed for listing, or candidate fish species occur in the Wyoming PRB study area. However, 9 species have special status by the BLM, FS, or WGFD. All 9 species have one of the four highest priority designations (NSS1, NSS2, NSS3, and NSS4) by the WGFD, all of which are native special status categories considered Species of Greatest Conservation Need by the WGFD.

The flathead chub is known to occur in five basins (Powder River, Little Powder River, Tongue River, Cheyenne River, and Little Bighorn River basins) and 12 subwatersheds within the Wyoming PRB study area. Surveys conducted in 2002 collected this species in the mainstem portion of the Powder River and several tributary draws (WGFD 2003). The preferred habitat for this species is relatively large rivers and streams in areas with swift currents and sand or gravel substrates (Baxter and Simon 1970; Woodling 1985).

The plains topminnow is known to occur in the Antelope Creek and Upper Cheyenne River subwatersheds. In Wyoming, the plains topminnow's characteristic habitat is clear, sand, or gravel-bottomed streams with considerable vegetation (Baxter and Simon 1970). It often is collected in streams inhabited by plains killifish. Spawning occurs in late spring or early summer in habitat with aquatic macrophytes (Woodling 1985).

The Yellowstone cutthroat trout may occur in suitable aquatic habitats of the Upper Tongue subwatershed within the Wyoming PRB study area. Suitable habitats include coldwater rivers, creeks, beaver ponds, and large lakes.

The sauger is native game fish species that is common within a limited range in Wyoming (WGFD 2012c). Within the Wyoming PRB study area, sauger occurs in the Clear Creek, Upper Powder River, and Upper Tongue River subwatersheds. Sauger habitat consists of reservoirs, rivers, or a combination of river and reservoir systems. The key components of sauger habitat in rivers are velocity and depth. Sauger also prefers low light conditions and often seeks turbid areas for cover.

Within the Wyoming PRB study area, the Upper Powder River is the only subwatershed inhabited by sturgeon chub, where it has been collected in the mainstem portion of the Powder River and several tributary draws (WGFD 2003). This species prefers swift currents in large, turbid rivers with sand or gravel-dominated bottoms (Baxter and Simon 1970; Lee et al. 1980).

The goldeye occurs in the Clear Creek, Crazy Woman Creek, Little Powder River, Middle Powder River, and Upper Powder River subwatersheds in the Wyoming PRB study area and the portion of the Little Powder River subwatershed outside of the Wyoming PRB study area. It occurs in lake and stream habitats and can tolerate turbid conditions.

The western silvery minnow occurs in the Little Missouri River, Middle Powder River, and Little Powder River subwatersheds where it prefers relatively large clear streams. This species often occurs in the same streams as flathead chub.

Plains minnow occurs in eleven of the Wyoming PRB study area subwatersheds (Antelope Creek, Clear Creek, Little Missouri River, Little Powder River, Middle Powder River, Salt Creek, South Fork Powder River, Upper Belle Fourche River, Upper Cheyenne River, Upper Powder River, and Upper Tongue River). Plains minnow prefers slower-moving water and side-pools in turbid streams.

The shovelnose sturgeon occurs in the Crazy Woman Creek and Upper Powder River subwatersheds within the Wyoming PRB study area. It has been extirpated from the North Platte and Bighorn drainages but was reintroduced to the Bighorn River (WGFD 2012c). While spawning has not been observed in Wyoming rivers, ripe males and females have been documented in the Powder River and Crazy Woman Creek. This species prefers habitat at or near the bottom of large unregulated, turbid rivers with relatively warm water and gravel substrates (WGFD 2012c).

ES.2.5 Grazing

The study area for grazing includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

BLM- and FS-administered allotments in the Wyoming PRB study area include privately owned and state owned land, as well as federally-administered lands. Because the majority of the Wyoming PRB study area consists of rangeland, most of which is privately owned, livestock grazing is one of the primary land uses within the study area. Livestock grazing occurs on lands administered by the BLM, FS, and State of Wyoming. BLM-administered rangeland within the study area is managed by the Buffalo Field Office (Sheridan, Johnson, and Campbell counties) and Casper Field Office (northern portion of Converse County). FS-administered rangeland within the study area is part of the TBNG, which is managed by the Douglas Ranger District.

Livestock grazing on federal lands in the Wyoming PRB study area is summarized in **Table ES.2.5-1**. Livestock grazing that occurs on BLM-administered rangeland in the Buffalo Field Office area within the Wyoming PRB study area includes 479 grazing allotments, which cover approximately 761,000 acres with an associated 398 lessees and 433 grazing leases. The majority of BLM grazing allotments that occur in the study area are leased by an individual lessee, although several allotments are leased by two or more lessees. The majority of ranch operations consist of cow/calf pairs and yearlings, and the remainder consists of sheep operations, horses, and indigenous livestock (i.e., bison and yaks). Based on an average stocking rate for these allotments of 5 to 7 acres per AUM (BLM 2012), the preferred livestock use on BLM-administered land within the Wyoming PRB study area averages approximately 126,833 AUMs. However, average stocking rates may vary widely based on ecological site conditions and annual precipitation levels (BLM 2012). As a result, the currently authorized livestock use on BLM-administered land within the Wyoming PRB study area is approximately 35,583 AUMs (BLM 2012).

Livestock grazing that occurs within the Wyoming PRB study area on BLM-administered rangeland in the Casper Field Office area includes 51 grazing allotments, which cover approximately 92,000 acres with an associated 52 lessees and 52 grazing leases. The majority of the ranch operations consist of cow/calf pairs or sheep operations; however, a small portion consists of horse or goat operations. Based on an average stocking rate for these allotments of 5 to 6 acres per AUM (BLM 2012), the preferred livestock

use on BLM-administered land within the Wyoming PRB study area averages approximately 16,727 AUMs. However, average stocking rates may vary widely based on ecological site conditions and annual precipitation levels (BLM 2012). As a result, the currently authorized livestock use on BLM-administered land within the Wyoming PRB study area is 3,535 AUMs (BLM 2012).

Table ES.2.5-1 Rangeland Summary for Federally-administered Lands in the Study Area

Allotments, Lessees, and AUMs[1]	BLM-administered Rangeland	FS-administered Rangeland	Total
Number of Grazing Allotments	530	73	603
Acres of Rangeland[2]	853,000	247,000	1,100,000
Number of Lessees[3]	450	NA	NA
Number of Grazing Leases[3]	485	NA	NA
AUMs[4]	143,560	56,977	200,537

[1] Reflects portions of allotments within the Wyoming PRB study area.
[2] Acreages include lands managed under the Bankhead-Jones Farm Tenant Act. The FS administers all Bankhead-Jones land that falls within the TBNG, and the BLM administers land outside the TBNG.
[3] Data not available.
[4] Total AUMs calculated based on average stocking rates for the respective management areas.

Sources: BLM 2012; FS 2012.

Livestock grazing that occurs within the Wyoming PRB study area on FS-administered rangeland in the southern portion of the TBNG includes entire or partial portions of 58 grazing allotments, which cover approximately 200,000 acres. The majority of ranch operations consist of cow/calf pairs and yearlings, and, to a lesser extent, sheep. Based on an average stocking rate for these allotments of 4.5 acres per AUM (FS 2012), the preferred livestock use on FS-administered land within the Wyoming PRB study area averages approximately 44,444 AUMs. However, average stocking rates may vary widely based on ecological site conditions and annual precipitation levels.

Livestock grazing that occurs within the Wyoming PRB study area on FS-administered rangeland in the northern portion of the TBNG (i.e., Spring Creek Unit north of Gillette, Wyoming) includes entire or partial portions of 15 grazing allotments, which cover approximately 47,000 acres. The majority of ranch operations consist of cow/calf pairs and sheep. Horses also utilize rangeland within this area but only comprise 1 percent of all grazing within the area. Based on an average stocking rate for these allotments of 3.5 to 4.0 acres per AUM (FS 2012), the preferred livestock use in the on FS-administered land within the Wyoming PRB study area averages approximately 12,533 AUMs. However, average stocking rates may vary widely based on ecological site conditions and annual precipitation levels.

Based on GIS analysis, the cumulative surface disturbance associated with energy-related development activities in the Wyoming PRB study area (as of the end of base year 2008) has resulted in the loss of approximately 104,082 acres of rangeland, 74,306 acres of which occur on BLM-administered allotments and 29,777 acres that occur on FS-administered allotments. Approximately 2,076 acres of the existing disturbance on BLM-administered allotments are related to coal mine development. The majority of the surface disturbance in the Wyoming PRB study area has occurred on private property. Based on an average stocking rate of 6.0 acres per AUM on BLM-administered land in the study area and an average stocking rate of 4.0 acres per AUM on FS-administered land, existing development-related disturbance has resulted in the loss of 12,384 and 7,444 AUMs, respectively.

ES.2.6 Land Use and Recreation

The study area for land use and recreation includes all or most of Campbell, Converse, Johnson, and Sheridan counties. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered

by the FS. State and private lands also are included in the study area. A somewhat larger perimeter around this primary study area was considered for wilderness issues because of the greater sensitivity (both practical and statutory) that wilderness and potential wilderness areas embody.

ES.2.6.1 Land Use, Access, and Easements

The Wyoming PRB study area is a predominantly rural, wide open landscape. Approximately 78 percent of the surface in the study area is privately owned. Approximately 14 percent is federal, with the BLM managing approximately 11 percent and the FS managing 3 percent. The State of Wyoming owns approximately 8 percent of the study area, most of which is State Trust lands.

In contrast to the surface ownership, mineral rights in much of the Wyoming PRB study area are in "split-estates." In much of the study area, the surface is privately owned but the mineral rights are at least partly federally owned. Although the federal government owns all mineral rights on large portions of the study area, there also are sizable areas where it owns only the coal rights and somewhat smaller areas where it owns only oil and gas rights. The State of Wyoming typically owns the mineral rights for a majority of the State Trust lands.

Climate and soil conditions in the Wyoming PRB study area dictate that the predominant use of land is for grazing; nevertheless, there is a range of other land uses present. The major categories include agriculture, barren land, forested, mixed rangeland, urban/disturbed, water, wetlands, and coal mines. **Table ES.2.6-1** shows approximate acreages for each of the land uses by surface ownership.

Table ES.2.6-1 Land Use by Surface Ownership

	Surface Ownership (acres)					Total[1]	
Use Category	**BLM**	**FS**	**Other Federal**	**State**	**Private**	**Acres[2]**	**Percent**
Agriculture	3,844	9,847	140	13,770	268,170	295,771	3.7
Barren	41,162	7,692	0	7,927	89,024	145,805	1.8
Forested	97,354	6,668	467	46,913	327,375	478,778	6.1
Mixed Rangeland	722,772	211,800	4,082	528,192	5,221,562	6,688,408	84.6
Urban / Disturbed	2,246	1,870	156	5,104	97,584	106,961	1.4
Water	137	34	0	336	4,596	5,102	0.1
Wetlands	2,827	3,081	5	9,185	107,408	122,507	1.5
Coal Mines	105	8,947	0	3,560	54,629	67,241	0.9
Total[1,2]	**870,448**	**249,939**	**4,851**	**614,987**	**6,170,348**	**7,910,573**	**100.0**

[1] Total acreage in the Wyoming PRB study area is 7,912,721 acres. Approximately 2,148 acres are designated as water.

[2] Slight differences in totals may occur due to rounding.

Source: USGS 2010.

Agricultural land uses in the Wyoming PRB study area include cropland and pasture, confined feeding operations, and other agricultural uses. Most of the cropland is not irrigated. Rangeland primarily is used for livestock grazing, which is the dominant land use in the study area on private and public lands. Urban/disturbed land uses include residential; industrial/commercial areas; and transportation, communications, and utility rights-of-way (ROWs), as well as areas in transition from rural to more densely developed areas. Although rural residences are scattered throughout the study area, the

majority of homes are located in or immediately adjacent to incorporated communities. There are 13 operating coal mines in the Wyoming PRB study area, as well as existing and historic mines in the study area that have produced coal, uranium, bentonite, and aggregate materials (sand and gravel).

As of the end of base year 2008, a total of 19,509 active CBNG wells and 3,107 active conventional oil and gas wells existed on federal, state, and private lands within the Wyoming PRB study area (AECOM 2011). CBNG and conventional oil and gas development has resulted in approximately 110,900 acres of cumulative disturbance, of which approximately 49,800 acres have been reclaimed (AECOM 2011).

Land Use Planning and Management

Lands administered by the BLM in the Wyoming PRB study area are managed under the guidance of adopted Resource Management Plans (RMPs) for the Buffalo and Casper field offices. Several BLM Special Management Areas (SMAs) that provide recreational opportunities are located within the study area. These areas include wilderness study areas (WSAs) and other special areas. Oil and gas leases are issued with no surface occupancy rights within WSAs in order to preserve wilderness values. Surface disturbances also are restricted within designated recreational areas and wildlife habitat management areas.

Most of the BLM and FS lands in the study area are used for livestock grazing under permitted grazing allotments, which are classified by the BLM into one of three management categories: maintain (M), improve (I), and custodial (C). Most of the public land in the Wyoming PRB study area is in the M and I management categories.

The FS administers land uses on National Forest System lands based on multiple use principles. The TBNG comprises all national forest land in the Wyoming PRB study area. Guidance is provided by the Land and Resource Management Plan (LRMP) for the Medicine Bow National Forest and TBNG. Most of the FS-administered land in the Wyoming PRB study area is managed for livestock grazing.

Wyoming established the State Land Use Commission in 1975 to guide land use planning in the state. The Office of State Lands and Investments is responsible for all leases, easements, and temporary uses on state lands, including mineral and agricultural leasing, timber leasing and sales, and public recreation. The WOGCC regulates drilling and well spacing, regardless of land ownership, including wells on federal lands.

The City of Gillette and the Town of Wright have zoning ordinances and land use plans for the incorporated areas. The City of Gillette/Campbell County Comprehensive Planning Program addresses potential future land use (City of Gillette and Campbell County 1998). This plan is the most recent plan adopted by Campbell County, although the county is in the process of developing a new comprehensive plan targeted for release in 2013. The City of Gillette zoning regulations (City of Gillette 2009) define oil, gas, and mineral exploration and production activities as permitted uses in agricultural, light industrial, or heavy industrial zoning districts. City noise ordinances would apply to drilling or construction operations within city limits. Similar permits and mitigation requirements are required in the Town of Wright's jurisdictional area through the Town of Wright Master Plan (Town of Wright 1998, 2004).

The Converse County Land Use Plan (Converse County 2003) describes the current land use in the Wyoming PRB study area as primarily agriculture, predominantly dryland (nonirrigated) grazing. Mineral extraction is the second prominent use for this portion of the county.

Key plan issues of the Johnson County Comprehensive Land Use Plan include maintaining the availability of public lands for livestock grazing, focusing higher density development activities near the existing communities of Buffalo and Kaycee, and working with federal and state agencies to retain and enhance conservation and recreation opportunities (Johnson County 2005). The Powder River Conservation District's 2011-2015 Long Range Natural RMP also provides land use guidance primarily

focused on watershed planning, natural resource conservation, and agricultural land management (Powder River Conservation District 2010).

According to the Sheridan County Zoning Resolution, the anticipated future land uses and current zoning for most of the county is agricultural (Sheridan County 2011). The Sheridan County Comprehensive Plan provides for a buffer zone of several miles adjacent to and east of the Bighorn National Forest (Sheridan County 2008).

ES.2.6.2 Recreation

With nearly 78 percent of the Wyoming PRB study area privately owned, public lands provide important open space and recreation resources including both developed recreation facilities and areas to pursue dispersed recreation activities. The private sector contributes commercial recreation opportunities and tourism services such as motels and restaurants. Some private landowners also allow hunting with specific permission, often for a fee.

Major attractions include the TBNG, several state historic sites, and the historic Bozeman Trail. Formal recreation opportunities are most prevalent in the western portion of the Wyoming PRB study area, near the foothills of the Big Horn Mountains and in the Powder River Breaks.

The primary developed recreation sites and informal recreation areas on BLM lands, all in the area administered by the Buffalo Field Office, include the South Big Horns Area, in southwest Johnson County; the Middle Fork Recreation Area (RA), along the Middle Fork of the Powder River; The Ed O. Taylor Wildlife Habitat Management Area, west of Kaycee; and the Dry Creek Petrified Tree Environmental Education Area, a designated outstanding natural area near Buffalo. The Mosier Gulch RA, west of Buffalo; Weston Hills RA, in the eastern part of the Wyoming PRB study area; and Burnt Hollow Management Area, north of Gillette provide additional recreational opportunities. Historic sites associated with the Bozeman Trail provide recreational opportunities through interpretive programs.

The TBNG provides a variety of wildland recreational opportunities to local residents and visitors on FS-administered land.

Dispersed recreational opportunities in the Wyoming PRB study area include hunting, fishing, off-highway vehicle (OHV) use, sightseeing, and wildlife observation. Hunting is a major recreation use of federal and state lands; various big game and upland game bird species are hunted in the region. Mule deer and pronghorn hunting are by far the most popular hunting activities in the study area, accounting for 63,081 and 49,407 hunter days, respectively, in 2011-2012 (WGFD 2012a). Hunting of elk, white-tailed deer, and upland game birds was close behind at 39,011, 38,669, and 20,813 hunter days, respectively (WGFD 2012a). Big game harvest data for the past decade vary by species. Elk harvest statewide has been fairly consistent, ranging from 19,708 in 2005 to 25,672 in 2010, but more typically being between 21,000 and 23,000 animals annually. Statewide deer (both mule and white-tailed) harvests have ranged from 43,366 in 2011 to 55,061 in 2007, while being consistently between 47,000 and 53,000 animals. Statewide antelope harvests have grown every year from 2002 (30,260 animals) to 2010 (58,863 animals), although dropping modestly to 55,525 animals in 2011 (WGFD 2012a).

Approximately 20,386 acres within the BLM Buffalo Field Office management area are open to unlimited vehicle travel on and off roads. There are 4,680 acres in the area that are closed to all OHV use and approximately 867,534 acres available for limited use. Recreational use of public lands in the Wyoming PRB study area has increased substantially over the past two decades, and is expected to continue to increase by approximately 5 percent every 5 years for most recreational activities.

Some private landowners in the Wyoming PRB study area receive supplemental income from providing hunting and fishing opportunities. There has been a trend toward a reduction in private land available for public hunting (Jahnke 2012; Shorma 2005). While the WGFD attributed much of the change to the dramatic expansion in CBNG development in the PRB in the late 1990s and early 2000s, causes have

apparently evolved in more recent years (Jahnke 2012). Economic factors may be causing some hunters, especially out-of-state individuals, to reduce or delay their Wyoming hunting activity. Also, a reduction in the mule deer population may be causing landowners and outfitters to reduce the numbers of hunters on private guided hunts to ensure good success rates. Coal development is not considered to be a major factor in the reduced hunting access, because it is more localized with disturbed acreage concentrated in a few areas (Jahnke 2005). Reclaimed mine lands may or may not be available for hunting and other recreational activities depending on site-specific constraints.

CBNG development has had the effect of degrading the hunting experience for those who do hunt in the PRB, resulting in a substantial number of adverse comments in the WGFD's hunter harvest surveys. The loss of hunting land also has created problems for the WGFD, making herd management more difficult and reducing revenues from hunting (Shorma 2005). The reduced access to private land has substantially increased pressure on public lands and has tended to concentrate hunting activity (Jahnke 2005).

Recreation Planning

The goals of recreation management for all BLM-administered lands in the Wyoming PRB study area are to provide outdoor recreational opportunities while also protecting resources, providing visitor services, and protecting the health and safety of public land visitors. Additional details on recreation objectives and standards for BLM lands in the study area can be found in the Buffalo Field Office RMP (BLM 1985, 2012C) and the Casper Field Office RMP (BLM 2007, 2012a).

The Medicine Bow-Routt National Forest has developed an LRMP for the TBNG (FS 2001a, 2002, 2006). The FS lands are inventoried and mapped by recreation opportunity spectrum (ROS) class to identify the opportunities for recreation activities.

The Wyoming Department of State Parks and Cultural Resources has the authority to promulgate rules and regulations governing state parks. There is no provision in the rules and regulations governing the development of mineral or other industrial developments within state parks.

Land use plans of the four counties in the Wyoming PRB study area all address recreation activities and facilities to varying degrees. All consider recreation an important community asset.

ES.2.6.3 Wilderness and Roadless Areas/ Wild and Scenic Rivers/ Lands with Wilderness Characteristics

There are no designated wilderness areas in the Wyoming PRB study area. There are three BLM WSAs in the study area: the Fortification Creek WSA, the North Fork WSA, and the Gardner Mountain WSA. The WSAs await Congressional action before they can be designated as wilderness or released from consideration.

There is a FS "inventoried roadless" area within the TBNG. It was not recommended for wilderness designation but, as with the WSAs, it will not be released from consideration until, and unless, Congress acts on it.

The BLM has identified public lands along four waterway segments in the Wyoming PRB study area that were determined to meet the eligibility criteria for Wild and Scenic River (WSR) designation. Of the four, only the Middle Fork of the Powder River was determined to be "suitable" for addition to the WSR system.

In December 2010, the Secretary of the Interior issued Order 3310 – Wild Lands, providing the BLM with new guidance on managing "lands with wilderness characteristics" (LWC) that were not included in designated Wilderness Areas or WSAs. Subsequently, Congress prohibited expenditure of moneys to implement the policy, and the policy was put into abeyance in April 2011. The BLM issued Instruction Memorandum (IM) 2011-154, providing guidance on the lands in question. Under the new policy, the

BLM will not implement Order 3310, will not designate “wild lands,” and will not require a special review of projects that could impair lands with wilderness characteristics. The BLM will maintain inventories of LWCs and will consider whether to protect, or not protect, such lands under the planning provisions of the Federal Land Policy and Management Act (FLPMA) of 1976 (Roche 2011).

There is only one property in the Wyoming PRB study area that is currently identified as a LWC: the Face of the Big Horns in the BLM Buffalo Field Office area. The Casper Field Office began a review of potential LWC parcels; however, the review was cancelled in response to IM 2011-154. Consequently, there are no identified LWC tracts in the Casper Field Office area (Skillman 2012).

ES.2.7 Noise and Visual Resources

The study area for noise and visual resource issues includes all or portions of Campbell, Converse, Johnson, and Sheridan counties. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

ES.2.7.1 Noise

Ambient noise is generally a function of land use and density, although other environmental factors also often play a substantial role. Wind, precipitation, wildlife, and insects substantially can increase ambient noise.

Land uses in the Wyoming PRB study area range from sparsely populated rural ranching areas to more densely populated urbanized areas and industrial areas such as coal mining and CBNG operations. Major sources of noise are larger towns; industrial facilities (e.g., coal mines and gas compressor stations); and major transportation facilities, particularly higher volume roadways near communities and railroad corridors. Frequent high winds raise noise levels well above ambient levels without wind.

Background noise measurements have not been conducted in the Wyoming PRB study area; however, noise in rural areas away from industrial facilities and transportation corridors is likely to be in the range of 30 to 40 decibels on the A-weighted scale (dBA) when the wind speeds are low (U.S. Environmental Protection Agency [USEPA] 1971). Levels of noise close to industrial facilities and transportation corridors are likely to be in the range of 50 to 70 dBA or more, depending on the source and proximity to the source. The most substantial noise from CBNG operations results from operation of compressor stations that use multiple engines to move natural gas from central gathering facilities and along high-pressure transmission pipelines. Noise from compressor stations has been estimated to be 55 dBA at 600 feet from the compressor station (BLM 2000).

The potential effects of noise depend on the spatial relationship between a noise source and noise-sensitive receptors. Noise attenuates over distance; the rate of attenuation also depends on the nature of the ground surface, atmospheric conditions, and topography, which either can block or reflect noise transmission. Consequently, effects of noise generally are site-specific, and generalizations over an area as large and diverse as the Wyoming PRB study area may be misleading if not carefully qualified.

ES.2.7.2 Visual Resources

The Wyoming PRB study area is in the Great Plains physiographic province; it is bordered by the Big Horn Mountains to the west and the Black Hills to the east. The landscape is composed of open grasslands, low rolling hills, and unobstructed views over many miles in most places. Most of the area is covered with dryland vegetation consisting of grasses and shrubs. Ponderosa pine forest covers large portions of the northeast quarter of the Wyoming PRB study area. Outside the urban centers of Sheridan, Gillette, Buffalo, and Douglas, the Wyoming PRB study area is characterized by a rural landscape that has been modified by oil and gas field development, coal mines, grazing, and small

towns. Portions of the Wyoming PRB study area remain natural and undeveloped in character despite widespread mineral development and grazing.

The most significant scenic values occur in the western portion of the Wyoming PRB study area. The South Big Horns Area along the Middle Fork of the Powder River provides sensitive and unique resource values. The Powder River Breaks in eastern Johnson County, the Fortification Creek SMA and WSA, and the Weston Hills RA in the eastern part of the Wyoming PRB study area also provide scenic settings for a variety of dispersed recreational activities.

Two scenic byways in the western portion of the Wyoming PRB study area provide access to the Big Horn Mountains. The Bighorn Scenic Byway is on U.S. Highway 14 west of Ranchester, and the Cloud Peak Skyway is on U.S Highway 16 west of Buffalo.

Oil and gas pumping units and associated well pads and access roads are evident in much of the Wyoming PRB study area. Well development is most evident in Campbell County between Gillette and Wright, and north, west, and northwest of Gillette. The wells are readily visible and visually dominant in foreground views from roads and trails. At greater distances, oil and gas facilities are less visually prominent; exposed soils of well pads and associated access road clearings are the most obvious features.

The most prominent natural gas features are the large compressor stations. Although colors usually are selected to blend with the surroundings, the scale and character of the structures is often larger and appears more industrial than the agricultural landscape and facilities common to the area. Oil development generally entails the use of pumping “mules” on each well and tanks to store the oil awaiting shipment. Although typically smaller than the compressor stations, these facilities are more widely dispersed in the landscape and sometimes exhibit greater color contrast.

Coal mining occurs primarily in the east-central portion of the Wyoming PRB study area, in a north-south trending corridor from approximately 10 miles north of Gillette to approximately 5 miles south of the Campbell-Converse County line. Thirteen open-pit coal mines are actively producing coal in Campbell and Converse counties. Open-pit mining results in landscapes that have been altered considerably from the natural character of the landscape. Coal mines dominate foreground and middleground views in the affected viewsheds; background views generally depend on the status of reclamation activities and the perspective from a particular viewpoint. Night lighting can be visually dominant at all viewing distances. Coal mines commonly result in greatly disturbed landscapes that require rehabilitation through required reclamation activity after mining. Generally, reclamation occurs concurrently with active mining, and reclaimed areas are intended to resemble the natural landscape. However, returning the visual resource to pre-mining quality may take several years to accomplish, depending on the vegetation types to be reestablished and whether sufficient precipitation or irrigation is available.

The BLM is responsible for identifying and protecting scenic values on public lands under several provisions of the FLPMA and National Environmental Policy Act. The BLM Visual Resource Management (VRM) system was developed for that purpose. The VRM system includes an inventory process and a contrast rating procedure for evaluating the potential visual effects of a proposed project or management activity.

Lands in the Buffalo Field Office management area are still being managed under the VRM classes established in the Buffalo RMP adopted in 1985. Under this current management, approximately 78 percent of the Wyoming PRB study area has been identified as Class IV, 14 percent as Class III, and 8 percent as Class II. Class V, Rehabilitation, applies to active coal mines and to certain areas near the larger communities and applies to approximately 1 percent of the Wyoming PRB study area.

As part of the revision process of the Buffalo RMP, visual resources are undergoing a comprehensive reevaluation. Although none of the alternatives undergoing analysis for the RMP update will be official until the process is completed, the BLM has identified a preferred alternative. While there are some

similarities between the existing VRM map and the preferred alternative, there also are substantial differences. Much of the area adjacent to the foothills to the Big Horn Mountains would be designated Class II in place of the current Class III. The three WSAs in the Wyoming PRB study area would be designated as Class I, the most stringent management class befitting lands considered to have potential for designation as wilderness; this area is currently a mixture of Class II and Class III. The preferred alternative also contains substantially more Class III land than the existing VRM map. The coal mine corridor would continue as a VRM Class IV area under the preferred alternative, but without the eliminated Class V (Rehabilitation) designation in and near the mines.

The FS inventoried visual resources under the new Scenery Management System (SMS) in the Revised LRMP for the TBNG. The SMS parallels the BLM VRM system with some variations in application and terminology. Scenic Integrity Objectives (SIOs) were assigned to each management area based on the intent of the management area direction. TBNG lands in the Wyoming PRB study area have been inventoried with two of the possible five SIOs: Low, where the landscape character appears moderately altered by development, and Moderate, where the valued landscape character appears slightly altered.

Three of the four counties in the Wyoming PRB study area consider the importance of scenic resources through their land use planning policies; Converse County does not.

Much of the Wyoming PRB study area is not visually sensitive because of its remoteness from viewpoints used by the public. The portions that are considered to have higher levels of sensitivity to landscape modification occur near communities, along highway corridors, and at recreation-use areas.

ES.2.8 Transportation and Utility ROWs

The study area for transportation and utility ROWs includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

ES.2.8.1 Transportation

Consistent with the low population density in the Wyoming PRB study area, the major road network is quite sparse. In the approximately 120-mile by 140-mile area, there are only two major north-south highways, I-25 and State Route (SR) 59, and one major east-west route, I-90. Two additional primary highways, U.S. Highway 14/16 and SR 387, cross the Wyoming PRB study area from east to west. Several short segments of U.S. highways and secondary state roads and numerous county roads also provide local access to public and private lands. In addition, there is a complex network of essentially unimproved local roads serving the area, some of which are not open to public access without landowner permission.

Traffic volumes on the road network in the Wyoming PRB study area are highly variable. The highest volume counts are found on major roadways in or near the largest communities. In rural areas, I-90 and I-25 carry the largest traffic volumes. Current traffic volumes are well within the capacity of major highways in the Wyoming PRB study area. There is no readily discernible pattern to changes in traffic volumes over the past 10 years, except that the largest numerical increases generally have occurred in or near the larger communities, particularly Gillette. However, rates of change in traffic volumes have varied a great deal throughout the Wyoming PRB study area. The percent changes in traffic volumes were often, but not consistently, larger from 2003 to 2008 than from 1998 to 2003. These changes in traffic growth rates track the increased population growth rates in Campbell and Sheridan counties in the latter half of the decade, which were driven by increases in coal and CBNG employment.

The BLM transportation planning for the Wyoming PRB study area is discussed in the updated RMPs for the Buffalo and Casper field offices (BLM 1985, 2007). A revision to the Buffalo RMP is in progress (BLM 2012). The BLM and FS are responsible for ensuring that new roads on federal lands meet the

criteria for design and construction. The BLM minimum road design and maintenance requirements are provided in BLM Manual Section 9113 – Roads (BLM 2011). New roads across non-federal lands would have to comply with requirements of the state or local jurisdictions, mainly counties. The four counties in the study area have given varying degrees of attention to planning for transportation improvements.

Two major rail lines serve the Wyoming PRB study area. The Burlington Northern and Santa Fe (BNSF) Railroad enters Sheridan County from Montana north of Sheridan, runs southerly through the city, and then southeast through Clearmont to the City of Gillette in Campbell County. From Gillette, the railroad continues southeasterly to South Dakota. A secondary route jointly operated by BNSF and Union Pacific Railroad, primarily serving coal trains from PRB mines, generally heads straight south from Gillette into Converse County toward Douglas where it splits into southerly and easterly branches. The typical ROW corridor for the railroad in the Wyoming PRB study area is 400 feet wide (BLM 2012).

Recent coal train traffic averages approximately 160 coal unit trains per day (total outbound and returning): approximately 75 percent on the southern route and 25 percent on the northern route (BNSF 2011; UPRR 2012). The difference has been accommodated by upgrading the line south of Bill, Wyoming, to a triple main track configuration, plus a 20-mile section of 4-main-line tracks in the rugged terrain north of Bill near the Campbell-Converse County line.

Three public airports exist in the Wyoming PRB study area: the Gillette-Campbell County Airport northwest of Gillette, the Sheridan County Airport southwest of Sheridan, and the Johnson County Airport northwest of Buffalo. Federal Aviation Administration regulations require a 2-mile radius safety zone around airports and restrict height of construction within 5 miles to reduce the potential for safety hazards near airports.

ES.2.8.2 Utility ROWs

A study to locate major energy corridors throughout the western U.S. was conducted by the BLM, FS, and other federal agencies, culminating in both BLM and FS Records of Decision in 2009. None of the designated major corridors traverse the Wyoming PRB study area.

There are four major 230-kilovolt electric power line corridors through the Wyoming PRB study area. Two of these run in a generally north-south direction. One of the north-south corridors on the western side of the Wyoming PRB study area essentially parallels the I-90 corridor from the Montana border to the I-25 corridor, which parallels southward to the Laramie River Station near Wheatland, Wyoming. The other north-south corridor runs along the east side of the Wyoming PRB study area and connects the Wyodak/Neil Simpson/Wygen Power Plant complex near Gillette to the Dave Johnston Power Plant near Glenrock, Wyoming. Two other power lines run in a generally east-west direction. One runs from near Gillette to Buffalo, and the other (Hughes Transmission Line) runs from Rozet to Gillette and northwesterly to an existing substation northeast of Sheridan.

The Wyoming PRB study area is crossed by an extensive network of oil and gas transportation pipelines. The gas collection network has expanded in recent years as new areas have been developed for CBNG production. Among the major crude oil lines are the Belle Fourche pipeline running northeast from near Kaycee to the Montana state line near the Campbell-Crook county line, and the Rocky Mountain Pipeline System running from the same junction northeast of Kaycee south to Casper.

There are numerous large diameter natural gas pipelines carrying gas from the extensive network of gathering lines to markets outside the basin. These include a pair of parallel Fort Union Gas Gathering System pipelines running nearly straight south from southeast of Gillette to the I-25 corridor west of Douglas, the Thunder Creek Gas Services pipeline running nearly straight south from gas fields northwest of Gillette to the I-25 corridor between Douglas and Casper, two pipelines running southerly from the Western Gas Resources processing plant northeast of Wright, and numerous smaller natural gas gathering and oil, natural gas, and products transmission pipelines lacing across the PRB that are operated by more than a dozen pipeline companies.

ES.2.9 Hazardous Materials and Solid Waste

The study area for hazardous materials and waste includes all or portions of Sheridan, Johnson, Campbell, and Converse counties. It includes most of the area administered by the BLM Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the TBNG, which is administered by the FS. State and private lands also are included in the study area.

As industrial development in the PRB has increased, so too has the use of hazardous materials and disposal of hazardous waste. Air, water, soil, and biological resources potentially could be affected by an accidental release or misuse of hazardous materials that could occur during transportation, storage, or use for various industrial activities.

Hazardous materials are defined in various ways under a number of regulatory programs and include materials regulated by a variety of statutes and regulatory programs (e.g., Occupational Safety and Health Administration, U.S. Department of Transportation, Resource Conservation and Recovery Act [RCRA], etc.) Many of the hazardous materials or substances are regulated under more than one program.

RCRA governs the handling and disposal of solid wastes (USEPA 2006), which comprise a broad range of materials that include garbage, refuse, sludge, non-hazardous industrial waste, municipal wastes, and hazardous wastes. Solid wastes as defined include solids, liquids, and contained gaseous materials. Hazardous wastes exhibit certain characteristics (as defined by laboratory analysis), are generated from specific industrial processes, or are chemical compounds that if abandoned could pose a threat to human health and the environment.

In most cases, hazardous materials consist of products and materials that are used and consumed during industrial activities. Examples of such materials could include cement, fuel, solvents, acids, and many other chemicals and products. Often the hazardous constituents comprise a small percentage of the product being used, the rest of the material in the product being inert or not defined as hazardous under any of the regulatory programs. If these materials are not consumed during ordinary use and are regarded as waste, and if a waste is determined to be a hazardous waste, it must be handled and disposed of according to strict rules under the RCRA. The RCRA program in Wyoming is delegated to the Hazardous and Solid Waste Division of the WDEQ. If the material to be discarded is determined not to be a hazardous waste, the material must be disposed of, or recycled, in a manner according to the applicable statutes and regulations. Certain types of materials (e.g., used oil), while they may contain potentially hazardous constituents, are specifically exempted from regulation as hazardous wastes. Other wastes that otherwise might be classified as hazardous are managed as “universal wastes” and are exempt from hazardous waste regulations as long as those materials are handled in ways specifically defined by regulation.

The USEPA has specifically exempted certain waste materials generated in oil and natural gas exploration and production from regulation as hazardous wastes (USEPA 2002). To classify as an exempt exploration and production waste, these materials must be intrinsic or uniquely associated with the production of oil and natural gas. Disposition of exempt wastes is regulated by the WOGCC, the BLM, or the WDEQ, depending on the particular waste and how it must be disposed.

The BLM does not regulate the handling of hazardous materials or non-exempt solid waste; therefore, they do not maintain a database of the amount of materials consumed or potentially spilled at coal mines or any other industrial sites in the Wyoming PRB study area (Henke 2012). The BLM also does not track the types of wastes that are generated for the same reason. Specific to the oil and gas industry, the WOGCC disclosure rule for hydraulic fracturing requires disclosure of the types of amounts of hazardous materials used in oil and gas well completions. The BLM hydraulic fracturing rules proposed in 2012 would require disclosure of similar information, but only from wells drilled where there is a federal interest.

The primary hazardous materials consumed during coal mine operations include petroleum fuels and lubricants. The amounts of these materials would vary considerably from mine to mine based on production methods and overall output from the mine. The fuel used is primarily diesel for excavators, heavy equipment, and haul trucks. The fuels are stored at the various mines in tanks (aboveground or underground) that have release containment systems and spill contingency plans to handle leaks and larger spills.

In addition to storage of fuels and lubricants in stationary tanks, mobile tanker trucks are used to provide fuel for excavators, haul trucks, and other equipment. Portable tanks and drums also would be stored in a manner to prevent spills from reaching soils or water. Used oil would be recycled through a licensed used oil recycler during the life of the mine.

During the operational lives of the mines, the probability of minor spills of materials such as fuel and lubricants would be relatively high. These releases could occur during fueling operations or from equipment failure (e.g., hydraulic hose failure). Spills of this nature would be localized, contained, and disposed of in accordance with the applicable laws and regulations. Accidents involving other hazardous materials also could occur during mine operation. Mine operations are required to develop and maintain a site-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan to deal with unplanned releases of petroleum products. They also have Emergency Response Plans that establish procedures for responding to accidental spills or releases of hazardous materials to minimize health risks and environmental effects. The plans include procedures for evacuating personnel, maintaining safety, cleanup and neutralization activities, emergency contacts, internal and external notifications to regulatory authorities, and incident documentation. Proper implementation of the SPCC and Emergency Response Plans has reduced the potential for major impacts associated with potential releases of hazardous materials.

Some of the materials listed above may become hazardous wastes (i.e., spent solvents). Materials that are considered hazardous must be accumulated, transported, and disposed of under very specific requirements. A review of the USEPAs Enforcement and Compliance History Online database indicates that the coal mines in the PRB do not generate large amounts of hazardous waste, and most of the mines are classified as Small Quantity Generators or Conditionally Exempt Small Quantity Generators.

Non-hazardous solid wastes generated at coal mining operations typically consist of floor sweepings, empty containers, scrap metal, tires, filters, office trash, and food waste (BLM 2010). Some of these items may be disposed of within the mine boundaries in accordance with WDEQ-solid waste disposal plans. Other waste is discarded at permitted off-site landfills.

Drilling operations for conventional oil and gas and CBNG are very similar. Many of the potentially hazardous materials used in drilling the wells are the same. However, the amounts of material for CBNG wells are somewhat less because the wells generally are shallower. The materials used in these industries include fuels, lubricants, additives, and explosives. In addition to materials used in the drilling of wells, there are materials that are used and consumed in the production operations of oil and natural gas wells. Some materials may be used exclusively for oil well operations and others used exclusively for gas wells and associated gas processing and compression.

Produced water, a RCRA-exempt oil field waste, comprises the largest waste stream that is generated as a result of oil and gas production operations (National Petroleum Council 2011). In the Wyoming PRB study area, disposal of produced water from oil and gas wells is regulated by the WOGCC and WDEQ and is accomplished by re-injection into oil and gas zones for pressure maintenance, injected into saline aquifers through the use of saltwater disposal wells, or discharged to the surface. Most of the water produced in association with CBNG production is discharged to the surface. The produced water volume associated with oil and gas production was 21 billion barrels for the U.S. in 2007. In the Wyoming PRB study area in 2008, approximately 110 million barrels of produced water was attributed to conventional oil and gas production and approximately 660 million barrels to CBNG production (AECOM 2011).

In addition to the potentially hazardous materials that would be used and generated during oil and gas drilling and production operations, the products derived from these activities are considered hazardous. Oil, condensate, natural gas liquids, and methane can be considered hazardous materials either because of their volatility, flammability, or explosive nature. There are standards and regulations that apply as well to the storage and transportation of these products.

Natural gas pipelines also would use potentially hazardous materials. Materials typically used in the construction and operation of transportation pipelines include fuels (diesel, gasoline, methane), lubricants, water treatment chemicals, ethylene glycol, propylene glycol, methanol, sand blast media, and acids.

List of Acronyms

amsl	above mean sea level
APD	application for permit to drill
APLIC	Avian Power Line Interaction Committee
AUM	animal unit month
AVF	alluvial valley floor
BBS	breeding bird survey
Bcf	billion cubic feet
BLM	Bureau of Land Management
BNSF	Burlington Northern and Santa Fe Railroad
C	custodial
CBNG	coal bed natural gas
CFR	Code of Federal Regulations
dB	decibels
dBA	decibels on the A-weighted scale
EA	environmental assessment
EC	electrical conductivity
EIS	environmental impact statement
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FLPMA	Federal Land Policy and Management Act
FR	Federal Register
FS	Forest Service
FY	fiscal year
GIS	Geographic Information System
I	Improve
IM	Instruction Memorandum
LBA	lease by application
LQD	Land Quality Division
LRMP	Land and Resource Management Plan
LRP	limited reclamation potential
M	Maintain
MMcfpd	million cubic feet per day
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
NWReGAP	Northwest Regional Gap Analysis Project

OHV	off-highway vehicle
OSM	Office of Surface Mining
PFYC	potential fossil yield classification
P.L.	Public Law
PRB	Powder River Basin
PSO	Public Service Company of Oklahoma
RA	Recreation Area
RCRA	Resource Conservation and Recovery Act
RFD	reasonably foreseeable development
RMP	Resource Management Plan
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
SAR	sodium adsorption ration
SARA	Superfund Amendments and Reauthorization Act
SDD	State Decision Documents
SIO	Scenic Integrity Objectives
SMA	Special Management Area
SMCRA	Surface Mining Control and Reclamation Act
SMS	Scenery Management System
SPCC	Spill Prevention, Control, and Countermeasure Plan
SR	State Route
STIP	Surface Transportation Improvement Program
SSURGO	Soil Survey Geographic Database
TBNG	Thunder Basin National Grasslands
TCF	trillion cubic feet
TDS	total dissolved solid
U.S.	United States
UPRR	Union Pacific Railroad
USC	United States Code
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOR	very high frequency omnidirectional range (flight navigation aid)

VRM	Visual Resource Management
WDEQ	Wyoming Department of Environmental Quality
WEST	Western EcoSystems Technology, Inc.
WGFD	Wyoming Game and Fish Department
WIA	walk-in area
WOGCC	Wyoming Oil and Gas Conservation Commission
WSA	Wilderness Study Area
WSR	Wild and Scenic River
WWPC	Wyoming Weed and Pest Council
WYDOT	Wyoming Department of Transportation
WYNDD	Wyoming Natural Diversity Database

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