CHAPTER 3

AFFECTED ENVIRONMENT

3.0 INTRODUCTION

The Affected Environment chapter of this environmental assessment (EA) for the proposed Brown Cow coalbed methane project discusses environmental, social, and economic factors as they currently exist within the Brown Cow project area (BCPA). The material presented here has been guided by management issues identified by the Bureau of Land Management (BLM), Great Divide Resource Area (GDRA); public scoping; and by interdisciplinary field analysis of the area.

This proposal could potentially affect critical elements of the human environment as listed in BLM's National Environmental Policy Act (NEPA) Handbook H-1790-1 (USDI-BLM 1988). The critical elements of the human environment, their status in the BCPA and their potential to be affected by the proposed project are listed in Table 3-1.

Table 3-1. Critical Elements of the Human Environment[1], Brown Cow CBM POD Development Project Carbon County, Wyoming

Element	Status on the Project Area	Addressed in text of EA
Air Quality Issues	Potentially affected	Yes
Areas of critical environmental concern	None present	No
Cultural resources	Potentially affected	Yes
Environmental justice	Potentially affected	Yes
Prime or unique farmlands	None present	No
Floodplains	None present	No
Native American religious concerns	Potentially affected	Yes
Invasive plants	Potentially affected	Yes
Threatened and endangered species	Potentially affected	Yes
Hazardous or solid wastes	Potentially Affected	Yes
Water quality (surface water)	Potentially affected	Yes
Wetlands/riparian zones	Potentially affected	Yes
Wild and scenic rivers	None present	No
Wilderness (study area)	None present	No

[1] As listed in BLM *National Environmental Policy Act Handbook H-1790-1* (BLM 1988b) and subsequent Executive Orders

CHAPTER 3: AFFECTED ENVIRONMENT

In addition to the critical elements, this EA discussed potential effects of the project on range resources, transportation, geology/minerals/paleontology, soils, fisheries, vegetation, wildlife, special status species, visual resources, noise, recreation, socioeconomics, and health and safety.

3.1 GEOLOGY/PALEONTOLOGY

3.1.1 Geology

3.1.1.1 Regional Geologic Overview

The BCPA lies within the southeastern arm of the Washakie Basin sub-basin region of the Greater Green River Basin of southernmost central Wyoming. Bedrock in the area dips westward off the structural high of the Precambrian-cored Sierra Madre Range into the eastern edges of the Washakie Basin, the southeastern part of the Greater Green River Basin. Dips in upper Cretaceous and Paleocene rocks are steep. Dips lessen upward into younger rocks of early Eocene age and westward away from the mountain flank.

Along its western flank the Sierra Madre is bounded by a major eastward dipping reverse fault system along which it was elevated over the eastern edge of the Washakie Basin during the Laramide Orogeny in late Cretaceous through Early Tertiary time. These reverse faults are not exposed at the surface, but rather lie buried beneath Early Tertiary sediments that filled the basin and lapped onto the mountain flank. The Washakie Basin to the west, into which the surface rocks dip, is bound by east-west oriented structural highs, the Wamsutter Arch and Cherokee Ridge, to the north and south, respectively. The structural axis of Cherokee Ridge trends east-west along the Wyoming-Colorado State line and separates the Washakie Basin from the Sand Wash Basin of Colorado, to the south.

Numerous faults, chiefly normal faults, occur along Cherokee Ridge and the western flank of the Sierra Madre (Love and Christiansen 1985; Winterfeld and Bown 2003). Many of these faults show evidence of recurrent motion throughout the last 20 million years, however, none show any indication of Quaternary movement (Case and others 1994).

Geologic mapping by the USGS and Wyoming Geologic Survey (Weitz and Love 1952, Love and Christiansen 1985, Love et al. 1993, and Roehler 1973, 1977, 1985) document that the BCPA is underlain at the surface by sedimentary deposits of Quaternary and Late Cretaceous age. These deposits are underlain by Phanerozoic age sedimentary rocks of Cretaceous to Cambrian age, which are in turn underlain by Precambrian metamorphic bedrock that comprises part of the ancient North American craton and exceeds 2 billion years in age. Although they have been mapped in the Atlantic Rim project area, no sediments of early Tertiary age actually occur in the BCPA.

Information on geologic units preserved at the surface and beneath the project is provided in Table 3-2. Additional details on surface deposits are provided below.

TABLE 3-2. SURFACE AND SUBSURFACE GEOLOGIC DEPOSITS BROWN COW POD AREA (Source Weitz and Love 1952, Love and Christiansen 1985, Love, Christiansen and Ver Ploeg 1993)

Geologic Deposit	Geologic Age	Environment/Lithology	Resources/BLM Paleontology Condition (Surface exposed formations only)
Surface Deposits			
Unnamed Quaternary Deposits	Holocene-Pleistocene	Eolian/fluvial/ landslide. sand, gravel, clays, weathered in place residuum from exposed outcrops	none reported within area, economic deposits of windblown sand reported 20-30 miles NNE of the town of Baggs, Wyoming, just east of the project area
Wasatch Formation	Early Eocene	Terrestrial:fluvial/flood plain/swamp, drab to varicolored mudstone, sandstone, carbonaceous shale and coal.	Vertebrate, invertebrate and plant fossils (BLM Condition 2). Coal. Petroleum in subsurface. Uranium reported in adjacent areas near Wamsutter Creston and Latham
Lance Formation	Late Cretaceous	Terrestrial: fluvial/flood plain/swamp, brown and gray sandstone , shale and mudstone, coals, and carbonaceous shales.	Vertebrate, invertebrate and plant fossil (BLM Condition 2). Coal. Coal Bed Methane.
Lewis Shale Fox Hills Sandstone	Late Cretaceous	Fox Hills: Marine - shoreline, light-colored sandstone and gray sandy shale, Lewis Shale: Marine – near shore to offshore, gray shale containing gray, brown sandstones	Fox Hills: Vertebrate and invertebrate fossils (BLM Condition 3) No mineral resources reported, Lewis Shale Invertebrate fossils. Petroleum in Espy Field

Geologic Deposit		Geologic Age	Environment/Lithology	Resources/BLM Paleontology Condition (Surface exposed formations only)
Subsurface				
Mesaverde Group	Almond Formation	Late Cretaceous	Marine, Terrestrial, deltaic: white and brown sandstone, sandy shale, coal, carbon-aceous shale	Vertebrate, invertebrate and plant fossils (BLM Condition 2) Coal. Coalbed methane. Petroleum in Baldy Butte, Cherokee Creek, Cow Creek, Creston, Deep Gulch, Espy, Savery Fields.
	Pine Ridge Sandstone (=Williams Fork Formation)	Late Cretaceous	Marine: coastal plain, estuary/beach , white sandstone, lenticular conglomerate, coal	
	Allen Ridge Formation (= Iles Formation)	Late Cretaceous	Terrestrial, coastal plain white to brown sandstone, shale, mudstone, coal	
	Haystack Mountains Formation	Late Cretaceous	Marine:	
Subsurface				
Steele Shale (includesShannon, Sussex Sandstones)		Late Cretaceous	Marine, gray shale, with numerous bentonites, sandstone	Petroleum in Browning Cherokee Creek, Cow Creek, Deep Creek, Deep Gulch, Sierra Madre Fields.
Niobrara Formation		Late Cretaceous	Marine, light-colored limestone, gray limey shale	Petroleum in Espy Field.
Frontier Formation		Late Cretaceous	Marine: deltaic, gray sandstone and sandy shale	Petroleum in Browns Hill, Cherokee Creek, Cow Creek, Deep Gulch, Sugar Creek Fields.
Mowry Shale		Late Cretaceous	Marine: silver-gray, hard siliceous shale, with abundant fish scales and bentonites	Bentonites, mined about 10 miles east of area.
Muddy Sandstone		Early Cretaceous	Marine: deltaic, gray to brown sandstone, conglomeratic	Petroleum in Browning, Deep Creek, Sugar Creek Fields.
Thermopolis Shale		Early Cretaceous	Marine, black, soft, fissile shale	none reported, oil and gas source rock

Geologic Deposit	Geologic Age	Environment/Lithology	Resources/BLM Paleontology Condition (Surface exposed formations only)
Cloverly Formation (=Dakota Sandstone)	Early Cretaceous	Terrestrial, variegated mudstone, bentonitic, conglomeratic sandstone	Petroleum in Browning, Cherokee Creek Fields.
Morrison Formation	Jurassic	Terrestrial, varicolored mudstones, white sandstone, bentonite	Petroleum in Browning Field.
Sundance Formation	Jurassic	Marine, green-gray glauconitic sandstone and shale, underlain by red and gray non-glauconitic shale and sandstone	none reported
Nugget Sandstone	Triassic to Jurassic	Eolian, gray to red, massive to cross-bedded sandstone	Petroleum in Cow Creek, Deep Gulch Fields.
Chugwater Formation	Triassic	Terrestrial/mud flat, red shale and siltstone, sandstone	Petroleum in Browning Field.
Goose Egg Formation	Permian to Triassic	Marine, gray to olive dolomitic siltstone; red sandstone and siltstone, gypsum, halite, purple to white dolomite and limestone	none reported
Tensleep Sandstone	Pennsylvanian	Marine, white to gray sandstone with limestone and dolomite	Petroleum in Browning, Espy, Sugar Creek Fields.
Amsden Formation	Mississippian to Pennsylvanian	Marine, red and green shale and dolomite, persistent red to brown sandstone at base	none reported
Madison Limestone	Mississippian	Marine, glue-gray massive limestone and dolomite	none reported
Flathead Sandstone	Cambrian	Marine/shoreline, red, banded, quartzose sandstone	none reported
unnamed metamorphic rocks	Precambrian	Igneous/metamorphic, granitic and/or intrusive	none in area but in Sierra Madre contain ores of uranium, copper, silver, lead, zinc, gold, and barium industrial (building and decorative) grades of quartzite, marble, and granite

3.1.1.2 Surface Deposits

Quaternary Deposits

Quaternary deposits in the BCPA include gravels, colluvium and slope wash, as well as residuum developed on formations of Cretaceous (Lance Formation) age. Younger soils have formed on these deposits in places. Additional descriptions of the soil units are provided in Section 3.5.

Tertiary B Wasatch Formation

Outliers of Tertiary age rocks Have been mapped at three places within the BCPA: (1) just northeast of the town of Baggs, in Sec. 35, T13N, R91W, where they overlie the Paleocene Fort Union Formation; and (2) as two distinct outliers capping the highest hills in the E 2 T14N, R91W, overlying rocks of the Upper Cretaceous Lance Formation and Lewis Shale. Weitz and Love (1952) mapped the outlier rocks as the Wasatch Formation of Eocene age. Later Love and Christiansen (1985) mapped them as rocks of the Browns Park Formation of Miocene age. Field examination of these outlier outcrops reveals that they are neither the Wasatch nor Browns Park Formations. In actually they represent weathered and flat-lying Lewis Shale that may represent a small structural flexure or a weather zone developed into the underlying Lewis Shale.

Upper Cretaceous B Lance Formation

The Lance Formation of latest Cretaceous age crops out only along the westernmost (W 2 Sec 14 and W 1/4 Sec 23, T41N, R91W) and southernmost (S 1/4 Sec 23, T41N, R91W) parts of the BCPA.

Regionally, the Lance Formation consists of about 2,890 feet of interbedded gray sandstone and mudstone, carbonaceous shale and coal (Hettinger et al. 1991, Hettinger and Kirschbaum 1991). Sandstones of the formation, abundant at its base in the BCPA, are relatively resistant to erosion and form ridges that hold up the major highlands in the BCPA area.

Upper Cretaceous B Lewis Shale

The Lance Formation is underlain by the Lewis Shale, and this relatively nonresistant unit underlies most of the BCPA. The Lewis Shale consists of up to 1,500 feet of near shore marine shale, and thin, discontinuous stringer sandstones (Smith 1961, Roehler 1993). With the exception of the uppermost part of the formation, which contains a series of laterally extensive sandstones that weather to ridges and small cliffs, the Lewis Shale is not very resistant to erosion and forms a broad strike valley.

The Lewis Shale interfingers westward into the upper part of the Mesaverde Group, the Fox Hills Sandstone, and the lower part of the Lance Formation. In the BCPA, the Lewis Shale is underlain by the Mesaverde Group; however, farther north and east (seaward at the time of deposition), along the Sierra Madre Range and in the Laramie Basin, respectively, the Lewis Shale directly overlies the Steele Shale (Ritzma 1949; Roehler 1993) and the Mesaverde is absent.

3.1.1.3 Mineral Resources

With the exception of gravel deposits, no economic deposits of locatable minerals are known to occur within the BCPA. Gravel, preserved as Quaternary terrace and channel remnants, occurs at the top of Wild Horse Butte and along Deep Creek Rim. The gravels along Deep Creek Rim are staked as a gravel mine.
Coal and coalbed methane occur in Cretaceous age geologic formations and oil and gas occurs in geologic formations of Cretaceous, Jurassic, Triassic, and Pennsylvanian age underlying the BCPA.

Coal and Coalbed Methane

Lance Formation

Coals occur discontinuously in outcrop in the Lance Formation from I-80 south to about T15N. Averaging about 5 feet in thickness, but ranging from a few inches to 22 feet thick, coals are thicker, more abundant, and laterally extensive in the lower part of the formation. The coals have limited lateral extent and usually cannot be traced more than a few hundred to several thousand feet.

Lance Formation coal beds are minor coalbed methane targets (Scott and others 1994, 1995), but because the formation occurs only along the westernmost and southernmost margin of the BCPA, chiefly stratigraphically above the rest of the area, it cannot be considered a potential target.

Mesaverde Group

Coals occur in outcrops in the Mesaverde Group, which stratigraphically underlies the Lewis Shale, in several places along the western flank of the Sierra Madre. These are best developed high in the Mesaverde Group (Pine Ridge Sandstone) near its contact with the overlying Lewis Shale in exposures several miles to the east of the BCPA (Atlantic Rim and Green River Coal Fields) and in T15-16N, R90-91W (an unnamed coal field). These fields have moderate KMDA value (less than $1 million, based on 1981 prices) and include about 230,400 leasable acres. Coals are also developed sporadically lower in the Mesaverde Group (Allen Ridge Sandstone), but these coals are thin and discontinuous and areas containing them are rated as having a low KMDA value. Based on vitrinite reflectance percentages from wells in the Sand Wash Basin, Mesaverde, coals underlying the BCPA rank as high volatile C bituminous, high volatile B bituminous, and high volatile A bituminous.

Coals in the Pine Ridge (=Williams Fork) Formation include the thickest and most extensive coals of the Upper Cretaceous in the Greater Green River Basin and are the basin=s prime coalbed methane targets. The maximum net coal thickness of about 220 feet, contained in 40 individual coal beds occurs near Craig, Colorado. The coal beds thin in a westerly and northerly direction, so that in the southeastern part of Carbon County, underlying the BCPA net coal thicknesses range from 40 to 90 feet. The coals of the Pine Ridge Formation are interpreted to have accumulated in coastal plain environments and fluvial dominated, wave modified deltas, along a southwest-northeast oriented strand (beach) line that faced southeastward into the Cretaceous epicontinental seaway. Three depositional coal cycles are represented that accumulated in response to progradation as a result of sea level drop or changes in delta location, or both. The thickest coals in these cycles overlie shoreline sandstones with thinner

and less continuous coals developed between deltaic distributary channel sandstones.

Gas content values for coals developed in the Pine Ridge Sandstone (= Williams Fork Formation) range from less than 1 to more than 540 scf/ton, but are generally less than 200 scf/ton. Samples from the Sand Wash Basin indicate a gradual increase in gas content with increasing burial, but that coal rank does not increase significantly with depth. Gas contents of samples taken shallower than 1,000 feet are less than 20 standard cubic feet per ton (scf/ton) suggesting that coalbed gases may have migrated out of the system because either confining pressures were low, the overlying seals were absent, or both. Analysis of 36 coal samples from 6 wells provided a gas dryness range from 0.79 to 1.0 with an average of 0.95, carbon dioxide content of less than 1 to more than 25%, with an average of 6.7 %, and a nitrogen content of less than 1 to 20 % with an average of 4 %. Coals having a high carbon dioxide content are characterized by high C1-C1-5 values.

Based on gas content values, Scott and others (1994, 1995) estimated coal gas reserves in the in the western and southwestern parts of Carbon County, Wyoming, underlying the BCPA, to be less than or equal to 10 bcf/mi2 near the eastern margins of its subcrop and 8 to 40 bcf/mi2 in the extreme southwestern corner of the county.

Coals in the Allen Ridge (=Iles) Formation are thinner and not as well developed as those in the Pine Ridge and the formation is considered a minor coal-bearing unit and coalbed methane target. A maximum net coal thickness of 32 feet occurs in the easternmost part of the Great Divide Basin, but most other places it is typically less than 15 feet. These coals are interpreted to have accumulated in a variety of swampy environments above shoreline sandstones and in flood plains adjacent to delta river channels.

Based on samples from wells primarily in the Rock Springs Uplift, gas content values in the Allen Ridge (=Iles) Formation range from 0 to more than 650 scf/ton. No estimates of total coal gas reserves are available for this unit.

Oil and Gas

Areas adjacent to the BCPA have produced significant quantities of oil and natural gas. Production is chiefly from Cretaceous geologic units including the Mesaverde Group, Steele Shale, Niobrara Shale, Frontier Formation, Muddy Sandstone, and Cloverly Formation. In addition, Jurassic rocks of the Morrison Formation, Triassic rocks of the Chugwater Formation, and Pennsylvanian rocks of the Tensleep Sandstone have proved productive. Oil and gas fields of interest (The Oil and Gas Fields Symposium committee 1957 1979 1992, Gregory and DeBruin 1991, DeBruin and Boyd 1991, and DeBruin 1996 Cronoble 1969; DeBruin, 1993; Kaiser et al. 1994) include the Baldy Butte (T17N, R92W), Browning (T14N, R91W), Browns Hill T16N, R90-91W), Cherokee Creek T15N, R91W), Cow Creek (T16N, R92W), Deep Creek (T16N, R90-91W), Deep Gulch (T16N, R91W), Dixon (T12-13N, R90W), Espy (T19N, R89W), Sierra Madre (T13N, R89-90W), and Sugar Creek (T19N, R90W). Oil and gas is produced from combined stratigraphic and faulted structural (anticlinal) traps.

3.1.1.4 Geologic Hazards

Naturally occurring geologic hazards (excluding soil hazards which are discussed in Section 3.3.3) include fault generated earthquakes, floods, and landslides or other mass movements of earth materials. The most likely of these to affect the BCPA are mass movements that could be initiated on steep slopes.

There are no known faults with evidence of Quaternary movement or earthquake epicenters mapped within the BCPA (NEIC 2002, WGS 2002). The nearest recorded epicenter, that of a 4.3 Richter magnitude earthquake occurred April 4, 1999, near Baldy Butte in T17N, R92W (41.45ºN, 107.74ºW) a few miles north of the BCPA. No other earthquake epicenters have been recorded in or immediately adjacent to the area in the past 100 years. This indicates that this quake may have been an unusual event and that the area may not be very seismically active.

Pyrophoricity

Pyrophoricity (spontaneous combustion) has been cited as potential hazard of coal gas development. Spontaneous combustion of coal has long been a concern for mankind and shallow coal mine fires in areas of abandoned mines are today still an environmental concern throughout the world (Lyman and Volkmer 2001).

Spontaneous combustion of coal is unlikely to occur in naturally exposed outcrops of coal because by the time coal is exposed by erosion it is already too degassed to ignite spontaneously (Coates and Heffern, 1999). Studies of in-situ coal gasification conducted during the 1970's in Wyoming suggest that even under extreme efforts to maintain combustion (by injecting air into the burn zones) in underground coals ignited in bore holes, coal burning away from the ignition area cannot be sustained. Loss of permeability associated with plugging of fissures by tar and combustion products resulted in the fires burning themselves out rather quickly. In their study of Powder River Basin CBM wells, (Lyman and Volkmer 1999) found that spontaneous combustion of coal beds during coalbed methane production is unlikely because completion methods, although Aopen-hole@, configure the well to keep air, necessary for combustion, out of the system. Even where the coal has been completely dewatered, insufficient oxygen is present for oxidation to be carried forward. After coal gas extraction is complete, CBM wells leave no underground voids susceptible to subsidence and associated coal ignition as seen in abandoned underground mines, which unlike CBM wells, are susceptible to spontaneous ignition.

Subsidence

Ground subsidence (resulting from withdrawal of coalbed-methane related water) has also been cited as a potential hazard of CBM development. A number of documented cases have demonstrated the association of withdrawal of underground fluids and subsidence. The best examples include specific sites in the San Joaquin Valley in California, Las Vegas, New Orleans, Houston, and Mexico City. Subsidences in these areas are all chiefly related to removal of water for human consumption or agricultural use. Removal of water from underlying saturated, chiefly unconsolidated and porous sand and gravel aquifers lowers the water table, and causes the previously saturated zones to compress, causing subsidence. Saturated unconsolidated sands and gravels and porous clays can compress significantly. In some cases as much as 29 feet of subsidence in these areas has resulted. The subsurface geologic conditions in the BCPA, however, differ significantly from these areas. The bedrock underlying the area is compacted and consolidated and porosity is much lower. In comparison, unconsolidated sands and gravels and clays have porosity values as high as 50% and 88%, respectively (Poland 1984), whereas, values for consolidated clay (shale) and sand (sandstone) in the BCPA have porosity values at most as high as 10% and 30%, respectively (Freeze and Cherry 1979).

Mass Movement

Mass movement (including earth flowage, landsliding, slumping, and creep) are associated with and accentuated by topographic relief and slope. Surface elevations within the BCPA range from a high of 7,220 feet atop an unnamed hill in the NW 1/4 of Sec 24, T14N, R91W and along the northern extension of Deep Creek Rim in the SW 1/4 of Sec 23, T14N, R91W to a low of about 6,600 feet along Wild Horse Draw in the SW 1/4 of Sec 23, T14N, R91W. Relief is approximately 620 feet. Slopes within the area are generally undulating, broken by areas of steeper (10 to 40 percent) and very steep slope to vertical faces (rock outcrops). Maximum slope over a one mile intersect is about 7.5 % grade (400 feet rise in 5,280 ground feet) and the minimum slope is about 2.3 % grade (120 feet rise in 5,280 ground feet) in the SW 3 Sec 19, T14N, R90W.

Mass movement of earth materials occurs around Wildhorse Butte (T14N, R91W) and is associated with steep slopes developed in the Lewis and Lance formations. These geologic units contain clay-rich shale beds that are susceptible to mass movement when water saturated, especially where exposed on steep or undercut slopes. Of the two formations, the Lewis Shale is most susceptible to mass movement. A small rotational slump has developed in the formation in the NW 1/4 of Sec 24, T14N, R91W. The Lewis Shale is also extensively involved in earth flow to the south and east. It is susceptible to mass movement because it forms broad exposures of shale that are actively being eroded. Sandstones and mudstones of the Lance Formation are less likely to be involved in mass movement. Both the Lewis and Lance Formation which dip steeply westward are more susceptible to mass movement along the western side of their exposures in places where down hill, down dip, toe support of the formation is removed or undermined.

Mass movement associated with soils is discussed in Section 3.3.3.

3.1.2 PALEONTOLOGIC RESOURCES

Geologic mapping and field evaluation documents four geologic deposits exposed at the surface in the BCPA. These include, from youngest to oldest: (1) unnamed deposits of Quaternary (Holocene) age; (2) Lance Formation of Latest Cretaceous age; and (3) Lewis Shale of late Cretaceous age. The Lewis Shale underlies most of the project area.

Holocene deposits (including soils) are widespread in the BCPA and too young to contain fossils. Exposures of the Lance and Wasatch Formations, which are known to contain scientifically significant fossils are restricted to the western-most and southern-most margins and top of Wild Horse Butte and Deep Creek Rim, respectively, and are not aerially extensive. The Lewis Shale, which is known to contain invertebrate fossils and occasionally significant vertebrate fossils, is the most widely exposed geologic unit in the BCPA.

Although no fossils have been reported from the BCPA to date, scientifically significant fossil vertebrates have been recovered from the Lance Formation from exposures along the Sierra Madre to the north (Morris 1954, Honey 1988, Roehler 1972, 1991 a-b, 1992 a-c, 1993, Roehler et al. 1988, Rigby 1980, Dorf 1942a, 1942b; Estes 1964, Clemens 1966; Clemens and others 1979; 1986; Weishample, 1992; Archibald, 1993 Lillegraven, 2002, Honey, 2003). The Lewis Shale is known to produce remains of marine reptiles and fish (Breithaupt, 1985).

Based on descriptions included in the BLM's Paleontological Resource Management Handbook 8270-I, the Lance Formation meets Condition 2 and the Lewis Shale meets Condition 3, with

regard to fossil resources. These conditions are as follows:

Condition 2: Areas with exposures of geological units or settings that have high potential to contain vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils. The presence of geologic units from which such fossils have been recovered elsewhere may require further assessment of these same units where they are exposed in the area of consideration.

Condition 3: Areas that are very unlikely to produce vertebrate fossils or noteworthy occurrences of invertebrate or plant fossils based on their surficial geology, igneous or metamorphic rocks, extremely young alluvium, colluvium or eolian deposits or the presence of deep soils. However, it possible it should be noted at what depth bedrock may be expected in order to determine if fossiliferous deposits may be uncovered during surface disturbing activities.

3.2 CLIMATE AND AIR QUALITY

3.2.1 Climate

The Brown Cow project area is located in a semiarid (dry and cold), mid-continental climate regime. The area is typified by dry, windy conditions, with limited rainfall and long, cold winters. The nearest meteorological measurements were collected at Baggs, Wyoming (1979-2000), approximately 3 miles southwest of the project area at an elevation of 6240 ft (WRCC 2003). Because of the wide variation in elevation and topography within the study area, site-specific climatic conditions vary considerably.

The annual average total precipitation at Baggs is 10.7 inches, ranging from 18.5 inches (1983) to 4.6 inches (1989). Precipitation is evenly distributed throughout the year, with minor peaks in May, July, and October. An average of 38.8 inches of snow falls during the year (annual high 104.0 inches in 1983), with December and January the snowiest months. Table 3-3 shows the mean monthly temperature ranges and total precipitation amounts.

Table 3-3. Mean Monthly Temperature Ranges and Total Precipitation Amounts.

Month	Average Temperature Range (°F)	Total Precipitation (inches)
January	5-33	0.56
February	9-36	0.43
March	20-47	0.44
April	28-59	0.82
May	34-68	1.52
June	41-79	0.89
July	48-86	1.33
August	46-84	0.99
September	38-74	1.14
October	27-61	1.39
November	16-43	0.66
December	7-34	0.54
ANNUAL	42.6 (mean)	10.71 (mean)

Source: (WRCC 2003)

The Baggs region has cool temperatures with average daily temperatures (in degrees Fahrenheit; °F) ranging between 3 °F (low) and 33 °F (high) in mid winter and between 56 °F (low) and 75 °F (high) in mid summer. Extreme temperatures have ranged from –50 °F to 100 °F (both occurring in 1984). The frost-free period (at 32 °F) generally occurs from mid-May to mid-September.

The project area is subject to strong and gusty winds, reflecting channeling and mountain valley flows due to complex terrain. During the winter months strong winds are often accompanied by snow, producing blizzard conditions and drifting snow. The closest comprehensive wind measurements are collected at the Rawlins, Wyoming, airport nearly 60 miles north-northeast of the project area. However, hourly wind data measurements for December 1994 through November 1995 were collected near Baggs, Wyoming during the Mount Zirkel Wilderness Area Visibility Study. Due to the proximity to the analysis area, these data (rather than the more distant Rawlins wind data) were used to describe the wind flow patterns in the region. Figure 3-1 shows the relative frequency of winds, with radial distributions by speed class, indicating the direction of the wind source. Table 3-4 provides the wind direction distribution in a tabular format. From this information, it is evident that the winds originate from the south to southwest nearly 37 percent of the time. The annual mean wind speed is nearly 10 mph.

Table 3-4. Wind Direction Frequency Distribution for Baggs, WY.

Wind Direction	Percent of Occurrence
N	5.2
NNE	3.8
NE	2.7
ENE	3.8
E	4.8
ESE	8.9
SE	6.9
SSE	7.6
S	13.8
SSW	13.4
SW	10.0
WSW	5.1
W	4.4
WNW	4.0
NW	2.6
NNW	3.1

The frequency and strength of the winds greatly affects the dispersion and transport of air pollutants. Because of the strong winds in the project area, the potential for atmospheric dispersion is relatively high, although nighttime cooling will enhance stable air, inhibiting air pollutant mixing and transport. Dispersion conditions will be the greatest to the north and along the ridge and mountain tops.

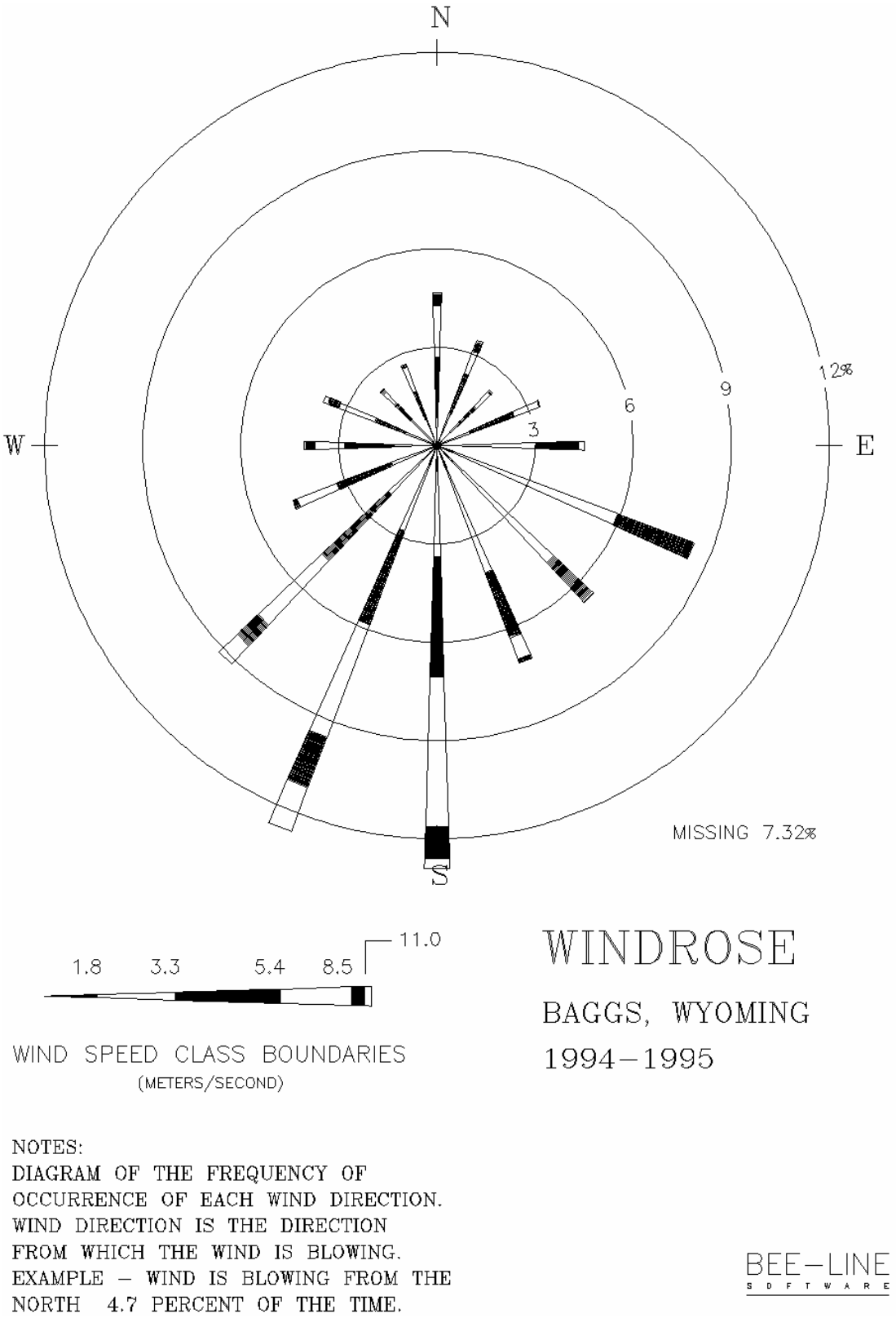

Figure 3-1. Wind Rose for the Brown Cow Pod Region.

Table 3-5 shows the frequency distribution of wind speed and atmospheric stability class. The atmospheric stability class is the measure of atmospheric turbulence, which directly affects pollutant dispersion. The stability classes are divided into six categories designated "A" (unstable) through "F" (very stable). The "D" (neutral) stability class occurs more than half of the time.

Table 3-5. Wind Speed and Stability Class Distribution.

Wind Speed (miles/hour)	Percent of Occurrence	Stability Class	Percent of Occurrence
0-4.0	6.4	A (unstable)	6.0
4.0-7.5	33.0	B	8.2
7.5-12.1	29.8	C	14.8
12.1-19.0	21.7	D (neutral)	56.6
19.0-24.7	5.4	E	9.9
Greater than 24.7	3.7	F (very stable)	4.5

3.2.2 Air Quality

The Wyoming Ambient Air Quality Standards (WAAQS) and National Ambient Air Quality Standards (NAAQS) set absolute upper limits for specific air pollutant concentrations at all locations where the public has access. Although specific air quality monitoring has not been conducted within the project area, regional air quality monitoring has been conducted. Air pollutants measured in the region for which ambient air quality standards exist include: carbon monoxide (CO), nitrogen dioxide (NO2), ozone, particulate matter less than 10 microns in effective diameter (PM10), particulate matter less than 2.5 microns in effective diameter (PM2.5), and sulfur dioxide (SO2). Background pollutant concentrations for these pollutants are compared to the WAAQS and NAAQS in Table 3-5.

As shown in Table 3-6, regional background values are well below established standards, the project area is designated as attainment for all criteria pollutants. These regional monitoring results also indicate that air quality conditions within the project area are likely to be very good, supported by limited air pollution emission sources (few industrial facilities and residential emissions in the relatively small communities and isolated ranches) and good atmospheric dispersion conditions. These factors generally contribute to relatively low ambient air pollutant concentrations.

Federal air quality regulations adopted and enforced by WDEQ-AQD limit incremental emissions increases to specific levels defined by the classification of air quality in an area as either Prevention of Significant Deterioration (PSD) Class I or Class II. Limitations on additional air pollution allowed in PSD Class I areas are very strict. Less stringent incremental air quality increases are allowed in PSD Class II areas. The Brown Cow Pod is classified as PSD Class II.

3.3 SOILS

Soil development is a function of parent material, living matter, climate, relief or topography, and time.

Parent Materials

Parent materials in the BCPA include chiefly the marine sandstones and shales of the Lewis Formation (Upper Cretaceous) and to a much lesser extent the fluvial sandstones and variegated mudstones of the Wasatch (Eocene) and Lance (Cretaceous) Formation. Slopewash debris and colluvium derived from those units also constitute parent materials for colluvial soils.

Table 3-6. Air Pollutant Background Concentrations, State and Federal Ambient Air Quality Standards (ug/m3)

Pollutant/Averaging Time	Measured Background Concentration	State and National Ambient Air Quality Standards
Carbon Monoxide (CO) [1]		
1-hour	3,336	40,000
8-hour	1,381	10,000
Nitrogen dioxide (NO_2) [2]		
Annual	3.4	100
Ozone [3]		
1-hour	169	235
8-hour	147	157
Particulate Matter (PM_{10}) [4]		
24-Hour	47	150
Annual	16	50
Particulate Matter ($PM_{2.5}$) [4]		
24-Hour	15	65
Annual	5	15
Sulfur dioxide (SO_2) [5]		
3-hour (National)	132	1,300
24-hour (National)	43	365
24-hour (Wyoming)	43	260
Annual (National)	9	80
Annual (Wyoming)	9	60

1 Background data collected by Amoco at Ryckman Creek for an 8-month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).

2 Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (ARS 2002).

3 Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).

4 Background data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2002.

5 Background data collected at LaBarge Study Area the Northwest Pipeline Craven Creek Site 1982-1983.

Living Matter

Living matter provides the biological community that changes inert rock material into soil. Under shrubs and grasses soils tend to have slight organic accumulations and different vegetative cover gives rise to different soil characteristics. Very wet soils tend to have more accumulation of organic material on the surface. The dominant vegetation in the BCPA is sage, which

commonly grows in patches or thickets. Growing between the patches of sage and along larger drainages, are desert grasses, greasewood, bunch grass, cactus, rabbit brush, moss, lichens, and a variety of wild flowers. The area is largely devoid of trees with the exception of juniper which grow on sandstone exposures at higher elevations.

Climate

Climate has a direct and indirect effect on soil development through its principal components, precipitation, temperature, humidity, wind, and sunshine. Precipitation promotes leaching and physical, chemical and biological activity and temperature affects bedrock by expansion, contraction and frost action. Humidity promotes plant growth. The climate of the project area is that of a semiarid windy desert. The annual precipitation ranges from about 7 to 14 inches including snow, and the annual temperature varies from about B30 degrees F during the winter months to more than 100 degrees F in summer. Wind is a very important component because it transports sand and to a lesser extent clay everywhere and this material is incorporated into the upper soil profile diluting organic material of a soils A horizon.

Relief

Relief or topography influences soils principally though its effect on microclimate and runoff. The BCPA is typical of a desert intermontane basin in that its physiography is dominated by: (1) hogbacks and strike valleys; (2) flat-topped stripped bedrock surfaces (strath surfaces or terraces); (3) pebble/gravel/cobble stream terraces; and (4) alluvial fan and slopewash deposit. Topography and slope are discussed in Section 3.2.

Time

The length of time for soils to form depends largely on other factors involved. Soils form more rapidly on sandstone than on granite, and more rapidly on sand than sandstone. A soil derived from granite will differ chemically from a soil derived from sandstone soil, and a soil formed on sandstone might closely resemble one formed on loose sand. Mature soils are in equilibrium with their surroundings, and begin to show the development of horizons. Very young soils lack horizons. In general, the best-developed (most mature) soils form on stable surfaces that are geomorphically at equilibrium with their surroundings and the highest of these stable surfaces are the oldest and will generally exhibit the thickest soil horizons. Soil horizonation is the development of different stratified textures and chemical properties that are ordered, from top to bottom, within the soil. The development of soil horizons is largely the result of translocation; that is, the depletion (eluviation) of the topsoil of some elements (e.g., clay, iron oxides), and their concentration (illuviation) in the subsoil.

3.3.1 Project Area Soils

Soils within the BCPA occur in Wyoming Soil Zone 9 as defined by Munn (1998)--intermontane basin, frigid and aridic. Baseline soils information was extracted from several sources, including BLM in house reports and the University of Wyoming Internet Map Server (http://www.sdvc.uwyo.edu) and supplemented by field survey.

Two Munn Soil Map Units: WY34 Ustic Haplargids and Ustic Natrargids, fine-loamy, frigid and WY35 Typic Natrargids and Typic Torriorthents, fine, frigid, and a single Stratsgo soil unit, the Delphill-Blazon-Landspring (WY138) Association is mapped in the BCPA. The Delphill-Blazon-Landspring is composed of the following components:

Landspring 15%, fine sandy loam, moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures. Well drained.

Delphill 25% loam, slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures. Well drained.

Blazon 20% loam, Blackhall 10% sandy loam, Rentsack 10%, Moyerson 10% silty clay loam, Rock Outcrop 5% unweathered bedrock WINT 5%

Blazon, Blackhall, Rentsack, Moyerson, Wint components and Rock Outcrop are generally clayey, have a high water table, or are shallow to an impervious layer. All except Wint, which is somewhat excessively drained, are well drained with very slow infiltration rates

Winterfeld and Bown (2003) mapped four specific geomorphic soil types within the BCPA: (1) *Gravel Terraces (GT)* with minimal soil development occur atop the highest points of the area; (2) *Residual-Colluvial soils* occur on steeper slopes and are underlain at a shallow depth by bedrock; (3) *Upland Slope Soils* are developed in less steep, more stable areas; and (4) *Strath Surface Soils* occur on remnant terraces formed on underlying bedrock. Soil sampling of these soil types did not reveal impervious layers as indicated by Stratsgo mapping.

Specific characteristics of these four soils are discussed below and a map of the distribution of the soil types is provided in Figure 3-2.

Gravel Terraces

Gravel terraces occur in the BCPA at an elevation of about 7,120 to 7,140 feet along the Deep Creek Rim and an unnamed hill in the NW 1/4 of Sec 24, T14N, R91W on top of the Lewis, Lance, and Wasatch formations. The terraces are formed by small boulder, cobble, as well as gravel clasts. The clasts are composed chiefly of Precambrian age igneous and metamorphic rocks.

Upland Slope Soils

Upland Slope Soils are shallow to moderately thick soils, that occur on gentle to moderate slopes, are very permeable and well-drained, are generally noncalcareous, and base-neutral loamy sands, sandy loams and sandy clay loams. They are developed on sloping surfaces on bedrock of the Lance Formation and Lewis Shale at elevations ranging from 6,680-6,942 feet, and on slopes varying from 1-5%.

Strath Surface Soils

Strath Surface Soils are medium thickness soils that occur on gentle-moderate slopes, are well-drained, slightly to moderately calcareous, slightly acidic, loamy sand, sandy loam and clay. They are developed on lower level stripped surfaces (bedrock, or strath terraces), at elevations of about 6,720-7,080 feet on slopes of 0-3%.

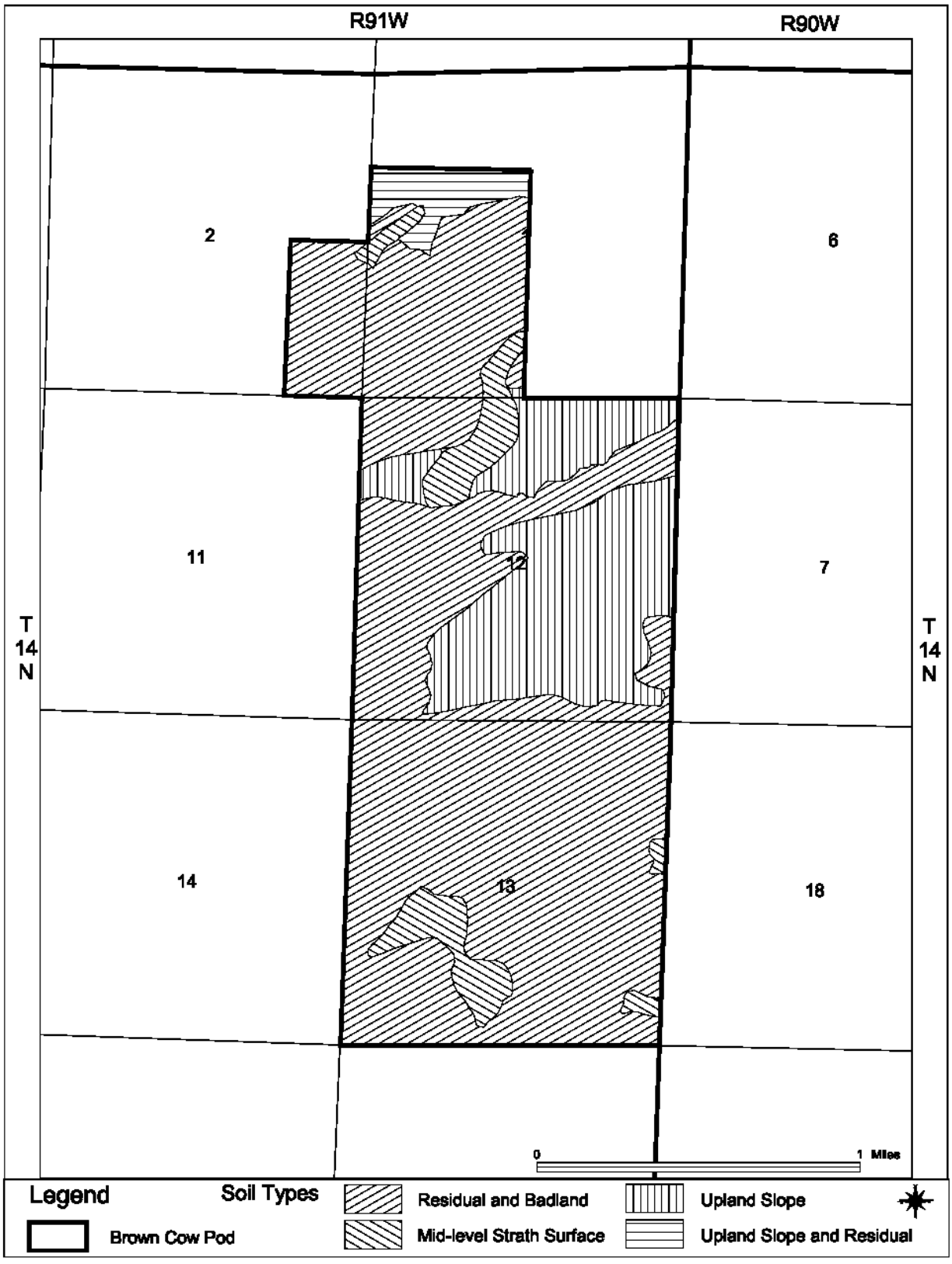

Figure 3-2. Soils Map of the BCPA.

Residual Colluvial Soils

Residual Colluvial Soils are shallow to deep soils that occur on gentle to steep slopes, are generally poorly-drained. They occur at all elevations within BCPA. Residual colluvial soils range from Apopcorn@-like crusts on mudstones and shales to accumulations of sandstone boulders at the bases of cliffs. Most of these soils, however, occur as thin zones of weathered, dislodged, or partially disaggregated bedrock on all slope gradients. The texture and composition of this soil varies with, and is nearly identical to, the bedrock formation it is developed on.

3.3.2 Erosion

Flowing water causes the erosion of soil material and can cause soil and geologic hazards associated with mass movement. Part of the process of water erosion involves detachment of soil material by the impact of raindrops. Loosened soil material is then carried off in suspension in runoff. Four kinds of water erosion are generally recognized sheet, rill, gully, and pipe (tunnel) erosion.

Sheet erosion involves the removal of soil from an area without the development of conspicuous channels. The channels instead are numerous and unstable in that they enlarge and straighten as the volume of runoff increases. Sheet erosion can be serious on soils with slope gradients of only 1 or 2 percent, but becomes more serious as gradient increases.

Rill erosion involves the removal of soil through cutting of many small, but conspicuous channels where runoff concentrates. The channels are small enough though that they are easily obliterated by tillage.

Gully erosion occurs when water cuts down into the soil along a line of flow. Gullies form in exposed natural drainages, in animal trails, in vehicle ruts, and below broken man-made terraces or stock ponds. Gullies cannot be obliterated by ordinary tillage and deep gullies cannot be easily crossed. The maximum depth to which gullies cut is determined by resistant layers in the soil, by bedrock, or by the local base level. Many gullies develop headward; that is, they extend up the slope, as the gully deepens in its lower part.

Piping or tunnel erosion can occur in soils with subsurface horizons or layers that allow water to pass more freely than the surface horizon or layer. Freely flowing water enters the soil through surface-connected macro-pores such as rodent burrows. Soil material entrained in the moving water moves downward within the soil and may move out of the soil completely if there is an outlet. The result is the formation of pipes or tunnels which enlarge and coalesce and can eventually collapse. Piping is also favored by the presence of appreciable exchangeable sodium.

To assess a water erosion problem or potential problem soil characteristics and rainfall and runoff factors must be considered. The impact of raindrops can break up soil aggregates and disperse soil material. Very fine sand, silt, clay and organic matter can be removed easily by raindrop splash and runoff, whereas greater energy or runoff is needed to remove sand and gravel particles. Soil movement caused by rainfall is usually greatest and most noticeable during short-duration, high intensity storms, however, less spectacular, long-lasting and less-intense storms can also result in significant soil movement. The effect of runoff can be compounded by soils that have reduced infiltration capacity.

BCPA soils are also eroded by wind action. Fine sands, loamy sands, and coarse sandy loams are most susceptible to erosion by wind. Overall wind erosion potential is moderate, but ranges from slight to severe.

Soil Erodibility

Soil erodibility is an estimate of the ability of soils to resist erosion, based on its physical characteristics. In general soils with faster infiltration rates, greater organic matter and improved soil structure have a greater resistance to erosion. Sand, sandy loam and loam textured soils tend to be less erodible than silt, very fine sand, and certain clay textured soils. Decreased infiltration and increased runoff can result from compacted subsurface soil layers. A decrease in infiltration can also be caused by a formation of a soil crust, which seals off the surface. A soil crust might decrease the amount of soil loss from sheet or rain splash erosion, but it might cause a corresponding increase in the amount of runoff water and contribute to greater rill erosion problems.

Past erosion also has an effect on a soils erodibility. Exposed subsurface soils on eroded sites tend to be more erodible than the original soils, because of their poorer structure and lower organic matter. Lower organic matter supports lesser vegetation and promotes poorer vegetative cover, which provides less protection for the soil.

Slope Gradient and Length

The steeper the slope of the land, the greater the amount of soil loss from erosion by water. Soil erosion by water also increases as slope length increases due to the greater accumulation of runoff. Consolidation of small slopes into larger ones results in longer slope lengths with increased erosion potential, due to increased velocity of water, which permits greater scouring.

Vegetation

Soil erosion potential is increased if the soil has little or no vegetative cover. Plant cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff and allows excess surface water to infiltrate, where part of it is absorbed by roots. The erosion-reducing effectiveness of vegetative cover depends on the type, extent and quantity of the cover.

3.3.3 Soil Hazards and Limiting Factors

Some soil properties hold significance for the engineering properties of the soils, and can limit the utility of specific soilsCin particular areasCfor a variety of uses. In general, the utility of a particular soil for a specific use is based on knowledge of the climate and existing or potential geologic hazards of the area under study, as well as a combination of one or more of the following soil properties: (1) slope, or surface inclination, on which the soil formed; (2) the permeability of the soil, both at the surface (as this affects runoff potential) and at depth (as this may affect the development of mass-wasting, piping, soil shifting, and soil collapsibility); (3) vegetation cover on the existing soil; (4) the soil parent material; and (5) the overall clay and type of clay content of the soil.

Several hazards relate to soil type. Chief among these are the relatively rapid mass-wasting effects of earth flow and slumping. Earth flow commonly results from the saturation of soils on

slopes and the collection of water and ensuing loss of cohesion along the plane separating the subsoil from the soil parent material (for example, in the case where a permeable, waterlogged soil might lie on a steeply sloping shale underlain by impermeable sandstone). Similarly, rapid rotational slumping can occur when soils and underlying parent materials are undercut by streams, or when the toe of a mass of soil or sediment is supersaturated or eroded away or removed by excavation. Both mass-wasting and slumping result from a combination of soil parameters (slope, permeability, nature of parent materials) acting in conjunction with two climatic aspects: precipitation and its spacing throughout the year.

Earth flow and rotational slumping can occur within spans of days or hoursCeven secondsChowever, other mass-movements take place over a period of weeks or months to years. Soil creep is the slow, downward movement of soils or soil materials on slopes. Creep can affect residual and colluvial soils as well as soils with sharply marked horizons, and this process results in phenomena as divergent as the piling-up of boulders at the bottom of an outcrop hill to the downhill tilt of trees. Soil collapse results from the frequent wetting and drying of mixed layer illitic/smectitic (expanding) clays in soils with thick (generally texturally unsorted) subsurface horizons rich in those clay minerals. Soil piping (tunneling) is especially prevalent in badland regions with large volumes of mudstone (an unsorted mixture of sand, silt, and clay), but is also common in soils rich in clay but with relatively unsorted textures. Pipes can collapse and piping is a major factor in the development of gullying by means of headward erosion along established stream courses. Piping, collapse, and headward erosion can occur on slopes of less than 1% grade, however, extensive or rapid gullying generally requires significant water runoff on steeper, less permeable soils.

In the BCPA, incipient creep of Residual Colluvial Soils is common on the dip slopes of the steeper hogbacks, in which colluvial debris (including sandstone blocks and shale bundles) has migrated downslope from its place of origin. Soil piping and headward erosion of gullies are ubiquitousCoccurring in to some degree everywhere in the project area and in all arid and semiarid areas. Gullying in the areas surrounding the BCPA is clearly exhibited below previously breached stock tanks and along slopes of varying degree along existing rutted, two track roads and animal trails.

3.4 WATER RESOURCES

Water resources in the project area include both surface water and groundwater. Surface waters include the perennial Little Snake River, the intermittent to perennial Muddy Creek, ephemeral Dry Cow Creek and several unnamed ephemeral channels and man-made ponds. Groundwater resources include free water contained within relatively shallow aquifers that are or could be utilized for culinary, agricultural, and/or industrial purposes. The occurrence and distribution of water resources in the project area are dependent on climate, soils, and structural geology.

3.4.1 Precipitation and Climate

The project area occurs in a continental dry, cold-temperature-boreal climate (Trewartha 1968). This climate is primarily characterized by a deficiency of precipitation (i.e., evaporation exceeds precipitation). Climatological data from the Baggs Station (No. 480484) is most relevant to the characterization of water resources in the BCPA. A brief description of the climatic conditions in the project area is presented below.

Temperature: The area generally has cold temperatures where fewer than eight months have an average temperature greater than 50°F, with hot summer days and cool summer nights, but bitterly cold winters. The average annual temperature is 42°F (WRCC 2000). The average daily low and high temperatures in January are 5°F and 33°F, respectively. In contrast, the average daily low and high temperatures in July are 48°F and 86°F, respectively. Data from the nearby Dixon recording weather station indicates that the average number of days per year with a minimum temperature at or below 32°F is 222, and the average number of days per year with a maximum temperature at or above 90°F is 3 (Martner 1986).

Precipitation: Mean annual precipitation is approximately 11 inches. Precipitation occurs throughout the year with a peak in May. The majority of precipitation falls as rain from frontal systems and thunderstorms. In regard to intensity of rainfall events, the estimated 50-year, 24-hour maximum precipitation event is 2.3 inches (Miller et al. 1973). Average annual snowfall depth is approximately 41 inches. Greatest snowfall usually occurs in December and January. Due to the effects of ablation and snow drifting, a discontinuous snow cover is usually present during the winter.

Other Climate Characteristics: Mean annual evaporation ranges from 55 inches (lake) to 75 inches (pan) and potential annual evapotranspiration is 20 inches (Martner 1986). Compared to the average annual precipitation of 11 inches, this gives an average annual deficit of approximately 9 inches. These meteorological and Climatological-*/ characteristics of the project area combine to produce a predominantly dry climate where evaporation exceeds precipitation.

3.4.2 Surface Water

3.4.2.1 Quantity

The project area is located within the Little Snake River drainage basin. Smiley Draw, an ephemeral tributary to Muddy Creek, is found within the project area. Muddy Creek is an intermittent to perennial stream that carries water most of the year to its confluence with the Little Snake River near Baggs.

The Little Snake River drains the largest basin in the Yampa River basin (Driver et al. 1984). It joins the Yampa River in northwest Colorado. The Yampa River flows southwest to its confluence with the Green River in Utah. The Green River drains to the Colorado River, which drains to the Pacific Ocean.

Annual peak flows for all streams within the project area generally occur in late May through early June in response to snowmelt. Baseflows are reached in the fall and continue through March until low elevation snowmelt initiates the rising limb of the hydrograph. A United States Geological Survey (USGS) continuous gaging station on the Little Snake River near Dixon recorded a maximum peak discharge of approximately 13,000 cfs on May 16, 1984, while minimum flows of near 0 cfs occur in late summer and early fall at the end of the irrigation season (Druse et al. 1993).

3.4.2.2 Quality

There are six USGS surface water quality stations in and around the project area, including two on the Little Snake River, two on Muddy Creek, and one each on Cow Creek and Dry Cow Creek. Average sample data from each of the stations are shown on Table 3-7. The data

suggest that surface waters in the project area are of moderately high pH (8.1 to 9.2) and moderate dissolved oxygen (9 to 11 mg/l).

Generalizations among other sample parameters are made difficult by high variability between stations. Trends become apparent, however, when the stations are divided according to the surface water designation. Table 3-8 averages select parameters from Table 3-7 into ephemeral, intermittent, and perennial classes.

Water quality in ephemeral streams is represented by the Smiley Draw monitoring station. The ephemeral quality is characterized by high TDS (1,620 mg/l) and sodium and bicarbonate dominance as the major dissolved ions. Sodium dominance is reflected in the relatively high sodium adsorption ratio (SAR) of 14.1.

Table 3-7. Surface Water Quality in the Project Area

	USGS Surface Water Quality Station[1]				
	Smiley Draw	**Muddy Creek**	**Muddy Creek**	**Little Snake River**	**Little Snake River**
Station Number	**1409018F**	**09258900**	**09259000**	**09257000**	**09259050**
Sample Period	**1988-1989**	**1976-1978**	**1957-1991**	**1957-1988**	**1980-1997**
Number of Samples[2]	2	3	41	107	100
pH, standard units	8.24	8.6	8.2	8.1	8.1
Conductance, mmhos/cm	1005	1350	966	259	366
Total Dissolved Solids[3]	598	913	630[4]	158	243
Suspended Solids	61	6198	3191	154	228
Turbidity	NM	1260 NTU	NM[5]	13 JTU	167 NTU
Hardness as $CaCO_3$	0	315	270	111	151
Oxygen	NM	11	10	9	10
Sodium	1416	200	286	11	26
Calcium	0.9	54	42	30	34
Magnesium	0.5	44	40	8	12
Potassium	2.4	7	9	2	2
Bicarbonate	3698	373	308	159	190
Carbonate	11.3	0.5	NM	0	1
Sulfate	1.05	380	320	25	54
Chloride	5.9	65	32	3	2
Fecal coliform, #/100 ml	NM	NM	8	NM	351

[1] Data available on the Internet at http://www.wrds.uwyo.edu
[2] Total number of grab samples analyzed; not every parameter was analyzed in every sample
[3] All units are mg/l except as noted
[4] TDS calculated from specific conductance due to lack of sample data
[5] NM = not measured

Table 3-8. Surface Water Quality Comparison

	Stream Class		
	Ephemeral	**Intermittent**	**Perennial**
Representative Surface Waters	Smiley Draw	Muddy Creek	Little Snake River
Total Dissolved Solids[1]	598	772	201
Sodium	1,416	243	19
Calcium	0.9	42	10
Magnesium	0.5	48	32
Potassium	2.4	8	2
Bicarbonate	3,698	341	175
Carbonate	11.3	0.5	0.5
Sulfate	1.05	350	40
Chloride	5.9	49	3
SAR	14.1	6.1	0.7

[1] All units are mg/l except SAR, which is unitless

The Wyoming Department of Environmental Quality (WDEQ) classifies Wyoming streams according to quality and degree of protection. Four classes have been identified as follows (WDEQ 2000):

Class 1: Those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices. Considerations employed during the designation of these waters include water quality, aesthetic, scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, archaeological, fish and wildlife, the presence of significant quantities of developable water and other values of present and future benefit to the people.

The two Muddy Creek monitoring stations represent intermittent surface water quality. Muddy Creek has actually been classified as an intermittent to perennial stream (Higley 1996), but its classification has been simplified for Table 3-8. Intermittent streams in the project area are characterized by moderate TDS (772 mg/l) and the replacement of bicarbonate by sulfate as the major anionic species. Sodium dominance is reflected in the SAR of 6.1, but is less marked than in ephemeral flows.

Two Little Snake River stations monitor perennial water quality in the project area. Perennial quality is characterized by a significantly reduced TDS (201 mg/l) from intermittent and ephemeral streams. Sodium is also displaced by calcium as the major cationic species. This is reflected in the low SAR (0.7 mg/l).

Class 2: Surface water other than Class 1 determined to be presently supporting game fish, have the hydrologic and natural water quality potential to support game fish, or include nursery areas or food sources for game fish.

Class 3: Those surface waters, other than those classified as Class 1, which are determined to be presently supporting nongame fish only, have the hydrologic and natural water quality potential to support nongame fish only, or include nursery areas or food sources for nongame

fish only.

Class 4: Those surface waters, other than those classified as Class 1, which are determined to not have the hydrologic or natural water quality potential to support fish and include all intermittent and ephemeral streams.

Smiley Draw is classified as a Class 3 stream. The Little Snake River and Muddy Creek are designated Class 2. The portion of the Little Snake River below Baggs has been further classified as a secondary body contact recreation water. This classification adds fecal coliform restrictions normally reserved for Class 1 water bodies.

3.4.2.3 Waters of the U.S.

Most of the surface water features in the project area qualify as Waters of the United States. Waters of the U.S. include territorial seas; interstate waters; navigable waterways (such as lakes, rivers, and streams) special aquatic sites and wetlands that are, have been, or could be used for travel, commerce, or industrial purposes; tributaries; and impoundments of such waters. All channels that carry surface flows and that show signs of active water movement are waters of the U.S. Similarly, all open bodies of water (except ponds and lakes created on upland sites and used exclusively for agricultural and industrial activities or aesthetic amenities) are waters of the U.S. (EPA 33 CFR § 328.3(a)). Such areas are regulated by the EPA and Department of Army Corps of Engineers (COE). As described previously, many of the drainage channels identified on the USGS topographic maps are vegetated swales which are not considered to be waters of the U.S. by the COE. Any activity that involves discharge of dredge or fill material into or excavation of such areas is subject to regulation by the COE pursuant to Section 404 of the CWA. Activities that modify the morphology of stream channels are also subject to regulation by the State Engineer's Office (SEO) of Wyoming. Special aquatic sites and wetlands are discussed in greater detail in the Vegetation Section 3.5.

3.4.3 Groundwater

The project area occurs in the Colorado Plateau and Wyoming Basin groundwater regions described by Heath (1984); the Upper Colorado River Basin groundwater region described by Freethey (1987); or Washakie Basin described by Collentine et al. (1981) and Welder and McGreevy (1966). Groundwater resources include deep and shallow, confined and unconfined aquifers. Site-specific groundwater data for the project area are limited. Existing information comes primarily from oil and gas well records from the Wyoming Oil and Gas Conservation Commission, water-well records from the Wyoming SEO, and from the USGS (Weigel 1987). Regional aquifer systems pertinent to the project area are discussed by Heath (1984), Freethey (1987), and Driver et al. (1984). Basin-wide evaluations of hydrogeology specific to the project area have been investigated by Collentine et al. (1981). The most relevant hydrogeologic study specific to the project are is by Welder and McGreevy (1966).

3.4.3.1 Location and Quantity

Groundwater in the Washakie Basin is generally found in artesian aquifers, although it is also present in unconfined alluvial valleys and in isolated, saturated outcrops (Welder and McGreevy, 1966). Table 3-9 summarizes the water-bearing characteristics of the geologic formations present in the project vicinity. Of the geologic units listed in the table, Welder and McGreevy (1966) suggest that those capable of producing the greatest quantity of water include the following: Quaternary alluvium; Tertiary deposits in the Browns Park, Wasatch, and Fort

Union Formations; Cretaceous formations, including Mesaverde, Frontier, and Cloverly; the Sundance-Nugget Sandstone of the Jurassic Age; and the Tensleep and Madison Formations of the Paleozoic Era. Following is a brief description of the major aquifers of the project area.

Table 3-9. Water-Bearing Characteristics of Geologic Formations in the Washakie Basin[1]

Era	Period	Geologic Unit	Thickness	Hydrologic Properties		
				Well Yield (gpm)	Transmissivity (gpd/ft)	Permeability (gpd/ft^2)
Cenzoic	Quaternary		0-70	<30	168-560	21-62
	Tertiary	Browns Park Fm.	0-1,200	3-30	100-10,000	NM
		Wasatch Fm.	0-4,000+	30-50	150-10,000	0.04-18.2
		Fort Union Fm.	0-2,700+	3-300	<2,500	<1
Mesozoic	Upper Cretaceous	Lance Fm.	0-4,500+	<25	<20	0.007-8.2
		Fox Hill Sandstone	0-400	NM	10-20	0.9
		Lewis Shale	0-2,700+	2-25[2]	0.03-50	0.002-0.9
		Almond Fm.[3] (Mesaverde Group)	0-600	NM	2,000-8,000	100-800
		Mesaverde Group (excl. Almond Fm.)	300-2,800	<100	<3,000	NM
		Baxter Shale (incl. Steele Shale and Niobrara Fm.)	2,000-5,000+	Major regional aquitard between Mesaverde and Frontier aquifers. Hydrologic data unavailable.		
		Frontier Fm.	190-1,1900+	1-100+	<100-6,500	NM
	Lower Cretaceous	Mowry Shale	150-525	Regional aquitard. Hydrologic data unavailable.		
		Thermopolis Shale (incl. Muddy Sandstone)	20-235	Considered a leaking confining unit. Hydrologic data unavailable.		
		Cloverly Fm.	45-240	25-120	340-1,700	1-177
	Upper Jurassic	Morrison Fm.	170-450+	Confining unit between Cloverly and Sundance-Nugget aquifers. Hydrologic data unavailable.		
		Sundance Fm.	130-450+	27-35	12-3,500	NM
	Lower Jurassic-Upper Triassic	Nugget Sandstone	0-650+	35-200	<2,166	NM
	Triassic	Chugwater Fm.	900-1,500+	Confining unit between Sundance-Nugget and Paleozoic aquifers. Hydrologic data unavailable.		
Mesozoic-Paleozoic	Lower Trassic Permian	Phosphoria Fm. (incl. Goose Egg Fm.)	170-460	Probable poor water-bearing capabilities due to low permeability. Hydrologic data unavailable.		
Paleozoic	Permian-Pennsylvanian	Tensleep Fm.	0-840+	24-400	1-374	NM
	Lower and Middle Pennsylvanian	Amsden Fm.	2-260+	Probable poor water-bearing capabilities due to predominance of fine-grained sediments.		
	Mississippian	Madison Limestone	5-325+	<400	Variable	NM
Paleozoic	Cambrian	Indef. rocks	0-800+	4-250	NM	NM
Precam-brian	N/A	Igneous and metamorphic rocks	Unknown	10-20	1<1,000	Generally high in upper 200 ft of unit

[1] Adapted from Table V-1 in Collentine et al. (1981). Formations not encountered in project area have been omitted.
[2] From well completion records on file with SEO
[3] From Atlantic Rim CBM well test data

Quaternary aquifers in the Washakie Basin are comprised of alluvial deposits along major floodplains and isolated windblown and lake sediments. The major Quaternary aquifers in the

vicinity of the project area occur in alluvial deposits along the Little Snake River and Muddy Creek, and in windblown segments along the Sand Hills. Groundwater flow within the sandy Quaternary aquifers is typically downward toward permeable underlying formations (Collentine et al. 1981).

Tertiary aquifers in and near the project area occur in the Browns Park Formation along the Little Snake River flood plain and adjacent to the Sierra Madre Uplift, the Fort Union Formation near the Muddy Creek flood plain to the west, and isolated Wasatch Formation outcrops near the center of the project area. Groundwater generally flows west-southwest from the higher elevations along the Sierra Madre Uplift toward the low-lying Washakie Basin center and the major streams (Collentine et al. 1981).

Cretaceous aquifers in the project area occur in three major geologic formations. From youngest to oldest they are the Almond Formation of the Mesaverde Group, the Frontier Formation, and the Cloverly Formation. The Mesaverde is exposed along the eastern slopes of the project area, although a mantle of Tertiary deposits unconformably overlies large areas of the Late Cretaceous strata. No outcrops of the Frontier or Cloverly Formations are present within the project area. The Cretaceous aquifers are composed of interbedded sandstone, shale, and coal and have demonstrated considerable yields in existing wells (Collentine et al. 1981). Recharge to these water-bearing strata is principally from precipitation infiltration and the movement of groundwater from the overlying Tertiary sediments at their outcrops and subcrops along the elevated eastern margin of the Washakie Basin. Regional groundwater flow direction is toward the west in response to the structural dip and surface topography. The Almond Formation coal seams, which are the targeted reservoir for the Brown Cow project, are classified as confined to semi-confined aquifers because they are bound by impervious to semi-pervious layers of shale and siltstone. CBM test wells completed in the Almond Formation coal seams located within the project area exhibit shut-in hydrostatic pressures indicative of flowing artesian conditions. This supports the potential for groundwater discharge in the form of springs along the eastern margin of the Washakie Basin. In fact, the Mesaverde Group is a source of many springs along the Atlantic Rim and flowing wells can probably be obtained by completing wells in the Mesaverde (USGS 1981).

Separated from the Cretaceous aquifers by the impermeable Morrison Formation is the Sundance-Nugget Aquifer of the Jurassic Age. The Sundance-Nugget aquifer is comprised of permeable sandstone with minor quantities of shale, siltstone, and limestone (Collentine et al. 1981). The flow characteristics of the Sundance-Nugget aquifer are not well defined.

The final two major aquifers occur in Paleozoic Era rocks. The Tensleep Formation from the Pennsylvania Age consists of fine- to medium-grained sandstone between confining layers of the Chugwater Formation (Triassic) and the Amsden Formation (Pennsylvanian) (Collentine et al. 1981). The Madison aquifer is comprised of limestone and dolomite bordered on the top by the fine-grained Amsden sediments and on the bottom by Cambrian rocks. Wells completed within both of these Paleozoic aquifers have demonstrated yields up to 400 gpm. Groundwater flow is west-southwest in the project area.

Driver et al. (1984) suggest that the Browns Park Formation would be the best candidate for large-scale groundwater development. Recharge to the aquifers is generally by precipitation and surface water seepage percolating through permeable overlying materials (Welder and McGreevy 1966).

An SEO records review revealed 13 permitted wells in the project area. They are apportioned

as follows: 4 stock, 1 industrial, and 8 miscellaneous. Of the 13 permitted wells, 12 reported positive yields. Geologic units and yields of the 30 wells are listed in Table 3-10. The majority of these wells were developed in the Upper Cretaceous age Lance Formation, Lewis Shale and Mesaverde Group, and the Quaternary age Alluvium.

3.4.3.2 Quality

Groundwater quality is related to the depth of the aquifers, flow between aquifers, and the rock type. Groundwater quality is variable in the BCPA. TDS, an indicator of salinity, is generally less than 2,000 mg/l (slightly saline to saline) in the project area, with local concentrations of less than 500 mg/l (considered fresh).

Because most existing groundwater wells and the proposed CBM wells of the Brown Cow project occur in Mesaverde aquifers, a detailed Mesaverde groundwater quality analysis has been included. Table 3-11 lists the major cation and anion composition of Mesaverde groundwater in the project area. Sodium and bicarbonate dominate as the major ionic species. Collentine et al. (1981) offer three possible explanations for this dominance: (1) exchange of dissolved calcium for sodium; (2) sulfate reduction resulting in bicarbonate generation; and (3) intermixing of sodium-rich, saline water from low-permeability zones within the Mesaverde or adjacent aquifers.

Table 3-10. Existing Groundwater Wells in Project Vicinity

Formation	Number of Wells	Yield[1] (gpm)
Alluvium	5	1.5-20
Browns Park Formation	2	8-25
North Park Formation	2	2-25
Wasatch Formation	2	5-10
Fort Union Formation	2	11.5-20
Lance Formation	4	2-7.5
Lewis Shale	7	1–25
Mesaverde Group	5	2-20
Unknown	1	2

[1] obtained from SEO well completion permits

Table 3-11. Major Ion Composition of Mesaverde Groundwater

Cation	Concentration (mg/l)	Anion	Concentration (mg/l)
Sodium	513	Bicarbonate[2]	1,284
Calcium	7	Carbonate[1]	9
Magnesium	3	Chloride	56
Potassium[1]	5	Sulfate	11

[1] potassium and carbonate concentrations were not measured in CBM samples; values represent composite of USGS data for Mesaverde wells in project vicinity (USGS, 1980)
[2] bicarbonate was not measured; value shown was calculated from ion balance

Table 3-12 presents a comparison of Mesaverde groundwater with WDEQ suitability standards. The composite results of the three CBM wells analyzed indicate water that is generally suitable for livestock use, but is unsuitable for domestic supply or irrigation without treatment or dilution. Parameters with measured concentrations in excess of Wyoming drinking water standards

include iron, manganese, and TDS. Calculated SAR (47.3) and residual sodium carbonate (41 meq/l) exceed the agriculture suitability limits of 8 and 1.25, respectively. Unless the water were mixed with an existing water source of lower sodium and bicarbonate and lower total salinity, irrigation would result in reduction in infiltration in the affected soil.

Table 3-12. Groundwater Quality for Mesaverde Wells in Project Area

Parameter	Concentration[1]	Unit	Groundwater Suitability Standards[2]		
			Domestic	Agriculture	Livestock
Aluminum	0.045	mg/l	---	5	5
Ammonia	0.9	mg/l	0.5	---	---
Arsenic	0.0006	mg/l	0.05	0.1	0.2
Barium	0.36	mg/l	1	---	---
Beryllium	<0.002	mg/l	---	0.1	---
Boron	0.25	mg/l	0.75	0.75	5
Cadmium	<0.0002	mg/l	0.01	0.01	0.05
Chloride	56	mg/l	250	100	2000
Chromium	0.002	mg/l	0.05	0.1	0.05
Cobalt	NM	mg/l	---	0.05	1
Copper	0.03	mg/l	1	0.2	0.5
Cyanide	<5	mg/l	0.2	---	---
Fluoride	1.0	mg/l	1.4 - 2.4	---	---
Hydrogen Sulfide	NM	mg/l	0.05	---	---
Iron	3.06	mg/l	0.3	5	---
Lead	0.004	mg/l	0.05	5	0.1
Lithium	NM	mg/l	---	2.5	---
Manganese	0.102	mg/l	0.05	0.2	---
Mercury	<0.0004	mg/l	0.002	---	0.00005
Nickel	0.041	mg/l	---	0.2	---
Nitrate	<0.03	mg/l	10	---	---
Nitrite	<0.03	mg/l	1	---	10
Oil & Grease[3]	<1	mg/l	Virtually Free	10	10
Phenol	65	mg/l	0.001	---	---
Selenium	<0.005	mg/l	0.01	0.02	0.05
Silver	<0.003	mg/l	0.05	---	---
Sulfate	11	mg/l	250	200	3000
TDS	1,322	mg/l	500	2000	5000
Uranium	NM	mg/l	5	5	5
Vanadium	NM	mg/l	---	0.1	0.1
Zinc	0.3	mg/l	5	2	25
pH	8.2	s.u.	6.5 - 9.0	4.5 - 9.0	6.5 - 8.5
SAR	47.3	<none>	---	8	---
RSC[4]	41	meq/l	---	1.25	---
Radium 226 + Radium 228	0.9	pCi/l	5	5	5
Strontium 90	NM	pCi/l	8	8	8
Gross alpha	NM	pCi/l	15	15	15

[1] boron, ammonia, fluoride, and nitrate/nitrite concentrations from 11 Mesaverde groundwater wells (USGS, 1980); remaining concentrations from three Mesaverde CBM wells in project area

[2] from WDEQ Water Quality Rules and Regulations, Chapter VIII

[3] reported as total petroleum hydrocarbons

[4] residual sodium carbonate calculated from measured calcium and magnesium concentrations and calculated bicarbonate concentration

The confining beds slow the movement of water, and hence, movement of potential contaminants between aquifers. Although there is some downward movement of the water from the surface units, most of the groundwater movement, if any, is upward from the deeper aquifers to the shallower aquifers. Concerns have been raised for several gas field projects in southwest Wyoming regarding groundwater quality degradation due to the piercing of confining layers and vertical and horizontal migration and mixing of water of variable qualities. Data suggesting this is a current problem in the project area are not available. Improperly completed injection wells could be a potential source of contamination.

3.5 VEGETATION, WETLANDS, and NOXIOUS WEEDS

3.5.1 Introduction

The BCPA is located in Sections 1, 2, 12 and 13, T14N:R91W of the BLM-Rawlins Field Office Resource Area and encompasses about 1,570 acres. A total of 12 CBM wells are proposed for development on the BCPA. Ancillary facilities proposed for development within the BCPA include access roads, gas and water pipelines, two injection wells, and two pumping stations.

3.5.2 Vegetation Cover Types

The BCPA is generally located on the north and east flank of Wild Horse Butte and within the area commonly known as Wild Horse Basin. Topography of the area is highly variable with numerous hillsides, gullies and draws which have produced a diverse mix of vegetation cover types. A vegetation cover-type map of the project area was obtained from the Wyoming Natural Resources [WNR] Clearinghouse (2003) and used to delineate primary and secondary land cover type boundaries. Information for secondary vegetation types and plant species of concern was also provided by the Wyoming Natural Diversity Database (WYNDD 2003). The relevant portion of the land cover-type layer from the Wyoming Gap Analysis Project (Merrill et al. 1996) was downloaded as an ArcView shapefile from the University of Wyoming's Geographic Information Science Center.

The primary plant cover types mapped by GAP are Wyoming big sagebrush (*Artemesia tridendata* ssp. *wyomingensis*) which covers about 1,245 acres (about 80% of the 1,570 acre BCPA), and Juniper woodland (Utah juniper, *Juniperus osteosperma*) which was mapped at 326 acres and represents about 20% of the total project land area. Secondary vegetation cover types were mapped as Wyoming big sagebrush at 326 acres (20%) and Juniper woodland at 1245 acres (80%).

The GAP cover-type layer was derived from Landsat satellite imagery. Resolution of the layer is 100 hectares (248 acres) for uplands and 40 hectares (100 acres) in riparian areas and wetlands (Merrill et al. 1996). Given the resolution of the GAP layer, small stands of some cover-types may fail to appear on the map. For example, small linear stands of basin big sagebrush commonly associated with ephemeral draws as well as small cushion plant communities are too small to register at this resolution.

In addition to Wyoming big sagebrush, an August, 2003, on-site inspection revealed that varying densities of other species and subspecies of sagebrush are also present on the BCPA, including small stands of mountain big sagebrush (*Artemesia tridendata* var. *pauciflora*), Vasey big sagebrush (*A. tridendata* var. *vaseyana*), black sagebrush *(A. nova*), basin big sagebrush (*A. t*. ssp. *tridentada*) and plains silver sagebrush (*A. cana* ssp. *cana*). Much of the big

sagebrush habitat in the BCPA is moderately old and exhibits decadence inherent with age. The understory of these older vegetation areas is showing moderate to severe decline.

The BCPA encompasses the northern portion of a very unique and large alkali sagebrush (*Artemesia longiloba*) community beginning in Section 1 (UTM coordinates E283735 N4564317 NAD27) and extending south to the eastern flank of Muddy Mountain where the community becomes nearly a pure stand and occupies several thousand acres. The species is sometimes referred to as "early sagebrush" because of its early seasonal development. The majority of these plants had produced seeds and were senescent by late July of the 2003 growing season. This taxa was found in suitable habitats (clay soils with high cation exchange capacity below 7,500 feet) throughout the entire Atlantic Rim Project Area in various densities during the 2003 field investigation.

Greasewood (*Sarcobatus vermiculatus*) is the dominant shrub along several draw bottoms on the BCPA and becomes intermixed with sagebrush in various densities up to about 7,100 ft. elevation demonstrating its unique ability to grow on different sites. Both the native rabbitbrush species (*Chrysothamnus nauseosus and C. viscidiflorus)* are present on the BCPA and can be found at all elevations, including the summit of Wild Horse Butte (7255 ft.). Several small saltbush (*Atriplex gardneri*) dominated communities also occur on the BCPA and these sites are characterized by an accumulation of salt in poorly developed soils with a pH of 7.8 to 9. Grass cover is negligible and bare ground usually exceeds 50%. Birdsfoot sagebrush (*Artemesia pedifida*) also occurs in alkaline soils with pH levels of 8.5 to 11. At the lower pH levels, birdsfoot sagebrush can occur with Gardner saltbush in varying densities. At the higher pH levels, birdsfoot sagebrush usually occurs as a monoculture.

Dominant grass species on the BCPA include Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Agropyron spicatum*), king spike fescue (*Leucopoa kingii*), western wheatgrass (*Agropyron smithii*), Basin wildrye (*Elymus cinereus*), Columbian needlegrass (*Stipa columbiana*), Sandberg bluegrass (*Poa secunda*), wild oat (*Avena fatua*), Indian ricegrass (*Oryzopsis hymenoides*), sand dropseed (*Sporobolus cryptandrus*), bottlebrush squirreltail (*Sitanion hystrix*), and needle-and-thread (*Stipa comata)*. Commonly observed forb species include the phloxs, buckwheats, penstemons, Plains prickly-pear cactus (*Opuntia* sp.), scurfpea (*Psoralea tenuiflora*), Indian paintbrush (*Castilleja* sp.), and arrowleaf balsamroot (*Balsamorhiza sagittata*). Lupine (*Lupinus* sp.) is commonly observed on sites that have recently burned.

3.5.3 Wetlands and Waters of the U.S.

Location and classification of potential wetlands on the BCPA was determined from a USFWS National Wetlands Inventory (NWI) map obtained from the Wyoming Geographic Information Science Center (WYGISC 2003). No jurisdictional wetlands exist on the BCPA and the nearest perennial/intermittent streams are Cherokee Creek about 3/4 mile north and Deep Creek about 1 mile east of the project area. Both of these creeks are considered Waters of the U.S. and are subject to Section 404 of the Clean Water Act (CWA) under the jurisdiction of the Army Corps of Engineers (ACOE) and EPA. Any activity that involves fill or dredging to these waters would need to be permitted under current BLM, Wyoming DEQ, and ACOE regulations. Several flowing wells and springs on the BCPA are also considered Waters of the U.S. and are regulated in the same manner as perennial/intermittent streams.

Several ponds/reservoirs are located within the BCPA, however, on 9 January 2001, the U.S. Supreme Court, in a 5-4 ruling, ruled that isolated wetlands and ponds that are used by

migratory birds do not satisfy the "interstate commerce" clause and are not Waters of the U.S. and therefore are not subject to Section 404 of the Clean Water Act jurisdiction (SWANCC vs. Supreme Court). The numerous ephemeral draws common to the area are not considered Waters of the U.S. (ACOE 1987).

3.5.4 Invasive/Noxious Weeds

The BCPA is vulnerable to infestations of invasive/noxious weeds, especially Russian thistle (*Salsosa iberica)*, Canada thistle (*Cirsium arvense)*, common cocklebur (*Xanthium strumarium*), and musk thistle (*Carduus nutans*). All of these species were observed on the BCPA and adjoining areas during the 2003 field investigation. The most common invasive species observed throughout south-central Wyoming during the 2003 growing season were halogeton (*Halogeton glomeratus*), desert alyssum (*Alyssum desertorum* var. *desertorum)*, curlycup gumweed (*Grindelia squarrosa*), whitetop (Cardaria draba, Russian knapweed (Centaurea repens L.), bull thistle (Cirsium vulgare), and perennial pepperweed (*Lepidium latifolium*). Any newly disturbed surface (e.g., well pads, pipeline and road ROW's) within the BCPA would be highly susceptible to invasive/noxious weed infestations, especially after the heavy 2003 weed seed production season. Close monitoring and the development/implementation of an effective management program coordinated by Merit Energy, the BLM, and the Carbon County Weed and Pest District will be required to prevent establishment and spread of these species.

3.6 RANGE RESOURCES AND OTHER LAND USES

3.6.1 Range Resources

The BCPA lies within a portion of the Cherokee Grazing Allotment which encompasses about 73,966 acres, most of which is public land. The Cherokee Allotment supports a total of 9,508 AUM's, of which, 7,920 are allocated to cattle and 1,588 for sheep. The average stocking rate is approximately 10 acres per AUM. The season of use varies from late spring to late summer (June 15 to August 15), however, recent fencing by the BLM has placed a portion of the allotment into the Deep Creek Pasture which is grazed in the early spring and early summer on a two-year alternating rotation (Warren 2003).

3.6.2 Other Land Uses

The BCPA contains approximately 1,570 federally owned acres. There are no State of Wyoming or privately owned acres within the BCPA. The Proposed Action is located on federal lands administered by the BLM Rawlins Field Office in accordance with the Great Divide RMP.
Other land uses within and adjacent to the BCPA are agriculture (primarily cattle and sheep grazing), wildlife habitat, oil and natural gas exploration, development, and transmission, and dispersed outdoor recreation (primarily hunting in the fall). No developed recreation facilities exist within or adjacent to the project area. For more information on recreational resources in the project area (see Section 3.8).

3.7 WILDLIFE

Wildlife surveys discussed and summarized herein were conducted as part of larger scale surveys being performed in preparation of the Atlantic Rim Coalbed Methane EIS. The Brown

Cow Pod lies within the Great Divide Resource Area and management decisions are guided by the Resource Management Plan (RMP; USDI-BLM 1990) for that resource area.

3.7.1 General Wildlife

The BCPA includes approximately 1,570 acres with Wyoming big sagebrush, alkali sagebrush, and juniper woodland as the two primary cover types intermixed with other sub-dominant shrub, forb, and grass species. Many common species of birds, mammals, amphibians, and reptiles may be found within the pod area. The proposed development is not expected to significantly impact the common species found in the BCPA, therefore they are not considered in this analysis. Those species being considered for threatened or endangered status, BLM state sensitive species, big game species, raptors, and greater sage-grouse are considered in this analysis. The area of analysis for wildlife concerns consists of the area of the BCPA plus a two-mile buffer for sage-grouse leks, and a one-mile buffer for raptor nests. Wildlife surveys discussed and summarized herein were conducted as part of larger scale surveys being performed in preparation of the Atlantic Rim Project Area EIS.

Information regarding the occurrence of species being considered for threatened or endangered status, big game species, and raptors, and sage-grouse near the BCPA was obtained from several sources. Sage-grouse lek locations, seasonal big game range designations, raptor nest locations, and locations for threatened and endangered species were obtained from the Wyoming Game and Fish Department's (WGFD) Wildlife Observation System (WOS) and BLM. WGFD big game herd unit annual reports were used for herd unit population statistics. This existing wildlife information for the BCPA was supplemented through survey data collected by Hayden-Wing Associates (HWA) biologists primarily during 2000 and 2001. These data collections consisted of aerial and ground surveys to: (1) determine occurrence of threatened, endangered, proposed, or candidate species for listing on the pod area; (2) determine the occurrence, location, size, and burrow density of white-tailed prairie dog colonies; (3) determine the location and activity status of raptor nests; (4) search for previously undocumented sage-grouse leks and determine the activity status of all leks in the area; (5) locate winter sage-grouse concentration areas; and (6) determine the occurrence, location, and size of mountain plover habitat and conduct a preliminary presence/absence survey for the species.

3.7.2 Big Game

Three big game species: pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*) occur on or may utilize the BCPA during the course of a year. The types of big game seasonal ranges designated by WGFD which are discussed are winter, winter/yearlong, and crucial winter/yearlong. Winter ranges are used by substantial numbers of animals only during the winter months (December through April). Winter/yearlong ranges are occupied throughout the year but during winter they are used by additional animals that migrate from other seasonal ranges. Crucial big game range (e.g. crucial winter/yearlong range) describes any seasonal range or habitat component that has been documented as a determining factor in a population's ability to maintain itself at a specified level over the long term. Crucial winter ranges are typically used 8 out of 10 winters.

Pronghorn Antelope. The BCPA is located within the 1,394-square-mile Baggs Herd Unit. The BCPA is all designated as pronghorn winter/yearlong range (1,570 acres). Crucial pronghorn range is present two to three miles west of the BCPA (Figure 4-1). The project area lies within the transition area between crucial winter range and slopes to the east which are often unusable in winter. During years with higher snowfall across the winter range, pronghorn

congregate on the crucial winter range, resulting in heavy browse use here and only light use of the transition area in the fall and spring. In years with low amounts of snow, the pronghorn are not forced to spend as much time on the crucial winter range. Utilization of important shrub species is then more evenly distributed across this transition area with less use on the plants in the crucial winter range. The population objective was increased 25 percent in 1994, from 7,200 to 9,000. The 2001 post hunt season population estimate for the Baggs Herd Unit of 7,000 animals is 12.0 percent higher than the 1996-2000 estimated population average of 6,240. The population during the 2000 post season population was approximately 7,800; however, with the higher than normal winter mortality, the 2001 post season decreased approximately 15 percent. Therefore, the current population estimate remains well below the WGFD management objective. The BCPA is located within Hunt Area 53, where the hunter success rate for 2001 was 98.1%.

Mule Deer. The BCPA is located within the Baggs Herd Unit. The Baggs Herd Unit is very large (3,440 square miles) and contains habitats ranging from subalpine and montane coniferous forests to desert scrub. The BCPA is designated as winter/yearlong mule deer range (1,052 acres) and crucial winter/yearlong range (518 acres). No major mule deer migration routes pass through the BCPA (WGFD 2002a). The 2001 post-hunt population estimate for the Baggs Herd Unit was 18,000. This estimate is slightly below the (3.7%) WGFD management objective of 18,700. The BCPA is located within Hunt Area 82, where the hunter success rate for 2001 was 42.6%.

Elk. The BCPA is located within the Sierra Madre Herd Unit (2,425 square miles). Most elk in the herd unit utilize spring/summer/fall ranges in the Sierra Madre Mountains, although there are groups using habitats on Atlantic Rim and around McCarty Canyon. During winter, the elk migrate to lower elevation winter range habitats on the west side of the Sierra Madre Mountains and into the Atlantic Rim/Sand Hills areas. Some animals may migrate as far west as the Powder Rim (~ 40 miles west of Baggs; Porter 1999). However, no major elk migration routes pass through the BCPA (WGFD 2002a). The habitat in the BCPA is designated as elk winter range (1,570 acres). The 2001 post hunt season population estimate for the Sierra Madre Herd Unit of 5,500 animals is 31.0 percent above the WGFD management objective of 4,200. The BCPA is located within Hunt Area 21, where the hunter success rate for 2001 was 36.5%.

3.7.3 Wild Horse Management

The Rawlins Field Office is home to approximately 1,650 wild horses, the largest population of wild, free-roaming horses outside of Nevada (USDI-BLM 2003). BLM has the responsibility to protect, manage, and control wild horses pursuant to the Wild Free Roaming Horse and Burro Act of 1971. The wild horse program is responsible for monitoring both the land and the herds, removing excess animals, and preparing animals for adoption. In Wyoming, BLM maintains and manages about 3,000 wild horses in sixteen herd management areas (HMA's). The BLM establishes an appropriate management level (AML) for each HMA. The AML is the population objective for the HMA that will ensure a thriving ecological balance among all the users and resources of the HMA.

Three wild horse HMA's (Adobe Town, Lost Creek, and Stewart Creek) are within the RFO jurisdiction. However, none of the three HMA's are within the boundaries of the proposed BCPA. The Stewart Creek HMA (AML = 150 horses) is generally located northwest of Rawlins, with its southeast boundary beginning near the intersection of U.S. Hwy. 287 and Carbon County Road 63 (about 14 miles northwest of Rawlins). The Lost Creek HMA (AML = 70

horses) lies within the Great Divide Basin to the west of the Stewart Creek HMA with both HMA's sharing a common, fenced border.

The largest and nearest of the three HMA's to the BCPA is the Adobe Town HMA (AML = 700 horses) located in the extreme southwest portion of Carbon County, Wyoming and southeast portion of Sweetwater County, Wyoming. Daily or seasonal movement of wild horses from the Adobe Town HMA to the BCPA is highly unlikely due to the state-maintained, limited access fencing along Hwy. 789. Horses (some wild-appearing) may commonly be observed east of Hwy. 789 but they are privately owned (Newberry, Pers. Comm. 2003).

3.7.4 Upland Game Birds

Greater Sage-grouse. The BCPA is located within the extensive sagebrush/grassland habitat of southcentral Wyoming where sage grouse are common inhabitants. Important habitats for these birds include strutting (leks), nesting, brood-rearing, and wintering areas, all of which occur on the project area both in contiguous blocks and in isolated patches. During their spring mating season, greater sage-grouse gather on strutting grounds (leks) that typically occur in open or barren areas within a sagebrush matrix. Females usually nest within mature stands of sagebrush that provide adequate cover and protection from predators. Density of nesting greater sage-grouse tends to decrease with distance from the lek, with the majority of females nesting within two miles of leks (Braun et al. 1977, Hayden-Wing et al. 1986). The Greater-sage grouse is listed as a sensitive species by the BLM. In addition the sage grouse receives special consideration because of population declines over much of its range and its importance as an upland game bird in the state of Wyoming.

The BCPA is located within the Sierra Madre upland game management unit area (Area 25). According to the Annual Report of Upland Game and Furbearer Harvest for 2001, 761 sage-grouse were harvested in Area 25 providing 724 hunter recreation days (WGFD 2002b). The Sierra Madre Upland Game Management Area accounted for approximately 6.0 percent (761 birds out of 12,742) of the state-wide harvest of sage grouse in 2001.

The primary vegetation cover type on the Brown Cow Pod is Wyoming big sagebrush. Because sage grouse utilize sagebrush habitats all year, the area provides excellent year-round range. Aerial surveys were conducted by HWA biologists during the winter of 2001 to identify and define sage grouse concentration areas during winter. Transects were flown at ½-mile spacing using a Bell Jet Ranger helicopter at speeds between 60 and 80 MPH approximately 100-150 feet above the ground. The pilot and two observers visually searched for sage grouse and when sage grouse were spotted or flushed the helicopter circled the location and UTM coordinates were recorded using a hand-held GPS. Concentric circles were flown around each location (within 1/4 mile) where sage grouse were initially observed and the area was searched for additional sage grouse. The entire Atlantic Rim Coalbed Methane Project Area was surveyed in this manner on February 17-18, 2001. Snow cover during the winter 2000-2001 was much deeper than normal. Deep snow cover forced sage grouse to seek out habitat with tall sagebrush that remained above the snow. During the spring and summer of 2001 each sage grouse winter aerial location was visited on the ground and the habitat that was used by the sage grouse was mapped. Habitat patches located from the air were mapped by walking the perimeter of the patch and recording UTM coordinates with a hand-held GPS. Sagebrush in the sage grouse winter use areas was usually located in long linear patches in drainage bottoms and was between 2 and 4 feet tall. Those areas of habitat where sage grouse were located

during the winter aerial survey could be termed severe winter relief habitat. No sage grouse severe winter relief habitat was located on the Brown Cow Pod (Figure 4-1).

Aerial surveys were also conducted by HWA biologists in late March and early April, 2001 to check the status of known sage grouse leks and document new leks. Linear transects were flown at 1/4-mile spacing intervals at an average altitude of 300 feet using a slow moving fixed-wing aircraft. Lek locations were recorded with a handheld GPS receiver. No active sage grouse leks were located within the pod boundary, however, four were documented within two miles of the pod (Figure 4-1). A 2-mile buffer around these four leks includes all of the pod. None of the leks are within 1/4-mile of the pod. One lek lies within the pod, but it has been inactive for some time (WGFD, 2003).

3.7.5 Raptors

Raptor species that may occur on the BCPA include golden eagle, bald eagle, northern harrier, sharp-shinned hawk, Cooper's hawk, northern goshawk, red-tailed hawk, Swainson's hawk, rough-legged hawk, ferruginous hawk, American kestrel, merlin, prairie falcon, peregrine falcon, short-eared owl, long-eared owl, great-horned owl, and burrowing owl. Helicopter surveys of raptor nests on and around the BCPA were conducted by HWA biologists during late May 2001. The helicopter survey protocol consisted of flying low-level, ½ mile interval transects within a one-mile buffer zone of the pod. Areas of potential raptor nest habitat (cliffs, rock outcrops, etc.) were surveyed more intensively. Nest locations were recorded with a GPS unit. No active raptor nests were located within one mile of the BCPA in 2001. Four inactive ferruginous hawk nests, one inactive golden eagle nest, and one inactive red-tailed hawk nest were located within one mile of the pod boundary (Figure 4-1). One artificial ferruginous hawk nest is located within the pod boundaries.

3.8 SPECIAL STATUS PLANT, WILDLIFE, AND FISH SPECIES

Special status species include: (1) threatened, endangered, and species proposed for listing by the FWS (Under the ESA of 1973 as amended); (2) sensitive species identified by the BLM Wyoming State Sensitive Species List.

3.8.1 Threatened, Endangered, or Proposed for Listing Species of Plants, Wildlife, and Fish

The U.S. Fish and Wildlife Service (FWS) has determined that two plant species, four wildlife species, and four fish species listed as either threatened, endangered or proposed under the ESA may potentially be found in the Atlantic Rim EIS Project Area or be affected by activities conducted on the project area (USDI-FWS 2003). The Brown Cow Pod is a portion of the Atlantic Rim EIS Project area consisting of approximately 1,600 acres out of the total of over 310,000 acres comprising the Atlantic Rim project. These species and their federal status under the ESA are listed in Table 3-13.

3.8.1.1 Plant Species

One federally endangered plant species, blowout penstemon (*Penstemon haydenii*), and one threatened plant species, Ute ladies'-tresses (*Spiranthes diluvialis*), have the potential to occur within the Atlantic Rim EIS area of which the the BCPA is a portion, according to the USFWS (2003) and the Wyoming Natural Diversity Database (WYNDD 2003). No other threatened or

endangered plant species are known or expected to occur on the BCPA.

Blowout Penstemon. Blowout penstemon is a member of the snapdragon family. The species is most commonly found in the bowls and along the rims of sandy blowouts (Fertig 2000). In Wyoming, the species has been documented on very steep, unstable sand dunes (Fertig 2001). Within these limited habitats, blowout penstemon typically occurs in large, multi-stemmed clumps. When in bloom, its lavender-purple flowers stand out against other sparse vegetation found in and around sandy blowouts. In addition to features of its leaves and flowers, blowout penstemon's lavender or vanilla-like fragrance is a characteristic that distinguishes it from other *Penstemon* species. Blowout penstemon typically blooms between late May and late June. This short flowering period is the best time of year to survey for the species.

Table 3-13. Threatened, Endangered, and Proposed Plant, Wildlife and Fish Species Potentially Present or Affected by Development on the Atlantic Rim EIS Project Area.

Species	Scientific Name	Status
Plants		
Blowout penstemon	*Penstemon haydenii*	Endangered
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened
Mammals		
Black-footed ferret	*Mustela nigripes*	Endangered
Canada lynx	*Lynx canadensis*	Threatened
Birds		
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Mountain plover	*Charadrius montanus*	Proposed Threatened
Fish		
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered
Bonytail	*Gila elegans*	Endangered
Humpback chub	*Gila cypha*	Endangered
Razorback sucker	*Xyrauchen texanus*	Endangered

An area of vegetated sand dunes, referred to as the "Sand Hills", occurs about 12 miles north of the proposed BCPA. The Sand Hills area has the potential to provide habitat for blowout penstemon, however, vegetation has stabilized the dunes, thus eliminating potential sites required by blowout penstemon for establishment and growth. The species was not found during field surveys of this area conducted by the Wyoming Natural Diversity Database in June, 2000 (Fertig 2001) or the current 2003 growing season (Blomquist 2003). The closest known populations of blowout penstemon are located south of the Ferris Mountains (Blomquist 2003). Given the absence of suitable habitat (sandunes with active blowouts) in the BCPA, blowout penstemon is highly unlikely to occur within the BCPA.

Ute ladies'-tresses. The Ute ladies'-tresses (*Spiranthes diluvialis*), a threatened species, is a perennial, terrestrial orchid, endemic to moist soils near wetland meadows, springs, lakes, and perennial streams. It occurs generally in alluvial substrates along riparian edges, gravel bars, old oxbows, and moist to wet meadows at elevations from 4,200 to 7,000 feet. The orchid colonizes early successional riparian habitats such as point bars, sand bars, and low lying gravelly, sandy, or cobbly edges, persisting in those areas where the hydrology provides continual dampness in the root zone through the growing season. This species has been located in Converse, Goshen, Laramie, and Niobrara counties in Wyoming (Fertig 2000). Ute ladies'-tresses typically blooms from late July through August, however, it has been known to bloom in early July and as late as early October (USDI-FWS 2003).

3.8.1.2 Wildlife Species

Black-footed Ferret and Associated White-tailed Prairie Dog Colonies. The black-footed ferret's original distribution in North America closely corresponded to that of prairie dogs (Hall and Kelson 1959, Fagerstone 1987). In Wyoming, white-tailed prairie dog (*Cynomys leucurus*) colonies provide potential habitat for black-footed ferrets. Ferrets depend almost exclusively on prairie dogs for food and they also use prairie dog burrows for shelter, parturition, and raising their young (Fagerstone 1987).

Prairie dog colonies on the BCPA were mapped on the ground during the summers of 2000 and 2001 by HWA. The edges of the prairie dog towns were mapped using a handheld GPS receiver and an ATV. One small prairie dog town occurs on the pod, covering approximately 24.9 acres (1.6% of the pod; Figure 4-1). A black-footed ferret survey has not been conducted within the town.

Canada Lynx. Records of lynx in Wyoming indicate that most lynx or lynx sign between 1973 and 1986 were in lodgepole pine (18%) and spruce-fir (41%) communities (Reeve et al. 1986). According to Reeve et al. (1986), more than 50 percent of lynx records in Wyoming occurred in the northwestern region of the state. The nearest records of lynx to the BCPA were from the Medicine Bow River in 1856 (Reeve et al. 1986). Since then, no lynx sightings or sign have been documented in Carbon County.

Due to the facts that: (1) the BCPA does not include high elevation lodgepole pine/spruce-fir habitat types preferred by this species, (2) the BCPA does not support a population of snowshoe hares (preferred prey item), (3) there are no recorded lynx sightings near the BCPA (WGFD 2000, WYNDD 2003), and (4) the closest potential habitat is more than ten miles away in the Sierra Madre Mountains, it is unlikely that lynx occur on or near the BCPA.

Bald Eagle. Primary bald eagle wintering areas are typically associated with concentrations of food sources along major rivers that remain unfrozen where fish and waterfowl are available, and near ungulate winter ranges that provide carrion (Steenhof et al. 1980). Wintering bald eagles are also known to roost in forests with large, open conifers and snags protected from winds by ridges, often near concentrations of domestic sheep and big game (Anderson and Patterson 1988).

Incidental sightings of bald eagles have been recorded in the vicinity of the BCPA (WGFD 2000). Most observations were documented between November and March, indicating that the area is commonly used by bald eagles during the winter months. No communal winter roosts are known to exist on or near the BCPA. Inspection of BLM and WGFD raptor nest records,

and results of aerial and ground raptor nest surveys conducted by HWA reveal that no bald eagle nests occur within a two-mile buffer of the BCPA. The closest known nest is located in Section 11, T12N:R93W (Cerovski 2000), approximately 18 miles southwest of the project area.

Mountain Plover. The mountain plover nests over much of Wyoming and is typically found in areas of short (less than four inches) vegetation on slopes of less than five percent. Any short grass, very short shrub, or cushion plant community could be considered plover nesting habitat (Parrish et al. 1993), however, mountain plovers prefer shortgrass prairie with open, level or slightly rolling areas dominated by blue grama and buffalograss (Graul 1975, Dinsmore 1981, Dinsmore 1983, Kantrud and Kologiski 1982).

The BCPA was surveyed for mountain plover habitat in May, 2001 by HWA biologists. Areas with habitat that approximated the habitat requirements for mountain plovers discussed above were identified on the ground and mapped on 1:24,000 scale topographic maps. In order to not overlook any potential mountain plover habitat, we conservatively classified habitat and included some areas with slopes greater than 5% and vegetation taller than four inches. These areas were termed potential mountain plover habitat. Mountain plover surveys were conducted between April 29 - May 8, 2001 on all areas determined to provide potential habitat on the Atlantic Rim Coalbed Methane Project Area, and followed the 2001 Mountain Plover Survey Protocol developed by the Rawlins Field Office and the FWS. Four patches, totaling 97.5 acres, of potential mountain plover habitat were located within the pod boundary (Figure 4-1). Potential plover habitats defined during 2001 were again surveyed for plovers in April 2002 and 2003. No plovers were sighted during any of the three years' surveys of the Atlantic Rim Project Area. It is unlikely that plovers would nest in the pod due to a lack of habitat.

3.8.1.3 Fish Species

Four federally endangered fish species may occur as downstream residents of the Little Snake River system: Colorado pikeminnow *(Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker *(Xyrauchen texanus*) (USDI-FWS 2003). The last sighting of any of these fish in the Little Snake River was of a single Colorado pikeminnow in 1990. Currently, these fish species are not likely to be found in the mainstem of the Little Snake River or Muddy Creek, and critical habitat for these species has not been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999).

The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to impacts of water development on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USDI-FWS 1993).

3.8.2 Sensitive Plant, Wildlife, and Fish Species

The BLM has developed a sensitive species list for public lands in Wyoming. The objective of the sensitive species designation is to ensure the overall welfare of these species is considered when undertaking actions on public lands, and that they do not contribute to the need to list the species under the provisions of the Endangered Species Act (ESA). It is the intent of this policy to emphasize the inventory, planning consideration, management implementation, monitoring,

and information exchange for the sensitive species on the list. The BLM Sensitive Species List is meant to be dynamic and will be reviewed annually with recommendations from BLM and appropriate non-BLM authorities for additions and deletions (USDI-BLM 2002). The following 32 species (7 plants, 7 mammals, 15 birds, and 3 amphibians) occur on the BLM Sensitive Species List in the RFO management area and may occur on or near the Brown Cow Pod (Table 3-14).

3.8.2.1 Plant Species

Seven plant species of concern may potentially occur on or near the BCPA. Of these, Gibben's beardstongue has the highest conservation priority (WYNDD 2003). Table 3-14 provides information on the names, sensitivity status, habitat requirements, and probability of occurrence on the BCPA. Four of the species are unlikely to occur on or near the BCPA because suitable habitats are not present. The remaining three plant species of concern may possibly occur on or near the BCPA but have not been recorded there (WYNDD 2003).

3.8.2.2 Wildlife Species

Mammals. Seven sensitive mammal species may potentially be found on the Brown Cow Pod. These include: dwarf shrew, Wyoming pocket gopher, white-tailed prairie dog, swift fox, fringed myotis, long-eared myotis, and Townsend's big-eared bat. Only one of these species, the white-tailed prairie dog is known to occur on the Brown Cow Pod; one small town (24.9 acres) exists in the southeast quarter of Section 12. The dwarf shrew is likely to occur on the Brown Cow Pod. The remaining species: Wyoming pocket gopher, swift fox, fringed myotis, long-eared myotis, and Townsend's big-eared bat have a slight potential to occur on the pod.

Birds. Fifteen sensitive bird species may potentially be found on the Brown Cow Pod. These include: Baird's sparrow, sage sparrow, Brewer's sparrow, long-billed curlew, sage thrasher, western burrowing owl, yellow-billed cuckoo, loggerhead shrike, Columbian sharp-tailed grouse, greater sage-grouse, white-faced ibis, trumpeter swan, peregrine falcon, ferruginous hawk, and northern goshawk. The western subspecies of yellow-billed cuckoo is considered a FWS candidate for listing as endangered. Two of these species are known to be present in the area of the Brown Cow Pod and include: greater sage-grouse (see Section 3.7.4), and ferruginous hawk. Five species: Baird's sparrow, long-billed curlew, yellow-billed cuckoo, white-faced ibis, and trumpeter swan are unlikely to occur. The Columbian sharp-tailed grouse, sage sparrow, Brewer's sparrow, sage thrasher, western burrowing owl, loggerhead shrike, northern goshawk (not likely to nest on the Brown Cow Pod, though), and peregrine falcon have a slight potential to occur in the Brown Cow Pod.

Amphibians. Three sensitive amphibian species may potentially be found on the Brown Cow Pod. These include: boreal toad, Great Basin spadefoot toad, and northern leopard frog. The boreal toad and the Great Basin spadefoot toad have a slight potential to occur, and the northern leopard frog is likely to occur on the Brown Cow Pod.

3.8.2.3 Fish Species

Fish species that are not listed as endangered or threatened by the FWS, but have been identified for possible listing in the future, are classified as "species at risk" and are also included on the Wyoming BLM Sensitive Species List. Three fish species that have the potential to occur, or are known to occur within the specific project area, are designated as "species at risk" by the FWS and are considered sensitive by the Wyoming BLM. These

species are described below.

The three Wyoming BLM sensitive fish species that occur within or downstream from the project area are the roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*Catostomus latipinnis*) (WYNDD 2003, USDI-BLM 2002). All three of these species can be found downstream of the project area within the Muddy Creek drainage or immediately downstream from its confluence with the Little Snake River. The potential for project-related impacts to water that contributes to downstream quality and flow and direct impacts to instream habitat quality or fish passage necessitates their inclusion in this NEPA document. Similar to the endangered fish species discussed previously in this document, original numbers and distribution of these special concern fishes have been reduced through the introduction of competitive and predatory non-native fish, and habitat alterations that reduce or impair fish habitat and migration abilities.

Table 3-14. Sensitive Plant, Wildlife, and Fish Species Potentially Present in the Brown Cow Pod.[1]

Plant Species				
Common Name	**Scientific Name**	**Sensitivity Status[2]**	**Habitat**	**Occurrence Potential[3]**
Laramie columbine	*Aquilegia laramiensis*	G2/S2, FSR2	Crevices of granite boulders and cliffs, 6,400-8,000'	unlikely
Nelson's milkvetch	*Astragalus nelsonianus*	G2/S2 CO	Alkaline clay flats, shale bluffs and gullies, pebbly slopes, and volcanic cinders in sparsely vegetated sagebrush, juniper, and cushion plant communities at 5,200-7,600'	possible
Cedar Rim thistle	*Cirsium aridum*	G2Q/S2	Barren, chalky hills, gravelly slopes and fine textured, sandy-shaley draws 6,700-7.200'	possible
Weber's scarlet gilia	*Ipomopsis aggregata ssp. weberi*	G5T1T2Q/S1,FSR2	Openings in coniferous forests and scrub oak woodlands 8,500-9,600'	unlikely
Gibbens' beardtongue	*Penstemon gibbensii*	G1, S1, BLM	Sandy or shaley (often Green River Shale) bluffs and slopes, 5,500-7,500 ft. Associated vegetation: *Juniperus* spp., *Cirsium* spp., *Eriogonum* spp., *Elymus* spp., *Amelanchier alnifolia*, *Chrysothamnus* spp., *Thermopsis* spp., *Arenaria* spp., and *Astragalus* spp.	certain, within eastern portion of project
Persistent sepal yellowcress	*Rorippa calycina*	G3/S2S3	Riverbanks and shorelines, usually on sand soils near high water line	unlikely
Laramie false sagebrush	*Sphaeromeria simplex*	G2/S2	Cushion plant communities on rocky limestone ridges and gentle slopes 7,500 - 8600'	unlikely

Wildlife Species			
Common Name	**Scientific Name**	**Sensitivity Status[2]**	**Occurrence Potential[3]**
Mammals			
Dwarf shrew	*Sorex nanus*	G4/S2S3, R2, NSS3	Likely
Wyoming pocket gopher	*Thomomys clusius*	R2, G2/S1S2, NSS4	Possible
White-tailed prairie dog	*Cynomys leucurus*	G4/S2S3, NSS7	Present
Swift fox	*Vulpes velox*	R2, G2/S2S3, NSS3	Possible
Fringed myotis	*Myotis thysanodes*	R2, G5/S1B, S1N, NSS2	Possible
Long-eared myotis	*Myotis evotis*	G5/S1B, S1?N, NSS2	Possible

Townsend's big-eared bat	*Corynorhinus townsendii*	R2/R4, G4/S1B, S2N, NSS2	Possible
Birds			
Baird's sparrow	*Ammodramus bairdii*	G4/S1B, SZN, R2, NSS4	Unlikely
Sage sparrow	*Amphispiza belli*	G5/S3B, SZN	Likely
Brewer's sparrow	*Spizella breweri*	G5/S3B, SZN	Likely
Long-billed curlew	*Numenius americanus*	G5/S3B, SZNR2, NSS3	Unlikely
Sage thrasher	*Oreoscoptes montanus*	G5/S3B, SZN	Likely
Western burrowing owl	*Athene cunicularia*	R2, G4/S3B, SZN, NSS4	Likely
Yellow-billed cuckoo	*Coccyzus americanus*	G5/S2B, SZN, R2, NSS2	Unlikely
Loggerhead shrike	*Lanius ludovicianus*	G5/S4B, SZN, R2	Likely
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*	R2/R4, G4T3/S1	Possible
Greater sage-grouse	*Centrocercus urophasianus*	G5/S3	Present
White-faced ibis	*Plegadis chihi*	G5/S1B, SZN, R2, NSS3	Unlikely
Trumpeter swan	*Cygnus buccinator*	R2/R4, G4/S1B, S2N, NSS2	Unlikely
Peregrine falcon	*Falco peregrinus*	G4/T3/S1B, S2N, R2, NSS3	Possible
Ferruginous hawk	*Buteo regalis*	R2, G5/S23B, S4N, NSS3	Present
Northern goshawk	*Accipiter gentilis*	R2/R4, G5/S23B, S4N, NSS4	Possible
Amphibians			
Boreal toad	*Bufo boreas boreas*	G4T4/S2, R2, R4, NSS1	Possible
Great Basin spadefoot toad	*Spea intermontanus*	G5/S4, NSS4	Possible
Northern leopard frog	*Rana pipiens*	G5/S3, R2, NSS4	Likely
Fish			
Roundtail chub	*Gila robusta*	G3G4/S2?, NSS1	Unlikely
Bluehead sucker	*Catostomus discobolus*	G4/S2S3, NSS1	Unlikely
Flannelmouth sucker	*Catostomus latipinnis*	G3G4/S3, NSS1	Unlikely

[1] - Source: USDI-BLM (2002).
[2] - Definition of status

G Global rank: Rank refers to the range-wide status of a species.
T Trinomial rank: Rank refers to the range-wide status of a subspecies or variety.
S State rank: Rank refers to the status of the taxon (species or subspecies) in Wyoming. State ranks differ from state to state.
1 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.
2 Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species vulnerable to extinction.
3 Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).
4 Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5 Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.
H Known only from historical records. 1950 is the cutoff for plants; 1970 is the cutoff date for animals.
X Believed to be extinct.
A Accidental or vagrant: A taxon that is not known to regularly breed in the state or which appears very infrequently (typically refers to birds and bats).
B Breeding rank: A state rank modifier indicating the status of a migratory species during the breeding season (used mostly for migratory birds and bats)
N Nonbreeding rank: A state rank modifier indicating the status of a migratory species during the non-breeding season (used mostly for migratory birds and bats)
ZN or ZB Taxa that are not of significant concern in Wyoming during breeding (ZB) or non-breeding (ZN) seasons. Such taxa often are not encountered in the same locations from year to year.
U Possibly in peril, but status uncertain; more information is needed.
Q Questions exist regarding the taxonomic validity of a species, subspecies, or variety.
? Questions exist regarding the assigned G, T, or S rank of a taxon.

WGFD Native Species Status Codes - Fish and Amphibians

NSS1 - Populations are physically isolated and/or exist at extremely low densities throughout range. Habitats are declining or vulnerable. Extirpation appears possible. The Wyoming Game and Fish Commission mitigation category for Status 1 species is "Vital". The mitigation objective for this resource category is to realize "no loss of habitat function". Under these guidelines, it will be very important that the project be conducted in a manner that avoids alteration of habitat function.
NSS2 - Populations are physically isolated and/or exist at extremely low densities throughout range. Habitat conditions appear to be stable. The Wyoming Game and Fish Commission mitigation category for Status 2 species is also "Vital". The mitigation objective for this resource category is to realize "no loss of habitat function". Under these guidelines, it will be very important that the project be conducted in a manner that avoids alteration of habitat function.
NSS3 - Populations are widely distributed throughout its native range and appear stable. However, habitats are declining or

vulnerable. The Wyoming Game and Fish Commission mitigation category for Status 3 species is "High". The mitigation objective for this resource category is to realize "no net loss of habitat function within the biological community which encompasses the project site". Under these guidelines, it will be important that the project be conducted in a manner that either avoids the impact, enhances similar habitat or results in the creation of an equal amount of similarly valued fishery habitat.

NSS4-7 - Populations are widely distributed throughout native range and are stable or expanding. Habitats are also stable. There is no special concern for these species.

WGFD Native Species Status Codes - Birds and Mammals

NSS1 - Populations are greatly restricted or declining, extirpation appears possible. AND On-going significant loss of habitat.

NSS2 - Populations are declining, extirpation appears possible; habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance. OR Populations are declining or restricted in numbers and/or distribution, extirpation is not imminent; ongoing significant loss of habitat.

NSS3 - Populations are greatly restricted or declining, extirpation appears possible; habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance. OR Populations are declining or restricted in numbers and/or distribution, extirpation is not imminent; habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance. OR Species is widely distributed; population status or trends are unknown but are suspected to be stable; on-going significant loss of habitat.

NSS4 - Populations are declining or restricted in numbers and/or distribution, extirpation is not imminent; habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance. OR Species is widely distributed, population status or trends are unknown but are suspected to be stable; habitat is restricted or vulnerable but no recent or on-going significant loss; species may be sensitive to human disturbance.

NSS5 - Populations are declining or restricted in numbers and/or distribution, extirpation is not imminent; habitat is stable and not restricted. OR Species is widely distributed, population status or trends are unknown but are suspected to be stable; habitat is not restricted, vulnerable but no loss; species is not sensitive to human disturbance.

NSS6 - Species is widely distributed, population status or trends are unknown but are suspected to be stable; habitat is stable and not restricted.

NSS7 - Populations are stable or increasing and not restricted in numbers and/or distribution; habitat is stable and not restricted.

[3] - Occurrence potential based upon presence of habitat and known distribution.

The roundtail chub is a close relative of the federally endangered humpback chub and bonytail and is common within the Little Snake River drainage and can also be found in Muddy Creek (Carbon County, Wyoming), a small perennial stream located downstream of the project area (Baxter and Stone 1995). The bluehead sucker is restricted to the Little Snake and Green River basins in Wyoming (Baxter and Stone 1995) and occupies habitat similar to that of the roundtail chub. The species is known to occur in the Little Snake River and was considered to occur in large numbers in Muddy Creek by Baxter and Stone (1995). Fish populations sampling conducted in Muddy Creek during 2000 and 2001 by Rawlins, BLM field office personnel indicated that there are far fewer bluehead sucker in this drainage than reported by Baxter and Stone (1995). Populations of bluehead sucker are considered rare in Wyoming, in comparison to other sucker species. Although the flannelmouth sucker has been considered one of the most abundant and widely distributed fish species of the tributaries and mainstream portions of the Upper Colorado River Basin (Tyus et al. 1982) and was considered a common resident of Muddy Creek by Baxter and Stone (1995), the additional sampling of BLM during 2000-2001 suggests that even fewer flannelmouth sucker exist in the Muddy Creek drainage than bluehead sucker.

3.9 RECREATION

Recreation resources in the BCPA are typical of those found in the Red Desert Region of Wyoming. Recreation use of BLM and private lands within the project area are best characterized as dispersed; there are no developed recreation sites or facilities. Most recreation activities occur during the fall hunting seasons. The area attracts small game hunters in September and October during the sage grouse season. Pronghorn hunting also occurs in September. Other hunting use occurs during the mule deer season in mid to late October and hunting for rabbits and predators later in the fall and winter. During other seasons, the area attracts small numbers of recreationists engaged in rock collecting, camping and hiking, wild horse and wildlife observation, outdoor photography and picnicking. The area also has a limited

amount of use by off-road vehicle enthusiasts. Although data on non-consumptive recreational visitation are not available, overall use levels are generally low (BLM 2000). Low visitation is a function of the small number of local residents, long drives from major population centers, lack of publicized natural attractions, and road conditions that limit vehicle access into many back country areas.

3.10 VISUAL RESOURCES

The BCPA is typical of the more rugged sections of Wyoming Red Desert Region. The characteristic landscape is moderately undulating with occasional areas of steep topography (badland breaks and buttes) which stand out as contrasting forms across most of the rest of the area. Numerous small drainages dissect the landscape adding diversity. The combination of topography, buttes and badland breaks subdivide the area into a number of small viewsheds. Larger views that encompass several viewsheds are available from high points. The sky/land interface is a significant aspect of all distant views. The predominant vegetation, typical of cold desert steppe, is alkali and low sage brush, mixed desert scrub, grasses and forbs with scattered patches of big sage/rabbit brush on flatter north and east facing slopes, along drainage ways and in large depressions. Small established stands of juniper exist within the study area. The combination of plant communities creates a subtle mosaic of textures and colors. Predominant vegetation colors in early spring are green and gray green changing to gray green and buff/ochre as grasses and forbs cure in the summer and fall. Reddish brown and buff colors of the badland formations add contrast and dominate in areas of steep topography. Evidence of cultural modification in and near the BCPA includes improved and unimproved roads, power lines and some oil and gas production facilities. Motorists traveling Wyoming Highway 789 would have limited views of the project area because of viewing distance (3 to 6 miles) and intervening elevated topography. However, facilities and activities located on ridge lines or buttes are visible over longer viewing distances. The area receives moderate use by recreationists including big and small game hunters, rock collectors, wild horse and wildlife watchers, backpackers and ATV operators. The quality of the visual resource is an important part of the recreational experience for many of these users. Other non-recreational users of the area, including grazing permit holders and those working in the oil and gas industry, would also be affected by changes to the visual resources.

The intent of the BLM VRM program is to preserve scenic values in concert with resource development. BLM personnel responsible for visual resource management have classified the BCPA as Class 3. The VRM describes the levels of change to the visual resource permitted in Class 3 landscapes as:
Class 3: *Contrasts to the basic elements caused by a management activity are evident but should remain subordinate to the existing landscape.*

Thus for projects in Class 3 areas, project facilities, activities and site disturbance that contrast enough to attract viewer attention and are evident in the landscape are allowed, but they should be constructed in a manner that reflects the lines, forms, colors and textures of the characteristic landscape.

3.11 CULTURAL RESOURCES

3.11.1 Culture Chronology of the Project Area

Archaeological investigations in the Washakie Basin indicate the area has been inhabited by prehistoric people for at least 10,000 years from Paleoindian occupation to the present. The accepted cultural chronology of the Washakie Basin is based on a model for the Wyoming Basin by Metcalf (1987) and revised by Thompson and Pastor (1995). The Wyoming Basin prehistoric chronology is documented in Table 3-15.

Paleoindian Period - The oldest period for which there is archaeological evidence is the Paleoindian, beginning ca. 12,000 years B.P. and ending around 8500 B.P. This is the transition period from the periglacial conditions of the Wisconsin ice advance during the terminal Pleistocene to the warmer and drier climatic conditions of the Holocene. A savanna-like environment with higher precipitation than occurs today was prevalent in southwest Wyoming. Understanding paleoenvironmental conditions operating at the end of the Pleistocene and into the Holocene will provide insights into the articulation between human populations and the environment (Thompson and Pastor 1995). Paleoindian sites are rare in southwest Wyoming. However, isolated surface finds of Paleoindian projectile points are not uncommon and suggest that site preservation may be a major factor affecting the number of known sites. The Paleoindian tool assemblage includes lanceolate points, gravers, and end-scrapers.

Table 3-15. Prehistoric Chronology of the Wyoming Basin.

Period	Phase	Age (B.P.)
Paleoindian		12,000 - 8500
Early Archaic	Great Divide	8500 - 6500
	Opal	6500 - 4300
Late Archaic	Pine Spring	4300 - 2800
	Deadman Wash	2800-2000/1800
Late Prehistoric	Uinta	2000/1800 - 650
	Firehole	650 - 300/250
Protohistoric		300/250 - 150

from Metcalf (1987), as modified by Thompson and Pastor (1995)

Archaic Period - Settlement and subsistence practices, in southwest Wyoming, remained largely unchanged from the end of the Paleoindian period through the Archaic and continued until at least the introduction of the horse, or even until Historic Contact. Reduced precipitation and warmer temperatures occurred ca. 8500 B.P. The environmental change at the end of the Paleoindian period led to a pattern of broad spectrum resource exploitation which is reflected in the subsistence and settlement practices of the Archaic period which became more diverse. The Archaic period is divided into the Early and the Late periods and subdivided in the Great Divide and Opal and the Pine Spring and Deadman Wash phases, respectively. Large side- and corner-notched dart points and housepits are found during the Archaic period. The presence of ground stone implements suggests a greater use of plant resources during the Archaic period. Faunal assemblages from Archaic components document increased use of small animals (Thompson and Pastor 1995). At the Yarmony site in Colorado, at least one

housepit has been investigated which produced radiocarbon dates of ca. 6300 B.P. (Metcalf and Black 1991). The housepit is a large, semi-subterranean, two-room dwelling containing four slab-lined storage bins, interior hearths and other floor features. Large side-notched points have not been recovered from components dated to the Great Divide phase in the Wyoming Basin. The earliest dated context for side-notched points are Component I at Maxon Ranch (6400-6000 B.P.), west of the project area. Large side-notched points from the Great Basin and Colorado Plateau occur as early as 7000 years B.P.

Late Prehistoric Period - The Late Prehistoric period 2000/1800 B.P. is subdivided into the Uinta and the Firehole phases. Large-scale seed processing and an increase in the number of features including roasting pits is noted in the Late Prehistoric period as is the presence of pottery and the introduction of bow and arrow technology. A characteristic of the Uinta phase is clusters of semi-subterranean structures dating to ca. 1500 B.P. At least two different types of structures have been identified: a more substantial, cold weather habitation is present at the Nova site (Thompson 1989) and a less substantial, warm weather structure serving more as a windbreak is present at the Buffalo Hump site (Harrell 1989).

The Firehole phase is distinguished from the preceding Uinta phase by a dramatic decline in radiocarbon dates possibly related to a decline in population density. The South Baxter Brush Shelter site (Hoefer et al. 1992) and Firehole Basin 11 site (Metcalf and Treat 1979) are sites located west of the project area attributed to the Firehole phase.

Protohistoric Period - The Protohistoric period begins sometime after 300 years B. P. with the first European trade goods to reach the area, and ends with the development of the Rocky Mountain fur trade 150 years ago. The Wyoming Basin was the heart of Shoshone territory during this period, with occasional forays into the area by other groups such as the Crow and Ute (Smith 1974). The most profound influence on native cultures during this time was the introduction of the horse enabling Native Americans to expand their range. All forms of rock art denoting horses, metal implements, and other Euro-American goods are associated with the Protohistoric period. These include the Upper Powder Spring Hunting Complex site immediately west of the project area (Murcray 1993). Metal projectile points have been recovered from both surface and subsurface contexts in southwest Wyoming.

Historic use of the area is limited by the formidable topographic relief. Steep canyons, inadequate water supply, badlands, and escarpments make the area inhospitable for settlement with only limited ranching activities present. Previously recorded historic sites are represented by a ranching/stock herding site, three historic debris sites, one historic cairn, and the Rawlins-Baggs freight/stage road. In addition, the Cherokee Trail, stage stations, and trash scatters all exist near the project area. Table 3-16 displays the historic chronology of the Washakie Basin.

Table 3-16. Historic chronology of the Washakie Basin.

Phase	Age A.D.
Pre-Territorial	1842 - 1868
Territorial	1868 - 1890
Expansion	1890 - 1920
Depression	1920 - 1939

Modern	1939 - Present

from Massey 1989

3.11.2 Summary of Extant Cultural Resources

The Cultural Records Office in Laramie provided information on the previous work conducted and sites recorded in the project area. Thirty-two Class III cultural resource projects have been previously conducted and 3 sites recorded in the project area. Limited amounts of field work have resulted in the documentation of cultural resources through survey, test excavations, examination of ethnographic records, and historic record research. No excavations have been conducted in the project area.

Of the 32 projects conducted in the area of the Brown Cow locations, 23 were block/linear surveys and 9 were linear surveys. Of the three previously recorded sites, two are recommended not eligible for the National Register, and one is recommended eligible.

In southwest Wyoming, sand deposits (dunes, shadows, and sheets) are recognized as highly likely to contain cultural material. The topographic setting of the Brown Cow locations could be conducive to prehistoric occupation. The area is bisected by Cherokee Creek. The topography gently slopes to the west and the south toward Cherokee Creek.

3.11.3 Site Types

Site types previously identified, recently located, or predicted to be in the Brown Cow study area are discussed below.

Prehistoric open camps (n=3) contain evidence of a broad range of activities including subsistence-related activities. Cultural remains include formal features, lithic debris, chipped stone tools, evidence of milling/vegetable processing activities including ground stone, and pottery. Single as well as long-term occupation may be represented.

Lithic scatters consist of sites containing lithic debris such as debitage or stone tools. No features or feature remnants are found at the site. The sites are interpreted as representing short-term activities.

Quarries are sites where lithic raw material was obtained and initially processed. Primary and secondary lithic procurement areas are geologic locations where chert and quartzite cobbles have been redeposited and later used by prehistoric inhabitants for tool manufacture.

Human burials, rock art, both pictographs and petroglyphs, and rock alignment sites, are unknown in the analysis area, but have been identified as sensitive or sacred to Native Americans. Few of these types of sites have been located in all of southwestern Wyoming.

Pottery/ceramics are as yet undocumented in the study area. Pottery is associated with the Uinta phase of the Late Prehistoric period. There are numerous pottery sites in southwestern Wyoming and northwestern Colorado.

3.11.4 Excavation Data

No sites have been extensively tested or excavated in the Brown Cow analysis area. However, several excavations have been conducted in the surrounding area contributing data about the prehistory of the area.

The Sheehan site is a multi-component prehistoric site (Bower et al.1984) located in the Washakie Basin, west of the analysis area. Component I dates to the Archaic period and Component II dates to the Late Prehistoric period. Data suggests both components reflect short-term winter camps with meat processing activities identified and locally available lithic materials exploited. The Nova Site (48CR4419) is located ca. 4 miles northwest of the SDPA block. The site is a Uinta phase housepit dating from 1098 to 1285 B.P. represents Component I as a short-term spring/late summer occupation. Component II was not dated but is believed to occur as the reuse of the Component I housepit.

3.11.5 Summary

The Class III intensive survey of ten well locations within the Brown Cow Unit produced only one prehistoric open camp, which could indicate a low site density within the survey area. Out of 32 inventories within the area, only three prehistoric sites have been reported. There were no historic sites identified within the immediate area of the Brown Cow Unit.

3.12 SOCIOECONOMICS

The primary geographic area of analysis for potential socioeconomic effects of the Proposed and No Action alternatives is Carbon County, Wyoming and the communities of Baggs, Dixon and Rawlins. Temporary housing availability is also described for the Moffat County, Colorado community of Craig, and the Sweetwater County, Wyoming community of Wamsutter. Carbon County socioeconomic conditions characterized for the assessment include economic and population conditions, temporary housing resources, law enforcement and emergency management services, certain local and state government revenues and local attitudes and opinions.

3.12.1 Economic Conditions

Carbon County has a natural-resource-based economy. Basic economic sectors, which bring revenues into the county, include oil and gas production and processing, coal mining, electric power generation, agriculture (primarily ranching and logging), some manufacturing and transportation (primarily the Union Pacific railroad).Those portions of the retail and service sectors which serve travelers, tourism and recreation visitors are also basic.

Employment and earnings are two common measures of economic activity. The mining sector, which includes oil and gas employment, would be the primary sector affected by the Proposed and No Action alternatives.

In 2000 Carbon County employment totaled 9,804 full and part-time jobs, which was a little less than one percent lower than the 1990 level (WDAI 2003a) and about 28 percent lower than the1980 level of 13,560 jobs. Mining sector employment, which includes oil and gas jobs, decreased 66 percent from 1990 to 2000, from 934 to 318 jobs. The 2000 level was 91 percent lower than the 1980 level of 3,563 jobs mining jobs. The mining sector losses and the volatility in total employment are attributed to the shutdown of the Rosebud and Seminoe # 2 mines (USDI-BLM 1999) and more recently closure of the RAG Shoshone mine near Hanna (Rawlins

Daily Times 2000a). However, in recent years increased natural gas drilling has resulted in employment increases in support sectors such as construction and specialized services (Schnal 2000).

In Carbon County, ten-year annual unemployment averages ranged from a low of 4 percent (2000) to a high of 6.1 percent (1993). The 2002 Carbon County annual unemployment rate was 5.3, based on 306 unemployed persons out of a total labor force of 7,672. The Carbon County labor force declined 9 percent between 1990 and 2002 (Wyoming Department of Employment 2003).

Carbon County earnings increased from $202 million to $225 million between 1990 and 2000, an 11 percent increase. However, when adjusted for inflation, Carbon County earnings decreased by 15 percent during the decade.

3.12.1.1 Oil and Gas Activity

Carbon County natural gas production increased, from 76 million MCF in 1995 to about 98 million MCF during 2002, an increase of 29 percent. Carbon County oil production in 2002 was 1.7 million barrels or about 30 percent higher than the 995 level of 1.3 million barrels. In 2002, During 2002, there were a total of 1,191 producing oil and gas wells in Carbon County, and the County produced 5.6 percent of all gas produced in Wyoming and 3.1 percent of all oil.

One indicator of future production, approved applications for drilling permits (APD), increased steadily in Carbon County in recent years, from 50 in 1995 to 199 in 2002. Increased drilling may result in increased production in the county if drilling efforts are successful and commodity prices increase or stabilize at economic levels (WOGCC 1995-2002).

3.12.1.2 Economic Activities in the Vicinity of the Proposed Action

Other economic activities occurring on and near the BCPA include oil and gas exploration (Vosika Neuman 2000), cattle grazing (Warren 2000) and outdoor recreation activities such as hunting (pronghorn antelope, mule deer, elk and upland birds), hiking, off road vehicle use, camping and sightseeing. Currently 35 commercial hunting outfitters hold permits for the hunt areas for the portion of Carbon County that contains the BCPA (Clair 2000).

3.12.2 Population

Carbon County population growth and decline parallels the employment boom and bust cycle outlined at the beginning of this section. For example, the 2000 Carbon County population (15,639) was 29 percent lower than its 1980 level of 21,896 (WDAI 2001). Between 1990 and 2000, the City of Rawlins, the largest community in Carbon County, lost an estimated 842 persons to end the period at 8,538. The Town of Baggs, the closest community to the Brown Cow project area, gained 76 residents or 28 percent of its 1990 population, and the Town of Dixon, several miles east of Baggs, gained 12 persons to end the period with an estimated population of 79.

3.12.3 Temporary Housing Resources

The nature of CBM drilling and field development activities (relatively short duration tasks performed primarily by contractors) results in demand for temporary housing resources such as motel rooms and mobile home and recreational vehicle (RV) spaces near the project area.

3.12.3.1 Baggs/Dixon Area

In the Baggs/Dixon area, temporary housing resources include rental houses, duplexes, apartments, motels and mobile home parks. Several houses currently under construction are intended to serve the rental market. A 26-space mobile home park in Baggs is equipped to accommodate RV's as well as mobile homes. Within the park there are several rental mobile homes. There is a small four-space mobile home park in Savery and a number of mobile home lots scattered throughout the Little Snake River Valley (Grieve 2000).

There are two motels in Baggs with a total of 64 rooms, most of which can accommodate several guests. Both motels routinely accommodate oil and gas industry workers as well as tourists, travelers and hunters (Willis 2000, Hawkins 2000).

During the summer of 2003, there were more available rental units than in recent years, including vacant rental houses and vacant spaces in mobile home parks (Grieve 2003)

3.12.3.2 Craig, Colorado

The Craig Chamber of Commerce lists 12 motels with a total of 467 rooms and 2 campground/RV parks with a total of 128 spaces (Craig Chamber of Commerce 2000).

3.12.3.3 Wamsutter

Temporary housing resources in Wamsutter include two mobile home operations; one has 26 spaces (Highland 2000, 2002), the other had 75 spaces and some pads equipped to serve RV's (Waldner 2000, 2002). There are two motels in Wamsutter. Although drilling activity in the Wamsutter area was relatively high during the summer of 2003, there were some vacancies in mobile home parks (Carnes 2003)

3.12.3.4 Rawlins

Rawlins has 19 motels and 4 RV parks (Hiatt, 2000). There are also a substantial number of apartment buildings (Hewitt 2000).

3.12.4. Law Enforcement and Emergency Response

Law enforcement services in the southwestern portion of the county are provided by the Carbon County Sheriff's Department. Currently coverage is provided by one full-time and one part-time deputy. The deputies provide coverage for the Town of Dixon and the community of Savery; the Town of Baggs has one police officer (Colson 2000).

Medical services in Baggs are provided by the county-owned clinic, which is staffed by a physician's assistant (PA), supported by other medical and administrative personnel. Emergency response is provided by six volunteer emergency medical technicians (EMT) who staff two county-owned ambulances. Seriously injured patients are transported to Craig or Rawlins, depending on the location of the accident. Casper-based Flight-for-Life is also available if appropriate (Herold 2000).

3.12.5 Local Government and State Government Revenues

Local and state government fiscal conditions most likely to be affected by the Proposed Action and No Action alternatives include county, school and special district ad valorem property tax revenues, state, county and municipal sales and use tax revenues, state severance taxes, and federal mineral royalty distributions. Some county, municipal and special district service expenditures may also be minimally affected.

3.12.5.1 Ad Valorem Property Tax

Carbon County assessed valuation in fiscal year (FY) 2002 totaled about $515 million, which yielded total property tax revenues of $32.4 million. Total mill levies (within Carbon County communities) ranged from 68.39 to 72.89. FY 2002 assessed valuation from 2001 natural gas production totaled $338 million or about 66 percent of total assessed valuation. Assessed valuation from oil production totaled $26.3 million or about 5 percent of total valuation (WTA 2002).

3.12.5.2 Sales and Use Tax

FY 2000 sales and use tax collections in Carbon County totaled about $18.5 million. These include collections from a four percent statewide sales and use tax and a one-percent general purpose local-option sales and use tax (WDAI 2003b).

3.12.5.3 Severance Taxes

In Wyoming, severance taxes are levied against certain minerals produced in the state, including a six percent severance tax on natural gas. In FY 2000, severance tax distributions totaled $299.4 million (WDEA 2003c). Of the total, 43 percent was attributable to severance taxes on natural gas.

3.12.5.4 Federal Mineral Royalty Distributions

The federal government collects a 12.5 percent royalty on oil and natural gas extracted from federal lands. Fifty percent of those royalties are returned to the state where the production occurred. In Wyoming, the state's share is distributed to a variety of accounts, including the University, School Foundation fund, Highway fund, Legislative Royalty Impact Account, and

cities, towns and counties. In FY 2002, a total of $348.6 million in federal mineral royalty funds were distributed to Wyoming entities (WDEA 2003d)

3.12.6 Attitudes and Opinions

A 1996 survey conducted in conjunction with the preparation of the Carbon County Land Use Plan provides some insight into resident attitudes and opinions regarding land use, oil and gas development, natural resource conservation and use and other topics. Just over 300 residents completed the survey, yielding an estimated statistical reliability of about 95 percent (Pederson Planning Consultants 1998).

Water resource conservation and concern for government regulation of land use were the most frequently listed important land use issues, followed closely by the availability of water to support future land uses, the economic viability of ranching, timber and oil and gas industries, and the need to conserve wildlife habitat.

County-wide, 54.9 percent of survey respondents (based on a weighted average; some respondents indicated more than one response) indicated that conservation of land, water and wildlife resources was more important than increased oil and gas production, while 36.9 percent indicated that increased oil and gas production was more important. However, among Baggs respondents, the reverse was true. About 54 percent indicated that increased oil and gas production was more important than conservation of land, water and wild life resources while 36 percent indicated that resource conservation was more important. The land use plan attributes this difference to Baggs' greater economic dependence on future oil and gas employment.

Concerning management of federal lands, the largest number of respondents (69.5 percent) indicated that more federal lands within the county should be designated for the purpose of conserving fish and wildlife habitat and surface and groundwater resources. In addition, 60.8 percent of respondents indicated that more land should be designated for public recreation, 48.8 percent indicated more land should be leased for oil and gas industry exploration and production, 48.7 percent indicated more land should be leased for commercial mining, and 44.5 percent indicated more land should be made available to local timber companies for commercial timber harvest.

Coal-bed methane development was not considered during the survey, therefore resident attitudes and opinions about unique aspects of coal bed methane are not known (Hewitt 2000).

3.12.7 Environmental Justice

Executive Order (EO) 12898, "Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations" was published in the *Federal Register* (59 FR 7629 on February 11, 1994. EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (defined as those living below the poverty level).

Communities within Carbon County, entities with interests in the area, and individuals with ties to the area all may have concerns about the presence of a natural gas development within the project area. Communities potentially impacted by the presence or absence of the proposed natural gas development have been identified above in this section of the DEIS. Environmental Justice concerns are usually directly associated with impacts on the natural and physical

environment but these impacts are likely to be interrelated to social and economic impacts as well.

3.13 TRANSPORTATION

The regional transportation system serving the project area includes an established system of interstate and state highways and county roads. Local traffic on federal land is served by improved and unimproved BLM roads.

3.13.1 Access to the Project Site

Access to the project site is provide by a combination of Interstate, state highways and BLM roads. Table 3-17 displays specific access routes to the BCPA. The Wyoming Department of Transportation (WYDOT) measures average daily traffic (ADT) on federal and state highways. ADT on highways providing access to the BCPA are shown in Table 3-17.

WYDOT assigns levels of service to highways in the state system. Levels of service (A through F) are assigned based on qualitative measures (speed, travel time, freedom to maneuver, traffic interruptions, comfort and convenience) that characterize operational conditions within traffic streams and the perceptions of those conditions by motorists. A represents the best travel conditions and F represents the worst. Levels of service for highways providing access to the BCPA are also shown in Table 3-17

The BCPA would be accessed from WYO 789 and BLM Rd # 3309. WYO 789 is a two-lane, all-weather paved highway classified as a minor arterial in the state's Primary highway system (WYDOT 2001). BLM Rd. # 3309 (the Wild Horse Road) is an improved dirt road which is accessible except in very wet conditions.

Table 3-17. Access Routes to the BCPA

Highway or Road		
Highway or Road	2001 ADT	Level of Service / Accidents
I-80 (Junction 789)	12,000 (6,260 trucks)	A 1999: 89 5 yr average: 112.4
WYO 789 (Creston Jct. - Baggs)	890 (210 trucks)	B 1999: 27 5 yr average 16.4
BLM Rd # 3309	n/a	n/a

Sources: WYDOT 2001

3.14 HEALTH AND SAFETY

Existing health and safety concerns in and adjacent to the BCPA include occupational hazards associated with oil and gas exploration and operations; risk associated with vehicular travel on improved and unimproved county and BLM roads; firearms accidents during hunting season and by casual firearms use such as plinking and target shooting; and low probability events such as landslides, flash floods and range fires.

3.15 NOISE

Other than vehicle traffic on Wyoming State Highway 789, jet aircraft overflights at high altitudes, localized vehicular traffic on county, BLM and two-track roads and on-going drilling and production operations on lands adjacent to the project area create even modest sound disturbances within, and in the immediate vicinity of, the BCPA.