CHAPTER 3

AFFECTED ENVIRONMENT

3.0 INTRODUCTION

The Affected Environment chapter of this environmental assessment (EA) for the proposed Warren Shallow Gas Development project discusses environmental, social, and economic factors as they currently exist within the Pacific Rim Shallow Gas project area (PRPA). The material presented here has been guided by management issues identified by the Bureau of Land Management (BLM), Rock Springs Field Office; 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) (Table 3-1). This EA discusses potential effects of the project on range resources, air quality, transportation, geology/minerals/paleontology, soils, water resources, vegetation (including invasive and non-native species) and wetlands, wildlife, special status species, visual resources, noise, recreation, socioeconomics (including environmental justice), cultural resources (including native American religious concerns), and health and safety (including hazardous and solid waste). The resource elements to be analyzed in this EA are summarized in Table 3-2.

Table 3-1. Critical Elements of the Human Environment[1], Pacific Rim Shallow Gas Project Sweetwater 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	None present	No
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

Table 3-2. Other Elements for Analysis, Pacific Rim Shallow Gas Project Sweetwater County, Wyoming.

Element	Status on the Project Area	Addressed in text of EA
Geology/Minerals/Paleontology/Hazards	Potentially affected	Yes
Soils	Potentially affected	Yes
Vegetation	Potentially affected	Yes
Wildlife	Potentially affected	Yes
Special Status Species	Potentially affected	Yes
Noise	Potentially affected	Yes
Visual Resources/Recreation	Potentially affected	Yes
Ground Water	Potentially affected	Yes
Socioeconomic Issues	Potentially affected	Yes
Range/Other Uses	Potentially affected	Yes
Cumulative Impacts	Potentially affected	Yes

3.1 GEOLOGY/MINERALS/PALEONTOLOGY

3.1.1 Geology

3.1.1.1 Overview

The PRPA lies on the southeastern flank of the Rock Springs Uplift, a major Laramide structural element that is part of the Wyoming Basin Physiographic Province. The uplift is a north-south trending, doubly plunging, asymmetric anticline that formed during Late Cretaceous time and showed intermittent uplift during the Early Tertiary (Figure 3-1). Breaching of the anticline has exposed a complete section of Upper Cretaceous Mesaverde Group in its core. In ascending order the Mesaverde consists of the marine Baxter and Blair Formations, the coal-bearing Rock Springs Formation, the fluvial Ericson Formation, and the coal-bearing Almond Formation. The Mesaverde Group is in turn overlain by marine shales of the Lewis Formation, beach and nearshore sandstones of the Fox Hills Formation, coal-bearing rocks of the Lance (Latest Cretaceous) and Fort Union (Paleocene) Formations, the fluvial rocks of the Wasatch Formation (Eocene), and lacustrine rocks of the Green River Formation (Eocene) that form the flanks of the uplift.

Structural dips in the PRPA are gentle, measuring between 5 and 9 degrees off the flanks of the uplift. A major northwest-southeast trending reverse fault system, the Sparks Ranch Thrust, extends several miles along the Colorado-Wyoming border south of the PRPA. This fault which was active during the Laramide Orogeny, in latest Cretaceous time, has an estimated displacement of about 3 to 5 miles to the northeast.

Movement on the Sparks Thrust and resulting crustal shorting caused minor folds and faults to develop between it and the southern end of the Rock Spring Uplift during the early Tertiary (Roehler 1979b). Three of these minor cross-trending folds occur in and adjacent the PRPA. From north to south, these include the Pine Butte Syncline, Salt Wells Anticline, and Red Creek Syncline (Figure 3-1). The axis of the Pine Butte Syncline, just north of the PRPA, trends northeastward from the SE/4 of Section 13, T15N, R102W through the NW/4 of Section 17, T 15N, R101W, before changing to a southeasterly trend toward Kinney Rim. The axis of the Salt Wells Anticline trends southeastward through the center of Section 11, T14N, R102W into the center of Section 16, T14N, R101W. Further westward the Salt Wells Anticline is bound by reverse faults on both its northern and southern flanks. The fault on its northern flank dies out southeastward before reaching the PRPA, so that in the PRPA the anticline is only fault bound along its southern flank. This unnamed bounding fault dips northeastward steeply, at about 65 degrees. The fault lies buried beneath and does not break Quaternary alluvium in East Salt Wells Creek in the SW/4 of Section 18, T14N, R101W and East Draw in SE/4 Section 21, T14N, R101W. The axis of the Red Creek Syncline trends northeastward just south of the PRPA from the north flank of Scrivner Butte into the northern half of Section 13, T 13N, R101W. Rocks in the southern flank of this syncline, which bounds the Canyon Creek Oil Field on its northern side, strike to the northeast and dip very gently (about 2 degrees) to the northwest.

Geologic mapping by the USGS and Wyoming Geologic Survey (Love and Christiansen 1985, Love et al. 1993, and Roehler 1973, 1974, 1978, 1987) documents sedimentary deposits of Quaternary and Early Tertiary age crop out in the PRPA (Figure 3-1). These rocks are overlain at the surface by unconsolidated Quaternary alluvium along the northward drainages of East Salt Wells Creek and its tributary East Draw and Scheggs Draw, and southward drainage of Vermillion Creek and Granary Draw.

Early Tertiary deposits in the PRPA consist chiefly of rocks that accumulated in swampy, terrestrial, and lake environments that dominated the area during Paleocene and early Eocene time (Bradley 1964; Kirschbaum and others 1988, 1994; Love 1970; Roehler 1973 1977a-c, 1979a, b, 1985, 1987, 1991 a-b, 1992 a-c, 1993; Winterfeld 1982). These deposits comprise three geologic units, from youngest to oldest, the Green River, Wasatch, and Fort Union Formations (Figure 3-2).

On the east flank of the Rock Springs Uplift, a major angular unconformity separates the Fort Union Formation from underlying Cretaceous rocks. To the north of the PRPA the Fort Union Formation rests on the Lance Formation. Progressively southward the Fort Union Formation truncates increasingly older Cretaceous rocks so that within the PRPA, it rests unconformably on the Lewis Shale. Further southward the Fort Union Formation truncates the Lewis Shale and rests on the Almond Formation. Coincident with the unconformable contact in some places is a very well developed, deeply weathered, paleosol horizon (Ritzma 1957).

Green River Formation

Rocks of the Green River Formation (Early Eocene) exposed within the PRPA include four members. From oldest to youngest these include the Laney, Wilkins Peak, Tipton, and Luman, all of which accumulated in the ancient Green River Lakes system. All four members crop out along the southern and eastern edges of the area. None of the members contain economic mineral deposits in the PRPA, but do contain uneconomic deposits of oil shale, and produce vertebrate fossils of scientific interest and significance.

Only the basal rocks of the Laney Member occur in the PRPA, represented by the lower 20 feet of the LaClede Bed, which only occur along the eastern margin of Section 8, T15N, R100W along the west side of Kinney Rim about ½ mile south of Pine Butte. The basal rock of the Laclede Bed consists chiefly of oil shale with lesser amount of limestone, sandstone, claystone and tuff that overlie the Cathedral Bluffs Member of the Wasatch Formation.

The Wilkins Peak Member includes a maximum of 522 feet of gray-green, and gray-brown silty to sandy mudstone and thin interbeds of gray very fine grained calcareous and micaceous sandstone, brown flaky oil shale, gray tuff, gray and brown mudstone, gray dolomite, and tan algal limestone that accumulated in ancient Lake Gosiute (Roehler 1974, 1977a-c, 1991 a-b; 1992 a-c, 1993). The Wilkins Peak Member form gently rolling hills that form the south facing back slope of Rifes Rim and occupy the central axis of the Red Creek Syncline.

The Tipton Shale consists of a maximum of about 157 feet of brown flaky oil shale and very thin interbedded brown ostracodal limestone and brown tuffaceous siltstone that underlies the Wilkins Peak Member of the Green River Formation and overlies the Niland Tongue of the Wasatch Formation. Beds of the Tipton also form the back slope of Rifes Rim.

The Luman Tongue consists of a maximum of about 483 feet of organic-rich carbonaceous shale, limestone, sandstone, and mudstone that underlie the Niland Tongue and overlie the main body of Wasatch Formation. The Luman Tongue forms the top of Rifes Rim.

Wasatch Formation

Rocks of the Wasatch Formation (Early Eocene) exposed in the PRPA include three members. From youngest to oldest these include the Cathedral Bluffs, Niland Tongue, and Main Body members. None of the members of the Wasatch contain economic mineral accumulations within the PRPA, but all produce vertebrate fossils of scientific interest and significance. The Niland contains economic deposits of coal immediately south of the PRPA in the Vermillion Creek Basin.

The Cathedral Bluffs Member consists of terrestrial and fluvial sediments that accumulated in chiefly upland environments surrounding Lake Gosiute. Deposits consist of a maximum of about 1,200 feet of gray, green and variegated mudstone; interbedded gray, fine to coarse-grained, partly crossbedded sandstone and minor thin beds of gray-brown shale, algal limestone, oolitic limestone, and gray calcareous siltstone. The member interfingers with and is replaced laterally toward the basin center by sediments of the Wilkins Peak Member of the Green River Formation that accumulated chiefly in lake environments. Within the PRPA this unit occurs along the eastern flank of Pine Butte and head of Alkali Creek in Sections 8, 17, 18, 19, 29 and 30, T 15N, R100W.

The Niland Tongue consists of terrestrial and fluvial sediment that lies stratigraphically between the overlying Tipton and underlying Luman tongues of the Green River Formation and forms low-lying exposures above the rimrock of Rifes Rim. Deposits of the Niland Tongue include a maximum of about 315 feet of silty to sandy mudstone and sandstone interbedded with thin beds of brown flaky oil and carbonaceous shale and limestone. These deposits accumulated in smaller lakes, ponds, swamps, and flood-plains following restriction of the Green River Lake system.

The Main Body of Wasatch Formation crops out over the central parts of the PRPA where it forms a series west-east trending, high standing ridges and intervening valleys below Rifes Rim. The member includes a maximum of 1,730 feet of gray sandy mudstone and interbedded gray-green silty shale and gray very fine to fine grained sandstone that accumulated chiefly in fluvial and well drained flood plains during Early Eocene time. The Main Body overlies the Fort Union Formation unconformably, the line of contact between the two formations crosses WYO 430 at Scheggs Draw and then trends southward and westward crossing the highway again at East Draw.

Fort Union Formation

The Fort Union Formation (Paleocene) crops along in the western parts of the PRPA along the east side of WYO 430. The formation is a maximum of about 1,715 feet thick and consists of drab gray and brown mudstone and interbedded siltstone, sandstone, carbonaceous shale, orange to tan limestones and coal that accumulated in swampy to fluvial environment during the middle and late Paleocene. Like the Main Body of the Wastach Formation, the Fort Union Formation weathers to a series of high standing ridges and intervening valleys. Pollen (Kirschbaum and others 1988, 1994, Nicols 1999) and vertebrate fossils (Winterfeld 1982, Wilf and others 1998) indicate that earliest Paleocene strata are probably missing from the section along the eastern flank of the Rock Springs Uplift because of either an intraformational unconformity or the unconformity at the base of the formation. The Fort Union Formation contains uneconomic coal deposits in the PRPA and produces vertebrate fossils of scientific significance. Economic deposits of coal occur a few miles north of the RPA in the Burley Draw, Sand Butte Rim, and Black Butte areas.

Older Sedimentary deposits

The Fort Union Formation is underlain by Phanerozoic sedimentary rocks, that with the exception of lacking Silurian and Ordovician deposits, range in age from Cretaceous to Cambrian in age (Table 3-1). These are in turn underlain by Precambrian metamorphic bedrock that comprise part of the ancient North American cratonic shield and probably exceeds 2 billion years in age.

3.1.1.2 Mineral Resources

3.1.1.2.1 Locatable Minerals

No locatable mineral deposits have been mapped within the PRPA, (http://wogra.wygisc.uwyo.edu/wyoims2/wims2awogra.html).

3.1.1.2.2 Leasable Minerals

Petroleum resources, both oil and gas may occur in Cretaceous rocks underlying the PRPA and the immediate vicinity. The nearest producing oil and gas field is the Salt Wells Field in T14N, R103W. This field discovered in 1949 has produced 317,614 BBLS of oil and 24,597,389 MCF gas, as of November 3, 2003 from the Dakota, Lakota, Frontier, Mesaverde, and Morrison Formations. The field is developed in a faulted anticline, the Salt Wells Anticline, which as described above, trends southeastward across the PRPA. Although it has been extensively drilled in the PRPA, no production has been established in area itself.

Coal occurs in Tertiary Fort Union Formation in the Burley Draw 7.5 minute quadrangle (Roehler 1974) and in the Wasatch Formation in the Ericson – Kent Ranch and Chicken Creek Southwest 7.5 minute Quadrangles (Roehler 1973, 1978). The coals are sparse, thin and discontinuous. The coals in the Wasatch Formation have low Known Mineral Deposit Area (KMDA) value and the PRPA is considered an area less favorable for mineral development, (http://wogra.wygisc.uwyo.edu/wyoims2/wims2awogra.html).

Coalbed Methane

Cretaceous and Tertiary coal beds buried in the subsurface around the Rock Springs Uplift are considered to be exploration targets for coalbed methane to a depth of about 5,000 feet (McCord, 1980). Coal rank around the Rock Springs Uplift at exploitable depth ranges from subbituminous to high volatile C bituminous (Hamilton et al 1994).

The Rifes Rim and Pacific Isle exploratory CBM units partially overlap the boundaries of the PRPA.

Primary coalbed methane targets in these units and within the PRPA are in the Almond Formation (Williams Fork Formation) of the upper Mesaverde Group. Roehler (1979b) who mapped the Almond Formation in the Ericson Kent Ranch, just northwest of the PRPA, subdivided the formation into three informal units. The thickest coals occur in the middle part of the formation, about 400 feet below the top of the formation. Depth to the top of the Almond Formation (top of the Mesaverde Group) ranges from about 1,200 feet to 2,000 feet in the western and eastern parts of the PRPA, respectively. Gas content of coals in the upper Mesaverde Group range from less than 1 to more than 540 scf/ton, but is generally less than 200 scf/ton (Scott 1994). Net coal maps of the upper part of the Mesaverde Group beneath the PRPA indicate 20 to 40 feet of coal present (Tyler and Hamilton 1994, Scott and others 1995). Secondary CBM methane targets occur in the lower part of the Mesaverde Group (Ericson Sandstone and Iles Formation). Gas contents of coals from the lower Mesaverde range from 0 to more than 650 scf/ton (Scott 1994).

Tertiary age coals of the Fort Union and Wasatch Formations are probably too thin and discontinuous to be considered economic targets for coalbed methane development in the PRPA. The Lance Formation, which contains economic coal deposits to the north, is either absent or preserved as a wedge edge in the subsurface of the area, having been eroded away prior to deposition of the Fort Union Formation of Paleocene age. That erosion episode is represented by the unconformity at the base of the Fort Union Formation.

Oil shale occurs in the Green River Formation south of Rifes Rim and has a moderate favorability ranking.

3.1.1.3 Geologic Hazards

Naturally occurring geologic hazards include fault generated earthquakes, floods, landslides or other mass movements. In addition, pyrophorocity (spontaneous combustion), subsidence, and subsidence generated earthquakes have been noted as potential hazards of CBM development.

There are no known earthquake epicenters mapped within the PRPA (NEIC 2003, WGS 2003). Thirty magnitude 2.0 and greater earthquakes have been recorded in Sweetwater County, exclusive of the trona mine region west of Green River. Of these earthquakes, those closest to the PRPA area include: (1) a magnitude 3.9 event that occurred on January 5, 1964, approximately 23 miles south of Rock Springs (2) a magnitude 2.5 earthquake that occurred on April 29, 1986 northeast of Pine Mountain in south-central Sweetwater County; and (3) two magnitude 3.2 earthquakes that occurred on March 1, 1984 and September 14, 1984, approximately 14 miles southeast of Point of Rocks and approximately 13 miles east-southeast of Point of Rocks (Stover, 1988; U.S. Geological Survey, 1994), respectively.

The PRPA falls within seismic Zone 1 of the Uniform Building Code (UBC) Seismic Zone Map (1997). UBC seismic zones are in part defined by the probability of having a certain level of ground shaking (horizontal acceleration) in 50 years. Zone 1 Effective Peak Acceleration, % of gravity is 5 to 10% (Seismology Committee of the Structural Engineers Association of California - Building Standards, September-October, 1986). There is a 90% probability that the 5 – 10 % values will not be exceeded in 50 years and a 100% probability that the values will be exceeded in 475 to 500 years. Case, Toner, and Kirkwood (2002) noted that an average peak acceleration of 10.0%g could be applied to the design of a non-critical facilities located in that part of Sweetwater County, including the PRPA, that falls into Seismic Zone 1.

There is one fault with surface expression in the PRPA area (Roehler 1973). This unnamed east-southeast trending reverse fault bounds the southern flank of the Salt Well Anticline and crosses

WYO 430 into the PRPA in the SW/4 of Section 18, T14N, R101W. From here the fault trends southeastward into the SE/4 of Section 21, T14N, R101W. The fault dips steeply northeastward (about 70 degrees) and places the Fort Union Formation in fault contact with the overlying Wasatch Formation at the surface, representing a maximum displacement of less than 500 feet. As described above, the fault is mapped as lying buried beneath Quaternary alluvium in the valley of East Salt Creek and East Draw, suggesting that it has not had recent movement.

The nearest active fault system to the PRPA is the Chicken Springs Fault System in northeastern Sweetwater County about 75 miles to the northeast. The Chicken Springs fault system is composed of a series of east-west trending segments in the northeastern corner of Sweetwater County. The most recent activation on the system appears to be Holocene in age.

Reconnaissance-level studies indicated that the fault system is capable of generating a magnitude 6.5 earthquake. A magnitude 6.5 earthquake on the Chicken Springs fault system would generate peak horizontal accelerations of approximately 4%g at Wamsutter and approximately 4.8%g at Rawlins and somewhat less at the PRPA. These accelerations would be roughly equivalent to an intensity V earthquake, which may cause some light damage.

The U.S. Geological Survey (USGS) publishes probabilistic acceleration maps for 500-, 1000-, and 2,500-year time frames. The maps show what accelerations may be met or exceeded in those time frames by expressing the probability that the accelerations will be met or exceeded in a shorter time frame. For example, a 10% probability that acceleration may be met or exceeded in 50 years is roughly equivalent to a 100% probability of being exceeded in 500 years. Based upon the 500-year map (10% probability of exceedance in 50 years) the estimated peak horizontal acceleration in the PRPA ranges from approximately 5%g in the southeastern corner to 6%g in the northwestern corner. These accelerations are roughly comparable to intensity V earthquakes (3.9%g – 9.2%g). These accelerations are comparable to the accelerations to be expected in Seismic Zone 1 of the Uniform Building Code. Intensity V earthquakes can result in cracked plaster and broken dishes. Based upon the 1000-year map (5% probability of exceedance in 50 years), the estimated peak horizontal acceleration in the PRPA ranges from 8%g in the far southeastern corner to over 9%g in the northeastern corner. These accelerations are roughly comparable to intensity V earthquakes (3.9%g – 9.2%g). Intensity V earthquakes can result in cracked plaster and broken dishes (Case, Toner, and Kirkwood 2002).

There are no mass movement deposits mapped in the area and none were observed during field reconnaissance. Topographic relief is approximately 991 feet, from 6,840 feet in East Salt Wells Creek to 7,950 feet along the western side of Kinney Rim. Slope in the northern part of the area is low to moderate and varies from low to moderate over the central part of the area. Slopes are steepest along the north side of Rifes Rim (Sec. 32, T17N, R100W) where over a lateral distance of about 1000 feet elevation rises on average 230 feet, and along the west side of Kinney Rim where over a lateral distance of about 1,600 feet elevation rises at most 360 feet, yielding slopes of about 13 degrees.

Rifes Rim itself is a vertical cliff formed in limestones of the Luman Tongue of the Green River Formation, that dips to the south opposite to the slope which dips to the northwest, thus lessening the chance for naturally occurring mass movements. Kinney Rim is a prominent west facing escarpment that bounds the area to the east is developed in the Laney Formation. Numerous springs occur along the base of the escarpment and mass movement deposits are developed along its length (http://www.wygisc.uwyo.edu/24k/surfgeol/quad3.html, http://www.wrds.uwyo.edu/wrds/wsgs/hazards/landslides/lshome.html). Additional steep slopes and vertical to near vertical cliffs are developed in massive fluvial sandstone in the Fort Union and Wasatch Formations in the central part of the PRPA, but dips are low making mass movement less likely.

Pyrophoricity (spontaneous combustion) has been cited as potential hazards 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 (UCG) conducted during the 1970's in Wyoming suggest that even under extreme efforts to maintain combustion (by injecting air into the burn zones) of 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. 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 “open-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, a CBM well leave no underground voids susceptible to subsidence and associated coal ignition as seen in abandoned underground mines, which are susceptible to spontaneous ignition.

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 demonstrate the association of withdrawal of underground fluids and subsidence. The best examples include the San Joaquin Valley in California, Las Vegas, New Orleans, Houston, and Mexico City. Subsidence in these areas all are 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 has resulted. The subsurface geologic conditions in the PRPA, 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 of as high as 50% and 88% respectively (Poland 1984), whereas values for consolidated clay (shale) and sand (sandstone) in the PRPA have porosity values at most as high as 10% and 30%, respectively (Freeze and Cherry 1979). Calculations of modeled ground subsidence associated with coalbed methane production for the Wyodak coal in the Powder River Basin, near Gillette indicate that subsidence of less than 2 inch can be expected (Case, Edgar, and DeBruin 2002). This amount of subsidence is not considered significant and is very unlikely to initiate earthquakes.

3.1.2 Paleontology

3.1.2.1 Overview

Paleontologic resources within sedimentary deposits exposed at the surface of the PRPA record the history of animal and plant life in Wyoming during the early part of the Cenozoic Era (Paleocene and Eocene Epochs). As described above, mapping documents four geologic deposits that are exposed at the surface of the area. These include, from youngest to oldest: (1) unnamed deposits of Quaternary (Holocene) age; (2) Green River Formation of middle Eocene age; (3) Wasatch

Formation of early Eocene age, and (4) Fort Union Formation of Paleocene age.

With the exception of the Holocene deposits that are too young to contain fossils, all sedimentary rock units exposed in the area have the potential to produce fossils of scientific interest and significance. Scientifically significant fossil vertebrates have been recovered from within the area or immediately adjacent areas in the Wasatch (Morris 1954, Roehler 1972, 1991 a-b, 1992 a-c, 1993, Roehler et al. 1988, Casilliano 2003, Holroyd 2003) and Fort Union (Winterfeld 1982) Formations. Scientifically significant fossil vertebrates, primarily fish, but other groups as well, have been recovered from the Green River Formation throughout its extent.

Green River Formation

Plant, invertebrate, and vertebrate fossils are known from the Green River Formation. The LaClede Bed of the Laney Member yields fossils of gastropods, bivalves, and fish. Plant, invertebrate (ostracod), and vertebrate fossils (fish and bird) are well known from the lower part of the Wilkins Peak Member. Freshwater gastropods, such as *Goniabasis tenera* and *Viviparus* sp., and the large unionid bivalve, *Lampsilis*, as well as fish fossils occur abundantly in the Tipton Tongue, and at least one fossil mammal locality has been reported from that member. The fossil mammal locality discovered in an ostracodal limestone, produced the mold of a jaw of the early horse *Hyracotherium*, with incisors preserved and impression of molars.

Fossils of fresh water molluscs are abundant throughout the Luman Tongue and the assemblages of fossils are commonly characterized by the large prosobranch gastropods *Goniabasis tenera* and *Viviparus sp.*, and by the large unionid bivalve, *Lampsilis*. Fish, ostracod, and trace fossils are also common in the tongue (Roehler, 1991 a-b; 1992 a-c, 1993).

Wasatch Formation

The high paleontologic potential of the Wasatch Formation in southern Wyoming is well known. Along the east flank of the Rock Springs Uplift the Niland Tongue and Main Body contain accumulations of fossil vertebrates (fish, turtles, crocodiles, birds and mammals), invertebrates (snails and clams), and traces and tracks of these organisms and fossil plants. Vertebrate remains include isolated bones and teeth and rarely articulated skeletal parts (Morris, 1954; Gazin, 1962; Honey, 1992; Roehler, 1991 a-b; 1992 a-c, 1993). The fossil mammals include primates, insectivores, marsupials, condylarths (archaic hoofed animals), artiodactyls, perissodactyls, carnivores, creodonts, bats, rodents, arctocyonids, and tillodonts. The Cathedral Bluffs Member also contains fossil vertebrates but apparently is not as rich as the other members of the Wasatch Formation (Honey 1988, Morris, 1954).

Review of institutional records (University of California, University of Colorado, University of Wyoming) reveals that more than 250 fossil vertebrate localities have been identified in the Wasatch Formation along the east flank of the Rock Springs Uplift. At least two dozen fossil localities are known from the main body of the formation exposed along the east side of Patrick Draw Road north of the area. To date, more than 13,000 cataloged specimens in the University of California Museum of Paleontology, the University of Colorado Museum, the U.S. National Museum, and the University of Wyoming have come from these sediments (Holroyd 2003).

These localities and specimens from them are of high scientific significance and interest because they include: (1) mammalian mass death assemblages (Williamson 2001 and McGee 2001, 2002) preserving skulls and skeletons of multiple individuals; (2) small mammals (Gunnell 2001, Cuozzo, 2002), lizards (Gauthier, 1982), birds, and amphibians, many of which are new species and are the subject of ongoing study by researchers at the University of California, University of Michigan, University of Colorado, Yale University, and Las Positas College; (3) localities showing the greatest fossil bird, reptile, and mammal diversity of any area localities of early Eocene vertebrates known from North America and perhaps the world (Stidham, 1999, Holroyd and Hutchison, 2000, Holroyd, 2001); and (4) localities that are tied closely to the basin-wide stratigraphic framework (Savage et al. 1972; Roehler, 1992a-c; and field notes on file at UCMP).

Not much work has been conducted by paleontologists on the Wasatch Formation to date in the PRPA itself, however. During field reconnaissance, vertebrate fossils including turtle bones and shell fragments, crocodile osteoderms, gar fish scales, and mammalian teeth and postcranials were found at a single locality in the N/2 Section 10, T14N, R101W. This locality suggests that additional undiscovered fossil localities are present in the PRPA.

Fort Union Formation

The high potential of the Fort Union Formation to produce scientifically significant fossils of vertebrates, invertebrates and plants in outcrops exposed along the eastern flank of the Rock Springs Uplift is well documented (Winterfeld, 1982, Wilf and others 1998). Fossils vertebrate remains are known from more than 50 fossil localities presently identified in the formation. Mammal fossils from these localities include at least 70 species of representing multituberculates, marsupials, proteutherian, insectivores, primates, carnivores, condylarths, pantodonts, and taeniodonts of middle to late Paleocene age (Winterfeld 1982). The uppermost rocks of the formation contain fossil mammals that mark the transition to the Eocene epoch and document the appearance of modern mammalian families in North America as well as the disappearance of archaic forms (Wilf and others 1998).

These localities and specimens from them are of high scientific significance and interest for several reasons including: (1) they yield small mammals (Winterfeld 1982), reptiles and amphibians many of which are new species and are the subject of ongoing study by researchers at Idaho State University and the Carnegie University; (2) include among them a late Paleocene age locality (Clarkforkian age) with the greatest diversity of fossil mammals known from that age that is also not significantly biased against smaller forms (Wilf and other 1998); and (3) include localities that are closely tied with plant fossils allowing the study of mammalian evolution as it ties with climatic evolution.

Not much work has been conducted by paleontologists on the Fort Union Formation to date in the PRPA itself, however. During field reconnaissance, vertebrate fossils including turtle bones and shell fragments, crocodile osteoderms and mammalian teeth and postcranials were found at a three localities in the N/2 Section 19, T14N, R101W. These localities suggest that additional undiscovered fossil localities are present in the PRPA.

Paleontology Ranking

The Wyoming BLM considers the Wasatch and Green River Formations to be Class 5 paleontological formations which means they are highly fossiliferous geologic units that regularly and predictably produce vertebrate fossils and/or scientifically significant nonvertebrate fossils, and that are at risk of natural degradation and/or human-caused adverse impacts. The BLM considers the Fort Union Formation to be a Class 3 paleontological formation which means that it is a fossiliferous sedimentary geologic unit where fossil content varies in significance, abundance, and predictable occurrence.

Class 5 paleontological formations require mitigation of ground disturbing activities. Class 3 paleontological formations require sufficient mitigation to determine whether significant paleoresources occur in the area of the proposed action.

3.2 CLIMATE AND AIR QUALITY

3.2.1 Introduction

Air quality within any region may be influenced by a combination of factors including climate and meteorology, the magnitude and spatial distribution of local and regional emission sources, and the chemical properties of emitted pollutants. Within the lower atmosphere, synoptic and local scale air masses interact with regional topography to influence atmospheric dispersion and transport of pollutants. The following sections summarize the climatic and air quality conditions prevailing within the Pacific Rim Shallow Gas Project Area (PRPA) and surrounding region.

3.2.2 Climate

The PRPA is located in a semiarid mid-continental climate regime typified by dry windy conditions, limited rainfall, and long cold winters. The ground elevation across the project area ranges from 6,900 feet to in excess of 7,600 feet, resulting in a relatively cool climate. In the wintertime, it is characteristic to have rapid and frequent changes between mild and cold spells.

The nearest National Weather Service (NWS) meteorological measurements were recorded at Bitter Creek, Wyoming (1962 to present). The Bitter Creek station is located approximately 25 miles northeast of the project area at an elevation of 6,720 feet (Western Regional Climate Center, 2003).

The annual mean precipitation recorded at Bitter Creek is 6.3 inches, and ranges from a minimum of 2.59 inches recorded in 1988, to a maximum of 9.44 inches recorded in 1965. March is the driest month with an annual mean precipitation of 0.27 inches, and May is the wettest month with an annual mean of 1.09 inches. The annual average snowfall is 18 inches, with December, January and February being the snowiest months. A maximum snowfall of 34.5 inches was recorded in 1991.

The area is typically cool, with an annual mean temperature of 41.5 °F. Average winter temperatures range from 9°F to 34°F, while summer temperatures range from 44°F to 81°F. Recorded extreme temperatures are -46°F in January 1971 and 103°F in July1969. Table 3-3 summarizes the climatic conditions by month.

Wind speed and direction along with vertical temperature profiles in the lower atmosphere greatly affect the transport and dispersion of air pollutants. Within the region, the potential for atmospheric dispersion is relatively high due to the frequency of strong winds. However, calm periods and nighttime cooling often enhance air stability, thereby inhibiting air pollutant transport and dilution. During periods of stable atmospheric conditions, cold air tends to be trapped at the surface and vertical mixing of pollutants is limited. Temperature inversions are of shorter duration during the summer months when daytime ground-level heating rapidly leads to inversion break-up and increased vertical mixing.

The nearest comprehensive wind measurements are recorded at the Rock Springs, Wyoming airport, approximately 35 miles northwest of the project area. Winds blow predominately east through northeast 46 percent of the time and the average wind speed is nearly 12 miles per hour (5.33 meters/second). Figure 3-1 presents a wind rose for the Rock Springs Airport for the period 1991 through 1995. The wind rose depicts the direction of wind flow and thus illustrates the predominate directions in which emitted air pollutants would be transported. The wind data are tabulated in Tables 3-4 and 3-5.

The degree of stability in the atmosphere is important to the dispersion of emitted pollutants. During stable conditions, vertical movement in the atmosphere is limited and the dispersion of pollutants is inhibited. Temperature inversions can result in very stable conditions with virtually no vertical air motion thereby restricting dispersion. Conversely, in unstable conditions upward and downward movement in the atmosphere is prevalent and the dispersion of pollutants is enhanced.

Atmospheric stability is typically categorized by stability classes “A” through “F”, with “A” representing a high degree of atmospheric turbulence, and “F” representing a high degree of atmospheric stability. As illustrated in Table 3-6, atmospheric stability in the region favors mid-range conditions associated with fair dispersion capacity 46.6% of the time.

Table 3-3. Average Monthly Climatic Conditions Recorded at Bitter Creek, Wyoming (1962-2003)

Month	Average Temperature Range (Fahrenheit)	Average Monthly Temperature (Fahrenheit)	Average Total Precipitation (inches)	Average Total Snowfall (inches)
January	7.7 – 32.2	19.9	0.32	3.6
February	11.0 – 35.7	23.4	0.28	3.4
March	18.6 – 44.0	31.3	0.27	1.9
April	25.1 – 54.5	39.9	0.47	1.9
May	32.9 – 65.7	49.3	1.09	0.0
June	40.4 – 76.0	58.2	0.81	0.0
July	46.7 – 84.1	65.3	0.59	0.0
August	45.0 – 82.3	63.7	0.55	0.0
September	35.9 – 72.5	54.2	0.68	0.0
October	26.2 – 59.6	42.9	0.63	0.9
November	16.7 – 42.8	29.5	0.37	2.9

December	8.5 – 33.3	20.9	0.25	3.4
Annual Average	26.2 – 56.9	41.5	6.30	18.0

Source: Western Regional Climate Center (2003). Data collected at Bitter Creek, Wyoming from 1962 through April 2003.

Table 3-4. Wind Direction Frequency Distribution[1]

Direction of Wind Origin	Frequency	Direction of Wind Origin	Frequency
North	1.3%	South	6.7%
North Northeast	1.5%	South Southwest	5.8%
Northeast	4.5%	Southwest	11.6%
East Northeast	4.1%	West Southwest	19.8%
East	2.7%	West	14.7%
East Southeast	1.3%	West Northwest	3.3%
Southeast	2.5%	Northwest	1.8%
South Southeast	3.6%	North Northwest	1.3%

Table 3-5. Wind Speed Frequency Distribution[1]

Wind Speed Category (miles per hour)	Frequency
Calm to 4.0	4.1%
4.0 to 7.5	22.7%
7.5 to 12.1	24.8%
12.1 to 19.0	21.7%
19.0 to 24.7	8.9%
Greater than 24.7	4.3%

[1] Source: Wyoming DEQ-AQD (2002). Meteorological data collected at Rock Springs Airport for years 1991, 1992, 1993, 1994, and 1995.

3.2.3 Air Quality

3.2.3.1 Regulatory Environment

National and Wyoming Ambient Air Quality Standards (NAAQS and WAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. The Clean Air Act (CAA) established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings. Standards have been set for six pollutants, termed criteria pollutants, which include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}) or less than 2.5 microns in diameter ($PM_{2.5}$), and lead (Pb).

Figure 3-1. Rock Springs, Wyoming Wind Rose

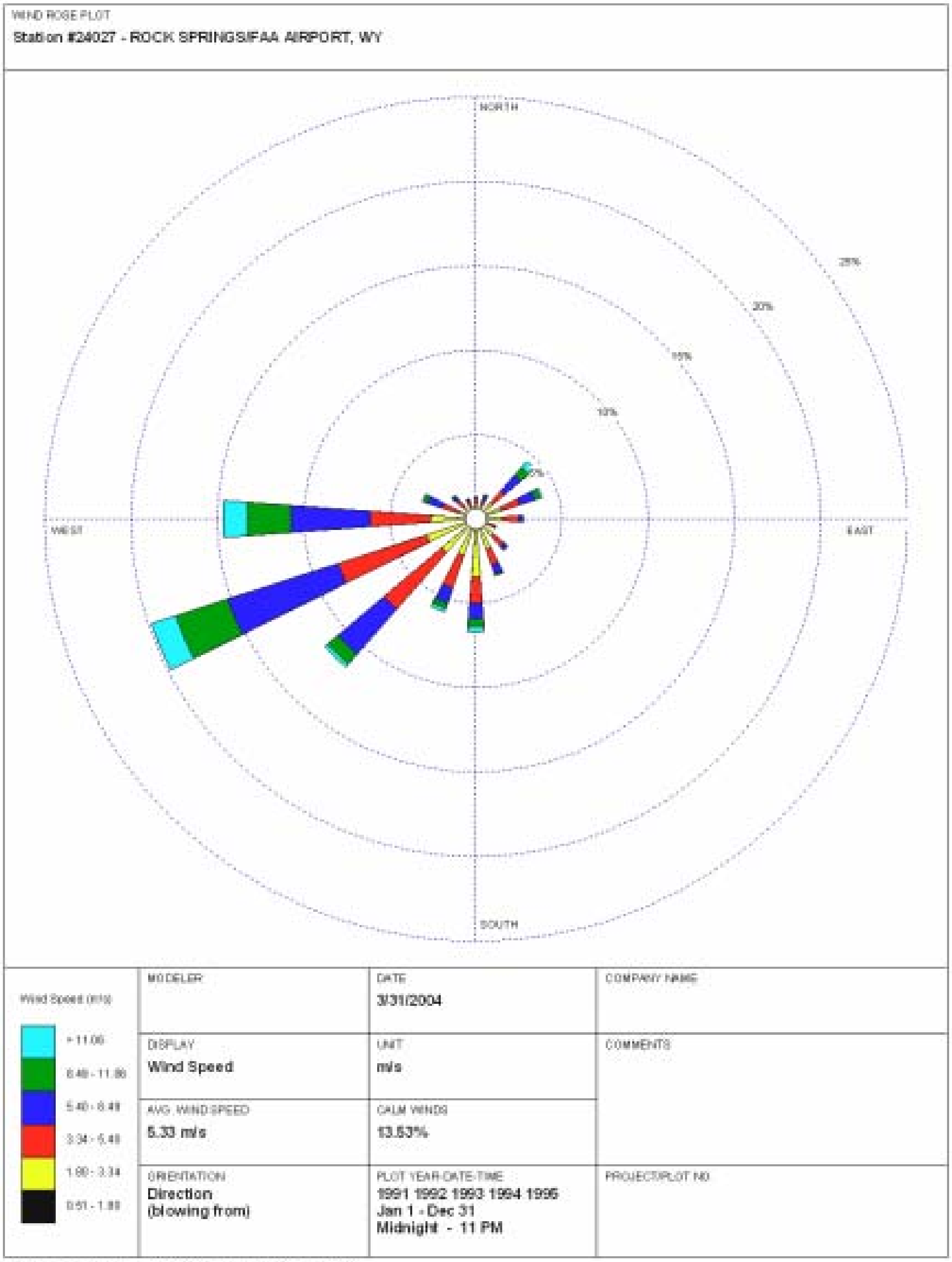


Table 3-6. Atmospheric Stability Class Distribution

Stability Class	Percent Occurrence
A	0.5%
B	4.4%
C	9.7%
D	46.6%
E	14.7%
F	10.5%
Calm	13.5%

Source: Wyoming DEQ-AQD (2002). Wind data collected at Rock Springs Airport for years 1991, 1992, 1993, 1994, and 1995.

Under the Prevention of Significant Deterioration (PSD) provisions, incremental increases in criteria pollutant concentrations are limited above a legally defined baseline level. All national parks and many wilderness areas are designated as PSD Class I. The PSD program protects air quality within Class I areas by allowing only slight incremental increases in pollutant concentrations. Areas of the state not designated as PSD Class I are classified as Class II. For Class II areas, greater incremental increases in ambient pollutant concentrations are allowed.

Toxic air pollutants, also known as hazardous air pollutants (HAPs), are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental impacts. The EPA has classified 189 air pollutants as HAPs. Examples of listed HAPs emitted by oil and gas operations include formaldehyde (HCHO), BTEX compounds (benzene, toluene, ethylbenzene, isomers of xylene) and normal-hexane (*n*-hexane).

The CAA requires EPA to regulate emissions of toxic air pollutants from a published list of industrial sources referred to as "source categories." As required under the Act, EPA has developed a list of source categories that must meet control technology requirements for these toxic air pollutants. Under section 112(d) of the CAA, the EPA is required to develop regulations establishing national emission standards for hazardous air pollutants (NESHAP) for all industries that emit one or more of the pollutants in major source quantities. These standards are established to reflect the maximum degree of reduction in HAP emissions through application of maximum achievable control technology (MACT). Source categories for which NESHAPs have been implemented include Oil and Natural Gas Production and Natural Gas Transmission and Storage.

This NEPA analysis compares potential air quality impacts from the Proposed Action and Alternatives to applicable ambient air quality standards and PSD increments. However, comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and do not represent a regulatory PSD Increment Consumption Analysis. Although most of the development activities would occur within areas designated PSD Class II, the potential impacts on regional Class I areas are to be evaluated. For a new source review air quality permit application for a major source, the applicable air quality regulatory agencies may require a regulatory PSD increment analysis. More stringent emission controls beyond Best Available Control Technology may be stipulated in the air quality permit if impacts are predicted to be greater than the PSD Class I or II increments.

3.2.3.2 Pollutant Characteristics

Criteria Air Pollutants

The term NO_X is used to describe the combination of nitrogen monoxide (NO), NO_2, and other nitrogen oxides including dinitrogen oxide (N_2O). The National Ambient Air Quality Standard refers only to NO_2, rather than all species of NO_X. Nitrogen oxides are by-products from the combustion of fossil fuels. The primary sources of anthropogenic NO_X include automobiles and power plants. Furnaces and gas stoves also contribute to NO_X emissions. Most NO_X emissions are emitted in the form of NO, which is not stable in the atmosphere and is eventually converted to NO_2. Nitrogen dioxide is a toxic, reddish-brown gas that is reactive in the atmosphere and plays a role in the formation of smog. Long-term human exposure to NO_2 may lead to increased susceptibility to respiratory infection and may cause alterations in the lung. Nitrogen oxides also contribute to the formation of acid rain and to visibility impairment.

Carbon monoxide (CO) is formed when fossil fuels are not burned completely. Nation-wide, the primary source of CO is automobile emissions. Other sources of CO include industrial processes, non-transportation fuel combustion and forest fires. Carbon monoxide is a colorless, odorless gas that is poisonous in high concentrations. When humans are exposed to CO, the gas enters the bloodstream through the lungs and reduces oxygen delivery to the body's organs and tissues. Reduced work capacity, reduced manual dexterity, poor learning capacity and difficulty in performing complex tasks are associated with exposure to elevated levels of CO.

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide gases (SO_x). These gases are highly soluble in water. Sulfur is prevalent in many raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil or metals are extracted from ore. SO_2 dissolves in water vapor to form acid, and interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and the environment. Health effects of SO_2 exposure range from short-term breathing difficultly to longer-term respiratory illness. SO_2 also contributes to atmospheric deposition ("acid rain") and to visibility impairment.

Ground-level ozone is a gas created through a chemical reaction between NO_X and VOCs in the presence of heat and sunlight. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of NO_x and VOC that help to form ozone. Emissions of NO_x and VOC in hot weather may cause ground-level ozone to form in harmful concentrations in the air. As a result, it is generally known as a summertime air pollutant. Ozone can be transported great distances and therefore contributes to air pollution issues on a regional scale. Primary health effects resulting from exposure to high concentrations of O_3 range from breathing difficulty to permanent lung damage. Ground-level ozone also contributes to plant and ecosystem damage.

Particulate matter, or PM**,** is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particulate matter is further classified as total suspended particulates (TSP), particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns in diameter

($PM_{2.5}$). Particulate matter may be emitted directly to the atmosphere from mobile and stationary sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and wood burning. Additionally, PM may be generated from secondary chemical reactions in the atmosphere involving oxides of nitrogen and sulfur. The primary health hazard stems from inhalation of fine particulate matter or $PM_{2.5}$. Many health studies have correlated increased $PM_{2.5}$ exposure with increases in premature death as well as a range of serious respiratory and cardiovascular effects. Environmentally, particulate matter in the form of atmospheric sulfates and nitrates, organics, and elemental carbon (soot), represents the primary source of visibility impairment and contributes to atmospheric deposition.

Lead is a metal found naturally in the environment as well as in manufactured products. The major source of lead emissions has historically been motor vehicles. However, the levels of lead in the atmosphere have decreased dramatically since 1978 due to the phase out of leaded gasoline. Currently, the highest levels of lead in the atmosphere are generally found near lead smelters, waste incinerators, utilities, and lead-acid battery manufacturers. Health effects resulting from lead exposure include damage to the liver, kidneys, brain and nervous system. The Pacific Rim Project is not expected to emit any substantial quantities of lead, and therefore is not discussed further in this document.

Hazardous Air Pollutants

Formaldehyde is an irritant to humans. Acute (short-term) and chronic (long-term) exposures can result in eye, nose and throat irritation and respiratory symptoms including coughing, wheezing and bronchitis. In addition, the Environmental Protection Agency (EPA) has classified formaldehyde as a Group A, probable human carcinogen of medium carcinogenic hazard (EPA 1994). The highest levels of airborne formaldehyde have been found in indoor air, where it is released from various consumer products (EPA 2002). One survey (EPA 1988) reports measured formaldehyde levels in homes ranging from 0.10 to 3.68 parts per million (ppm), or 122 to 4,520 $\mu g/m^3$. The smoking of tobacco products also represents an important source of human formaldehyde exposure.

Benzene emissions typically result from coal and oil combustion, volatilization from gasoline service stations, and motor vehicle exhaust. Acute inhalation exposure to benzene may cause drowsiness, dizziness, headaches, as well as eye, skin, and respiratory tract irritation, and, at high levels, unconsciousness. Chronic inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia. Adverse reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests. Increased incidence of leukemia (cancer of the tissues that form white blood cells) have been observed in humans occupationally exposed to benzene. EPA has classified benzene as a Group A, human carcinogen (EPA 1994).

Additional BTEX compounds including toluene, ethylbenzene, and xylene, as well as *n*-hexane, are of concern for both acute and chronic health effects. EPA has classified these compounds as a Group D, not classifiable as to human carcinogenicity (EPA 1994). These compounds are released to the atmosphere through a variety of pathways, including volatilization through their use as solvents, as fugitive emissions from industrial sources, and through automobile exhaust.

3.2.3.3 Existing Air Quality Conditions

Comprehensive air quality monitoring has not been conducted within the PRPA. However, air quality in and surrounding the area is expected to be relatively good due to the limited number of large industrial emission sources and predominately favorable atmospheric dispersion conditions. Background values recorded in the region are below the NAAQS and WAAQS. Measured regional background concentrations are presented in Table 3-8 with the applicable ambient air quality standards.

The PRPA and surrounding region is federally designated as a PSD Class II area. The two nearest PSD Class I areas are Bridger and Fitzpatrick Wilderness areas located north of the PRPA in the Wind River Mountain Range. Contiguous with Bridger Wilderness are Popo Agie Wilderness and the Wind River Roadless Area, both designated as PSD Class II. Savage Run, a state designated PSD Class I area, is located east of the project area. Figure 3-2 presents a regional map indicating the location of the PRPA and the areas of special concern while Table 3-7 summarizes the distances the PRPA and the areas of special concern. The applicable PSD increments for both Class I and II areas are presented in Table 3-7.

Table 3-7 Areas of Concern PSD Class I and Sensitive Class II Areas.

Area of Special Concern	Distance[1] and Direction From Pacific Rim Project Area	PSD Classification
Bridger Wilderness	125 miles North Northwest	Federal PSD Class I
Fitzpatrick Wilderness	145 miles North Northwest	Federal PSD Class I
Wind River Roadless Area	125 miles North Northwest	Federal PSD Class II
Popo Agie Wilderness	145 miles North Northwest	Federal PSD Class II
Savage Run Wilderness	120 miles West	State PSD Class I

1 - Distance from the center of the project area to the center of the area of concern.

3.2.3.4 Air Quality Related Values

Areas of special concern, including some PSD Class I areas, are monitored for Air Quality Related Value (AQRV) impacts. These AQRVs include terrestrial and aquatic deposition and visibility impairment.

<u>Atmospheric Deposition</u>

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and is reported as the mass of material deposited on an area (kilograms per hectare or kg ha^{-1}). Air pollutants are deposited by wet deposition (precipitation) and by dry deposition (gravitational settling of particles and adherence of gaseous pollutants).

Total deposition refers to the sum of airborne material transferred to the Earth's surface by both wet and dry deposition. Total terrestrial deposition voluntary guidelines have been estimated for several areas, including the Bridger Wilderness in Wyoming (Fox et al. 1989). Estimated total terrestrial deposition guidelines include the "red line" (defined as the total deposition that the area can tolerate) and the "green line" or "level of concern" (defined as the acceptable level of total deposition).

Table 3-8. Air Pollutant Background Concentrations, National and State Ambient Air Quality Standards, and PSD Increments

Pollutant And Averaging Time	Measured Background Concentration ($\mu g/m^3$)	National [2] and Wyoming [3] Ambient Air Quality Standards ($\mu g/m^3$)	PSD [4] Class I Increment ($\mu g/m^3$)	PSD [4] Class II Increment ($\mu g/m^3$)
Carbon Dioxide (CO)				
1-hour	2,299 [a]	40,000	n/a	n/a
8-hour	1,148 [a]	10,000	n/a	n/a
Nitrogen Dioxide (NO_2)				
Annual	3.4 [b]	100	2.5	25
Ozone (O_3)				
1-hour [1]	169 [c]	235	n/a	n/a
8-hour [5]	147 [c]	157	n/a	n/a
Particulate Matter (PM_{10})				
24-hour	47 [d]	150	8	30
Annual	16 [d]	50	4	17
Particulate Matter ($PM_{2.5}$)				
24-hour [5]	15 [d]	65	n/a	n/a
Annual [5]	5 [d]	15	n/a	n/a
Sulfur Dioxide (SO_2)				
3-hour	29 [e]	1,300	25	512
24-hour (National)	18 [e]	365	5	91
24-hour (Wyoming)	18 [e]	260	5	91
Annual (National)	5 [e]	80	2	20
Annual (Wyoming)	5 [e]	60	2	20

Note: 1 - Measured background ozone concentration value represents the top tenth percentile maximum 1-hour value. Other short-term background concentrations are second-maximum values.
2 - 40 CFR part 50 National Primary and Secondary Air Quality Standards.
3 - Wyoming Air Quality Standards and Regulations, Chapter 2 - Ambient Standards.
4 - 40 CFR part 51.166 Prevention of Significant Deterioration of Air Quality.
5 – State implementation of this standard is pending.
n/a: Not Applicable.

Sources of Measured Background Concentrations

[a] Data collected at Rifle and Mack, Colorado in conjunction with proposed oil shale development during the early 1980's (CDPHE-APCD 1996)

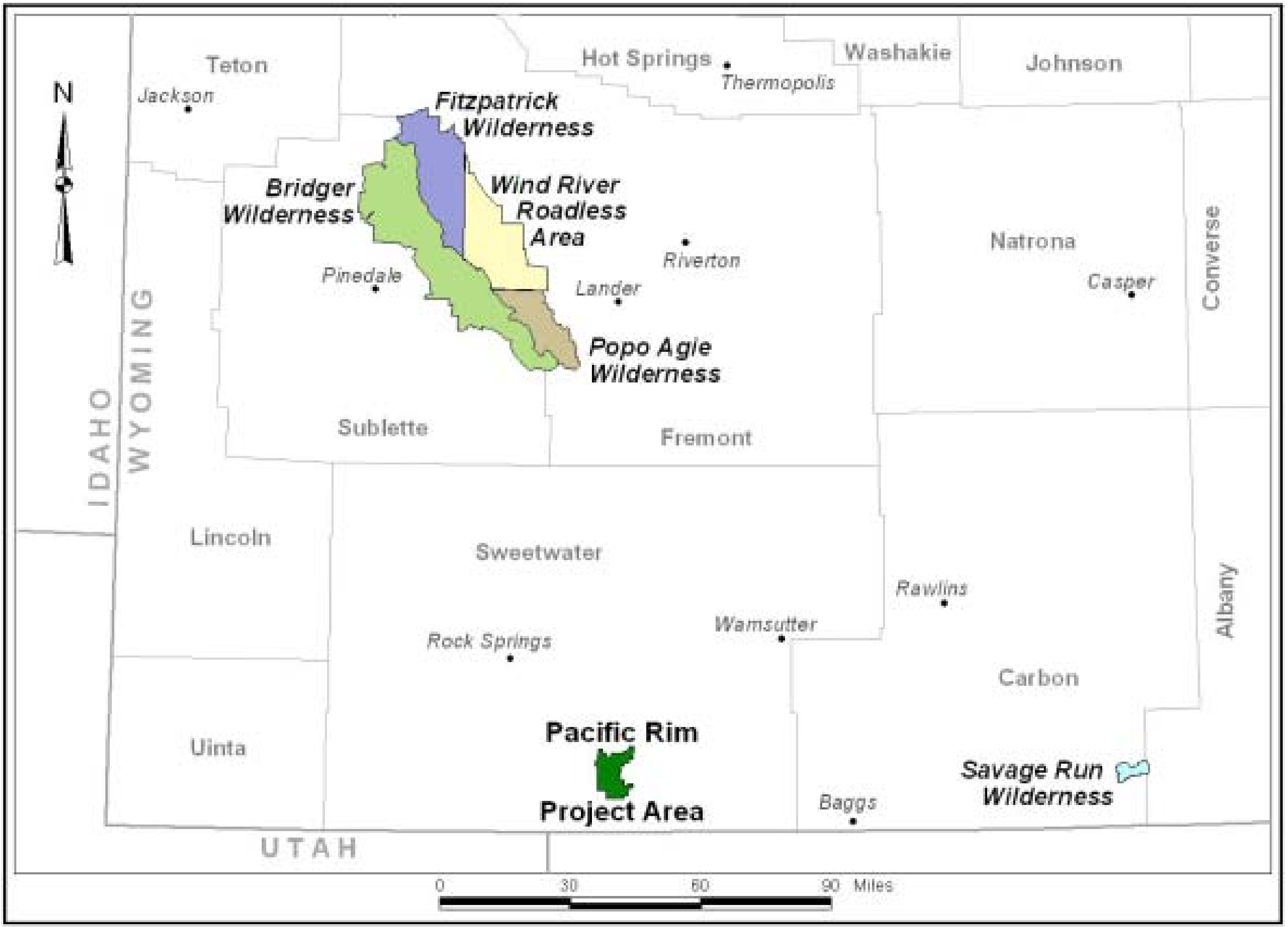
[b] Data collected at Green River Basin Visibility Study site, Green River, Wyoming during the period January-December 2001. (ARS, 2002)

[c] Data collected at Green River Basin Visibility Study site, Green River, Wyoming during the period June 10, 1998 through December 31, 2001 (ARS, 2002).

[d] Data collected at the Emerson Building, Cheyenne, WY during 2002 (WDEQ, 2003).

[e] Data collected at the Craig Power Plant site and at Colorado Oil Shale areas from 1980 to 1984. (CDPHE-AQCD 1996)

Figure 3-2. Pacific Rim Project Area and Areas of Special Concern



Total deposition guidelines for Bridger include a "red line" set at 10 kg/ha/year for nitrogen and 20 kg/ha/year for sulfur, and a "level of concern" set at 3-5 kg/ha/year for nitrogen and 5 kg/ha/year for sulfur. Air quality scientists are currently re-evaluating the thresholds, because the thresholds may be set too high.

Incremental project-level Deposition Analysis Thresholds (DATs) for Class I areas have also been proposed jointly through the National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS). The DAT is the additional amount of deposition that triggers a management concern, not necessarily the amount that constitutes an adverse impact to the environment. Both the NPS and the FWS utilize a case-by-case approach to permit review and National Environmental Policy Act (NEPA) related proposals. Adverse impact determinations are considered on a case-by-case basis for predicted deposition values that are higher than the DAT. The DAT for sulfur and nitrogen deposition in Western Class I areas, developed as a function of natural background deposition, has been set at 0.005 kg/ha/yr N or S (National Park Service 2003).

Project Area Conditions

The National Atmospheric Deposition Program (NADP) assesses wet deposition by measuring the chemical composition of precipitation (rain and snow). The NADP station closest to the Pacific Rim project area is near South Pass City, Wyoming, approximately 90 miles north northwest of the PRPA. Data are available from 1985 through 2002.

The mean annual precipitation pH recorded at the South Pass City NADP site ranges from 4.7 to 5.2. The natural acidity of precipitation is considered to range from 5.0 to 5.6 pH (Seinfeld, 1986). Annual nitrogen wet deposition rates recorded at South Pass City average 0.47 kg/ha ammonium ($NH4^+$), and 0.74 kg/ha nitrate. The annual average wet sulfate deposition rate is 0.91 kg/ha.

The Clean Air Status and Trends Network (CASTNet) measures dry deposition of nitrogen and sulfur compounds. The CASTNet station nearest to the PRPA is near Pinedale, Wyoming, approximately 130 miles northwest of the PRPA. Data are available from 1992 through 2001.

Annual dry nitrogen deposition rates recorded near Pinedale include average 0.11 kg/ha ammonium ($NH4^+$), 0.08 kg/ha nitrate (NO_3^-), and 1.97 kg/ha nitric acid (HNO_3). Annual sulfur deposition rates average 0.53 kg/ha sulfur dioxide (SO_2) and 0.28 kg/ha sulfate (SO_4).

Bridger Wilderness Conditions

In order to characterize the current deposition rates for the Bridger Wilderness area, dry and wet deposition monitoring data taken from Pinedale, Wyoming (as recommended in the FLAG [2000] Phase I report) were evaluated. Wet deposition data from Pinedale are available through the National Atmospheric Deposition Program (NADP) for the period 1982 through 2002. As previously discussed, CASTNet data for the Pinedale measurement site are available for the years 1992 through 2001.

Figures 3-3 and 3-4 present graphical representations of the Pinedale annual deposition rates, along with comparisons to the Bridger "level of concern" acceptable deposition thresholds. Note that the charts represent deposition as total nitrogen (N) or total sulfur (S). The charts present only the years for which both NADP and CASTNet are available. As the data illustrate, total background deposition of nitrogen and sulfur are below the Bridger "level of concern" thresholds, although the "level of concern" may be set to a lower value in the future.

Acid Neutralization Capacity

Aquatic bodies such as lakes and streams are important resources in most Class I areas. Acid deposition resulting from industrial emissions of sulfur and nitrogen based compounds can have a direct effect on the acid neutralization capacity (ANC) of sensitive lake ecosystems. Screening methodologies involving comparisons of sulfate and nitrate deposition fluxes to changes in background ANC values have been applied in New Source Review and NEPA processes to predict air pollution caused changes to the chemistry of sensitive lakes (USDA–FS 2000). The following Table 3-9 summarizes the background ANC values for selected lakes located in the areas of special concern. As shown, Upper Frozen Lake in the Bridger Wilderness has a low tolerance for additional acid deposition with an ANC of 5.0 micro-equivalents/liter (µeq/l). The current conditions at Upper Frozen Lake are estimated from a limited number of samples (six), that range in value from 2.6 µeq/l to 18.4 µeq/l.

Table 3-9. Background Acid Neutralization Capacity for Sensitive Lakes [1]

Lake Name	Special Concern Area	Managing Agency	Background ANC Level [2] (µeq/l)	Monitoring Period	Number Of Samples
Black Joe	Bridger Wilderness	USFS	67.0	1984 – 2003	61
Deep	Bridger Wilderness	USFS	59.9	1984 – 2003	58
Hobbs	Bridger Wilderness	USFS	69.9	1984 – 2003	65
Upper Frozen	Bridger Wilderness	USFS	5.0	1997- 2003	6
Ross	Fitzpatrick Wilderness	USFS	53.5	1988 – 2003	44
Lower Saddlebag	Popo Agie Wilderness	USFS	55.5	1989 – 2003	43

1 – Background ANC values compiled from 24 data files supplied by the USDA-FS (USDA-FS 2003).
2 - 10% lowest ANC as measured at the lake outlet.

Visibility

Visitors to national parks and wilderness areas list the ability to view unobscured scenic vistas as an important part of a satisfying experience. However, visibility impairment has been documented in many Class I areas. Most visibility impairment is in the form of regional haze. In the intermountain west, atmospheric sulfate, organics and elemental carbon are the main cause of regional haze and visibility impairment (FLAG 2000).

Visibility is usually characterized by two parameters, visual range (VR) and the light-extinction coefficient (b_{ext}). The visual range parameter represents the greatest distance that a large dark object can be seen. The light extinction coefficient represents the attenuation of light per unit distance due to scattering and absorption by gases and particulate matter in the atmosphere. Under typical conditions, the visual range and b_{ext} parameters are inversely related to each other. Good visibility conditions are represented by long visual ranges and low b_{ext} values, while poor visibility conditions are represented by short visual ranges and high b_{ext} values.

Figure 3-3. Nitrogen Deposition Measured At Pinedale, Wyoming

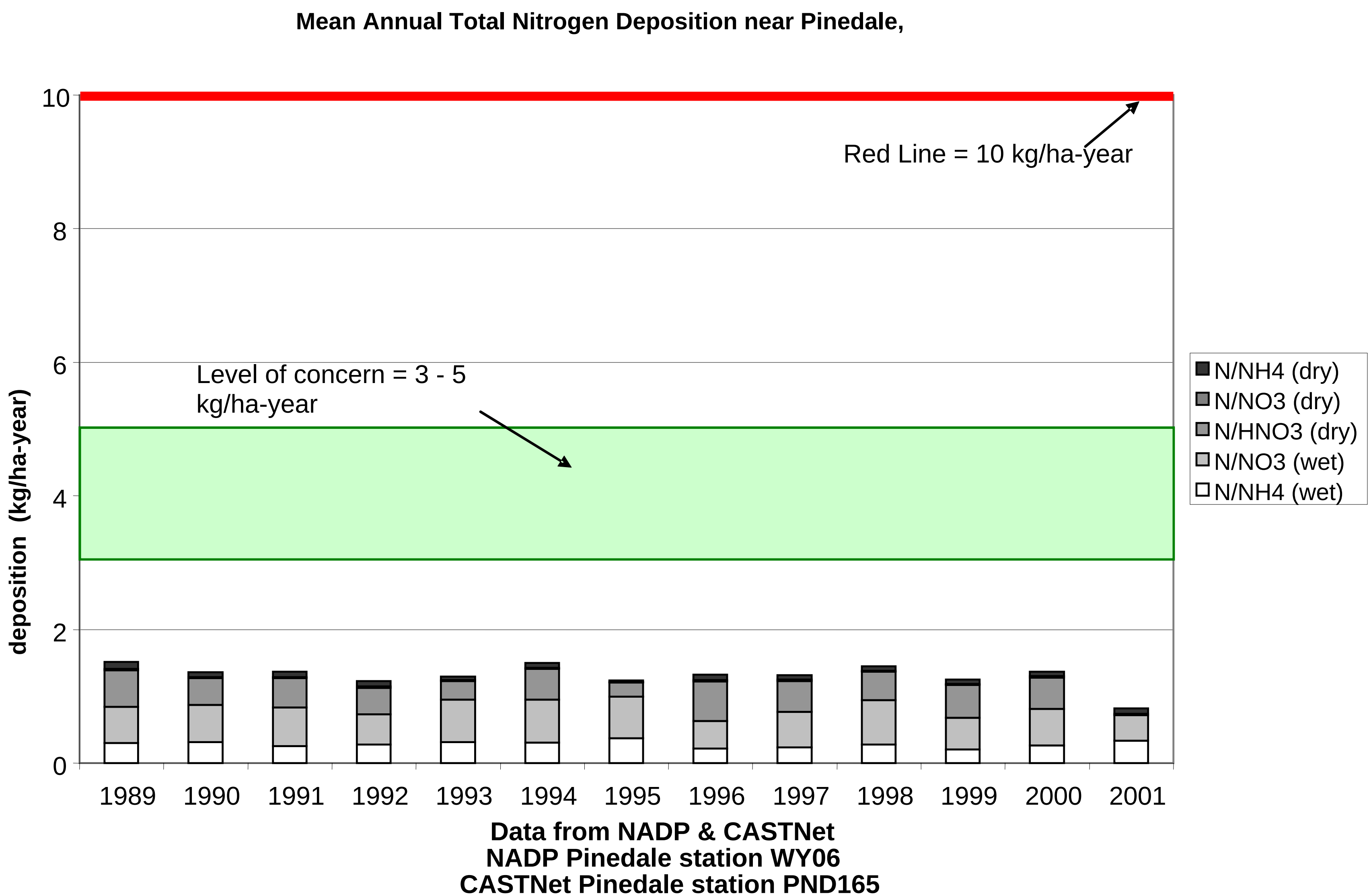
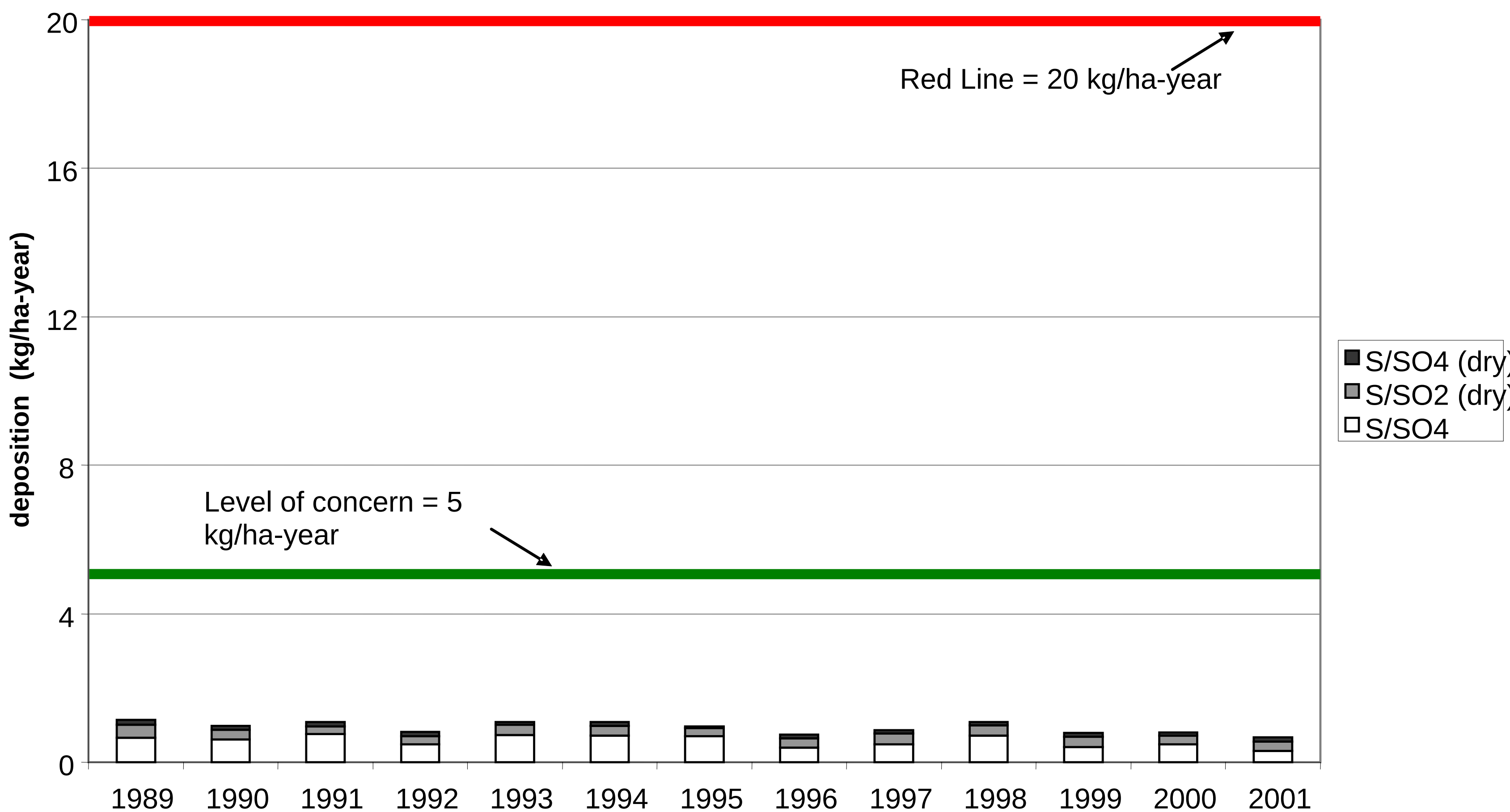


Figure 3-4. Sulfur Deposition Measured At Pinedale, Wyoming

Mean Annual Total Sulfur Deposition near Pinedale,



Data from NADP & CASTNet
NADP Pinedale station WY06
CASTNet Pinedale station PND165

The dimension for b_{ext} is 1/length (inverse length) and the coefficient is typically expressed as "inverse kilometers" (km^{-1}), or "inverse megameters" (Mm^{-1}), the reciprocal of 1 million meters.

Visibility impairment is frequently expressed in terms of deciview (dv). The deciview index was developed as a linear perceived visual change. Increasing deciview values represent proportionately larger perceived visibility impairments. A change in visibility of 1.0 dv represents a "just noticeable change" by the average person under most circumstances. However, when visibility conditions are very good, changes in visibility of 0.5 dv or less may be perceived The U.S. Forest Service (USFS) has identified specific "Level of Acceptable Change" (LAC) values that they use to evaluate potential air quality impacts within their wilderness areas (USDA-FS 1993). The USFS utilizes a visibility LAC threshold of 0.5 deciview.

Visibility related background data are collected as part of the Interagency Monitoring of PROtected Visual Environments (IMPROVE) program. The nearest IMPROVE site to the PRPA is located in the Bridger Wilderness area, and data have been collected at the site since 1988.

Table 3-10 summarizes the seasonal visibility conditions recorded at Bridger Wilderness between March 1996 and February 1999. As the data illustrate, visibility conditions at Bridger Wilderness are typically very good with an average annual standard visual range (SVR) of 109 miles (175 kilometers). Visibility conditions are typically best in the winter months with an average SVR of 136 miles, and haziest in the summer with an average SVR of 101 miles.

Figure 3-6 presents the annual 20% cleanest, 20% haziest, and the mid-range 40% to 60% visibility conditions monitored at Bridger Wilderness between 1988 and 2001 (IMPROVE 2003). The 20% cleanest days represent good visibility conditions that are equaled or exceeded 20% of the time. Conversely, the 20% haziest days represent visibility conditions that are equaled or exceeded 80% of the time. As shown, monitored visibility conditions at Bridger Wilderness have been stable over the period, neither improving nor degrading. However, potential for impairment to existing visibility in the Bridger and Fitzpatrick wilderness areas, as well as in more distant Class I and II areas, has been identified as an area of potential concern associated with oil and gas development in the region.

3.3 SOILS

3.3.1 Introduction

The climate of the PRPA is that of a semiarid windy desert. The annual precipitation ranges from about 7 to 14 inches (including snowfalls), and annual temperatures vary from about -30 degrees F during the winter months, to more than 100 degrees F in summer. Sage thickets are the dominant vegetation, and this is augmented along drainages by greasewood, bunchgrass, other grasses, cactus, rabbit brush, and wildflowers. Sandstone exposures in the higher elevations commonly support cedar, juniper, and pine cover, and are host to lichen.

The PRPA is typical of a desert intermontane synclinal basin in that its physiography is dominated by: (1) hogbacks and strike valleys; and (2) alluvial deposits along the principal drainages. Strath (bedrock) and gravel/conglomerate-capped terraces do not occur in the area. This absence may be due to the overall higher elevations in the PRPA and may reflect a higher degree of ongoing downcutting by streams.

Figure 3-5. Special Concern Lake

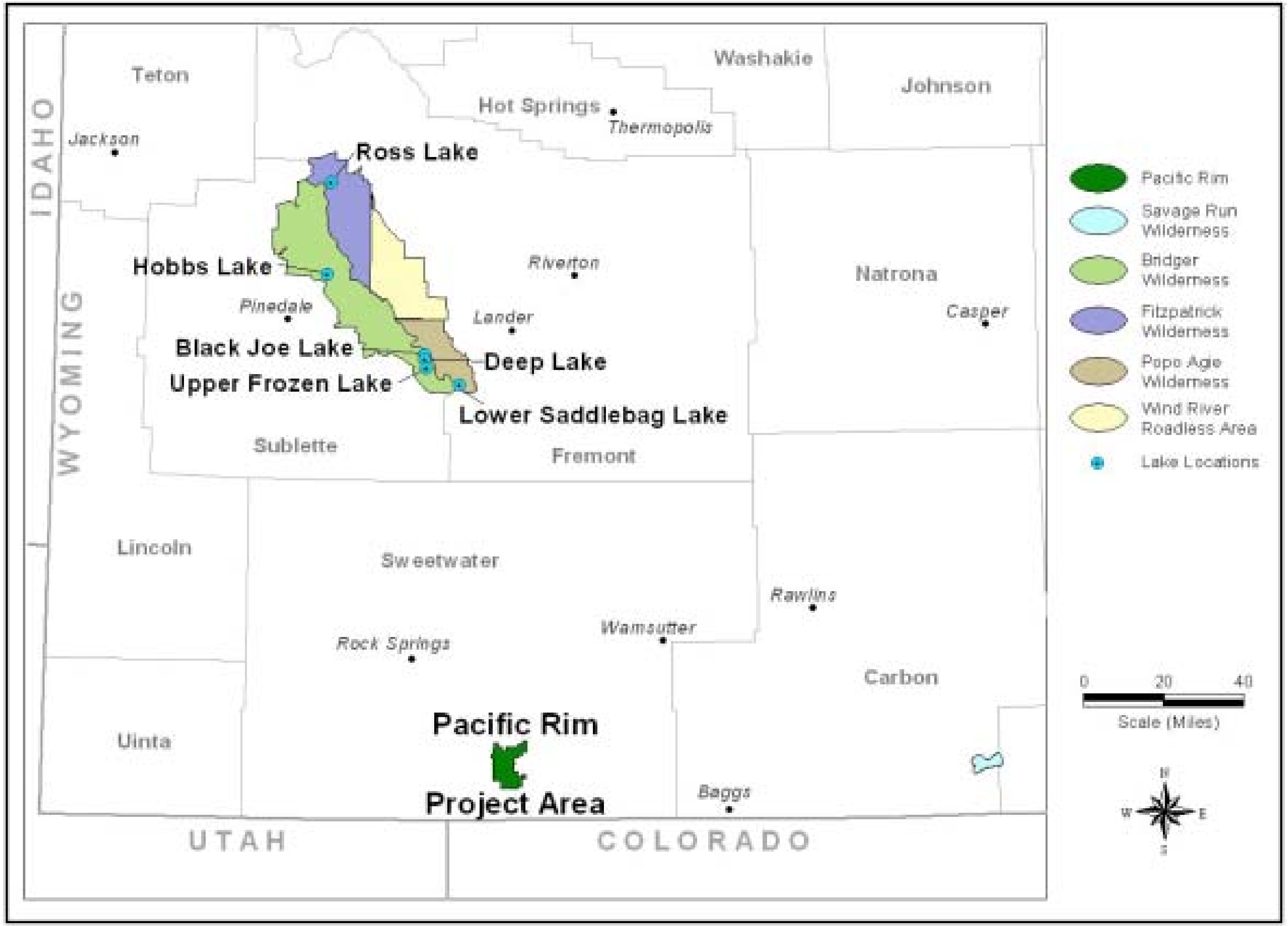


Table 3-10. Background Standard Visual Range for the Bridger Wilderness Area

Season	Standard Visual Range miles (kilometers)	Deciview (Unitless)
Annual	109 (175)	8.1
Spring	103 (165)	8.6
Summer	101 (162)	8.8
Autumn	105 (169)	8.4
Winter	136 (218)	5.9

Source: IMPROVE (2000). Data is aggregated over the three-year period between March 1996 and February 1999.

3.3.2 Topography

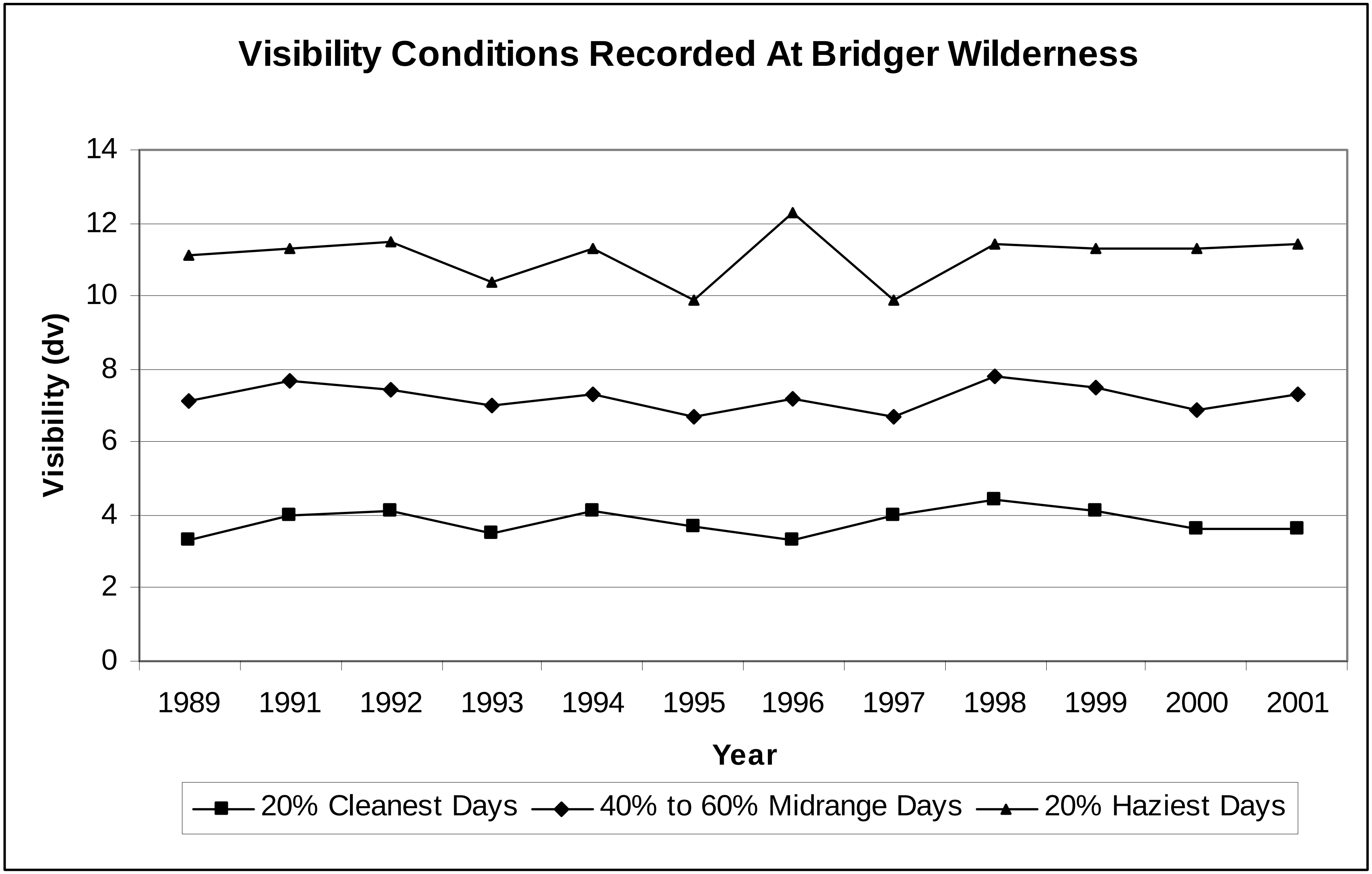
The topography within the PRPA varies from nearly flat alluvial bottom lands in and bordering the drainages of East Salt Wells Creek and Scheggs Draw to moderate to steep ridges and cliffs along Rifes Rim to the south and east. Steep terrain is also present in the central part of the area along the edges of thick fluvial sandstone channels preserved in the Fort Union and Wasatch Formations. South and east of Rifes Rim gently sloping and rolling terrain is developed in the Tipton and Wilkins Peak members of the Green River Formation Relief within the PRPA totals 954 feet. The highest elevation is 7,950 feet on the west side of Kinney Rim in the NE most corner of Section 8, T15N, R100W (Pine Butte Quadrangle). The lowest point (6,877 feet) lies in alluvium in the valley of East Salt Wells Creek, in the SW1/4 Section 18, T15N, R101W (Burley Draw Quadrangle).

Principal streams draining the PRPA include East Salt Wells Creek and Scheggs Draw, which drain northward, Alkali Creek and Granary Draw, as well as other unnamed upper tributaries of Vermillion Creek, which drains southward. All of these drainages, are ephemeral spring or runoff-fed streams that are actively down cutting into the alluvium of their floodplains and originate in areas chiefly underlain by easily weathered and eroded bedrock sandstone, shale, and mudstone. East Salt Wells Creek essentially bounds the western margin of the area and Rifes Rim forms the drainage divide between north draining and south draining streams.

3.3.3 General Soil Characteristics

Soil parent materials in the project area include: (1) thin sandstones and thicker shale sequences of the lacustrine Niland Tongue of the Green River Formation (middle Eocene); and (2) the largely fluvial and paludal (marshy) sandstones, mudstones, shales, and coals of the Paleocene Fort Union Formation and the Main Body of the lower Eocene Wasatch Formation. Slopewash debris and alluvium derived from these units also constitute parent materials for PRPA colluvial and alluvial soils, with the relative proportions of relatively sandy or clay-rich parent materials dependent on the dominant composition of local outcrop rocks. Small swatches of stabilized sand dunes also occur locally as loess hills in the east-central part of the project area, and the upper (A) horizons of nearly

Figure 3-6. Visibility Conditions Recorded at Bridger Wilderness



every soil--excluding Bedrock soils--were found to contain an appreciable percentage of fine sand of probable eolian (windblown) origin.

3.3.3.1 Geomorphic Setting, Soil Texture and Slope

In the absence of detailed baseline soils information, site-specific data was gathered from the field. Soils of the PRPA were grouped according to geomorphic setting and six broad soil categories are recognized. These include: (1) Bedrock; (2) Mixed Residual Colluvial Soils and Bedrock Soils; (3) Upland Slope Soils; (4) Upper Alluvial Bottomland Soils; (5) Lower Alluvial Bottomland Soils, and (6) Loess Soils (Figure 3-7).

Soil textures consist of sandy loams, sandy clay loams, clay loams, sandy loam, and sandy clays, and are best developed in Alluvial Bottomland Soils and Upland Slope SoilsCthe soils which occur in areas with minimal slope. Mixed Residual Colluvial Soils and Bedrock Soils are formed on steeper slopes and consist of slope washed parent materials, including angular blocks of sandstone and shale debris mantling their source rocks. Bedrock includes bare exposed rock outcrop, as well as areas lacking soil development. Bedrock exposures grade imperceptibly into Mixed Residual Colluival and Bedrock Soils.

3.3.3.2 Soil Depth

All soils in the PRPA are shallow (less than 24 inches in total thickness), their combined A (top) and B (subsurface) horizons measuring from only 7 to 23 inches in thickness. The thickest soils are the Loess Soils (23 inches) and the thinnest (excluding Mixed Residual Colluvial and Bedrock Soils) are the Upland Slope Soils (6-7.5 inches depth). In test pits Alluvial Bottomland Soils and Upland Slope Soils exhibit effective rooting into the top of the C (unweathered parent material) horizon.

3.3.3.3 Soil Permeability and Erosion Potential

The majority of soils in the PRPA are moderately permeable due to their mixed sand and clay compositions. In the more highly clay-rich subsurface parts of the soils, permeability is diminished. The surfaces of most of the soils are quite sandy and thereby show relatively rapid permeability; however, all of these soils will become less permeable upon compaction.

Alluvial (stream) and eolian (wind) erosion potential is a function of soil texture which, in turn, is related to degree of soil development on differing parent materials. Clay-rich soils or clay-rich soil horizons have relatively low erosion potential due to their low permeability but they are subject to surface collapse because of the high absorptive properties of the clay minerals which, when wetted and dried, form puffy surface crusts. Sand-rich soils are more easily eroded by both water and wind, especially in places where the vegetation cover is scant or absent.

The presence of small areas covered by Loess soils and the high percentage of eolian (wind-blown) sandCespecially prevalent in the Upland Slope SoilsCis indicative of both active erosion and deposition of soil materials by wind during the time of soil formation. However, appreciable wind erosion of soils in the project area is unlikely unless the natural vegetation cover is significantly reduced.

Stream erosion due to runoff, bank collapse, and piping is common in and near drainages with deeply incised channels, as seen in Alluvial Bottomland Soils. Shallow gullying was also seen on rutted dirt roads on which the ruts had penetrated the relatively permeable A (upper) horizon of the soil and had exposed the more impermeable clay-enriched B (subsurface) soil horizon. Deep gullying was only observed in Section 19, T14N, R101W, in an unnamed tributary of East Draw, near where it joins East Salt Well Creek. Here erosion has down cut more a gully exceeding 10 feet deep and a few feet to more than 10 feet wide.

Erosion may be accelerated by surface disturbance such as the blading off of vegetation and of the very shallow yet more permeable A horizons of the soils. However, because all soils in the PRPA are shallow (less than 24 inches, 60 cm depthCmaximum 18 inches, 45 cm), it is probable that most blading will completely remove the topsoil and expose bedrock. Exposed bedrock is generally less susceptible to erosion than are the soil veneers, but much of the Fort Union, Wasatch, and Green River formations are comprised of clay-rich mudstones and shales that become exceedingly muddy after even minimal rainfalls. Therefore, runoff potential is low on most of the area of undisturbed soils in the project area, but can be expected to increase to moderate/high with surface disturbance of soils. Exceptions are where soil slopes are relatively steep, or the soils are proximal to gullies.

3.3.4 Site Specific Soil Characterizations

Site specific field investigation of soils in the PRU were undertaken to determine soil characteristics such as horizonation, texture, color, permeability, and topographic distribution. The five soil types distinguished during this study include: (1) Alluvial Bottomland Soils; (2) Upland Slope Soils; (3) Residual Colluvial Soils; (4) Stabilized Sand Dunes; and (5) Outcrop.

Erosional dissection has resulted in a profound ridgeline hogback and steep-sloping strike valley topography. ***Bedrock Soils*** are simply exposures of relatively unaltered bedrock of the Fort Union, Wasatch, and Green River formations. These thin soils grade imperceptibly into ***Residual Colluvial Soils*** commonly surround exposures of Bedrock Soils, and represent Bedrock that has been deeply weathered or broken up and dislodged by gravity, or both, from *in situ* rock. For the purposes of soil mapping, several large areas of Bedrock Soils are readily identifiable; however in many areas it is impossible to separate tracts of Bedrock Soils from those of Residual Colluvial Soils without extensive and detailed. For this reason, tracts of undifferentiated Residual Colluvial Soils and Bedrock Soils were mapped as ***Residual/Bedrock Soils***. ***Upland Slope Soils*** occur on relatively gently sloping surfaces and the uppermost parts of strike valleys. Soils on alluvium in the tributary drainages of the principal local stream (East Salt Wells Creek) are identified as ***Upper Alluvial Bottomland Soils***, and soils on alluvium in the valley of East Salt Wells Creek are identified as ***Lower Alluvial Bottomland Soils***. The Lower Alluvial Bottomland Soils formed on unconsolidated parent materials derived from the mixture of sediments from the tributary drainages to East Salt Wells Creek, and are commonly typified by a considerable thickness (in places exceeding 20 feet) of superposed soils. In contrast, the parent materials of the Upper Alluvial Bottomland Soils have a more restricted (more localized) origin. ***Loess Soils*** (**LS** on map) are developed on restricted areas of sand dunes that have been stabilized by vegetation.

1. *Bedrock Soils (BR)*

> *Unweathered to only slightly weathered* in situ *bedrock, including sandstones, mudstones, shales, thin limestones, carbonaceous shales, and coals of Fort Union, Wasatch, and Green River Formations. These soils occur at elevations of 6,970 to 8,040 feet, and on gradients of 0-16% slope. No sites were analyzed.*

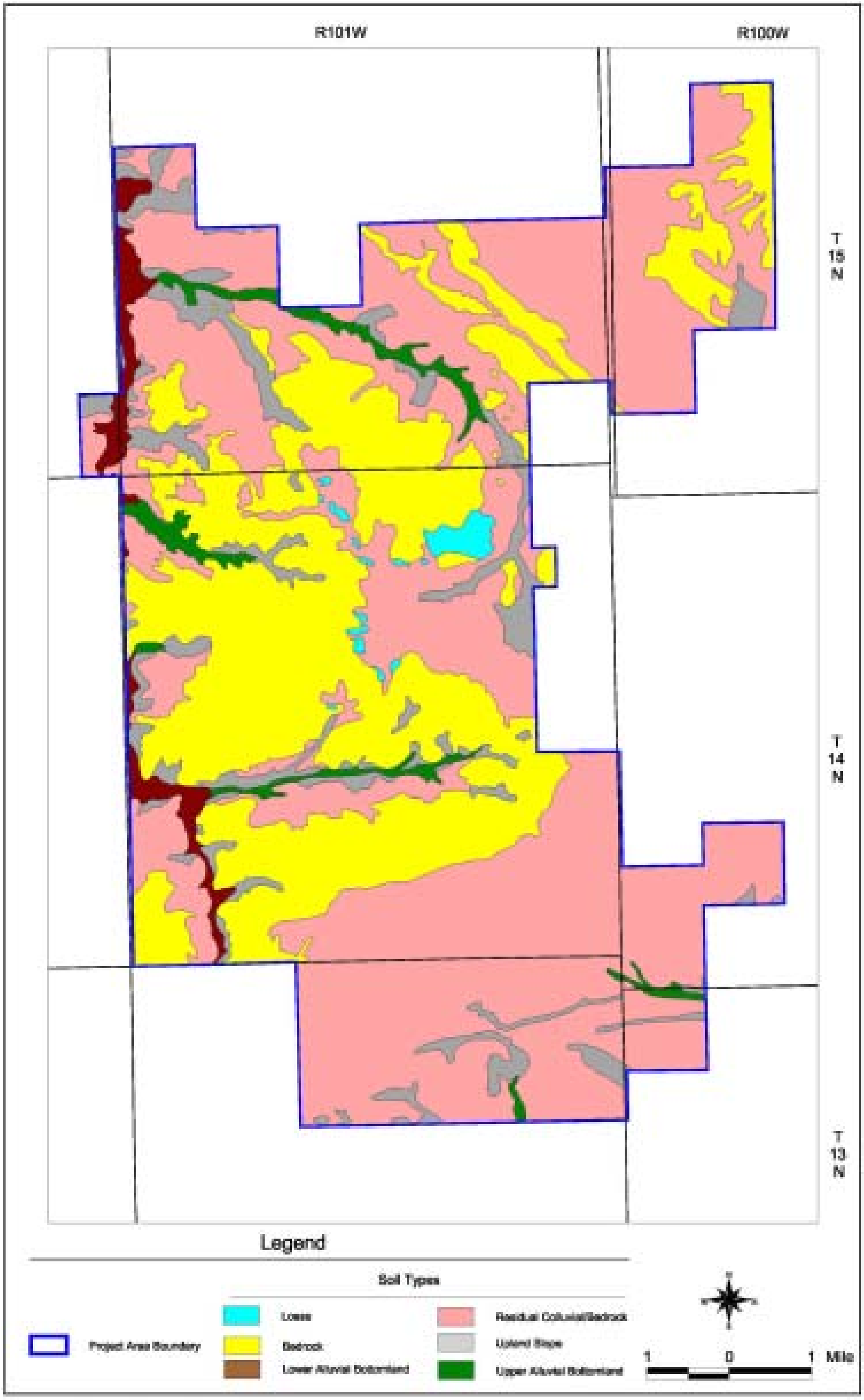


Figure 3-7. Soil Types in the PRPA.

2. *Mixed Residual Colluvial Soils and Bedrock Soils (R/BR)*

Residual Colluvial component of these soils consists of shallow soils on gentle to relatively steep slopes (0-7%), generally poorly-drained and occurring at elevations of 6,900 to,7,820 feet. Residual Colluvial Soils range from "popcorn"-like crusts on mudstones and powdering of shales to slope accumulations of brecciated sandstone fragments ranging from pebble to boulder in size. Most of these soils, however, occur as thin zones of weathered, dislodged, or partially disaggregated bedrock.

<u>SITE PR-4</u>

UTM Zone 12: 687770E, 4555856N; Erickson-Kent Ranch Quadrangle
SLOPE: 0-1%
ELEVATION: 7,460 feet
PARENT MATERIAL: Shale in Niland Tongue of Wasatch Formation
PHYSIOGRAPHY: Top of hogback
SOIL THICKNESS: 18 cm

A = Clay loam, highly calcareous, 10YR6/3 (pale brown); pH = 7.0; 6 cm; Completely unconsolidated flaky sediment with shale chips as residual lag on surface; some admixture of aeolian sand

Bw = Sandy Clay Loam, very calcareous, 10YR5/4 (yellowish-brown); PH = 7.9; 12 cm

C = Weathered Shale

3. Upland Slope Soils (US)

Shallow to moderately deep soils on gentle to moderate (0-5%) slopes, very permeable and well-drained. Calcareous, generally base-neutral loamy sands, sandy loams, and sandy clay loams developed on sloping surfaces of the Fort Union, Wasatch and Green River formations at elevations of 6,875 to 7,450 feet.

<u>SITE PR-3</u>

UTM Zone 12: 683084E, 4563272N; Erickson-Kent Ranch Quadrangle
SLOPE: 2-5%
ELEVATION: 7,150 feet
PARENT MATERIAL: Sandstones and mudstones of Fort Union Formation
PHYSIOGRAPHY: Slope at head of draw
SOIL THICKNESS: 41+ cm

A = Sandy Loam, moderately calcareous, 10YR6/1 (gray); pH = 7.5;
8 cm. Granular texture, some fine aeolian sand

Bw = Loamy Sand, moderately calcareous, 10YR5/2 (grayish-brown);
PH = 7.6; 23 cm

Btk = Sandy Loam, very calcareous, 10Y5/3 (brown); pH = 7.6; 10+ cm.
$CaCO_3$ pisoliths

4. Upper Alluvial Bottomland Soils (UA)

Relatively shallow soils on gentle (0-2.5%) slopes, generally poorly drained to moderately permeable, moderately calcareous to very calcareous, base neutral sandy clay loams and sandy clay developed on alluvium of tributary streams at elevations of 6,890 to 7,300 feet.

SITE PR-1

UTM Zone 12: 688398E, 4567520N; Erickson-Kent Ranch Quadrangle
SLOPE: 0-2%
ELEVATION: 7,150 feet
PARENT MATERIAL: Mixed Alluvium, moderately permeable
PHYSIOGRAPHY: Tributary drainage to East Salt Wells Creek
SOIL THICKNESS: 35+ cm

A = Sandy Clay Loam, very calcareous, 2.5Y7/2 (light gray); pH = 7.2; 7 cm. Probably largely eolian

Bt = Sandy Clay, very calcareous, 2.5Y6/3 (light yellowish-brown); pH = 7.2; 18 cm

Bt2K = Sandy Clay, highly calcareous, 2.5Y6/2 (light brownish-gray); pH = 7.5; 10+ cm

5. Lower Alluvial Bottomland Soils (LA)

Shallow to moderately deep multiple soils lying on gentle (0-1%) slopes, permeable at surface but drain poorly at depth. Moderately calcareous to very calcareous base neutral sandy clays, sandy clay loams, and clay loams developed on thick alluvium of principal ephemeral stream at elevations of 6,877 to 7,340 feet.

SITE PR-2

UTM Zone 12: 683084E, 4563272N; Erickson-Kent Ranch Quadrangle
SLOPE: 0-1%
ELEVATION: 6,895 feet
PARENT MATERIAL: Mixed alluvium from contributory tributary drainages
PHYSIOGRAPHY: Low-lying alluvial bottomland
SOIL THICKNESS: 55+ cm

A = Sandy Clay Loam, very calcareous, 2.5Y7/3 (pale yellow); pH = 7.5; 5 cm

Bw = Sandy Clay Loam, moderately calcareous, 2.5Y6/3 (light yellowish -brown); pH = 7.6; 20 cm

Btk = Clay Loam, highly calcareous, 2.5Y6/3 (light yellowish-brown); pH = 7.5; 30+ cm. Tiny $CaCO_3$ pisoliths, rooted to base of profile

6. Loess Soils (LS)

Multiple soils of moderate thickness on gentle to moderate (1-5%) slopes. Well-drained and highly permeable with low runoff potential; noncalcareous, pH neutral fine sands, loamy sands, and sandy *loams developed on vegetation-stabilized sand dunes at elevations of 7,000 to 7,650 feet. Buried horizons of older loess soils evident in a few localities.*

SITE PR-5

UTM Zone 12: 688275E, 4565048N; Erickson-Kent Ranch Quadrangle
SLOPE: 3%
ELEVATION: 7,420 feet
PARENT MATERIAL: Aeolian Sand
PHYSIOGRAPHY: Atop beveled hogback ridge of Main Body of Wasatch Formation
SOIL THICKNESS: 58+ cm

A = Fine Sand, noncalcareous, 10YR4/4 (dark yellowish-brown); pH = 7.5; 6 cm

Bt = Loamy Sand, noncalcareous, 10YR3/4 (dark yellowish-brown); pH = 7.5; 32 cm

Bt2 = Sandy Loam, noncalcareous, 10YR4/4 (dark yellowish-brown); pH = 7.6; 20+ cm

3.3.5 Biological Crusts

Vegetation cover in the arid and semi-arid lands comprising the PRPA is sparse in many places; however in open spaces between higher plants, the soil surface may not be as barren as it appears. Instead of being barren these areas may be covered by a community of highly specialized organisms known as biological soil crusts, or cryptogamic, cryptobiotic, microbiotic, or microphytic soil crusts.

Biological soil crusts are a complex mosaic of cyanobacteria, green algae, lichens, mosses, microfungi, and other bacteria. Soil crusts are concentrated in the top 1/8 inch of the ground surface, they primarily affect processes that occur at the soil surface or soil-air interface, including soil stability, erosion potential, atmospheric N-fixation, nutrient contributions to plants, soil-plant-water relations, infiltration, seeding germination, and plant growth. Crusts are well adapted to severe growing conditions, but poorly adapted to compressional disturbances such as trampling by humans and livestock, wild horses, wildlife, or vehicles driving off roads. Disruption of the crusts decreases organism diversity, soil nutrients, stability, and organic matter (Belnap et al. 2001).

Baseline studies of the presence, extent, and development of biological soil crusts are lacking for most rangelands in Wyoming, including the PRPA. In areas like the PRPA that have been heavily grazed by wild and domestic animals, as well as being subject to strong winds, and other disruption biological crusts may be restricted to protected areas such as under heavy vegetation and other inaccessible areas.

3.4 Water Resources

Water resources in the project area include both surface water and groundwater. Surface water resources include numerous ephemeral streams and a few shallow ponds that are both natural and man-made. The project area lies within the Salt Wells Creek and Vermillion Creek watersheds. Salt Wells Creek, an intermittent stream, is a major tributary to Bitter Creek, also an intermittent stream and a major tributary to the Green River in the Colorado River watershed. Vermillion Creek, a perennial stream, is also a major tributary to the Green River in the Colorado River watershed. Headwaters of ephemeral tributaries of Salt Wells Creek and Vermillion Creek originate in the project area. No naturally occurring seeps and springs have been identified within the project area. Groundwater resources include free water contained within relatively shallow aquifers that are or could be used for domestic, agricultural, and/or industrial purposes. The occurrence and distribution of water resources in the project area are largely dependent on climate, soils, and structural geology.

3.4.1 Precipitation and Climate

Climatological data from the Rocks Springs Airport (Station No. 487845, 1948-2003) and Bitter Creek 4 NE (Station No. 480761, 1962-2003) weather stations are most relevant to the characterization of water resources in the project area. The Rock Springs Airport, a comprehensive recording weather station, is located approximately 25 miles to the northwest at an elevation of 6,741 feet. Complete meteorological measurements are also recorded at the Bitter Creek station, located approximately 25 miles to the northeast at an elevation of 6,693 feet.

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), and generally has cold temperatures where fewer than eight months of the year have an average temperature greater than 50° degrees Fahrenheit (°F) with hot summer days and cool summer nights, but bitterly cold winters.

Temperature. The average annual temperature is 42.8°F at the Rock Springs Airport and 41.5°F at Bitter Creek. At the Rock Springs Airport, the average monthly low and high temperatures for January are 11.3°F and 29.1°F, respectively. At Bitter Creek, the average monthly low and high temperatures for January are 7.7°F and 32.2°F, respectively. In contrast, the average monthly low and high temperatures for July at the Rock Springs Airport are 53.2°F and 83.1°F, respectively, and at Bitter Creek the average monthly low and high temperatures for July are 46.7°F and 84.1°F, respectively. At the Rock Springs Airport, the average number of days per year with a minimum temperature at or below 32°F is 196.2, and the average number of days per year with a maximum temperature at or above 90°F is 5.7. At Bitter Creek, the average number of days per year with a minimum temperature at or below 32°F is 226, and the average number of days per year with a maximum temperature at or above 90°F is 6.8 (WRCC 2003).

Precipitation. Mean annual precipitation is expected to range from approximately six to nine inches in the project area, with the Rocks Springs Airport and Bitter Creek and stations having an annual average of 8.86 inches and 6.30 inches, respectively. Precipitation is somewhat evenly distributed throughout the year with a peak in May. At the Rock Springs Airport, the average monthly precipitation for the month of May is 1.21 inches. At Bitter Creek, the average monthly precipitation for the month of May is 1.09 inches (WRCC 2003). The majority of precipitation falls as rain from frontal systems and thunderstorms. In regard to intensity of rainfall events, the 50-year, 24-hour precipitation rate is 2.4 inches (Miller et al. 1973). Mean snowfall depth for the year is greater at the Rock Springs Airport (about 45 inches) than further east at Bitter Creek (about 19 inches). The greatest snowfall occurs in December and January at these two weather stations (WRCC 2003). Due to the effect of ablation and snow drifting, a discontinuous snow cover is usually present during the winter.

Other Climate Characteristics. Mean annual evaporation ranges from 50 inches (lake) to 70 inches (pan) and annual potential evapotranspiration is roughly 21 inches (Martner 1986). Compared to the mean annual precipitation of eight inches, this gives a mean annual water balance deficit of approximately 13 inches. The project area is subject to strong, gusty winds. Comprehensive wind measurements are collected at the Rock Springs Airport. The prevailing wind is from the west and southwest at an average of about 12 miles per hour. Violent weather is relatively common in the area; thunderstorms occur an average of 30 days per year and hail an average of three days per year. These meteorological and climatological characteristics of the project area combine to produce a predominantly dry, cool, and windy climate punctuated by quick, intense precipitation events.

3.4.2 Surface Water

3.4.2.1 Surface Water Quantity

Surface water is relatively rare or infrequent within the project area. As shown in Figure 3-8, numerous ephemeral stream channels, both named and unnamed, occur within the project area. Typically under this flow regime, streamflow will last for only a brief period of time following a runoff-producing snowmelt or precipitation event. The project area falls within the Bitter Creek drainage basin (USGS Basin #14040105) and Vermillion Creek drainage basin (USGS Basin #14040109). Bitter Creek is considered an intermittent stream that carries water most of the time over most of its course, although there are periods of no flow, especially during fall and winter. Most flow occurs in the spring during snowmelt or after storm events. The Bitter Creek watershed (approximately 2,200 square miles) discharges into the Green River near the town of Green River, Wyoming. Vermillion Creek flows south out of Wyoming into Colorado and is considered a perennial stream that carries water continuously throughout its course. The Vermillion Creek watershed (approximately 1,000 square miles) discharges into the Green River near the Gates of Lodore, Colorado. The Green River flows into the Colorado River, which ultimately flows to the Pacific Ocean.

The project area is drained primarily by East Salt Wells Creek (approximately 175 square miles), an ephemeral tributary of Salt Wells Creek (approximately 525 square miles), which is a sub-watershed of Bitter Creek. Salt Wells Creek is predominantly an intermittent stream. Alkali Creek and its tributaries Chicken Creek and Granary Draw drain the eastern edge of the project area, while some unnamed ephemeral tributaries of North Fork Vermillion Creek drain the southern portion of the project area. Alkali Creek (approximately 115 square miles) and North Fork Vermillion Creek (approximately 83 square miles) combine to form Vermillion Creek (Figure 3-8). Alkali Creek and all its tributaries are considered ephemeral streams, while North Fork Vermillion Creek is considered a perennial stream. Numerous springs located in the headwaters area of North Fork Vermillion Creek and its tributary, Coyote Creek, as well as appreciable snow accumulation in these headwater areas, which are in excess of 7,000 feet, account for a significant contribution to North Fork Vermillion Creek's annual runoff. There are no internally drained areas in the project area.

Some shallow, small ponds or reservoirs exist along a few of the ephemeral drainages within the project area. These ponds (shown on Figure 3-8) were constructed to contain surface runoff to be used for livestock watering. Water levels in these ephemeral ponds are erratic and typically fluctuate in response to the frequency of runoff events. Numerous small springs have been identified within the North Fork of Vermillion Creek watershed (shown on Figure 3-8), particularly near the headwaters area of the stream's main stem and its tributary, Coyote Creek. No flowing wells or springs have been identified to contribute flow within any of the ephemeral stream channels in the project area.

Flow within the stream channels in the project area correlates directly with precipitation; surface runoff occurs during spring and early summer as a result of snowmelt and rainfall (Lowham et al. 1985). Based on the peak flow records from the USGS's crest gage station 09216560 (located on Bitter Creek near Point of Rocks, Wyoming), the most probable month for peak runoff is April (BBCC 1998). Streams in the project area receive little to no support from groundwater discharge to sustain flow; consequently, there are extended periods of time when stream channels are dry. Active stream channels in the project area exhibit ephemeral flow only during snowmelt and high-intensity, short-duration summer thunderstorms. Rainstorm runoff can cause large peak flows, although the duration of flow from rainfall is relatively short in comparison to snowmelt runoff. Because precipitation varies from year to year, runoff volumes vary as well.

Within the general vicinity of the project area, runoff frequency may be insufficient to maintain active stream channels. Most of the small, lower-order stream channels that are identified on 7.5-minute USGS topographic maps are more accurately described as vegetated swales and lack active channels. Specific stream courses may grade between active channels and vegetated swales along their length. Similarly, some of the larger, higher-order streams such as Salt Wells Creek may exhibit intermittent flow in one section of the channel and ephemeral flow in another section.

No USGS surface water gaging stations are located within the project area. The closest streamflow gaging stations are located on Vermillion Creek, Salt Wells Creek, Big Flat Draw (an ephemeral tributary of East Salt Wells Creek), and Bitter Creek. Historical streamflow data recorded on these streams (USGS 2003) are as follow:

- USGS Station 09235300, Vermillion Creek near Hiawatha, Colorado, was maintained from 1975 through 1981. This site was located immediately downstream of the confluence between Alkali Creek and North Fork of Vermillion Creek, and roughly one mile north of the Wyoming-Colorado border. The mean daily streamflow values for the entire data record at this location range from 0.45 cubic feet per second (cfs) (in September) to 31.9 cfs (in April). The mean annual streamflow recorded at this location ranged from 1.88 cfs (in 1978) to 7.12 cfs (in 1980). Instantaneous peak discharges recorded at this site ranged from 458 cfs (in 1979) to 602 cfs (in 1981).

- USGS Station 09216750, Salt Wells Creek near Salt Wells, Wyoming, was maintained from 1975 through 1981. This site was located immediately upstream of Salt Wells Creek's confluence with Bitter Creek. The mean annual flow recorded at this location ranged from 1.99 cfs (in 1978) to 8.10 cfs (in 1980). Instantaneous peak discharges at this site ranged from 87 cfs (in 1978) to 1,650 cfs (in 1976). For the five years of record obtained at this site, the average runoff for Salt Wells Creek was about 2,000 to 3,000 acre-feet per year (Lowham et al. 1982).

- The USGS maintained crest-stage gages at Station 09216700, Salt Wells Creek near Rock Springs, Wyoming, from 1959 through 1976. This site was located roughly 10 miles upstream of Station 09216750. Instantaneous peak discharges at this site ranged from 75 cfs (in 1961) to 3,750 cfs (in 1962). A review of the weather records for the area indicates that the 1962 flood event resulted from a rain on snow pack (Lowham et al. 1982).

- USGS Station 09216565, Salt Wells Creek near South Baxter, Wyoming, was maintained from 1976 through 1981. This site was located more that 11 miles upstream of East Salt Wells Creek's confluence with Salt Wells Creek. Streamflow records indicate that the reach of Salt Wells Creek near this site appeared to be intermittent. Like the North Fork of Vermillion Creek, numerous springs contribute low flows from groundwater inflows; however, evapotranspiration, freeze up, and seepage deplete these flow so that downstream, the stream has only intermittent flows (Lowham et al. 1982). Instantaneous peak discharges at this site ranged from 13 cfs (in 1979) to 42 cfs (in 1981). The mean annual flow recorded at this location ranged from 0.55 cfs (in 1977) to 2.26 cfs (in 1980).

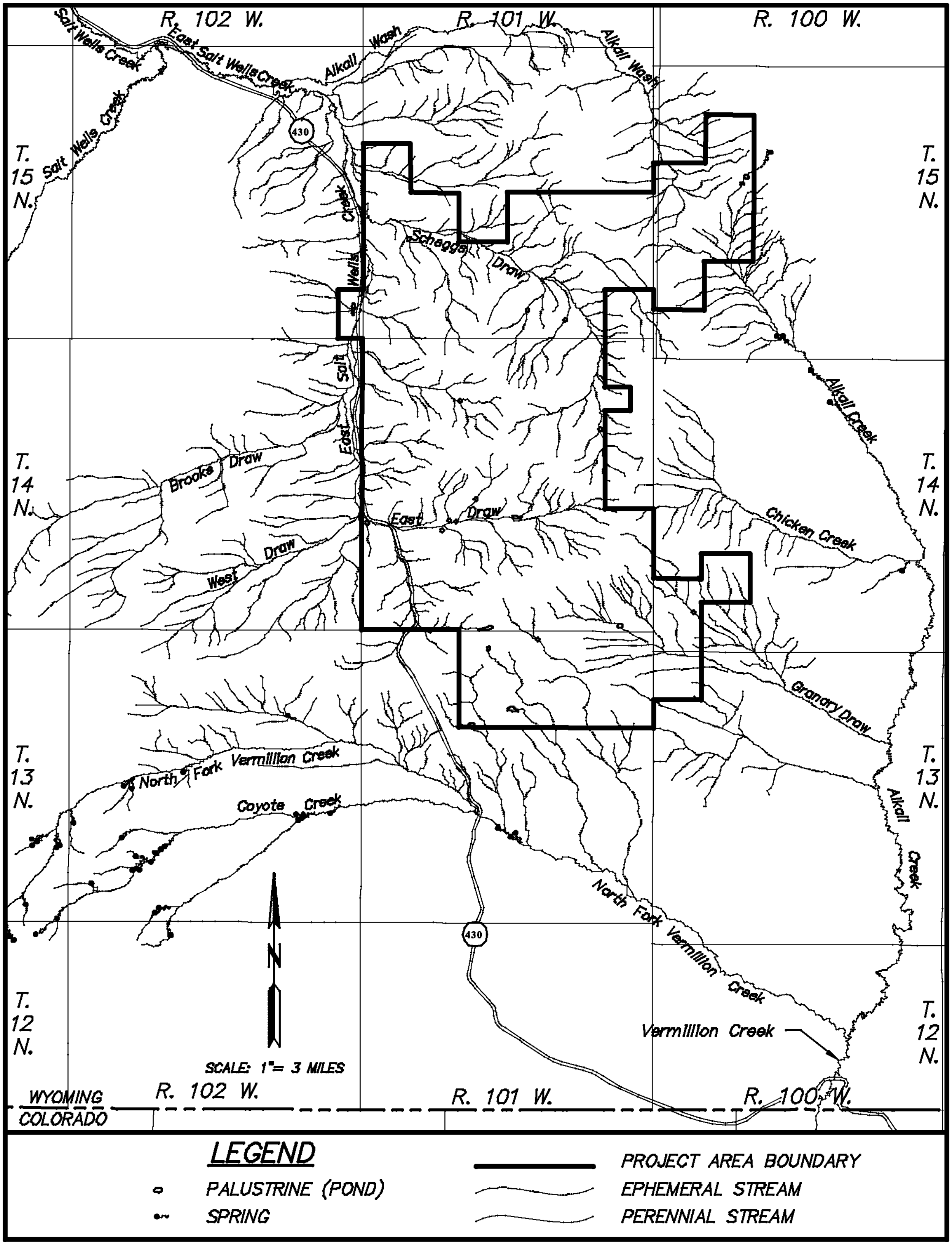

R. 102 W.
R. 101 W.
R. 100 W.
T. 15 N.
T. 14 N.
T. 13 N.
T. 12 N.
Salt Wells Creek
East Salt Wells Creek
Alkali Wash
Salt Wells Creek
Scheggs Draw
East Salt Wells Creek
Alkali Creek
Brooks Draw
East Draw
West Draw
Chicken Creek
Granary Draw
North Fork Vermillion Creek
Coyote Creek
Alkali Creek
North Fork Vermillion Creek
Vermillion Creek
430
N
SCALE: 1"= 3 MILES
WYOMING
COLORADO
LEGEND
PALUSTRINE (POND)
SPRING
PROJECT AREA BOUNDARY
EPHEMERAL STREAM
PERENNIAL STREAM

Figure 3-8. Surface Water Features in the PRPA.

- The USGS maintained crest stage gages at Station 09216580, (Big Flat Draw near Rock Springs, Wyoming) from 1973 through 1981. Instantaneous peak discharges at this site, located at the mouth of Big Flat Draw, ranged from 11 cfs (recorded September 10, 1975) to 217 cfs (recorded August 19, 1979). Big Flat Draw has a drainage area of approximately 20 square miles. No portion of the Big Flat Draw watershed overlaps the project area, although its streamflow records represent the nature of flood runoff events resulting from rainstorms in the general area.

- USGS Station 09216562, Bitter Creek above Salt Wells Creek near Salt Wells, Wyoming, was maintained from 1975 through 1981. The mean annual streamflow recorded at this location on Bitter Creek, which was immediately upstream of the Salt Wells Creek confluence, ranged from 3.6 cfs (in 1978) to 15.7 cfs (in 1980). Instantaneous peak discharges at this site ranged from 280 cfs (in 1980) to 888 cfs (in 1979).

Given the arid climate of the project area and the lack of well-established active channels, mean annual runoff (or watershed yield) is relatively low at less than 0.5 inch per year, or about 2.5 percent of the total annual precipitation (Wyoming Water Research Center 1990).

Runoff estimates prepared for the Bitter Creek watershed by the Black Butte Coal Company (BBCC 1998), which is located approximately 15 miles north of the project area, indicate that the annual runoff from the Bitter Creek watershed will average between 4,000 and 8,000 acre-feet, which results in a unit runoff of 1.8 to 3.6 acre-feet per square mile.

Based upon a recent (December 2003) review of the Wyoming State Engineer's Office (SEO) records, there are currently 10 active surface water rights in the project area. Eight of these water rights are reservoirs and permitted for livestock use. Two other surface water rights exist within the project area, although they are temporary rights to use surface water hauled from Salt Wells Creek for oil and gas drilling.

3.4.2.2 Surface Water Quality

There are no established surface water quality sampling stations located within the project area, although the surface water quality in the Green River drainage basin, in general, is addressed in several reports published by the USGS (i.e., DeLong 1977, DeLong and Wells 1988, Ringen 1984). A report published by the USGS on the hydrology of Salt Wells Creek (Lowham et al. 1982) provides surface water quality information that is more specific to the project area. Dissolved solids, suspended sediments, and salinity are the constituents that are primarily evaluated, as they are typically indicators for the evaluation of water for various uses. These reports also relate streamflow discharge to these constituents. In addition, the USGS and USDI-BLM have collected numerous miscellaneous surface water quality samples in the Bitter Creek and Vermillion Creek watersheds outside of the Pacific Rim project area that will also be discussed.

Surface water quality in semiarid regions varies seasonally and is dependent on the magnitude and frequency of discharge events, although the dissolved solids concentration typically increases in the downstream direction. During periods of little to no precipitation, evaporation and capillary action produce a salt residue on the surfaces of bedrock, soils, and channel deposits. Runoff from rainfall and snowmelt then periodically flushes the accumulated salts downstream. During high-intensity thunderstorm events, the dissolved solids concentration increases rapidly during the early period of runoff, but then will decrease after the initial flushing of salts has taken place. During less intense, low-flow events, the dissolved solids concentration generally increases in the downstream reaches. In streams where base flows are responsible for a very small part of overall streamflow, flushing of salts by floods appear to be the major mechanism by which dissolved solids are transported from the basin. The flushing action is a process that affects the quality of plains streams of southwestern Wyoming (Lowham et al. 1982). In less arid areas, less evaporation and more frequent flushing of accumulated salts would generally result in lower dissolved solids concentrations throughout the year.

Due to the erosive nature of the area, relatively high-suspended sediment concentrations are expected, particularly during high flow events. Ephemeral streams in the area also commonly exhibit very high suspended sediment concentrations during the first flows of a flood wave, apparently the result of a flushing action similar to the flushing of salts. During periods of several months or more without flow, basin surfaces and stream channels accumulate loose material due to weathering, wildlife and livestock movements, bank caving, and wind deposits. These loose materials are then readily picked up and transported (flushed) by the turbulent first flows of a floodwave. Once the initial flush has occurred, the amount of sediment transported is dependent upon supply (erosion) and magnitude of discharge (Lowham et al. 1982).

Although the amount of runoff from small ephemeral streams may be small in relation to that of the larger receiving streams (i.e., Salt Wells and Bitter Creeks), the flushing process results in relatively large concentrations of dissolved and suspended materials that may constitute a shock load to receiving streams, particularly during low flow summer months. Runoff from arid and semiarid plains areas can therefore have a significant affect on the water quality of the perennial streams (i.e., Green River) receiving such runoff (Lowham et al. 1982).

The USGS (Lowham et al. 1982) reported increasing dissolved solids concentrations in the downstream direction are typical of Salt Wells Creek during runoff events. Total dissolved solids (TDS) concentrations in the headwaters, where there are numerous small springs that contribute perennial groundwater inflow, are typically less than 100 milligrams per liter (mg/L), whereas TDS concentrations downstream at USGS Station 09216750 (Salt Wells Creek near Salt Wells, Wyoming) commonly exceed 3,000 mg/L. Concentrations of the major dissolved inorganic constituents in Salt Wells Creek, with the exception of bicarbonate and carbonate, increase in the downstream direction.

Lowham et al. (1982) reported large concentrations (sometimes exceeding 100,000 mg/L) of total suspended solids (TSS), or sediment, result from the flushing phenomena in Salt Wells Creek. After the initial flush, TSS concentrations generally increase with increasing discharge. Flows in the late summer and early autumn tend to have high amounts of dissolved and suspended solids, evidence of the erosiveness of the system. Winter and early spring flows tend to have low sediment loads, as runoff often occurs over ice and snow (BBCC 1998).

The water quality of Bitter Creek was monitored by the USGS at Station 09216562 (Bitter Creek above Salt Wells Creek Near Salt Wells, Wyoming) from 1975 through 1981 (USGS 2003). Streamflow recorded at this site was discussed previously in the Surface Water Quantity section. At site 09216562, the pH ranged from 7.6 to 8.8, while both the average and median pH values were 8.3. The TDS concentration ranged from 530 to 12,300 mg/L, the average concentration was 3,527 mg/L, and the median concentration was 2,860 mg/L. The TSS concentration ranged from 22 to 51,800 mg/L, the average concentration was 5,074 mg/L, and the median concentration was 635 mg/L.

The USGS collected miscellaneous TSS samples at Station 09216580, Big Flat Draw near Rock Springs, Wyoming, in 1976 and 1977. A range of instantaneous peak discharges recorded at this site from 1973 to 1981 is presented in the Surface Water Quantity section. The TSS concentrations ranged from 1,050 mg/L to 147,000 mg/L. Big Flat Draw streamflow recorded at the time these samples were collected was 0.05 cfs and 28 cfs, respectively.

Western Wyoming College collected a grab sample from East Salt Wells Creek at a location just upstream of the Salt Wells Creek confluence in August 1976 (WRDS 2003). The streamflow was 12 cfs, the pH was 7.8, the TDS concentration was 414 mg/L, and the TSS concentration was not analyzed.

The USGS and USDI-BLM collected numerous miscellaneous grab samples within the Vermillion Creek watershed in the mid- to late-1970s, particularly in the headwaters area where streamflow is more consistent throughout the year due to the presence of numerous small springs contributing groundwater inflow. As depicted in Figure 3-8, no springs are identified within the Vermillion Creek watershed that drains the project area. None of these miscellaneous surface water quality grab samples were collected from within the project area. In addition, none of these grab samples were collected during high flow or flood events, but rather, were collected during low or base flow periods.

Like Salt Wells Creek, increasing TDS concentrations in the downstream direction are typical of North Fork Vermillion Creek. TDS concentrations of grab samples collected from North Fork Vermillion Creek and its tributaries at numerous locations upstream of the WYO 430 bridge (Figure 3-8) were relatively low, typically ranging from around 100 to 500 mg/L, while the TDS concentration of samples collected downstream of the highway crossing were somewhat higher, generally ranging from 500 to 1,000 mg/L. The streams' discharge, measured at the time these grab samples were collected, was usually less than 1.0 cfs. The pH was typically between 8.0 and 9.0, and the TSS concentration was generally no greater than 500 mg/l (USGS 2003, WRDS 2003).

Only one surface water quality sample is recorded as having been collected from Alkali Creek. The USGS collected a single grab sample in March 1978 just upstream of Alkali Creek's confluence with North Fork Vermillion Creek. The discharge was measured at 0.26 cfs, the field pH was 8.2, the TDS concentration was 3,060 mg/L, and the TSS concentration was 359 mg/L (WRDS 2003).

The water quality of Vermillion Creek was monitored by the USGS at Station 09235300 (Vermillion Creek near Hiawatha, Colorado) from 1975 through 1981 (USGS 2003). As discussed in the Surface Water Quantity section, Station 09235300 was located immediately downstream of the Alkali Creek and North Fork of Vermillion Creek confluence, and streamflow was also monitored continuously at that station during that same time period. The pH ranged from 7.6 to 8.8, while both the average and median pH values were 8.3. The TDS concentration ranged from 185 to 2,560 mg/L, the average concentration was 1,226 mg/L, and the median concentration was 1,130 mg/L. The TSS concentration ranged from 9 to 13,200 mg/L, the average concentration was 1,238 mg/L, and the median concentration was 256 mg/L.

No other site-specific data are available. In general, the data that are currently available suggest that surface water quality in the project area is not suitable for domestic uses and is marginally suitable for agricultural and industrial uses, although it should be suitable for wildlife and livestock watering. Surface water, when present in the project area, is expected to be of relatively poor quality due primarily to high dissolved solids, suspended sediment, and turbidity.

Point pollution sources have not been documented in the project area, and if they have occurred, they were probably accidental and of limited areal extent and of short duration. The primary non-point pollution source is natural erosion of geologic units, which are easily eroded. Grazing, oil and gas development, and poor road construction may further increase the high erosion rates described in the Soils Section (USDI-BLM 1999).
The Wyoming Department of Environmental Quality (WDEQ 2000) classifies Wyoming surface water resources according to quality and degree of protection. Four classes have been identified as follows:

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.

Class 2. Those surface waters other than Class 1 determined to be presently supporting game fish or drinking water supplies or where these uses are attainable.

Class 3. Those surface waters, other than those classified as Class 1, that because of natural habitat conditions, do not support nor have the potential to support fish populations or spawning. Class 3 waters provide support for invertebrates, amphibians or other flora and fauna that inhabit water at some stage of their life cycles. Generally, Class 3 waters have wetland characteristics, which are a primary indicator used in identifying Class 3 waters.

Class 4. Those surface waters, other than those classified as Class 1, where it has been determined that aquatic life uses are not attainable.

East Salt Wells Creek and Alkali Creek are designated by WDEQ as Class 3 streams. Vermillion Creek, North Fork Vermillion Creek, and Coyote Creek are designated as Class 2 streams. All other ephemeral streams in the project area (i.e., named and unnamed tributaries of East Salt Wells Creek, Alkali Creek, and North Fork Vermillion Creek) are undesignated and by default take on the classification of the first stream they run into. Therefore, tributaries of East Salt Wells Creek and Alkali Creek are all Class 3 streams and tributaries of North Fork Vermillion Creek are Class 2 streams.

The WGFD has also classified surface waters in regard to the quality of trout fishery habitat and/or the importance of the trout fishery resource provided by the surface water bodies. All streams within the Bitter Creek drainage basin are Class 5 streams (very low production waters -- often incapable of sustaining a trout fishery) (WGFD 1991). All streams within the Vermillion Creek drainage basin in Wyoming, with the exception of the North Fork Vermillion Creek above the Coyote Creek confluence, are also Class 5 streams. North Fork Vermillion Creek above the Coyote Creek confluence is a Class 3 trout stream (important trout waters – fisheries of regional importance) (WGFD 1991).

Salinity. A primary water quality concern is increased salinity levels in area surface waters. Salinity has been noted as a key factor that limits water use and is a concern relative to downstream water uses. Salinity has become a major concern within the Colorado River drainage basin. The 1972 Clean Water Act (CWA) required the establishment of numeric criteria for salinity for the Colorado River. In 1973, seven Colorado River basin states created the Colorado River

Basin Salinity Control Forum. The Forum developed water quality standards for salinity including numeric criteria and a basin-wide plan of implementation. The plan consists of a number of control measures to be implemented by State and Federal agencies. In 1974, Congress enacted the Colorado River Basin Salinity Control Act. The Act was amended in 1984. The amendments required the Secretary of Interior to develop a comprehensive program to minimize contributions from lands administered by the BLM.

Moderately erosive and saline soils naturally occur within and around the project area. Saline soils are associated with parent material from sedimentary rocks of the Tertiary Green River and Wasatch Formations. Once the soil is disturbed (i.e., from construction of a road or well pad), the potential for the release of residual soil sediment is increased. It is possible that oil and gas activities in the general area have and will continue to contribute to both sedimentation and salinity levels presently being experienced in the Green River. All of the soils within the project area have the potential of creating water quality-related sediment and salinity problems when disturbed.

3.4.2.3 Waters of the U.S.

Waters of the U.S. is a collective term for all areas subject to regulation by the U.S. Army Corps of Engineers (COE) under Section 404 of the Clean Water Act. Waters of the U.S. include the 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 COE and U.S. Environmental Protection Agency (EPA). 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. As described previously, many of the ephemeral drainage channels within the project area identified on USGS topographic maps are vegetated swales, which are not considered to be Waters of the U.S. by the COE. Activities that modify the morphology of stream channels are also subject to regulation by the Wyoming SEO. Special aquatic sites and wetlands are discussed in greater detail in the Vegetation Section (Section 3.5).

3.4.3 Groundwater

Groundwater resources include deep and shallow, confined and unconfined aquifers. 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); and the Great Divide and Washakie Basins described by Collentine et al. (1981) and Welder and McGreevy (1966). Site-specific groundwater data for the project area are limited, although some miscellaneous information from water wells and springs located in the general vicinity are available from the Wyoming SEO (SEO 2003), the Wyoming Oil and Gas Conservation Commission (WOGCC 2003), and the Wyoming Water Resources Data System (WRDS 2003). Other sources of information on groundwater resources in the general area come from Lowham et al. (1982), which includes information on the quality of groundwater from different geologic units underlying the Salt Wells Creek drainage basin. In addition, groundwater resources in the general area of the Black Butte Coal Mine, a large-scale strip mining operation located between the project area and Point of Rocks, Wyoming, are included in Black Butte Coal Company's Wyoming Department of Environmental Quality (WDEQ) mining permit (BBCC 1998).

3.4.3.1 Groundwater Location and Quantity

The project area is located at the western edge of the Washakie Basin and the eastern flank of the Rock Springs Uplift. The shape of the Washakie Basin is nearly symmetrical and the strata in the basin dip toward the center at two to 12 degrees. Beneath the project area, geologic strata dip gently eastward and southeastward into the basin (Geology Section 3.1). Groundwater in the basinward-dipping strata is almost entirely found in confined aquifers, although it also occurs under unconfined conditions locally in some alluvial valleys and where saturated rocks are near the surface (Welder and McGreevy 1966). Welder and McGreevy (1966) suggest that the direction of groundwater movement in the deeper formations is down-dip toward the center of the structural basin and upward into the overlying formations; therefore, groundwater occurring within the project area is generally flowing eastward and southeastward at a gradient roughly equal to the stratigraphic dip. Recharge occurs along the outcrop areas of formations and low-lying subcrops where water availability is high. Discharge occurs as evaporation, seeps, pit openings, and pumped water from wells (BBCC 1998). Recharge to the water bearing strata of the Washakie Basin is principally from the infiltration of precipitation (direct rainfall, overland flow, and snow melt). However, most of the precipitation leaves the area as surface runoff before it can infiltrate. The estimated recharge rate for the general area ranges from 0.01 to 2.0 inches per year (Heath 1984). Groundwater discharge from the basin is principally by evaporation and underflow beneath stream channels. Discharge via water wells and transpiration by plants is not significant (Welder and McGreevy 1966).

Several rock units can be classified as water-bearing zones (aquifers) within the Washakie structural basin and the Rock Springs Uplift of southwest Wyoming. As described in Table 3-11, these aquifers vary in thickness, potential well yields, and water quality. The formations highlighted in Table 3-11 are those encountered within the project area to a depth of approximately 10,000 feet below land surface. The exposed geologic units within the project area are the Tipton Tongue of the Green River Formation, the Cathedral Bluffs Tongue of the Wasatch Formation, the main body of the Wasatch Formation, and the Fort Union Formation. The Tertiary-age Wasatch and Fort Union Formations are widely distributed in the Washakie Basin and most wells and springs produce and issue from them (Eddy-Miller et al. 1996). The Tertiary aquifer system is described as all the water-bearing strata between the Laney Shale Member of the Green River Formation and the Fox Hills Sandstone, inclusive. The Tertiary aquifer system is the most extensively distributed and accessible source of groundwater in the Washakie and Great Divide Basins, and the total estimated use of groundwater in that area is between 80,000 and 89,000 acre-feet per year (Collentine et al. 1981).

The Tipton Tongue of the Green River Formation consists of thin-bedded shale, claystone, mudstone, and siltstone with occasional thin limestone, sandstone, and coal (Welder and McGreevy 1966). Most of the Green River Formation has minimal permeability, but small springs are likely to occur where sandstones outcrop (Lowham et al. 1982). Wells drilled into the Tipton Tongue can be expected to have very low yields (Welder and McGreevy 1966). The Cathedral Bluffs Tongue of the Wasatch Formation consists of claystones and shales interbedded with fine-grained sandstones. Very low yields of mineralized groundwater can be expected from wells in the Cathedral Bluffs Tongue (Welder and McGreevy 1966). Sandstones in the main body of the Wasatch Formation generally contain groundwater under artesian conditions (Welder 1968). The main body of the Wasatch Formation has moderate to large permeability and is a major shallow aquifer for the area surrounding the Rock Springs Uplift (Lowham et al. 1982). The Fort Union Formation consists of gray or brown carbonaceous shale, gray shale, gray and green mudstone, gray very fine to medium grained sandstones and minor thin gray limy siltstones, gray claystone and coal. The sandstone in this unit contains some zones of high permeability and is a good source of groundwater in the general area. However, the sand layers are not large in extent and are discontinuous over the region (BBCC 1998).

The Mesaverde Formation is also a major aquifer within the Washakie Basin, although due to water quality variability and excessive drilling depths, it is considered a groundwater source near outcrop areas only. Likewise, all of the water-bearing units below the Mesaverde Group are considered important sources of groundwater only in the vicinity of their outcrops. The majority of groundwater

Table 3-11. Hydrostratigraphy of Southwest and South Central Wyoming, Including the Great Divide and Washakie Basins.

ERA	PERIOD	GEOLOGIC UNIT	THICKNESS (feet)	HYDROLOGIC PROPERTIES
Cenozoic	Quaternary		0-70	• Sand and gravel deposits; fine-grained lake deposits produce poor yields • Used extensively in Little Snake River valley and area north of Rawlins uplift • Well yields generally <30 gpm; springs south of Ferris Mountains flow up to 20 gpm • Transmissivity estimates from area east of Rock springs uplift 168 to 560 gpd/ft • Permeabilities from area east of Rock Springs uplift from 21 to 62 gpd/ft^2 • TDS vary from 200 > 60,000 mg/L
	Tertiary	North Park Formation	0-800	• Minor aquifer, supplies excellent quality spring water to the city of Rawlins • Three wells yield 4 to 20 gpm • Transmissivity estimates from 2 pump tests; 150 and 1,000 gpd/ft • TDS generally < 500 mg/L
		Browns Park Formation	0-1,200	• Excellent aquifer with good interstitial permeability; possible saturated zone 870 ft thick • Well yields range from 3 to 30 gpm • Transmissivity estimates from 100 to 10,000 gpd/ft • Numerous springs maintain baseflow of streams south of the Rawlins area; one spring flows 343 gpm • TDS generally < 500 mg/L
		Bishop Conglomerate	0-200+	• Major aquifer in Rock Springs uplift area • Absence of thick, saturated zones limits well yields; one well yields 42 gpm • Good interstitial permeability
		Uinta/Bridger Formations (Washakie Formation)	0-3,200+	• Relatively impermeable unit with only one questionably identified well and no spring data reported • Very low yields are expected
		Green River Formation (including Tipton, Wilkins Peak, and Laney members)	0-1,500	• Laney Member wells yield up to 200 gpm; other members relatively impermeable and would produce low-yield wells • Laney transmissivity range 110 to 300 gpd/ft; permeability averages 10 gpd/ft^2 • TDS generally <3,000 mg/L

ERA	PERIOD	GEOLOGIC UNIT	THICKNESS (feet)	HYDROLOGIC PROPERTIES
		Wasatch Formation	0-4,000+	• Major aquifer; water-bearing sandstone lenses yield 5 to 250 gpm although most yield 30 to 50 gpm; possible yields of 500 gpm from thick, saturated sequences • Wells tapping the lower sands are artesian in some areas • Transmissivity estimates range from 150 to 10,000 gpd/ft • Porosity and permeability are 16 to 38 percent and 0.04 to 18.2 gpd/ft^2, respectively • TDS generally < 1,000 mg/L but some over 3,000 mg/L
Cenozoic	Tertiary	Battle Springs Formation	0-4,700	• Major aquifer in eastern Great Divide Basin • Well yields range from 1 to 157 gpm • Transmissivity estimates from 29 to 3,157 gpd/ft • Porosity at one oil field was 15 to 25 percent • TDS generally < 1,000 mg/L
		Fort Union Formation	0-2,700+	• Major aquifer, especially around border of basins; discontinuous, isolated water-bearing zones • Well yield ranges from 3 to 300 gpm • Transmissivity estimate generally <2,500 gpd/ft • Porosity 15 to 39 percent • Permeability <1 gpd/ft^2; permeability largely fault-related on east side of Rock Springs uplift • TDS generally from 1,000 to 5,000 mg/L
Mesozoic	Upper Cretaceous	**Lance Formation**	0-4,500+	• Minor aquifer, with well yields generally <25 gpm • Transmissivity estimates generally <20 gpd/ft, with some estimates up around 150 to 200 gpd/ft • Oil field porosity 12 to 26 percent • Oil field permeability 0.007 to 8.2 gpd/ft^2 • TDS generally from 1,000 to 5,000 mg/L
		Fox Hills Sandstone	0-400	• Minor aquifer • Well and spring yields not available • Porosity 20 percent • Transmissivity 10 to 20 gpd/ft • Permeability 0.9 gpd/ft^2

ERA	PERIOD	GEOLOGIC UNIT	THICKNESS (feet)	HYDROLOGIC PROPERTIES
		Lewis Shale	0-2,700+	• Constricting layer mostly of impermeable shale but scattered sandstone lenses may be capable of yielding stock water supplies • Porosity ranges from 6 to 24 percent • Permeability ranges from 0.002 to 0.9 gpd/ft^2 • Transmissivity ranges from 0.03 to 50 gpd/ft
		Mesaverde Group (includes Blair, Rock Springs, Ericson and Almond Formations)	0-2,800	• Major aquifer with maximum well yield of 470 gpm from Rock Springs Formation; most yield less than 100 gpm • Transmissivity estimates generally < 3,000 gpd/ft and much lower in the Almond Formation • Porosity ranges from 8 to 26 percent • Ericson Formation is best water source near Rock Springs uplift • TDS range from 500 to over 50,000 mg/L (below 1,000 mg/L only at outcrops)
Mesozoic	Upper Cretaceous	**Baxter Shale** (includes Cody and Steele shales and Niobrara Form)	2,000-5,000+	• Major regional constricting layer throughout area west of Rawlins uplift • Thin sandstone beds may yield small quantities of water, but high TDS concentrations likely
		Frontier Formation	190-900+	• Productive aquifer; yields range from 1 to >100 gpm • Transmissivity estimates 15,000 to 20,000 gpd/ft for water well pump tests; however, generally <100 gpd/ft for drill stem tests, with maximum of 6,500 gpd/ft • TDS range from 500 to 60,000 mg/L (<1,500 mg/L near outcrops)
	Lower Cretaceous	Mowry Shale	150-525	• Regional constricting layer; well and spring data not available
		Thermopolis Shale (includes Muddy Sandstone Member)	20-235	• Leaky confining unit; water produces from Muddy Sandstone Member in northeast Great Divide Basin • Well and spring data not available
		Cloverly Formation	45-240	• Major aquifer which crops out on Rawlins uplift; deeply buried over most of area • Well yields range from 25 to >120 gpm • Transmissivity estimates range from 1 to 1,700 gpd/ft (combined water well and drill stem) • TDS range from 200 to 60,000 mg/L (1,500 mg/L near outcrops)
	Upper Jurassic	Morrison Formation	170-450+	• Confining unit • Well and spring data not available

ERA	PERIOD	GEOLOGIC UNIT	THICKNESS (feet)	HYDROLOGIC PROPERTIES
		Sundance Formation	130-450+	• Artesian flow to several wells in Rawlins area • Well yields between 27 and 35 gpm • Transmissivity ranges from 12 to 3,500 gpd/ft • TDS range from 1,100 to 40,000 mg/L (<1,500 mg/L near outcrops)
	Lower Jurassic-Upper Triassic	Nugget Sandstone	0-650+	• Well yield data limited but range from 35 to 200 gpm • Maximum transmissivity from drill stem tests 2,166 gpd/ft • TDS range from 1,100 to 40,000 mg/L (<1,500 mg/L near outcrops)
	Triassic	Chugwater Formation	900-1,500+	• Confining unit; hydrologic data not available
Mesozoic/ Paleozoic	Lower Triassic-Permian	Phosphoria Formation	170-460	• Water-bearing capabilities poorly known; probably poor due to low permeability of rock units • TDS generally between 5,000 to 10,000 mg/L
Paleozoic	Permian-Pennsylvanian	Tensleep Formation	0-840+	• Important water-bearing zone; well yields range from 24 to 400 gpm • One spring flows 200 gpm in Rawlins area • Transmissivity generally low, range 1 to 374 gpd/ft • TDS generally > 3,000 mg/L
Paleozoic	Lower and Middle Pennsylvanian	Amaden Formation	0-260+	• Hydrologic data not available; unit probably has poor water-bearing potential due to predominance of fine-grained sediments • TDS generally > 10,000 mg/L
	Mississippian	Madison Limestone	5-325+	• Major aquifer; excellent secondary permeability development due to solution channeling, caverns, and fractures • Well yields up to 400 gpm • Transmissivities highly variable • TDS range from 1,000 to >10,000 mg/L
	Cambrian	Undifferentiated	0-800+	• Major water-bearing zone, especially near Rawlins • Well yields between 4 and 250 gpm • Transmissivity data are suspect • TDS generally <1,000 mg/L but some areas with 5,000 to 10,000 mg/L
Precambrian			unknown	• Frequently used aquifer in northwestern corner of Great Divide Basin near South Pass City • Well yields typically range from 10 to 20 gpm • Reported transmissivities are <1,000 gpd/ft • Generally high permeability in fractured and weathered zone in upper 200 ft of unit

Adapted from Collentine et al. (1981); additional sources include Lowham et al. (1985), Heath (1964), and Freethey (1967) presently withdrawn from the Washakie Basin is from the Tertiary aquifer system, and where drilling depths permit, the Mesaverde aquifer (Collentine et al. 1981). The Mesaverde Formation is situated between the major confining units of the Lewis Shale above and the Baxter Shale below. The Mesaverde aquifer consists of, in ascending order, the Blair, Rock Springs, Ericson, and Almond Formations (Collentine et al.1981). The upper part of the Almond Formation consists of permeable massive beds of fossiliferous sandstone, which overlie low-permeability carbonaceous shale, siltstone, mudstone, and coal beds of variable thickness and quality (Collentine et al. 1981). Dana (1962) reported that one well completed in the upper sandstone yields 250 gpm. Transmissivity values determined from coal mine pumping tests on saturated coal beds of the Almond Formation are relatively low, between 0.7 and 15.8 gpd/ft (Collentine et al. 1981).

Beneath the project area the Wasatch Formation varies from zero to about 2,200 feet thick; the Fort Union Formation varies from about 800 feet to 1,800 feet thick; and the Mesaverde Formation is around 4,000 feet thick. The Pacific Rim Shallow Gas Project is proposing varying drilling depths between approximately 1,500 feet and 5,500 feet. Coal seams of the Fort Union Formation and Almond Formation occur at these depths in the project area.

The Black Butte Coal Mine, which is located about 15 to 25 miles north of the project area, is actively mining coal seams of the Fort Union, Lance, and Almond Formations. The Hydrology section of Black Butte mine's WDEQ mining permit describes these coal seams as the most regionally-extensive, water-bearing strata in the general area of the mine. Other saturated zones (i.e., sandstone lenses) of these formations are often discontinuous and occur as perched systems at the Black Butte mine site. Through drilling programs and monitor well installations in and around the Black Butte mine, it is observed that the Wasatch Formation is generally dry. Water in quantities sufficient for industrial supply is found in the Ericson Formation (BBCC 1998).

Most of the mine's Fort Union and Almond Formation coal seam monitoring wells are 100 to 400 feet deep and typically yield around 5 to 25 gallons per minute (gpm). The coal seams are confined between relatively impermeable shales and the average transmissivity value for the Fort Union and Almond Formation coal seams are 100 gallons per day per foot (gpd/ft) and 30 gpd/ft, respectively. The Fort Union Formation sandstones exhibit high transmissivity values, averaging about 8,835 gpd/ft. These sandstones are generally soft, fine grained, and saturated, especially when located close to the Bitter Creek valley (BBCC 1998).

A recent (December 2003) SEO records review revealed that there are currently 14 active groundwater permits within the project area. Nine of these wells are permitted for coalbed methane (CBM) production, three are permitted for domestic and livestock water supply, and two of them are permitted to be used as temporary water supply for oil and gas well drilling.

3.4.3.2 Groundwater Quality

Groundwater quality is largely related to the depth of the respective source aquifer, flow between aquifers, and the rock type. The quality of water in the various geologic formations underlying the Washakie Basin ranges from poor to good (Welder 1968). The TDS concentration is an indication of salinity. Elevated TDS is caused by a variety of factors, including evapotranspiration, mixing of adjacent aquifers, the presence of soluble material, and restriction of flow by faults or impermeable strata. TDS concentrations ranging from less than 1,000 mg/L (considered fresh) to roughly 2,000 mg/L (slightly saline to saline) is typically found within shallow members of the Tertiary aquifer system and near the outcrop areas of the Mesaverde Formation and older aquifers. Shallow groundwater (<1,500 feet) from the Tertiary aquifer system generally has a TDS concentration of less than 3,000 mg/L. Saturated alluvial aquifers that are associated with larger, intermittent streams in the area, such as Bitter Creek and Salt Wells Creek, commonly have very high TDS concentrations (Welder and McGreevy 1966).

The TDS concentration of groundwater from the Mesaverde Group varies from less than 500 to over 50,000 mg/L (Collentine et al. 1981). The rate of increase in TDS concentration away from the outcrop is variable, with the most saline Mesaverde waters found along the east flank of the Rock Springs Uplift at a relatively short distance from the outcrop. The high TDS levels that exist basinward may result from a fault-related restriction of ground-water circulation, or alternatively, through a fracture-controlled influx of saline waters from stratigraphically adjacent shales and/or overlying alluvium. The existence of stratigraphic gas traps and the generally low permeability (<1 gpd/ft^2) of Mesaverde gas reservoir rocks in this area indicate that zones of highly restricted flow also contribute to the high salinity levels (Collentine et al. 1981). Major ionic composition of Mesaverde aquifer water varies with salinity and location within the Washakie Basin. Water having a TDS concentration of 1,000 to 3,000 mg/L is typically enriched in calcium sulfate, probably from gypsum/anhydrite dissolution. Increasingly saline water is characterized by dissolved sodium, chloride, and bicarbonate, and is essentially free of sulfate.

A search of the Wyoming Water Resources Data System (WRDS 2003) was conducted for the analyses of groundwater samples collected from springs and wells located within and near the project area. The search revealed the chemical analyses of miscellaneous grab samples collected from seven flowing springs located near the project area: four springs that issue from the Cathedral Bluffs Tongue of the Wasatch Formation, which are all located in the headwaters area of North Fork Vermillion Creek; and three springs that issue from the Tipton Tongue of the Green River Formation, which are located on Alkali Creek and lower North Fork Vermillion Creek. The search also revealed the chemical analyses of grab samples collected from six wells: two completed in the Green River Formation; one completed in the Wasatch/Fort Union Formation; and three completed in the Almond Formation.

The samples of springs flowing from the Cathedral Bluffs Tongue of the Wasatch Formation had the lowest TDS concentrations (between 225 and 329 mg/L). This formation outcrops at the higher elevations of the North Fork Vermillion Creek watershed, which is a favorable position to receive direct recharge from rain and snowmelt. Therefore, the water would have been in contact only with this formation for a relatively short time, therefore resulting in a low degree of mineralization. Calcium and sodium were the dominant cations, while bicarbonate was the dominant anion.

The three springs discharging water from the Tipton Tongue of the Green River Formation had TDS concentrations that ranged from 714 to 2,590 mg/L. Sodium was the dominant cation and bicarbonate and sulfate were the dominant anions. Alkali Spring, located on the headwaters of Salt Wells Creek about 13 miles west of the project area, discharges water from the Tipton Tongue of the Green River Formation. A sample from that spring had a TDS concentration of 760 mg/L and the water type was magnesium/sodium bicarbonate.

The two wells completed in the Green River Formation were each sampled once and the samples had TDS concentrations of 528 and 1,270 mg/L, respectively. The water type from both wells was sodium bicarbonate.

One sample was collected from a Wasatch/Fort Union well located within the project area. This well is 145 feet deep and screened in the basal part of the Wasatch Formation and, possibly, the uppermost part of the Fort Union Formation. The TDS concentration of the sample from this well was 2,400 mg/L, and the predominant ions were calcium and bicarbonate.

One sample was collected from one of the Almond wells. This well is 60 feet deep and drilled through the alluvium of East Salt Wells Creek, so the water may be a combination of that from the alluvium and the Almond Formation. The water type was a sodium sulfate with a TDS concentration of 711 mg/L. The other two Almond wells are scientific monitoring wells located within the Black Butte mine permit area and the WRDS database contained analyses of baseline samples collected from them. Seventeen samples were collected from one of these Almond monitoring wells from 1975 through 1979, and the water type was consistently sodium bicarbonate with an average TDS concentration of 2,040 mg/L. The other Almond monitoring well was sampled 11 times from 1976 through 1979 and the water type was calcium sulfate with an average TDS concentration of 3,740 mg/L.

The Black Butte mine permit (1998) describes the chemical characteristics of groundwater from the Fort Union and Almond Formations' coal seams in the general area of the mine. Because the Pacific Rim Shallow Gas Project is proposing drilling to depths between approximately 1,500 and 5,500 feet, and the coal seams of the Fort Union and Almond Formations occur at those depths in the project area, the chemical characteristics of these coal seams as identified by the Black Butte Coal Mine should be similar to that encountered at the Black Butte Mine. The predominant ionic constituents of groundwaters within coal seams of both formations are sodium and bicarbonate. Groundwater from Fort Union Formation coal seams has sodium concentrations ranging from 441 to 1,267 mg/L, with a mean of 860 mg/L. The Sodium Adsorption Ratio (SAR) values range from 16.5 to 39, with a mean of 36, and the TDS concentrations range from 1,230 to 3,497 mg/L. Groundwater from wells completed in coal seams of the Almond Formation typically has a TDS concentration in excess of 2,000 mg/L.

A low rate of recharge and slow movement of water in these coal seam aquifers are often the major causes of a high degree of mineralization (BBCC 1998). The confining beds restrict the movement of groundwater between aquifers, hence, movement of potential contaminants between aquifers. Although there is some downward movement of the water from the shallow surficial 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 also be a potential source of contamination between aquifers.

3.5 VEGETATION, WETLANDS AND NOXIOUS/INVASIVE WEEDS

3.5.1 General Vegetation

Vegetation on the proposed Pacific Rim Project Area is dominated primarily by Wyoming big sagebrush/mixed grass prairie, Utah juniper woodland, and desert shrub communities. The project area is located within the Natural Resources Conservation Service (NRCS) Green River and Great Divide Basin (7" - 9") precipitation zone, Region 4 (USDA-NRCS 1986). As a result, native plants in this area of southwest Wyoming are predominantly drought-tolerant low shrub, grass, and flowering forb species. Prolonged drought in southwestern Wyoming has negatively impacted many native shrub communities and several small-scale natural die-backs can be observed throughout the project area with the most conspicuous occurring in basin big sagebrush (*Artemesia tridentada* ssp. *tridentada*)/black greasewood (*Sarcobatus vermiculatus*) communities associated with intermittent and ephemeral drainages common throughout the area.

3.5.2 Vegetation Cover Types

A vegetation cover-type map of the PRPA (Figure 3-9) was provided by the Wyoming Natural Resources Clearinghouse and used to delineate primary and secondary land cover type boundaries. Information for plant species of concern on or near the project area was provided by the Wyoming Natural Diversity Database (WYNDD 2003).

The vegetation cover-type layer was derived from Landsat Thematic Mapper (TM) satellite imagery, "acquired from mid-June to late August between the years 1984 and 1993" (Merrill et al*.* 1996). Resolution of this layer is 100 hectares (248 acres or 0.4 section) for uplands and 40 hectares (100 acres or 0.2 section) for riparian and wetland areas. Given the resolution of the GAP layer, small stands of some cover-types do not appear on the map. For example, linear stands of basin big sagebrush commonly associated with narrow ephemeral drainages, small saltbush-dominated openings, and smaller cushion plant communities are often too small to appear at this scale of resolution.

A preliminary assessment of the general vegetation types present on the PRPA was conducted 8 September 2003 followed by a thorough vegetation mapping activity during 7-11 October 2003. This mapping project was augmented with the GAP data to delineate other smaller primary vegetation types that occur on the PRPA.

Based upon these data, Wyoming big sagebrush (*Artemesia tridentada* spp. *wyomingensis*) and desert shrubs, principally Gardner's saltbush (*Atriplex gardneri),* collectively comprise about 81.8 percent of the primary cover types on the project area. Table 3-12 shows the extent of the primary vegetation cover types on the PRPA.

3.5.2.1 Wyoming Big Sagebrush

Wyoming big sagebrush is the most widespread cover type in the project area, covering 28,633.24 acres (66.34%). Merrill et al. (1996) describes this cover type as follows:

Total shrub cover in this type comprises more than 25% of the total vegetative cover. This type is variable in Wyoming and ranges from dense, homogeneous Wyoming big sagebrush to sparsely vegetated arid areas where Wyoming big sagebrush is the dominant shrub. Often, patches of Wyoming big sagebrush are found with patches of mixed grasses. In these cases the type is classified as Wyoming big sagebrush steppe if the sagebrush patches occupy more than 50% of the total landscape area and as mixed grass if the grasses occupy more than 50% of the total area.

In addition to Wyoming big sagebrush, the October mapping project revealed other *Artemesia* taxa on the PRPA, including mountain big sagebrush (*Artemesia tridendata* ssp. *vaseyana* var. *pauciflora*), Vasey big sagebrush (*A. tridendata* ssp*. vaseyana* var. *vaseyana*), black sagebrush *(A.*

nova), basin big sagebrush, birdsfoot sagebrush (*A. pedifida*), plains silver sagebrush (*A. cana* ssp. *cana,* mountain silver sagebrush (*A. cana* ssp. *visdiscula*), and alkali sagebrush (*A. longiloba*). A variation of Wyoming big sagebrush (*gosiute*) was located and identified in the southern portion of the PRPA. This undescribed variation of Wyoming big sagebrush is believed to occur in soils

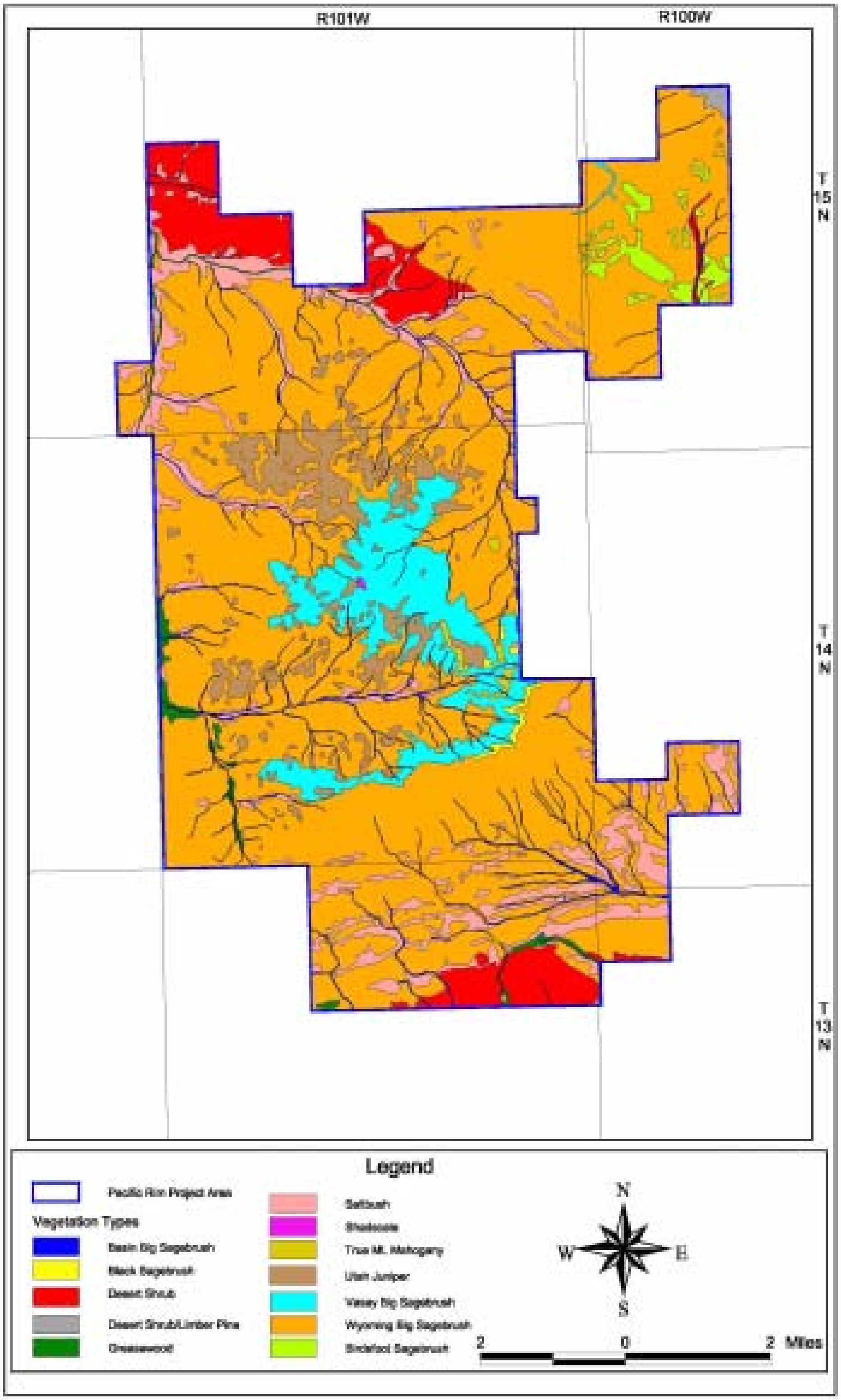

R101W
R100W
T 15 N
T 14 N
T 13 N
Legend
Pacific Rim Project Area
Vegetation Types
Basin Big Sagebrush
Black Sagebrush
Desert Shrub
Desert Shrub/Limber Pine
Greasewood
Saltbush
Shadscale
True Mt. Mahogany
Utah Juniper
Vasey Big Sagebrush
Wyoming Big Sagebrush
Birdsfoot Sagebrush
N
W
E
S
2 0 2 Miles

Figure 3-9. Primary Vegetation Cover Types on the PRPA.

associated with shoreline deposits of the paleolake Gosiute which covered most of the project area during the Eocene (Winward 1999). The total acreage of these other *Artemesia* species and sub-species is shown in Table 3-12.

3.5.2.2 Desert Shrub

This type is a catch-all for a mixture of shrubs usually associated with dry, saline habitats. Shrub cover is often dominated by alkaline/saline adapted species such as shadscale saltbush (*Atriplex confertifolia*), but can be a mixture of Gardner's saltbush, greasewood and/or desert cushion plants (Merrill et al. 1996). Many saltbush dominated communities occur on the PRPA and these sites are characterized by an accumulation of salt in poorly developed soils with a pH of 7.8 to 9.0. Grass cover is negligible and bare ground usually exceeds 50%. Birdsfoot sagebrush also occurs in alkaline soils with pH levels of 8.5 to 11. At the lower pH levels, birdsfoot sagebrush can occur with Gardner's saltbush in varying densities. At the higher pH levels, birdsfoot sagebrush usually occurs as a monoculture.

Total land area of the PRPA occupied by desert shrub-type communities is about 7,104 acres, which represents about 16.5% of the project area.

Table 3-12. Primary vegetation cover types on the Pacific Rim Project Area identified by field.

Vegetation Cover Type	Primary	
	Acres	**Percent**
Wyoming big sagebrush	28633.24	66.34
Saltbush fans and flats	3900.03	9.04
Vasey big sagebrush	3013.12	6.98
Desert shrub	2751.94	6.38
Utah juniper	2323.32	5.38
Basin big sagebrush	1251.05	2.90
Birdsfoot sagebrush	535.56	1.24
Greasewood flats and fans	361.50	0.84
True mountain mahogany	164.81	0.38
Black sagebrush	125.92	0.29
Desert shrub/Limber pine	90.59	0.21
Shadscale	8.52	0.02
Total	**43159.6**	**100.0**

3.5.2.3 Mixed Grass Prairie

Intermixed with the primary vegetation cover types on the PRPA are scattered areas mixed grass prairies. Dominant plant species in this cover type include: thickspike wheatgrass (*Agropyron* *dasystachyum*), western wheat grass (*Agropyron smithii*), bottlebush squirreltail (*Sitanion hystrix*), needle-and-thread (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), Sandberg bluegrass (*Poa secunda*), bluebunch wheatgrass (*Agropyron spicatum*), and threadleaf sedge (*Carex filifolia*).

Forbs and especially woody crowned half-shrubs such as Hood's phlox (*Phlox hoodii*), Hooker's sandwort (*Arenaria hookeri*), cushion wild buckwheat (*Eriogonum ovalifolium*), green rabbitbrush (*Chrysothamnus viscidiflorus*), winterfat (*Krascheninnikovia lanata*), and broom snakeweed (*Gutierrezia sarothrae*) occur in some locations as understory dominants with the sagebrush. These sites are usually alkaline with limited permeability, and often occur on thin soils with rocky or gravelly subsurface materials. Locoweed (*Oxytropis* ssp.) and milkvetch (*Astragulus* spp.) are poisonous plants often occurring with this cover type (Merrill et al. 1996).

3.5.3 Biological Soil Crusts

An often overlooked, but extremely vital component of Wyoming's semiarid rangelands, especially in the Wyoming big sagebrush cover type, are the biological soil crusts that occupy most of the open space not occupied by vascular plants. Biological soil crusts predominantly are composed of cyanobacteria (formerly blue-green algae), green and brown algae, mosses, and lichens. Liverworts, fungi, and bacteria can also be important components. Because they are concentrated in the top 0.04-0.16 inches of soil, they primarily affect processes that occur at the soil surface or soil-air interface, including soil stability, decreased erosion potential, atmospheric N-fixation, nutrient contributions to plants, soil-plant-water relations, infiltration, seeding germination, and plant growth. Crusts are well adapted to severe growing conditions, but poorly adapted to compressional disturbances such as trampling by humans and livestock, wild horses, wildlife, or vehicles driving off roads. Disruption of the crusts decreases organism diversity, soil nutrients, stability, and organic matter (Belnap et al. 2001).

3.5.4 Noxious and Invasive Weeds

On 3 February 1999, Executive Order (EO) 13112 (Invasive Species) was signed by President Clinton. The primary purpose of this EO is to prevent the introduction of invasive species and provides for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. In Wyoming, some 428 species have been documented as invasive (Hartman and Nelson 2000). Of these 428 plants, 24 are designated as noxious by the State of Wyoming (Rice 2002) and are shown in Table 3-13.

Table 3-13 Designated Noxious Weeds in Wyoming.[1]

Scientific Name	Common Name
Agropyron repens	Quackgrass
Ambrosia tomentosa	Skeletonleaf bursage
Arctium minus	Common burdock
Cardaria draba, C. pubescens	Hoary cress, whitetop
Carduus acanthoides	Plumeless thistle
Carduus nutans	Musk thistle
Centaurea diffusa	Diffuse knapweed

Centaurea maculosa	Spotted knapweed
Centaurea repens	Russian knapweed
Chrysanthemum leucanthemum	Ox-eye daisy
Cirsium arvense	Canada thistle
Convolvulus arvensis	Field bindweed
Cynoglossum officinale	Houndstongue
Euphorbia esula	Leafy spurge
Isatis tinctoria	Dyers woad
Lepidium latifolium	Perennial pepperweed
Linaria dalmatica	Dalmatian toadflax
Linaria vulgaris	Yellow toadflax
Lythrum salicaria	Purple loosestrife
Onopordum acanthium	Scotch thistle
Sonchus arvensis	Perennial sowthistle
Tamarisk spp.	Salt cedar
Hypericum perforatum	Common St. Johnswort
Tanacetum vulgara	Common tansy

[1] Designated Noxious Weeds, Wyoming Stat. ' 11-5-102 (a)(xi) and Prohibited Noxious Weeds, Wyoming Stat. ' 11-12-104.

Noxious weeds are very aggressive and invading infestations tend to exclude other native plant species thereby reducing the overall forage production of desirable shrubs, herbaceous grasses and forbs. The project area is vulnerable to infestations of noxious weeds, especially on newly disturbed surfaces. Current drought conditions in Wyoming favor the establishment of noxious weeds in stressed or disturbed habitats.

The most common invasive plant species observed on the PRPA are halogeton (*Halogeton glomeratus*), small infestations of downy brome (*Bromus tectorum*), Russian thistle (*Salsosa iberica*) gray horsebrush (*Tetradymia canescens*), and broom snakeweed (*Gutierrezia sarothrae*). Infestations are mostly associated with disturbed surfaces along road and pipeline rights-of-way (ROW). An unusually heavy infestation of halogeton was observed throughout central and western Wyoming during the 2003 growing season. Greatest densities were observed on disturbed areas such as road and pipeline ROW's, livestock feeding areas, and corrals; however, this poisonous plant was also observed invading un-disturbed rangeland.

3.5.5 Waters of the United States, Including Wetlands

The U.S. Fish and Wildlife Service (FWS) mapped wetlands according to the classification system of Cowardin et al. (1979) to create the National Wetlands Inventory (NWI). Digital files covering the area of the PRPA (nwi3) were downloaded by WYNDD (2003) from the web site of the University of Wyoming's Geographic Information Science Center (WGISC). Relevant portions were clipped from the map to provide wetland data for the project area using ArcView7 GIS software.

Waters of the US. All drainages (streams, draws, washes) in the PRPA are within the WDEQ fifth order hydrologic unit WYGR14040105 that eventually drain into the Green River. No perennial streams are located on the project area (J. Henderson 2004). Most of the surface water features in the project area qualify as Waters of the United States. Channels that carry surface flows and that show signs of active water movement are classified as 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)] and are regulated by the Army Corps of Engineers (COE). Many ephemeral drainage channels identified on the USGS topographic maps for the PRPA are vegetated swales and are not considered to be Waters of the U.S. (COE 1987, 1992).

Any activity that involves discharge of dredge or fill material into or excavation of "Waters of the U.S." 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 Wyoming Department of Environmental Quality (WDEQ).

Wetlands. The Green River RMP (USDI-BLM 1997) defines wetlands as lands transitional between terrestrial and aquatic systems where the water is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominately hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year (COE 1987, 1992).

Wetlands cover about 1.25 million acres (2 percent) of Wyoming and are the most diverse ecosystems in the State's semi-arid environment (Yuhas 1996). The physical, chemical, and biological interactions within wetlands are often referred to as wetland functions. These functions include surface and subsurface water storage, nutrient cycling, particulate removal, maintenance of plant and animal communities, water filtration or purification, and ground water recharge. The NWI has mapped wetlands throughout the project area and these are shown in Figure 3-10.

The most common linear wetland as shown in Figure 3-10 is classified as R4SBA (Riverine-Intermittent-Streambed-Temporarily Flooded). The total length of these intermittent streams within the project area is about 20,536 m (or about 12.8 miles). Many individual wetlands are so small that they hardly appear on a small-scale map such as Figure 3-10 (WNYDD 2003). Palustrine, Unconsolidated Shore Class wetlands (characterized by poorly vegetated bars) also account for a substantial number of small wetlands. All these wetland types are described in Cowardin et al. (1979). Table 3-14 describes the wetland types and their extent for the project area.

Table 3-14. Wetland types and extent on the Pacific Rim Project Area[1].

Type	Area (ac.)	Length (m/ft)
PEMC	----	1153.9/3585.9
R4SBA	----	20536.1/67378.9
PABFh	0.9	----
PUSA	5.7	----
PUSAh	1.6	----
PUSCh	6.2	----

[1] Source: WYNDD

3.6 RANGELAND RESOURCES

The proposed PRPA lies within the Rock Springs Grazing Allotment (No. 13018) and the Vermillion Creek Grazing Allotment (No. 04003). The northern portion of the project area lies within the Rock Springs Allotment and is composed of checkerboard lands owned or leased by the Rock Springs Grazing Association. The southern portion of the PRPA lies within the Vermillion Creek Allotment. Cattle and sheep are the primary livestock types permitted for the two allotments. Table 3-15 describes the affected allotments. Stocking rates for the two allotments are about 10 acres per animal unit month (AUM) for the Rock Springs Allotment and 11 acres/AUM for the Vermillion Creek Allotment.

Table 3-15. Grazing allotments and permitted AUM's within the Pacific Rim Project Area.[1]

Allotment Name	Allotment #	Total Acres	Total AUM's	Permittees
Rock Springs	13018	1,797,178	180,237	22
Vermillion Creek	04003	149,143	13,543	4

[1] Source: Kevin Lloyd, Range Management spec., RSFO (2004)

3.7 WILDLIFE AND FISHERIES

3.7.1 Wildlife

3.7.1.1 Introduction

The PRPA lies within the BLM Rock Springs Field Office. Objectives for wildlife management in the Rock Springs Field Office are directed by the ROD of the Green River RMP (USDI-BLM 1997). The RMP provides for multiple use planning and management of public lands and resources in a combination designed to meet present and future needs.

The project area provides diverse habitat that supports a wide variety of resident, migrant, and seasonally resident wildlife species. Because many wildlife species are highly mobile and can readily move in and out of the project area, records of current and historical wildlife species occurrences were obtained for the project area and an approximate six-mile zone surrounding it. Since activities
within the project area could potentially affect nesting raptors and greater sage-grouse breeding activities that are outside the project area, the area of analysis was expanded for these species to include a 1-mile and 2-mile buffer zone, respectively.

Information concerning current and historical wildlife locations was obtained from several sources. Information regarding greater sage-grouse lek and raptor nest locations was obtained from the BLM Rock Springs Field Office. Additional information was acquired from the Wyoming Game and Fish Department (WGFD) Wildlife Observation System (WOS) (WGFD 2003a). This listing contains records for all types of wildlife (birds, mammals, reptiles, amphibians). The Atlas of Birds, Mammals, Reptiles, and Amphibians in Wyoming (WGFD 1999) was also used to assess the potential occurrence of species in the project area. This atlas divides Wyoming into 28 degree blocks, and the presence or absence and breeding activity of vertebrate species are documented by degree block. The project area is located in degree block 24. A species was considered to have the potential for occurrence in the project area if it was reported as observed, breeding, or historically present within degree block 24. Annual big game herd unit reports from the WGFD were also used. Data was also acquired from Wyoming Natural Diversity Database (WYNDD). Location records for vertebrate species of special concern (federal or state) within a township buffer of the project area were obtained from WYNDD (WYNDD 2003). Although wild horses are not managed as wildlife by the WGFD and BLM, they are included in the wildlife sections of this document.

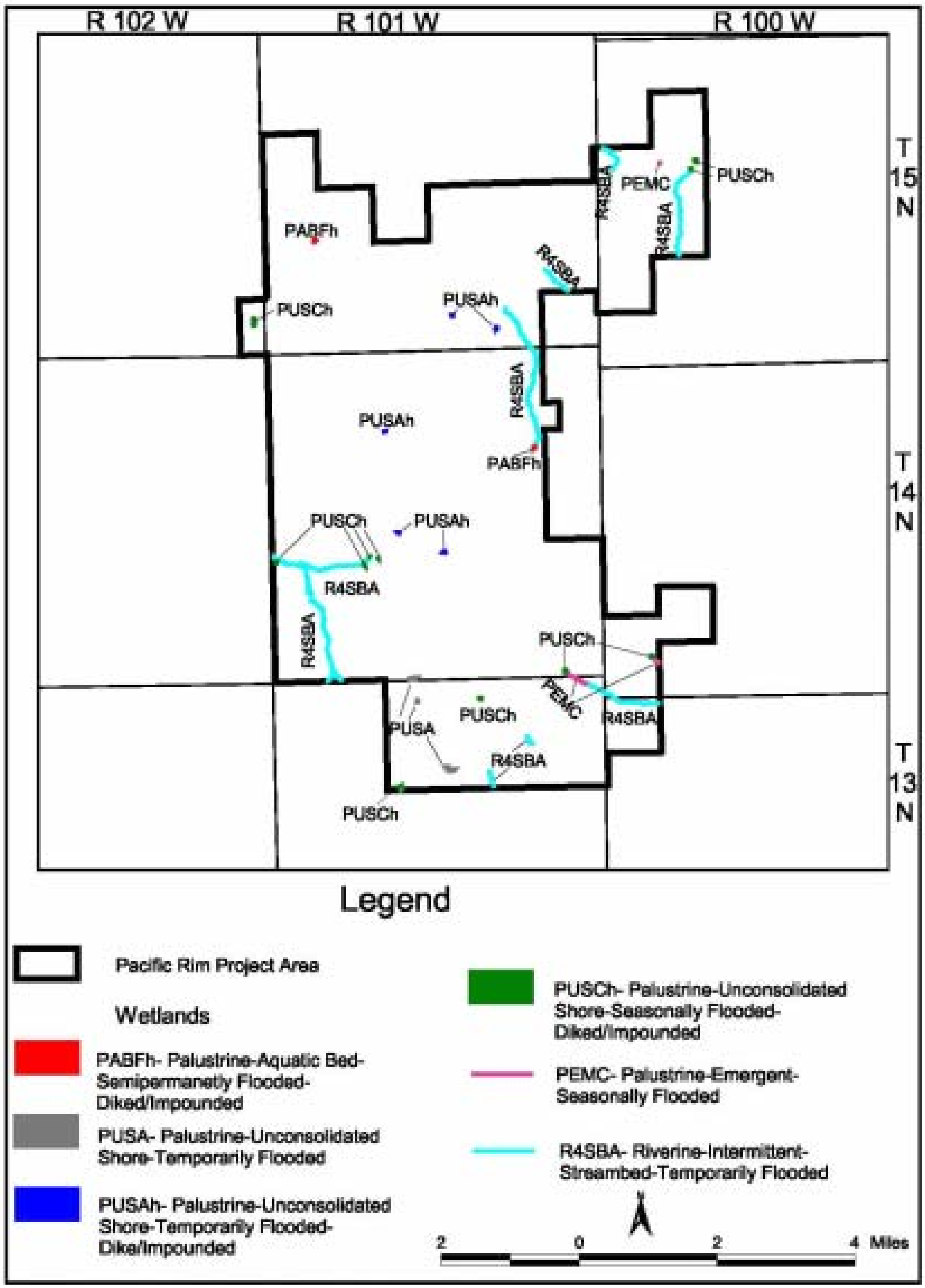


Figure 3-10. Wetlands on the PRPA.

Existing wildlife information for the project area was supplemented through survey data collected by Hayden-Wing Associates (HWA) biologists during the fall of 2003. The data collections in the fall of 2003 consisted of aerial and ground surveys to determine: (1) the occurrence, location, and size of white-tailed prairie dog colonies; (2) the occurrence, location, and size of potential mountain plover habitat; and (3) the presence/absence of black footed ferrets within white-tailed prairie dog colonies that provide suitable habitat.

3.7.1.2 Wildlife Habitat

Wildlife habitats that could be affected by the project include areas that would be physically disturbed by the construction of gas wells, related roads, pipelines, and production facilities, as well as zones of influence. Zones of influence are defined as those areas surrounding, or associated with, project activities where impacts to a given species or its habitat could occur. The shape and extent of such zones varies with species and circumstance.

The two most extensive wildlife habitats within the PRPA are Wyoming big sagebrush steppe and juniper/sagebrush woodlands. Smaller areas of desert shrub, mixed grass prairie, and intermittent shrub-dominated riparian habitats also occur on the project area. See Section 3.5.2 for further description of vegetation types within the PRPA.

3.7.1.3 General Wildlife

A total of 310 species has been recorded on or proximal to the project area either as residents or migrants and includes 59 mammal species, 242 bird species, 4 amphibian species, and 5 reptile species (Appendix A). The presence of these wildlife species was determined from the sources of information discussed in Section 3.7.1. Although all species in Appendix A are important members of a functioning ecosystem and wildlife community, most are common and have wide distributions in the region.

3.7.1.4 Big Game

Three big game species: mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), and pronghorn antelope (*Antilocapra americana*) occur on the project area. Big game populations are managed by the WGFD within areas designated as herd units and are discussed in that context.

According to the Green River RMP, big game crucial winter ranges and parturition areas will be protected to ensure continued usability by limiting activities during critical seasons of use and by limiting the amount of habitat disturbed. Crucial big game winter range is defined as those areas that are available, relatively intact, and winter most of the population at its objective in adequate body condition, eight or more years out of ten (ROD Green River RMP, Appendix 7).

Mule Deer. The project area lies within the South Rock Springs Herd Unit. The entire project area is utilized by mule deer on a year-round basis. Nearly 7,648 acres (17.7%) of the project area is crucial winter/yearlong mule deer range, located in the southwestern and extreme northeastern portions of the project area (Figure 3-12). This constitutes 2.2% of the crucial winter range in the South Rock Springs Herd Unit. No designated mule deer parturition areas occur in the PRPA.

Elk. The project area lies primarily within the Petition Herd Unit, but a small portion is located in the

South Rock Springs Herd Unit (Figure 3-13). The Petition Herd Unit consists of isolated groups of

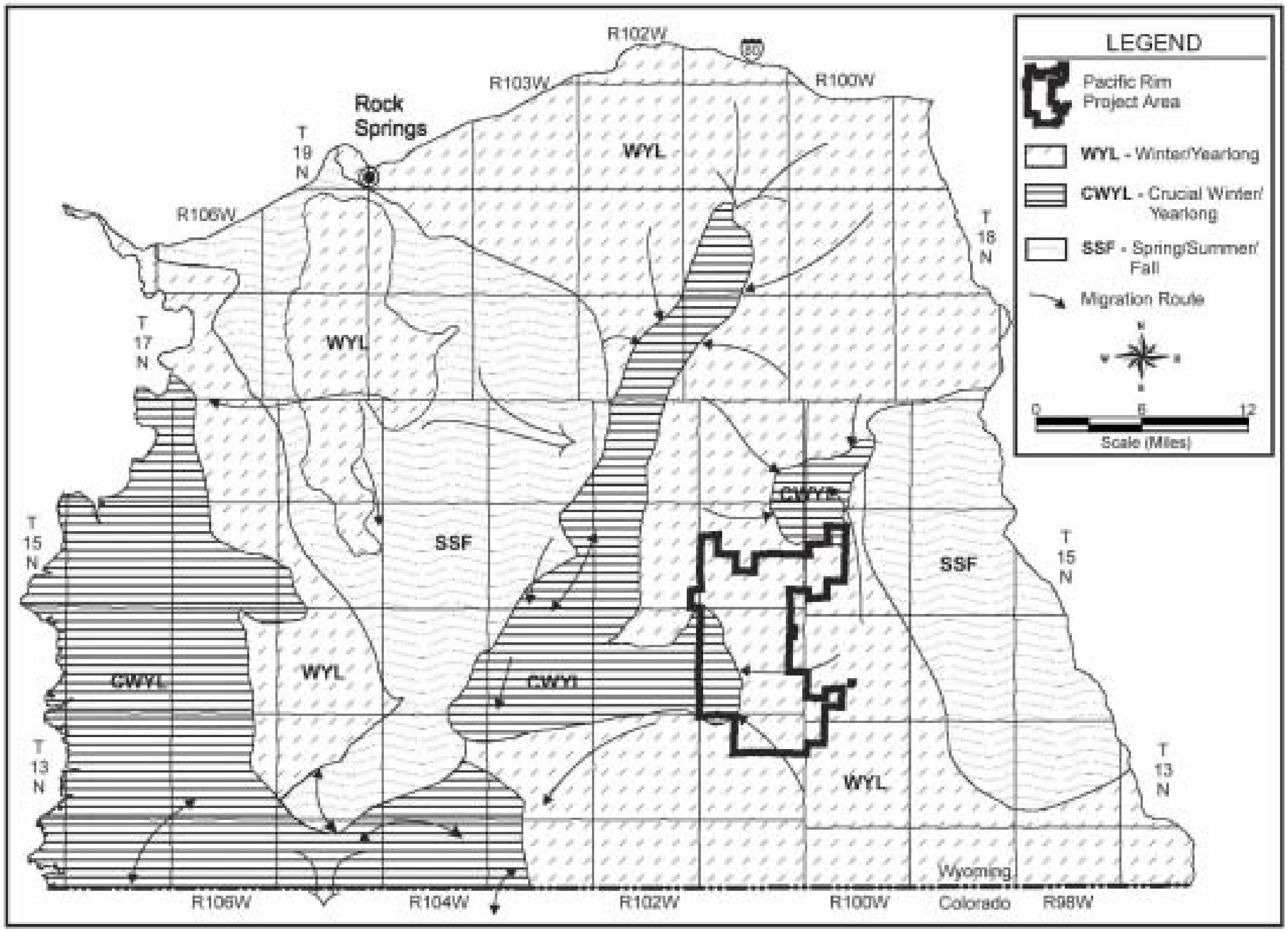


Figure 3-11. South Rock Springs Mule Deer Herd Unit seasonal ranges in relation to the PRPA.

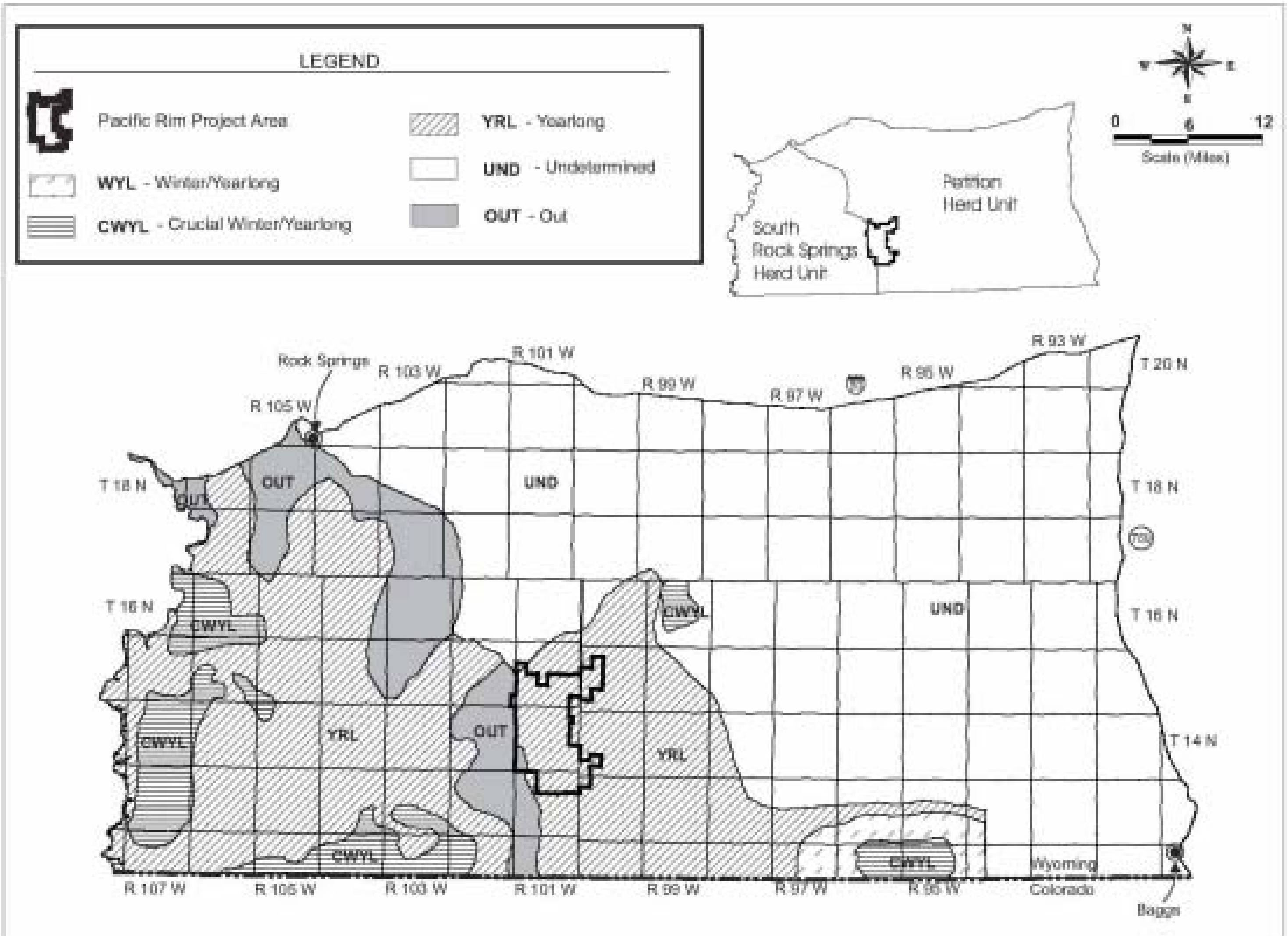


Figure 3-12. Petition and South Rock Springs Elk Herd Unit seasonal ranges in relation to the PRPA.

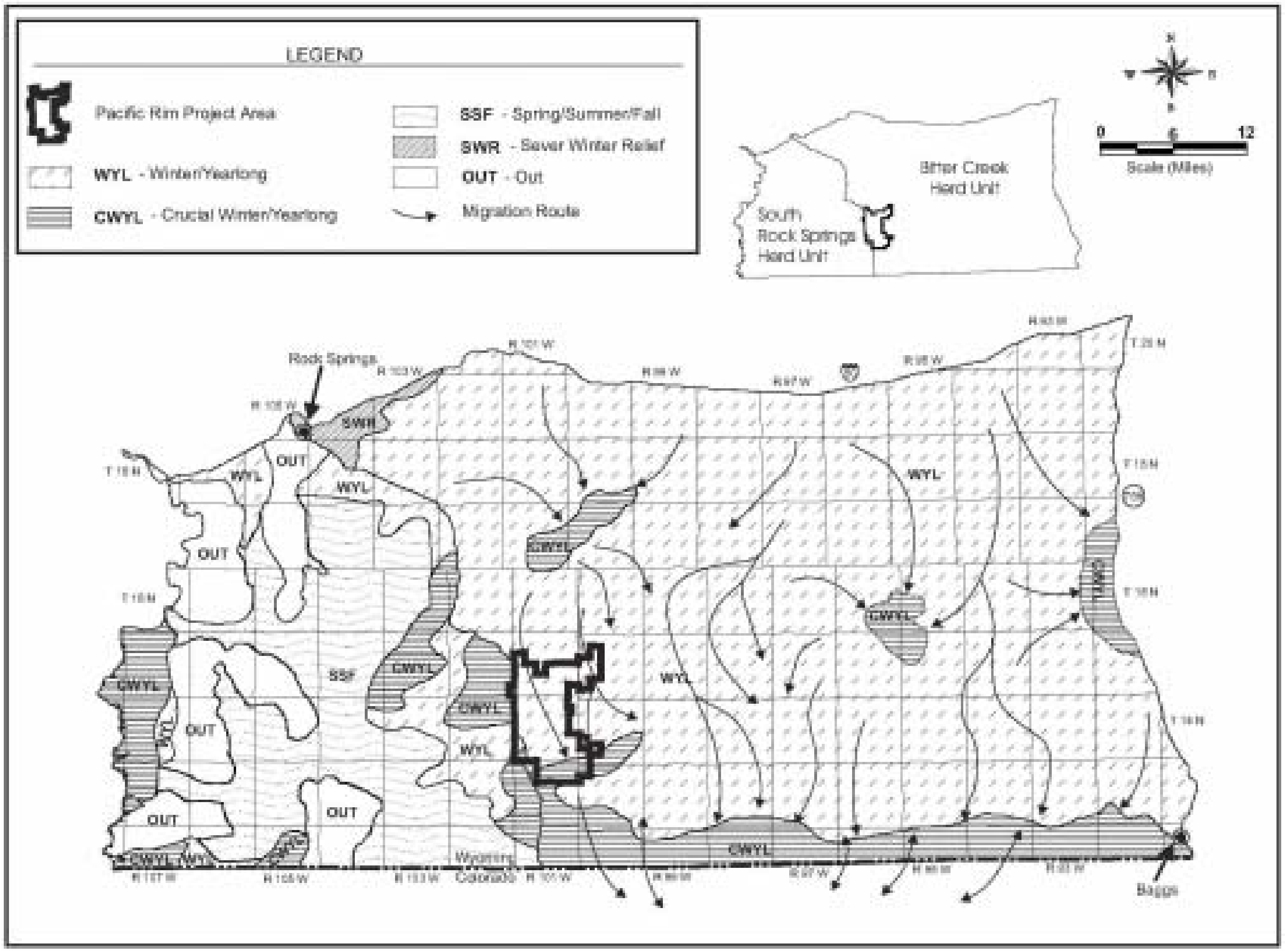


Figure 3-13. South Rock Springs and Bitter Creek Pronghorn Herd Unit seasonal ranges in relation to the PRPA

Figure 3-14. Big Game Crucial Seasonal Ranges in relation to the PRPA.

elk that utilize higher elevation ridges and adjacent habitats within a desert area. It is difficult to determine a population estimate for this herd because there are few animals scattered over a large area and a portion of the herd is migratory and interchanges with elk herds in Colorado. The project area includes no designated elk crucial winter range or parturition areas.

Pronghorn Antelope. The project area lies primarily within the Bitter Creek Herd Unit, but a small portion is in the South Rock Springs Herd Unit. The entire project area is utilized by pronghorn on a year-round basis. Approximately 15.5% or 6,705 acres of the project area is classified as crucial winter/yearlong pronghorn habitat (Figure 3-14). Crucial winter/yearlong pronghorn range is found in the southern portion and along the western edge of the project area (Figure 3-14). No designated pronghorn parturition areas occur in the PRPA.

Big Game Summary. The southern portion of the project area provides crucial habitat for pronghorn, while the southwestern and extreme northeastern portions of the project area provide crucial habitat for mule deer. A small area in the southwestern portion of the project area (662 acres) includes both mule deer and pronghorn crucial winter/yearlong range (Figure 3-14). The majority of the project area is used by elk on a year-round basis, however, none of the habitat is considered to be elk crucial winter range.

3.7.1.5 Wild Horses

A wild horse is defined as an unbranded and unclaimed free roaming horse in the western United States. Wild horses are protected and managed in accordance with the Wild Horse and Burro Act of 1971 (Public Law 92-195). They are classified to genus and species as *Equis caballus* and can be either domesticated or feral (feral refers to a wild state of existence for domesticated animals). The passage of the Wild Free Roaming Horse and Burro Act of 1971 officially assigned the status of wild horse to feral horses.

The PRPA lies within the Salt Wells Wild Horse Herd Management Area (HMA), which encompasses about 1,193,283 acres, of which 725,704 acres are BLM-administered public lands (61%). The remaining lands (39%) are predominantly checkerboard lands leased/owned by the Rock Springs Grazing Association (RSGA). Boundaries of the HMA extend from U.S. Highway 191 south of Rock Springs east to the Rock Springs-Rawlins Field Office management area boundary and south to the Wyoming-Colorado state line (USDI-BLM 1999a). The total surface area of the proposed PRPA represents about 3.6% of the total land surface area of the HMA.

The BLM Bureau 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. The current wild horse population estimate for the Salt Wells HMA is 345 horses. This population level falls within the desired range of 251-365 animals established for this HMA. A wild horse population census update of the Salt Wells HMA is scheduled for 1 March 2004 (Lloyd 2004).

With no known natural predators, the historical annual rate of increase in wild horse populations in the RSFO area is about 20 percent (USDI-BLM 1999a). The primary human-made hazards to wild horses in the PRPA may be possible injuries due to vehicle traffic and barbed wire fences. Minimal fencing exists in the HMA and is mostly associated with deeded property or major highways (i.e., WYO 430). Most secondary roads, grazing allotments, as well as checkerboard lands, are not fenced in the Salt Creek HMA (USDI-BLM 1999a).

3.7.1.6 Upland Game Birds

The greater sage-grouse and mourning dove are the only upland game bird species known to occur on or around the project area.

Greater Sage-grouse. See section 3.8.2.2.

Mourning Dove. Mourning doves may be found on the project area during the spring and summer months and are typically associated with sagebrush-grass, mountain shrub, and riparian habitats. It is likely that some mourning doves utilize the PRPA during the breeding season.

3.7.1.7 Waterfowl and Shorebirds

Primary use of the project area by waterfowl and shorebirds is minimal because of the small amount of open water and wetlands available (see Section 3.5.5). However, the limited wetlands available may still provide adequate cover and nesting habitat for a very limited number of waterfowl during moist years.

3.7.1.8 Raptors

According to the WOS data (WGFD 2003a), 13 raptor species have been observed on or within six miles of the PRPA: American kestrel (*Falco sparverius*), burrowing owl (*Athene cunicularia*), Cooper's hawk (*Accipiter cooperii*), ferruginous hawk (*Buteo regalis*), bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), great horned owl (*Bubo virginianus*), northern harrier (*Circus cyaneus*), prairie falcon (*Falco mexicanus*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus*), short-eared owl (*Asio flammeus*), and Swainson's hawk (*Buteo swainsoni*). Records from the BLM Rock Springs Field Office and HWA show that 23 raptor nests occur on or within one mile of the PRPA (Figure 3-15). Two of the raptor nests (identified by HWA) were red-tailed hawk nests; the species utilizing the remainder of the nests was unknown. Current activity status for the known raptor nest sites is unknown. Activity status of raptor nests will be checked at the APD level prior to well development. A one-mile buffer was placed around the 23 raptor nests and this area covers approximately 12,524 acres (29%) of the PRPA. This is the estimated area that may be subject to raptor stipulations from February 1 to July 31.

3.7.2 Fish

3.7.2.1 Fish Introduction

The PRPA lies within the Green River Basin. Most of the PRPA drains in a westerly direction into East Salt Wells Creek (Figure 3-7 Surface Water Features in the Pacific Rim Project Area). East Salt Wells Creek flows from the PRPA northwesterly into Salt Wells Creek, which is a tributary of Bitter Creek. Bitter Creek flows into the Green River at Green River, WY. Some of the northeastern, eastern and southeastern portions of the PRPA drain into Alkali Creek, a tributary of Vermillion Creek. A small part of the southwest portion of the PRPA drains into the North Fork of Vermillion Creek and hence into Vermillion Creek. Vermillion Creek flows south into Colorado and, hence, into the Green River.

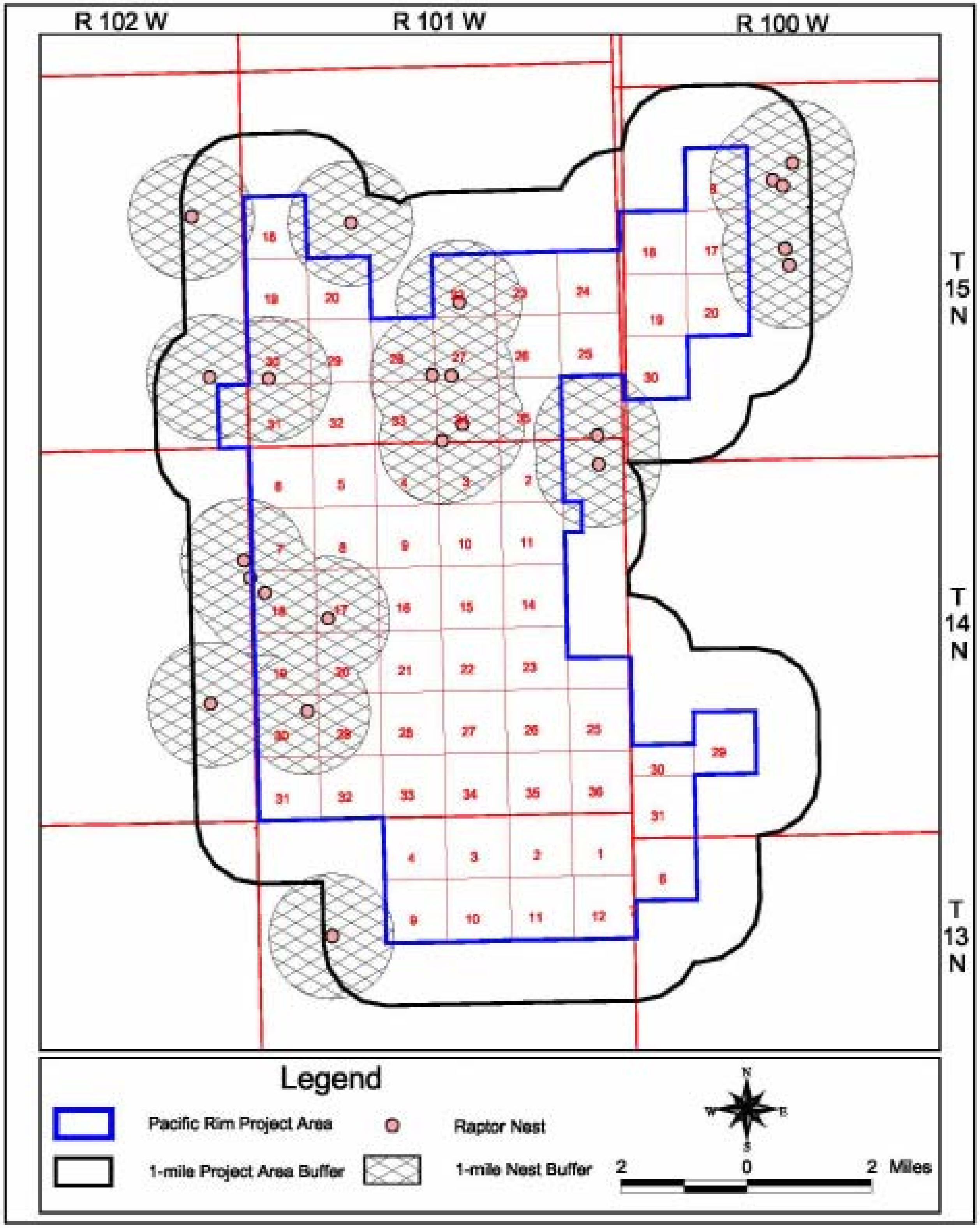


Figure 3-15. Raptor nests in relation to the Pacific Rim Project Area.

3.7.2.2 Fish Habitat

No perennial streams are present within the PRPA. All of the streams are ephemeral or intermittent. The PRPA also has a number of small ephemeral impoundments that are primarily used as water sources for livestock and wildlife, but which do not support fisheries. All streams within the PRPA are classified by the WGFD (1991) as Class 5 ephemeral drainages without fishery resources. The first streams downstream of the project are East Salt Wells Creek, Alkali Creek, Black Butte Creek, North Fork Vermillion Creek and Vermillion Creek. All except North Fork Vermillion Creek and Vermillion Creek are intermittent or ephemeral waters that do not support fish. Salt Wells Creek and Bitter Creek are intermittent Class 5 waters that only have non-game fish species. The North Fork Vermillion Creek upstream of the PRPA supports one game species, brook trout (*Salvelinus fontinalis)* and is a Class 3 water of regional importance. Most of the non-game species in these streams are native species. The Green River in Wyoming and Colorado supports a wide variety of game and non-game fish species, both native and non-native. In Wyoming, the Green River downstream of Bitter Creek is a Class 2 water that supports a fishery of state-wide importance.

No water quality data are available for any streams within the PRPA. Salt Wells Creek, Bitter Creek, and Vermillion Creek are desert streams characterized by low base flows and high concentrations of dissolved solids (Section 3.4.2.2). During periods of high flow, such as following rainstorms or snow melt, these waters often have very high concentrations of suspended solids.

3.7.2.3 General Fish

Twenty-six fish species are potentially present in waters downstream of the PRPA in Salt Wells Creek, Bitter Creek, North Fork Vermillion Creek, Vermillion Creek and the Green River (Appendix B-2). No game fish species are present in the three perennial and intermittent creeks immediately downstream of the PRPA, while at least 10 game fish species are present in the Green River downstream of Bitter Creek. Among the non-game species, four are endangered (Section 3.8.1.2) and four are BLM sensitive species (Section 3.8.2.2), though one is outside of its historic range.

3.8 SPECIAL STATUS WILDLIFE, FISH, AND PLANT SPECIES

Special status species include: (1) threatened, endangered, candidates, or those petitioned for listing as threatened or endangered by the FWS under the Endangered Species Act (ESA) of 1973, as amended; and (2) those designated by the BLM State Director as sensitive (USDI-BLM 2002).

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

The FWS has determined that one mammal, two birds, four fish, and one plant species listed as either threatened, endangered, candidate or proposed under the ESA may potentially be found or be affected by activities conducted within the project area (USDI-FWS 2003). These species and their federal status under the ESA are listed in Table 3-16. The black-footed ferret, bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker are listed as endangered. The bald eagle and Ute ladies'-tresses are listed as threatened and the yellow-billed cuckoo is a candidate for listing as endangered under the ESA. The four endangered fish species, which are downstream residents of the Colorado River System, are included in this analysis because of potential water depletions to the Colorado River System.

Table 3-16. Threatened, endangered, proposed, and candidate species potentially affected by or present on the Pacific Rim Project Area.

Species	Scientific Name	Status
Mammals		
Black-footed ferret	*Mustela nigripes*	Endangered
Birds		
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Yellow-billed Cuckoo	*Coccyzus americanus*	Candidate
Fish		
Bonytail chub	*Gila elegans*	Endangered
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered
Humpback chub	*Gila cypha*	Endangered
Razorback sucker	*Xyrauchen texanus*	Endangered
Plants		
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened

Source: USDI-FWS 2003

3.8.1.1 Mammal 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 essential habitat for black-footed ferrets. Black-footed ferrets depend almost exclusively on prairie dogs for food and they also use prairie dog burrows for shelter, parturition, and raising young (Hillman and Clark 1980, Fagerstone 1987). Existing white-tailed prairie dog colonies located on the PRPA were mapped by HWA in early September, 2003. An aerial survey was conducted on September 2, 2003 to locate white-tailed prairie dog colonies. The colonies located from the air were then mapped in their entirety from the ground, on foot, or from an ATV (Biggins et al. 1989). Boundaries of the colonies were mapped using a hand-held GPS receiver. Fifty-seven white-tailed prairie dog colonies were mapped on and near the PRPA; these colonies covered a total of 4,391 acres, with 3,237 acres occurring within the PRPA boundary (Figure 3-16). Eighteen colonies, covering 3,612 acres, were surveyed for the presence of black-footed ferrets in September and October 2003 (HWA 2003a, b). All black-footed ferret surveys were performed in accordance with black-footed ferret survey guidelines outlined by the FWS (USDI-FWS 1989). No black-footed ferrets or their sign were observed in the white-tailed prairie dog colonies that were surveyed (HWA 2003a, b). No black-footed ferrets or their signs were observed during the nocturnal spotlight survey or morning ground search (HWA 2003a,b). Survey results and maps are available at the BLM RSFO.

3.8.1.2 Bird Species

Bald Eagle. Bald eagles typically build stick nests in the tops of coniferous or deciduous trees along streams, rivers, or lakes. Selection of nests likely depends upon availability of food in the early nesting season (Swenson et al. 1986). The habitat on the project area lacks large perennial water bodies and nesting trees for bald eagles, therefore nesting on the project area is not likely. Wintering areas are typically associated with concentrations of food sources including major rivers that remain unfrozen where fish and waterfowl are available and ungulate winter ranges where carrion is available. Thirteen records of bald eagle occurrence approximately seven miles south of the project area were recorded in the WOS in January 1980 and February 1985 (WGFD 2003a). Although nesting and wintering habitat is limited, bald eagles may occasionally utilize the project area for hunting or foraging.

Yellow-billed Cuckoo. The yellow-billed cuckoo is a neotropical migrant that winters primarily in South America and migrates north into the United States during April and May. The yellow-billed cuckoo feeds primarily on large insects: caterpillars, katydids, cicadas, grasshoppers, and crickets. Occasionally small frogs, lizards, eggs, and young birds are eaten (Hughes 1999). It is a riparian obligate species that requires at least 25 acres of mature riparian woodland, especially cottonwood (*Populus* spp.) or willow (*Salix* spp.) with low, dense undergrowth at elevations below 7,000 feet. The cuckoo prefers 100 acres or more of deciduous woodland at least 100 meters wide. Marginal habitat is at least 10 acres of riparian habitat more than 50 meters in width. Nests are located less than 8 meters above the ground in at least 2.5 acres of dense deciduous vegetation near water (Cerovski et al. 2001).

Due to the lack of adequate habitat on the project area and the fact that no records are documented within six miles of the project area (WGFD 2003a, WYNDD 2003) it is unlikely that the yellow-billed cuckoo occurs on the project area.

3.8.1.3 Fish Species

Four federally endangered fish species may occur as downstream residents of the Green and Colorado River system: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail chub (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USDI-FWS 2003). The Colorado pikeminnow, bonytail chub, 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 (e.g. dams and reservoirs) 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).

The last occurrence of any of these fish species in the Green River in Wyoming was prior to the filling of Flaming Gorge Reservoir in 1963. Habitat for these species is not present within the PRPA and critical habitat for these species has not been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for project-related reductions in water quantity and/or quality to these tributaries to the Green River and Colorado River warrant their inclusion in this NEPA document.

Colorado Pikeminnow. The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of Colorado Basin rivers. The species was once abundant in the main stem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River in Wyoming at least as far north as the City of Green River.

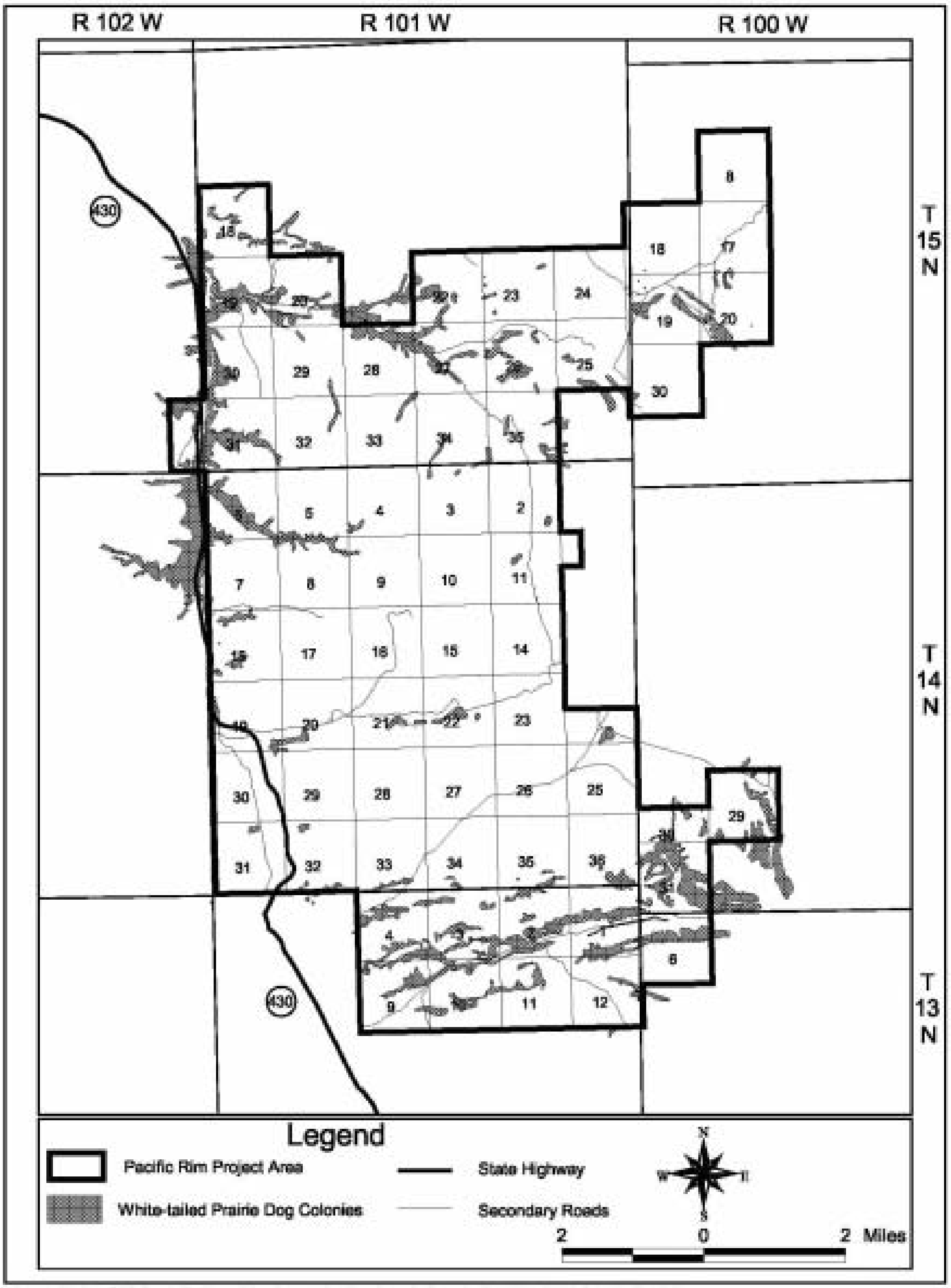


Figure 3-16. White-tailed prairie dog colonies in relation to the Pacific Rim Project Area.

Bonytail Chub. Habitat of the bonytail chub is primarily limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail chub is thought to be the rarest of the endangered fishes in the Colorado River System.

The bonytail chub historically inhabited portions of the upper and lower Colorado River basins. Today, in the upper Colorado River Basin, only small, disjunct populations of bonytail chub are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray canyons, in the Colorado River at the Colorado/Utah border, and in Cataract Canyon (Upper Colorado River Endangered Fish Recovery Program 1999).

Humpback Chub. Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and white water areas (Valdez and Clemmer 1982, Archer et al. 1985, Upper Colorado River Endangered Fish Recovery Program 1999). The humpback chub was historically found throughout the Colorado River System, and its tributaries, which are used for spawning (Valdez et al. 2000). It is estimated that the humpback chub currently occupies 68% of its original distribution in five independent populations that are thought to be stable (Valdez et al. 2000).

Razorback Sucker. The razorback sucker is an omnivorous bottom feeder and is one of the largest fishes in the sucker family. Adult razorback sucker habitat use varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today, in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado and occasionally in the Colorado River near Grand Junction (Upper Colorado River Endangered Fish Recovery Program 1999).

3.8.1.4 Plant Species

No federally listed threatened, endangered, or candidate plant species are known to occur on the PRPA (Glennon 2004). Ute ladies'-tresses (*Spiranthes diluvialis*), a FWS threatened species, is known to occur in certain habitats along the Green River in Daggett County, Utah, south of the PRPA. Although no suitable habitat for Ute ladies'-tresses occurs on the PRPA, the proximity of known populations in Utah requires field surveys for the plant in Sweetwater County to meet FWS and ESA Section 7 requirements for Environmental Assessments (Glennon 2004). The following description of the plant and its habitat requirements is summarized from information provided by the FWS (2003) and Fertig (2000).

Ute ladies'-tresses. Ute ladies'-tresses is a perennial, terrestrial orchid with stems 12 to 50 cm tall, narrow leaves, and flowers consisting of a few to many white or ivory flowers clustered into a spike arrangement at the top of the stem. It blooms from late July through August; however, depending on location and climatic conditions, orchids may bloom in early July or still be in flower as late as early October. Plants probably do not flower every year and may remain dormant below ground during drought years.

The Ute ladies'-tresses is 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 wet meadows 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 wetness in the root zone through the growing season. The orchid seems generally intolerant of shade and is found primarily in open grass and forb-dominated sites where vegetation is relatively open and is not dense or overgrown. The plants usually occur in small scattered groups.

3.8.2 Sensitive Wildlife, Fish, and Plant Species

Although these species have no legal protection under the ESA, the BLM and FWS still maintain an active interest in their numbers and status. It is BLM policy (BLM policy under 6840) to manage these species to preclude the need for listing under the ESA. Sensitive species included in this section include those listed on the BLM Wyoming State sensitive species list (USDI-BLM 2002). The BLM views management of sensitive species as an opportunity to practice pro-active conservation; this management should not be onerous, or a show-stopper of other legitimate, multiple use activities (USDI-BLM 2002). The BLM Wyoming Sensitive Species list is meant to be dynamic, and the list will be reviewed annually. The sensitive wildlife, fish, and plant species found in the Rock Springs Field Office and their sensitivity status/rank are listed in Table 3-17. The RSFO identified several of these species to be considered in more detail; a discussion of those species follows.

3.8.2.1 Mammals

Nine sensitive mammal species may potentially be found on the PRPA (USDI-BLM 2002; Table 3-17). These include: Idaho pocket gopher, Wyoming pocket gopher, pygmy rabbit, white-tailed prairie dog, swift fox, spotted bat, fringed myotis, long-eared myotis, and Townsend's big-eared bat. The RSFO identified five of these species that should be considered in more detail: Townsend's big-eared bat, swift fox, Wyoming pocket gopher, pygmy rabbit, and white-tailed prairie dog.

Townsend's Big-eared Bat. This bat can be found throughout Wyoming and its distribution is likely determined by the availability of roosts such as caves, mines, tunnels, and crevices with suitable temperatures (Clark and Stromberg 1987). The Townsends big-eared bat is known to gather in small groups. They can be found roosting in mines, caves, and structures in woodlands and forests generally up to 9,500 feet elevation, but sometimes higher. The most typical habitats for this bat are desert shrub lands, pinon-juniper woodlands, or dry coniferous forests (Armstrong et al. 1994). Potential habitat for Townsend's big-eared bat does occur within the PRPA and it is possible that it may occur there.

Swift Fox. The swift fox inhabits short grass and mid-grass prairies over most of the Great Plains including eastern Wyoming (Clark and Stromberg 1987). The swift fox commonly prefers areas with relatively flat to gently rolling topography (Fitzgerald et al. 1994, Olson 2000). Swift foxes prey on a variety of small rodents, lagomorphs, birds, and insects (Cutter 1958, Olson 2000). This species has been studied in Wyoming (Olson 2000), and surveys conducted by Woolley et al. (1995) show that it is much more widely distributed in Wyoming than previously thought. Woolley's studies have documented occurrences in northeastern Sweetwater County but his study area did not include the PRPA in southern Sweetwater County.

No records of swift fox were documented in the WOS (WGFD 2003a) or WYNDD (2003) within six miles of the PRPA. Although the majority of the project area is not ideal habitat, the eastern 1/3 of the project area may provide low quality habitat for swift fox.

Table 3-17. Sensitive wildlife, fish, and plant species potentially present in the PRPA.[1]

Wildlife Species			
Common Name	**Scientific Name**	**Sensitivity Status**[2]	**Occurrence Potential**[3]
Mammals			
Idaho pocket gopher	*Thomomys idahoensis*	G4/S2?, NSS3	Unlikely
Wyoming pocket gopher	*Thomomys clusius*	R2, G2/S1S2, NSS4	Likely
Pygmy rabbit	*Brachylagus idahoensis*	G4/S2, NSS3	Possible
White-tailed prairie dog	*Cynomys leucurus*	G4/S2S3, NSS3	Present
Swift fox	*Vulpes velox*	R2, G3/S2A3	Possible
Spotted bat	*Euderma maculatum*	R2/R4,G4/S1B, SZ?N, NSS2	Unlikely
Fringed myotis	*Myotis thysanodes*	R2, G5/S1B, S1N, NSS2	Unlikely
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			
Mountain Plover	*Charadrius montanus*	G2/S2B, SZN	Likely
Sage sparrow	*Amphispiza belli*	G5/S3B, SZN	Likely
Brewer's sparrow	*Spizella breweri*	G5/S3B, SZN	Likely
Long-billed curlew	*Numenius americanus*	G5/S3B, SZN, R2, NSS3	Unlikely
Yellow-billed cuckoo	*Coccyzus americanus*	G5/S2B, SZN, FSR2, TBNG, NSS2	Unlikely
Sage thrasher	*Oreoscoptes montanus*	G5/S3B, SZN	Likely
Western burrowing owl	*Athene cunicularia*	R2, G4/S3B, SZN, NSS4	Present
Loggerhead shrike	*Lanius ludovicianus*	G5/S4B, SZN, R2	Likely
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	Unlikely
Ferruginous hawk	*Buteo regalis*	R2, G4/S3B, S3N, NSS3	Present
Northern goshawk	*Accipiter gentilis*	R2/R4, G5/S23B, S4N, NSS4	Unlikely
Reptiles			
Midget-faded rattlesnake	*Crotalus viridis concolor*	G5T3/S1S2	Unlikely
Amphibians			
Boreal toad	*Bufo boreas boreas*	G4T4/S2, R2, R4, NSS2	Unlikely
Great Basin spadefoot toad	*Spea intermontanus*	G5/S4, NSS4	Possible
Northern leopard frog	*Rana pipiens*	G5/S3, R2, NSS4	Unlikely
Spotted frog	*Rana pretiosa*	G4/S2S3, R2, R4, NSS4	Unlikely
Fish			

Common Name	Scientific Name	Sensitivity Status[2]	Occurrence Potential[3]
Leatherside chub	*Gila copei*	G3G4/S2, NSS1	Unlikely
Roundtail chub	*Gila robusta*	G2G3/S2?, NSS1	Unlikely
Bluehead sucker	*Catostomus discobolus*	G4/S2S3, NSS1	Unlikely
Flannelmouth sucker	*Catostomus latipinnis*	G3G4/S3, NSS1	Unlikely
Colorado River cutthroat Trout	*Oncorhynchus clarki pleuriticus*	R2/R4, G4T2T3/S2, NSS2	Unlikely

Plant Species

Common Name	Scientific Name	Status[2]	Habitat	Occurrence Potential[3]
Meadow pussytoes	*Antennaria arcuata*	G5/S2 RSFO	Moist, hummocky meadows, seeps or springs surrounded by sage/grasslands 4950 to 7900'	Low
Small rock cress	*Arabis pusilla*	G1/S1 RSFO	Cracks crevices in sparsely vegetated granite/pegmatite outcrops within sage/grasslands 8000 to8100'	Low
Mystery wormwood	*Artemesia biennis* var. *diffusa*	G5T1/S1 RSFO	Clay flats and playas 6500'	Low, known-private land ownership
Nelson's milkvetch	*Astragalus nelsonianus*	G2/S2 CO RSFO	Alkaline clay flats, shale bluffs and gullies, pebbly slopes and volcanic cinders in sparsely vegetated sagebrush, juniper, and cushion plant communities 5200 to 7600'	Possible
Precocius milkvetch	*Astragalus proimanthus*	G1/S1 RSFO	Cushion plant communities on rocky, clay soils mixed with shales on summits and slopes of white shale hills 6800 to 7200'	Low
Cedar Rim thistle	*Cirsium aridum*	G2Q/S2 RSFO	Barren, chalky hills, gravelly slopes and fine-textured, sandy-shaley draws 6700 to 7200'	Low
Ownbey's thistle	*Cirsium ownbeyi*	G3/S2 RSFO	Sparsely vegetated shaley slopes in sage and juniper communities 6440 to 8400'	Probable
Wyoming tanseymustard	*Descurania torulosa*	G1/S1 RSFO	Sparsely vegetated sandy slopes at base of cliffs or volcanic breccia or sandstone 8300 to 10000'	Low
Large-fruited bladderpod	*Lesquerella macrocarpa*	G2/S2 RSFO	Gypsum-clay hills and benches, clay flats and barren hills 7200 to 7700'	Low

Common Name	Scientific Name	Status[2]	Habitat	Occurrence Potential[3]
Stemless beardtounge	*Penstemon acaulis* var. *acaulis*	G3T2/S1 RSFO	Cushion plant or black sage grassland communities on semi-barren rocky ridges, knolls, and slopes 6500 to 7000'	Low
Beaver Rim phlox	*Phlox pungens*	G2/S2 RSFO	Sparsely vegetated slopes on sandstone, siltstone, or limestone substrate 6000 to 7600'	Low
Tufted twinpod	*Physaria condensate*	G2/S2 RSFO	Sparsely vegetated shale slopes and ridges 6500 to 7000'	Low
Green River greenthread	*Thelesperma caespitosum*	G1/S1 RSFO	White shale slopes and ridges of Green River formation 6300'	Low
Uinta greenthread	*Thelesperma pubescens*	G1/S1 RSFO FSR4	Sparsely vegetated benches and ridges on coarse, cobbly soils of Bishop Conglomerate 8500'	Low
Cedar Mountain Easter daisy	*Townsendia microcephala*	G1/S1 RSFO	Rocky slopes of Bishop Conglomerate 8500'	Low

[1] - Source: USDI-BLM (2002), WYNDD (2003).
[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.
R2 Designated sensitive in U.S. Forest Service Region 2 (Rocky Mountain Region).
R4 Designated sensitive in U.S. Forest Service Region 4 (Intermountain Region).

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, known distribution, and personal communications with RSFO biologists J. Dunder (wildlife) and J. Glennon (botany).

Wyoming Pocket Gopher. Little is known about the Wyoming pocket gopher. The species is the only mammal restricted to Wyoming, and the only known populations occur in the south-central portion of the state (Clark and Stromberg 1987).

Like all pocket gophers, the Wyoming pocket gopher spends most of its life underground. The species is frequently found along dry ridge tops and is associated with gravelly, loose soils and greasewood vegetation communities (*Sarcobatus* spp.) (Clark and Stromberg 1987). Within these habitats, the Wyoming pocket gopher digs two types of tunnels: (1) deep burrows with chambers used for shelter, nesting, food storage, and deposition of fecal material, and (2) long, winding, and shallow tunnels used to forage for roots, tubers, and other vegetation material from above (Nowak 1999). The shallow food tunnels are often visible from the ground surface and are useful in detecting the presence of pocket gophers. The limited behavioral information available on the species suggests that except during the breeding season, Wyoming pocket gophers lead solitary lives with only one individual per burrow system (Nowak 1999).

Potential habitat exists within the project area for Wyoming pocket gophers. There has been one documented occurrence of a Wyoming pocket gopher approximately 2 mile west of the PRPA (WYNDD 2003) and it is likely that this species occurs within the PRPA.

Pygmy Rabbit. The former range of the pygmy rabbit was thought to be limited to portions of Idaho and Utah until their presence was confirmed in southwest Wyoming (Campbell et al. 1982). Pygmy rabbit sightings were documented by HWA in1994 south of Fontenelle Reservoir in eastern Lincoln and western Sweetwater Counties (HWA 1994). Pygmy rabbits are limited to areas of dense and tall big sagebrush in predominantly sandy soils (Campbell et al. 1982, Clark and Stromberg 1987, Heady et al. 2002). Burrows are located in areas with greater cover, higher shrub density, taller vegetation, and greater forb cover (Heady et al. 2002).

No pygmy rabbit records within six miles of the project area were documented in the WOS (WGFD 2003a) or the WYNDD (2003). The project area is primarily dominated by Wyoming big sagebrush and it is possible that pygmy rabbits could occur on the project area. J. Dunder (RSFO wildlife biologist) feels that the species may occur within the project area; therefore, stands of tall sagebrush should be avoided where possible.

White-tailed Prairie Dog. See Section 3.8.1.1.

3.8.2.2 Birds

Fourteen sensitive bird species may potentially be found on the PRPA (USDI-BLM 2002; Table 3-17). These include: mountain plover, sage sparrow, Brewer's sparrow, long-billed curlew, yellow-billed cuckoo (see Section 3.8.1.2), sage thrasher, western burrowing owl, loggerhead shrike, greater sage-grouse, white-faced ibis, trumpeter swan, peregrine falcon, ferruginous hawk, and northern goshawk. The RSFO requested that the mountain plover, greater sage-grouse, sage thrasher, loggerhead shrike, Brewer's sparrow, sage sparrow, and burrowing owl be considered in more detail. The ferruginous hawk is known to occur in the PRPA and is discussed collectively in the raptor section (Section 3.7.1.8).

Mountain Plover. The mountain plover was previously proposed for listing as threatened, however, on September 9, 2003 the mountain plover was removed from proposed status (Federal Register 2003). The mountain plover nests over much of Wyoming, but its preferred habitat may be limited throughout its range in the state (Oakleaf et al. 1982, Dinsmore 1983, Leachman and Osmundson 1990). This ground-nesting species 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 mountain 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). These habitats are quite often associated with prairie dog colonies, and researchers have found that plovers use prairie dog colonies more often than other areas (Knowles et al. 1982, Knowles and Knowles 1984, Olson and Edge 1985). Loss of wintering and breeding habitats and prey-base declines from pesticide use are thought to be factors contributing to the decline of mountain plovers on the North American Continent (Wiens and Dyer 1975, Knopf 1994).

No mountain plover records within the 6-mile buffer of the project area were reported in the WOS (WGFD 2003) or WYNDD (2003). Areas providing potential mountain plover habitat were mapped from the ground by HWA in early September 2003. Potential mountain plover habitat closely corresponded to the extent of the white-tailed prairie dog colonies. A total of 4,670 acres of potential mountain plover habitat was mapped, of which, 3,695 acres were located within the PRPA (Figure 3-17). Surveys to determine the presence/absence of mountain plovers within the potential habitats may be conducted in the spring of 2004. Surveys would be performed in accordance with the USFWS guidelines (USDI-FWS 2002).

Greater Sage-grouse. The greater sage-grouse is the upland game bird of primary interest in the project area. The sage-grouse has declined over much of its range in the western states during recent years and has been petitioned for listing under the ESA by the USFWS. Populations in Wyoming have recently been in a decline due to a wide range of possible factors including drought, habitat loss, and habitat degradation.

The project area is located within the extensive sagebrush steppe habitat of southern Wyoming where greater sage-grouse are common. According to Call (1974), Braun et al. (1977), and Hayden-Wing et al. (1986), preferred nesting habitat is usually located within two miles of leks. Locations of known sage grouse leks on and within two miles of the PRPA were obtained from the BLM Rock Springs Field Office and from the WGFD. According to these records, four active leks are located on and within two miles of the PRPA (three leks within the project area boundary and one lek within the two-mile buffer of the project area; Figure 3-18). Because the status of these leks is known (active), no surveys of these leks would be required in the spring of 2004. The two-mile buffer of the four active leks, that area most likely to be utilized by nesting hens, covers approximately 16,731 acres (39%) of the PRPA.

Sage Thrasher. The sage thrasher generally occurs within shrub-dominated valleys and plains of the western United States and is considered a sagebrush (*Artemesia* spp.) obligate. Insects are the primary food source and foraging occurs almost exclusively on the ground. For successful breeding, the sage thrasher requires large patches of sagebrush steppe habitat and typically nests in taller shrubs with wider crowns (Reynolds et al. 1999).

Suitable habitat for the sage thrasher occurs in the PRPA and the WGFD reported four records of sage thrashers occurring within six miles of the project area (WGFD 2003a). It is likely that sage thrashers use the larger patches of taller sagebrush within the project area.

Loggerhead Shrike. The loggerhead shrike is a small avian predator that hunts from perches and impales its prey on thorns, barbed wire fences, and other sharp objects (Yosef 1996). It prefers open country within close proximity to brushy areas containing trees or shrubs taller than six feet for nesting (Dinsmore 1983). It breeds in basin-prairie shrublands, sagebrush grasslands, mountain-foothills shrublands, pine-juniper woodlands, and woodland chaparral. Nests are located 1-5 feet

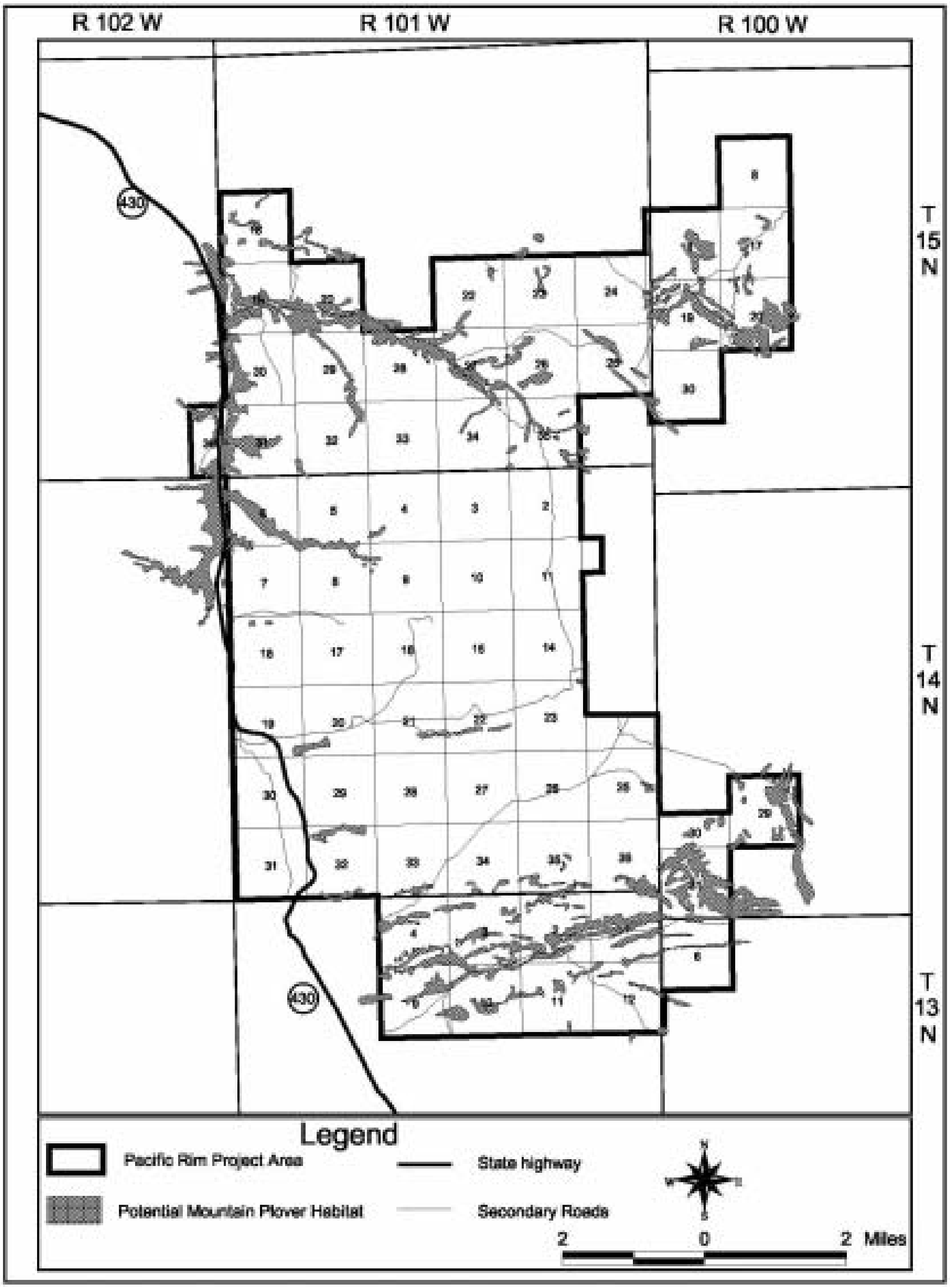


Figure 3-17. Potential mountain plover habitat in relation to the Pacific Rim Project Area.

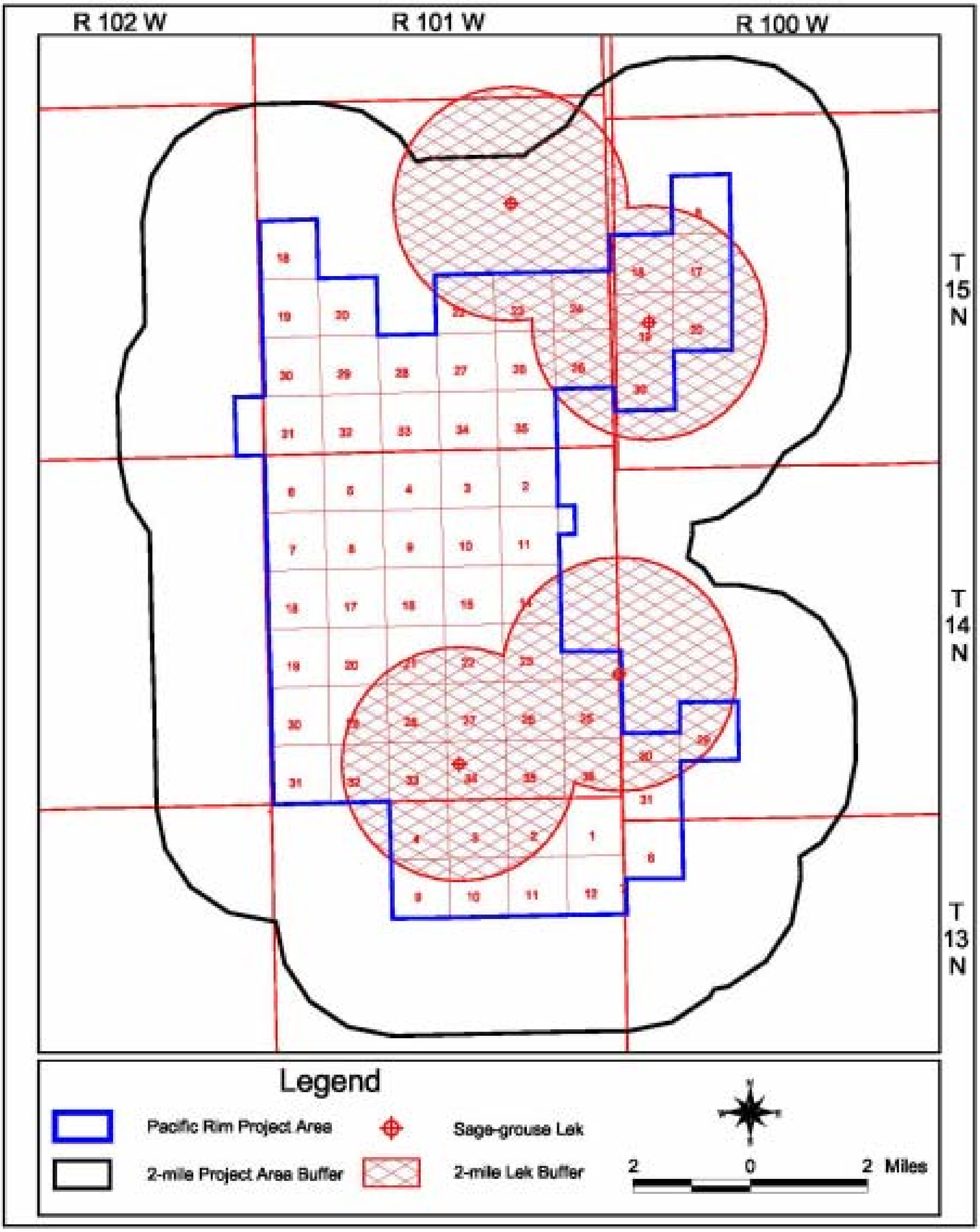


Figure 3-18. Greater sage-grouse leks in relation to the Pacific Rim Project Area.

above the ground regardless of shrub height. The loggerhead shrike feeds primarily on grasshoppers and other large insects although some small mammals and birds are also taken. Areas of low vegetation or bare ground are preferred foraging habitat (Cerovski et al. 2001).

Three records of loggerhead shrikes are documented within six miles of the project area (WGFD 2003a) and it is likely that loggerhead shrikes utilize portions of the project area during the nesting season.

Brewer's Sparrow. Most Brewer's sparrows breed in the Great Basin area of the western United States and winter in the Sonoran and Chihuahuan deserts of southwestern United States and Mexico (Rotenberry et al. 1999). Breeding habitat is closely associated with landscapes dominated by Wyoming big sagebrush with an average nest - shrub height of 0.5 meters. Nests are located less than 1.2 meters high in live sagebrush or on the ground at the base of a live sagebrush shrub. The Brewer's sparrow is a common cowbird host and parasitized nests are sometimes deserted (Cerovski et al. 2001).

Four records of Brewer's sparrows are documented within six miles of the project area (WGFD 2003a, WYNDD 2003). It is likely that Brewer's sparrows breed within the sagebrush habitats that exist on the project area.

Sage Sparrow. The sage sparrow prefers semi-open habitats with evenly spaced shrubs 1-2 meters high. Although closely associated with Wyoming big sagebrush, the sage sparrow will utilize sagebrush communities interspersed with other shrub species, such as bitterbrush (*Purshia tridentata*), saltbush (*Atriplex* spp.), shadscale (*Atriplex confertifolia*), rabbitbrush (*Chrysothamnus* spp.), or greasewood (Martin and Carlson 1998). Sage sparrows nest in shrubs up to one meter high and require a large block of unfragmented habitat to breed successfully (Cerovski et al. 2001).

One record of a sage sparrow was documented within six miles of the project area (WYNDD 2003). The project area is dominated by Wyoming big sagebrush and it is likely that sage sparrows occur on the project area.

Burrowing Owl. The burrowing owl is a summer resident on the plains over much of Wyoming and usually arrives on its breeding grounds from late March to mid-April (Johnsgard 1986, Haug et al. 1993). The species is associated with dry, open habitat that has short vegetation and contains an abundance of burrows (Thomsen 1971, Wedgwood 1978, Haug et al. 1993). In Wyoming, prairie dog burrows are the most important source of burrowing owl nest sites. Burrowing owl use of abandoned prairie dog towns is minimal, and active prairie dog towns are their primary habitat (Butts 1973). Destruction of burrowing mammal habitat that the birds depend on, pesticides, predators, and vehicle collisions have all combined to cause a decline in burrowing owl numbers (Haug et al. 1993).

Two burrowing owl sightings have been documented within six miles of the project area (WGFD 2003a, WYNDD 2003) and HWA biologists observed burrowing owls at two locations within the PRPA in September 2003. The extensive white-tailed prairie dog colonies within the PRPA provide adequate nesting habitat for burrowing owls.

3.8.2.3 Reptiles

The midget-faded rattlesnake may potentially be found on the PRPA (USDI-BLM 2002; Table 3-17). No records of midget-faded rattlesnakes are documented within six miles of the project area (WGFD 2003a, WYNDD 2003). The likelihood that the midget-faded rattlesnake occurs on the PRPA is low due to a lack of suitable habitat.

3.8.2.4 Amphibians

Four sensitive amphibian species may potentially be found near the PRPA (USDI-BLM 2002; Table 3-17). The boreal toad, northern leopard frog, and spotted frog are unlikely to occur on the PRPA; the Great Basin spadefoot toad has a slight potential to occur, and it is considered in more detail.

Great Basin Spadefoot Toad. In Wyoming, the Great Basin spadefoot occurs in sagebrush communities mostly west of the Continental Divide (Baxter and Stone 1992). They are dormant in fall and winter and their emergence in spring may be triggered by moisture in the burrow. Spadefoots may extend their dormancy period during drought for long periods of time. Breeding occurs during spring and early summer in permanent and temporary waters, including playas that develop after heavy rains and spring runoff pools. Males usually emerge from burrows after spring rains to breed, although Great Basin spadefoots do breed during periods of no rain. The stimulus for emergence for breeding in the absence of rain is unknown. Adult spadefoots are opportunistic carnivores and emerge from their burrows at night to forage for insects, arachnids, and snails only when the air is humid enough for dew to collect or during light rains (Howard 1996).

One record of a Great Basin spadefoot toad was documented in 1945, approximately seven miles east of the PRPA (WYNDD 2003). Although limited habitat exists in the PRPA, it is possible that Great Basin spadefoots may occur on the project area, where they may utilize intermittent and temporary water sources for breeding during years with adequate moisture.

3.8.2.5 Plants

Fifteen sensitive plant species have the potential to occur on or near the PRPA (USDI-BLM 2002). A summary of status, habitat associations, and potential of occurrence in the project area for the species are shown in Table 3-17.

Two BLM sensitive species known to occur near the project area include Nelson's milkvetch (*Astragalus nelsonianus*) and Wyoming tansymustard (*Descurainia torulosa*). The following discussion on these species is based on information provided by J. Glennon, RSFO Botanist (2004).

Nelson's milkvetch. Nelson's milkvetch is found all around the project area with the closest known population occurring more than 10 miles from the PRPA boundary. Potential habitat for this species is present on the project area. Not all of the PRPA has been surveyed and the possibility exists that it may be found during required BLM surveys.

Wyoming tansymustard. Wyoming tansymustard is known to occur north and northwest of the PRPA. It has been found closer than one mile from the project area boundary. There is some potential habitat for this species within the project area but it is generally located on steep slopes in areas that may be avoided in BLM's standard stipulations.

3.8.2.6 Fish

Fish species that are not listed as endangered or threatened by the FWS, but may be rare or declining in the state in the future, have been included on the BLM Wyoming Sensitive Species List (USDI-BLM 2002). Five sensitive fish species occur within the Rock Springs Field Office area (Table 3-17). These include: leatherside chub (*Gila copei*), roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*). Three of these species are known to occur in streams downstream of the PRPA. These include the roundtail chub, bluehead sucker, and flannelmouth sucker (WYNDD 2003, USDI-BLM 2002). All three species are present in the Green River downstream of the PRPA, while the bluehead sucker and flannelmouth sucker have been collected in Bitter Creek (WGFD 2004). WGFD is entering into a cooperative agreement with other states where these three non-game species are present. The goal of the cooperative agreement is to manage these species to prevent them becoming threatened or endangered. Likewise, it is BLM policy (BLM manual 6840) to manage sensitive species to preclude the need for listing under the ESA.

All of the streams within the PRPA are ephemeral and, therefore, do not have the potential to support BLM Wyoming state sensitive fish species on a year-round basis. Studies indicate that the non-game, native species may ascend ephemeral tributary streams to spawn (Maddux and Kepner 1988, Weiss et al. 1998). Thus, ephemeral drainages fed by runoff from the project area may provide habitat for sensitive fish on a seasonal basis only.

3.9 RECREATION

3.9.1 Introduction

The recreation resources of the PRPA, located within the vast Green River Basin of Wyoming, support only dispersed recreation because the area contains no developed recreation sites or facilities. Although the PRPA contains some private land areas, almost all recreation occurs on public land managed by the BLM.

Hunting is the main recreation use in the PRPA. The PRPA also attracts visitors who enjoy tracing historic trails and viewing wild horses and other wildlife. Camping and recreational use of off-highway vehicles (OHV) in the PRPA is almost entirely an accessory activity to other recreation, mainly hunting. There are no resources for sport fishing in the PRPA.

The PRPA is located within a larger region that the BLM places in visual resource management (VRM) category IV. For this category, the BLM's policy is to provide for activity that requires major modification of the existing character of the landscape. In fact, the PRPA already reflects some landscape change due to existing gas development (Foster 2003).

There are no recreational visitor data available for the PRPA, so characterization of the area's current use for recreation is possible only in very general terms. What is known is that recreation use of the PRPA is affected by several factors. First, the quality of recreational resources and settings, including areas used for hunting, is not unique compared to the lands of the BLM's RSFO as a whole and are generally not the kind that attract use from a wide area. Second, there are few population centers near the PRPA and those that are nearby are small. Finally, the PRPA contains no significant natural or historic sites, though it does overlap the visual setting of historical Cherokee Trail segments south of the PRPA.

The information presented here on recreation resources is based on interviews with agency personnel and information from published documents, including the Green River Resource Management Plan (BLM 1997).

3.9.2 Recreation Resources and Use

The principal recreation resources of the PRPA are public lands managed by the BLM. These resources mainly support big-game hunting. There is also some non-consumptive recreation, consisting mainly of historic trail visits and wild horse viewing.

3.9.2.1 Hunting

Some big game animals are hunted in the PRPA, and habitat within the PRPA does include some crucial big game winter range. The PRPA also supports some sage-grouse hunting, and the area contains some sage-grouse seasonal restriction areas (BLM 1997). (See section 3.8 for a discussion of greater sage-grouse). Hunting for mule deer, elk, antelope and sage-grouse occurs generally from September through October. Small game hunting also occurs in late fall and winter in the PRPA, as it does in habitat of various kinds throughout the RSFO and the state of Wyoming as a whole.

Table 3-18 presents data on hunting use reported by the WGFD for the entirety of hunt areas that contain the PRPA. These hunt areas generally extend from I-80 to Wyoming-Colorado border and from WYO 430 east to the Antelope Creek and Shell Creek drainages east of Kinney Rim for antelope and mule deer and east to WYO 789 for elk.

Table 3-18. Estimates of Hunting in 2002 for WGFD Hunt Areas Containing the PRPA

Game Species	Hunt Area Involved	Total Hunters	Non-Resident Hunters	Hunter Success, All Hunters	Average Days per Hunter, All Hunters
Antelope	53 Black Butte-Kenny Rim	185	23%	87%	3.4
Mule Deer	101 Black Butte	123	23%	59%	5.9
Elk	124 Powder Rim	67	13%	61%	6.4
Sage Grouse	6 Flaming Gorge	86	NA	NA	1.8

Source: WGFD 2002; Lloyd Levy Consulting.

Two areas near but not in the PRPA that contain a better-than-average habitat and setting for hunting are the Pine Mountain area, 10 miles southwest of the PRPA, and the Pine Butte area, which adjoins the PRPA to the northeast. The BLM has designated the Pine Mountain area a Recreation Use Area (RUA) (BLM 1997). In August 2003, the Pine Mountain RUA sustained resource damage in the Four Rim Fire (BLM 2003). The area surrounding Pine Butte is categorized as VRM Class II for visual quality (BLM 1997). Class II lands are managed to retain the existing character of the landscape, so this classification allows a low level of change to the characteristic landscape (BLM n.d. [a]).

Most hunting in these larger hunt areas is of local importance. However there is some hunting of big game species by out-of-state residents indicated by the data for the entire hunt areas (WGFD). These data, as presented in Table 3-18 for the hunt areas as a whole, may or may not represent the particular character of the part of each hunt area that is contained in the PRPA. No data for hunting are available exclusively for the PRPA (Foster 2003).

3.9.2.2 Other Recreation

The PRPA is near a historic trail that does support recreational use. The Cherokee Trail corridor, which is roughly aligned with the Vermillion Creek drainage, passes within a mile-and-a-half south of the PRPA boundary (BLM n.d. [b]). Recreation use of trail segments near the PRPA consists mainly of individual and group visits to experience the site and its setting or to reenact history on the actual trail. Under the existing RMP (BLM 1997) the Cherokee Trail is managed like a National Historic Trail, and bills to give it formal designation have been introduced in recent sessions of Congress. Users of the Cherokee Trail near the PRPA have included wagon train reenactments in recent years (Del Bene 2004). Another known trail, the Pine Butte variant of the Overland Trail, crosses the northeast corner of the PRPA but is not considered eligible for protected status (Del Bene 2004).

The PRPA is entirely within the Salt Wells Wild Horse Herd Management Area (WHHMA) (RMP exhibit). Observing wild horses is popular for recreation in the GRRA, and county roads entering the PRPA, including SCR 24, SCR 77 and SCR 19, are used to view wild horses. At present, use of county and BLM roads for wild horse viewing occurs simultaneously without much conflict with other resource uses of the area, including existing oil and gas development and associated operations and maintenance activities (Foster 2003). The PRPA contains no designated wild horse herd viewing areas.

Recreational camping and off-highway vehicle (OHV) riding, both popular on public lands throughout Wyoming, occur in the PRPA as accessory activities to the primary use of the area's resources, such as hunting, historic trail visits and wild horse viewing. There are no developed campsites or OHV free-use areas in the PRPA (Foster 2003).

3.9.3 Recreation Plans

The BLM and Sweetwater County have land use plans in place that address recreational land use. This section reviews existing goals and objectives for recreation from these plans that address the recreation resources and uses of the PRPA.

BLM recreation resource management objectives for the RSFO are to ensure continued availability of outdoor recreational opportunities while protecting other resources, meeting legal requirements for the health and safety of visitors, and mitigating conflicts between recreation and other types of resource uses (BLM 1997).

The Sweetwater County Comprehensive plan was approved in August 2002. The plan is a framework for the creation, administration and enforcement of land use regulations to be written and adopted in the future. This plan calls for the recognition and protection of unique recreational resources, identification of recreation areas that are suitable and desirable for preservation as open space, promotion of public agency awareness of recreation as a county issue and interest, and inclusion of representation for recreation on the county's Public Lands Committee (Sweetwater County 2002).

3.10 VISUAL RESOURCES

The Pacific Rim Shallow Gas Project Area (PRPA) is located within the Wyoming Basin physiographic province. The province is a large and variable region that contains high plains of 5,000 feet to 8,000 feet in elevation, broken by isolated hills, low mountains and eroded badlands that range in elevation from 1,000 feet to 2,000 feet.

The information presented here on visual resources is based on a site visit, interviews with agency personnel and information from agency documents, including the Green River Resource Management Plan (RMP) (USDI-BLM 1997).

3.10.1 General Visual Characteristics

The PRPA generally occupies a broken, high-plains landscape partially encircled by Rife's Rim, an escarpment that is generally about 7,700 feet in elevation. The topography of the central part of the PRPA is defined by the benches and draws below the Rife's Rim escarpment. To the south, a portion of the PRPA includes rolling, northward upslope to Rife's Rim. To the northeast, a "thumb" of the PRPA encompasses a saddle between Rife's Rim and Kinney Rim.

Pine Butte (approximately 8,800 feet in elevation) is the high point on Kinney Rim that is immediately northeast of the PRPA. Although Pine Butte is visible from the PRPA and has views into the PRPA, it is located outside the PRPA boundary. Another prominence, Pine Mountain (approximately 9,550 feet in elevation), is visible in the distant background southwest of the PRPA.

The down-cut bed of East Salt Wells Creek (ranging from 7,700 feet to 6,980 feet as it drains northward) and paved, two-lane WYO 430 generally define the western edge of the PRPA. Tributaries to East Salt Wells Creek flow west from Rife's Rim, passing through a number of draws. Rife's Rim divides the southern part of the PRPA from the north. Drainages from the "east slope" of Rife's Rim flow to the North Fork of Vermillion Creek, which runs on a southeasterly course south of the project area. The saddle in the northeast thumb of the PRPA (approx 7,490 feet) is on the divide between the Salt Wells Creek and North Fork drainages.

Landscape character in the PRPA varies from north to south. The northern edge, referred to by the Operator as the Pacific Isle unit, is broken country with scattered pinion and juniper cover. Most of the remainder of the project area, named the Rife's Rim unit, is a sloping brush covered plain. The northeast part of the PRPA, approaching Pine Butte, contains the upper end of Alkali Creek, a tributary of Vermillion Creek, and has some riparian area.

Much of the land within the PRPA has been culturally modified, primarily through grazing. Grazing areas usually contain livestock fencing and some non-native plant species. Beginning in 1954 and prior to recent development activity, one producing well was drilled and developed, five natural gas wells were drilled and shut in, and ten non-producing wells were drilled, plugged, and abandoned (BLM n.d.[c]). Since 2003, Warren E & P has been developing an exploratory "pod," (producing and processing unit) consisting of nine wells and ancillary facilities. The appearance of the surface in this area, centered on Section 31, Township 15, Range 101, is highly disturbed as construction continues on water and gas gathering systems.

3.10.2 Visual Resource Objectives within the PRPA

The BLM uses its own Visual Resource Management (VRM) system to measure the scenic value of the public land under its jurisdiction and to establish priorities for management of the visual resources in conjunction with other resource. The VRM classification of the project area helps to establish the minimum degree of contrast that is acceptable between the project and the major features of the existing landscape (BLM n.d. [a]).

All of public land within the PRPA is classified in VRM Class IV, the lowest scenic value classification. Management actions permitted on public lands with a Class IV VRM classification could result in major modification of the character of the landscape (USDI-BLM 1997).

3.10.3 Visual Resource Objectives for Other Resources

Although all land within the PRPA is classified in VRM Class IV, visual quality objectives for other resources overlap or are near the project area and may affect management and design of other permitted activities (USDI-BLM 1997).

Segments of the Cherokee Trail corridor, which is roughly aligned with the Vermillion Creek drainage, pass a mile-and-a-half south of the PRPA boundary (BLM n.d. [b]). Although the Cherokee Trail was omitted from the National Historic Trail System Act of 1992, bills put before recent Congresses have included the trail, and the trail is to be added to the system in the future (Del Bene 2004). The Cherokee Trail is considered eligible for the National Register of Historic Places.

Management objectives for trails with historic status include protection of landscape quality in areas comprising the visual setting and contributing to the historical and cultural character. The visual setting is areas visible in the foreground/middle-ground "distance zone" (BLM (n.d. [a]), defined as five miles from the trail's route. "Best management practices," mainly involving the manipulation of location and design attributes of facilities, are typically used to eliminate or reduce potentially adverse effects to the setting of contributing trail segments (Del Bene 2004).

Another known trail, the Pine Butte variant of the Overland Trail, crosses the northeast corner of the PRPA but is not considered eligible for protected status. Therefore, there are no visual resource management objectives for the setting of this trail (Del Bene 2003).

Under current RMP, the Pine Mountain Management Area (PMMA), which contains the Cherokee Trail segment, is a Geographic Management Area being managed to ensure adequate maintenance of a combination of resource values (BLM 1997). The PMMA is in VRM Class III. At its closest the PMMA is less than one-fourth mile from the PRPA. Management actions permitted on Class III lands would be designed to partially retain the existing character of the landscape (USDI-BLM 1997).

Northeast of the PRPA, the land immediately surrounding Pine Butte is in VRM Class II. At its closest, the VRM Class II land surrounding Pine Butte is less than one-half mile from the PRPA boundary. Management actions permitted on Class II lands would be designed so as to retain the existing character of the landscape (USDI-BLM 1997).

3.11. CULTURAL AND HISTORICAL RESOURCES

3.11.1 Summary of Extant Cultural Resources

The Cultural Records Office (CRO) in Laramie provided information on the previous work conducted in the Pacific Rim analysis area and previously recorded sites. Records at Western Archaeological Services (WAS) were consulted as well as records at the Rock Springs Field Office (RSFO) of the BLM. There have been 22 projects conducted and 76 sites recorded in the study area. Of these, there are 20 Class III block and linear surveys (including two seismograph or geophysical surveys), and two Class II sampling surveys. Limited amounts of previous work in the study area have resulted in the documentation of cultural resources through survey, examination of ethnographic records, and historic record research. No excavations have been conducted in the Pacific Rim study area. The Pacific Rim study area encompasses approximately 74.4 square miles or 47,597.82 acres. Approximately 1372 acres (block) or ca. 2.9% of the project area have been inventoried for cultural resources at a Class III level. The Salt Wells Class II Sampling survey (Treat and Tanner 1981), East Salt Wells Zone (Stratum 8), encompassed 66, 581.1 acres which included a portion of the Pacific Rim study area. A series of linear transects were surveyed through the East Salt Wells Study Area in 1981. The project specific site density per acre can not accurately be calculated because there are no acreage calculations at the CRO for the linear projects.

The overall site density within the study area varies with the highest number of sites located along drainages, in sand deposits, and in the juniper trees. Limited amounts of work previously conducted in the study area documents the highest density of sites recorded along Schreggs Draw, Alkali Creek, along unnamed ephemeral drainages of East Salt Wells Creek, and in the dunal deposits and juniper trees on the ridges east of East Salt Wells Creek. Twenty of the previously recorded sites within the Pacific Rim study area were documented during the Salt Wells Resource Area, East Salt Wells Zone, Class II inventory in 1981 (Treat and Tanner 1981). Twenty-nine newly identified sites were documented and one previously recorded site was relocated during the 2003 Pacific Rim Block Survey (Kautzman 2003) conducted for Petroleum Development Corporation. These two projects account for 50 (66%) of the 76 recorded sites in the study area.

Site types

The 76 sites in the project area include 60 (79%) prehistoric sites, 9 (11.8%) historic sites, 5 (6.6%) structures including rock alignment, cairns, rock piles, or rock shelters, and 2 (2,6%) prehistoric/historic sites. Of the recorded cultural resources, 25 (33%) are recommended eligible for nomination to the National Register of Historic Places (NRHP), 5 (6.5%) are eligible with State Historic Preservation Office (SHPO) concurrence, 9 (11.8%) are recommended not eligible for nomination to the NRHP, 4 (5.3%) are not eligible with SHPO concurrence, and 33 (43.4%) remain unevaluated.

Prehistoric sites

Prehistoric sites consist of camps that contain evidence of a broad range of activities including subsistence-related activities. Formal features, lithic debris, chipped stone tools, beads, evidence of milling/vegetable processing activities including ground stone, and pottery. Single as well as multiple occupations are represented.

Lithic debris scatters consist of sites containing lithic debitage or stone tools. The sites are described 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.

Human burials, rock alignments, and rock art have been identified as sensitive or sacred to Native Americans. There are no human burials documented in the Pacific Rim study area. One unknown rock alignment was documented in the northeastern portion of the study area (Treat and Tanner 1981). A stone pile was recorded during the Pacific Rim Block Survey (Kautzman 2003) and Native American consultation was completed. Rock alignments have been documented on Aspen Mountain located northwest of the study area. Rock art, recognized as pictographs or petroglyphs, is unknown in the project area. However, immediately south of the Pacific Rim study area, several panels of charcoal pictographs typical of Ute or Shoshone are located in the Upper Powder Springs complex as well as pecked trapezoidal anthropomorphic figures (Murcray 1993). Some of the pictographs were faded with time but had been painted red. Petroglyphs are also documented north of the Mud Springs Ranch on WYO 430. It is important to be cognizant of the possibility of similar resources in the project area.

Pottery/ceramics are unknown in the study area but have been documented to the north along Cooper Ridge. Gray ware and brown sherds are associated with the Uinta phase of the Late Prehistoric period.

Consultation with appropriate Native American tribes concerning areas of concern to them for traditional, cultural, and religious purposes will occur in accordance with the American Indian Religious Freedom Act and BLM Manual 8160-1 Handbook. Native American consultation will occur within the context of specific development proposals, but will also be an ongoing process between BLM and affected Indian tribes and traditional cultural leaders (USDI-BLM 1997).

Historic Sites

A cabin is recorded east of Scheggs Draw and a windmill is recorded at the confluence of East Draw with East Salt Wells Creek. Two historic debris sites have been documented in the study area. The earliest water rights documented in the drainages surrounding the Pacific Rim study area include appropriations by Rife for three ditches off Vermillion Creek including the West Fork of Vermillion Creek, the North Fork of Vermillion Creek, and Vermillion Creek in 1886; the School ditch in 1908; and the Farley No. 1, 2, and 3 ditches in 1909. Rife also appropriated water rights on Coyote Creek for the Schrivner No. 1 and 2 and the McKnight Nos. 1, 2, and 3 ditches. Gottsche appropriated water rights on the South Fork of Red Creek in 1902 for the Jones ditch. The use to which the water rights were applied included domestic use, irrigation, and stock dams (Freeborn 1926).

The Pine Butte Variant of the Overland Trail is generally located north of the study area but does traverse the northwestern-most zone of the study area. The Pine Butte Variant of the Overland Trail (48SW1226) as documented by Lowe (2001) “appears to be plausible and viable, but not extraordinarily significant, alternative Expansion-era freight road and emigrant route that deviated from the main Overland Trail to the southwest at the former LaClede Overland trail stage station on Bitter Creek, then continued in a westerly direction then northwest to either Salt Wells, Rock Springs, or Green River on the main Overland route.” Because the variant does not meet essential criteria for NRHP eligibility under Criterion A, B, or C, the site is documented not eligible for inclusion on the NRHP with SHPO concurrence.

The Cherokee Trail has been identified south of the project area. The Cherokee Trail was used in the 1850s by members of the Cherokee Tribe moving from the Oklahoma Reservation to the California gold fields. As depicted on the 1882 GLO maps, the Southern Variant of the Cherokee Trail trends across southwestern Wyoming and northwestern Colorado, ascending Powder Rim and trending west along the rim to Vermillion Creek. The Cherokee Trail crosses the ridge between Sage and Current creeks and continues west/northwest to the Green River.

As with any of the westward migratory trails of the mid 1800s, variants have been documented. Reasons for variations in routes include inaccessibility at certain times of year or members of the group may have traveled the route previously and found an easier or more direct avenue to water. The route of the Cherokee Trail depicted on the USGS quadrangle maps does not exactly match the route of the trail depicted on the 1882 GLO maps.

Excerpts from Cherokee Trail diarist found in *Cherokee Trail Diaries* (Fletcher et al. 1999) document stops along the southern variant of the Cherokee Trail. Brown(1850) at Vermillion Creek:

> “July 15...20 miles...Man & Beast sick. Caused by drinking the water that we have been drinking for several days. Traveled today 20 miles and came to a narrow swift Branch of good cold water with tolerable good grass – Camp 64–.”

The Cherokee Trail (48SW3680) is an historic linear property located south of the Pacific Rim study area. The viewshed of the Cherokee Trail extends north into the southernmost portion of the project area. The Cherokee Trail is recommended eligible for inclusion on the NRHP. Management of historic roads and trails that are eligible for the NRHP but are not congressionally designated will generally be the same as for designated trails including a ¼ mile protective setback on either side of the trails (USDI-BLM 1997).

The Outlaw Trail is purported to be near the project area. There is no formal documentation of the trail showing its exact location. The trail was used by the outlaws to go “from Brown’s Hole north to Hole-in-the-Wall in Johnson County, Wyoming” (Kelly 1959). Historic accounts of the outlaw movements place them in Rock Springs, Green River, and Powder Springs. However, the location of the trail is largely unknown and its exact locale will be difficult to ascertain.

The Rock Springs to Browns Park Freight Road (48SW3865) and the Rock Springs to Hiawatha Road (48SW10752) follow the same route south from Rock Springs through the westernmost portion of the study area superceded in part by what is now Wyoming Highway 430. The Rock Springs to Hiawatha Road departs the Rock Springs to Browns Park Road south of the study area and trends east to the Hiawatha gas fields whereas the Rock Springs to Browns Park Road continues south into Browns Park, Colorado. The Rock Springs to Browns Park Road underwent two distinct phases of development. The first phase constituted a two-track road connecting the rural ranching population from Brown’s Park in Utah and Colorado and southern Sweetwater County with Rock Springs. The second phase of development of the Rock Springs to Browns Park Road came about because of the gas deposits identified in the Hiawatha Dome field (Johnson 1997). The Rock Springs to Browns Park road is recommended eligible for inclusion on the NRHP under Criteria A. The route is documented as an interstate trail which connected the railhead at Rock Springs to Browns Park in northeast Utah and northwest Colorado. The Rock Springs to Hiawatha Road is recommended not eligible for inclusion on the NRHP with SHPO concurrence.

Rife’s Road to Bitter Creek (48SW12070) was originally used to provide supplies to winter range sheep camps. Rife’s Road to Bitter Creek is a two-track road that departs the Guy Rife Ranch south of the Pacific Rim study area trending northerly to East Salt Wells Creek, then parallels the creek (modern WYO 430). The road then trends northeasterly into Scheggs Draw and eventually becomes Sweetwater County Road 24 (Patrick Draw Road). The route follows this improved road for six miles before continuing to the northeast for an additional ca. 25 miles to the railroads at Bitter Creek. Portions of the road have been upgraded at various times starting in the early 1900s by Sweetwater County. Later upgrades in the Bitter Creek area and around Scheggs Draw were upgraded for use by the oil and gas industry, however the majority of the road remains a two-track (Ficenec 1998). Rife’s Road to Bitter Creek (48SW12070) is considered not eligible for the NRHP with SHPO concurrence.

Excavation Data

Test excavations at the Mud Spring Ranch site (48SW1670), located immediately north of the study area, resulted in the documentation of a multi-component site. The artifact analysis for Mud Springs shelter indicates that the site was a base camp from which both hunting and gathering activities were conducted (Creasman 1998). Artifacts from Mud Springs Shelter representing the Late Prehistoric period include a steatite pipe, a pottery vessel, a bone awl, two bone beads, carved wood, Rose Spring, Uinta side-notched, and Cottonwood style projectile points. Historic artifacts were limited to six shell casings and bullets dating between 1866 and present.

Site 48SW11483, Alkali Creek site, located southwest of the study area is a multi-component site. Data from the excavation place the occupation of the site to the Pine Spring and Deadman Wash phases of the Late Archaic period. The composition of cultural material produced by each occupation at the Alkali Creek site, particularly the bone refuse, lithic debitage, and artifact types, is characteristic of a class of mobile hunter-gatherer camps recognized by Binford (1980) and Bertram et. al. (1991) as short-to-moderate duration residential occupations (Murcray 2003). Analyses of material recovered from the site indicate the consumption of large game supplemented by small game species and plant exploitation.

Summary

The subsistence and settlement patterns in the study area reflect a hunter-gather lifeway. Research into the subsistence and settlement patterns used during the Archaic period indicates summer occupations in the mountains, winter occupations in the foothills, and spring and fall movements utilizing all available zones (Creasman and Thompson, 1997). Subsistence patterns in the Archaic period and the Late Prehistoric period are similar in that they are based on seasonal movement throughout the basins and foothills in response to the availability of floral and faunal resources (Creasman and Thompson 1988). A wide diet breadth is evident in extensive procurement and processing of small mammals. By 450 B. P. (Shimkin 1986), or possibly earlier (Bettinger and Baumhoff 1982), Numic-speaking Shoshonean groups occupied the Wyoming Basin and continued to reside there until Euro-American expansion relegated them to reservations beginning in 1868.

Significant cultural resources are found along the major ephemeral drainages and along the lower benches of escarpments that dominate the terrain in the study area (Treat and Tanner 1981). Kautzman (2003) notes prehistoric sites identified in the Pacific Rim Block Survey “are located along the broad northwest-southeast ridge system either near the top or along the side slopes or ridge fingers”, noting that no sites were identified during the block survey within the drainage bottoms. Previous work in the area, although limited in scope, would indicate culturally sensitive areas include drainages such as Alkali Creek, East Salt Wells Creek, and Scheggs Draw, as well as along juniper covered ridges. Certain topographic settings have higher archaeological sensitivity such as eolian deposits (sand dunes, sand shadows, and sand sheets), alluvial deposits along major drainages, and colluvial deposits along lower slopes of ridges. Native American consultation in this area will be carried out with the Eastern Shoshone, Northern Ute, Northern Arapaho, and Shoshone-Bannock Tribes should any sites of potential cultural significance to those tribes be found within or near proposed areas of disturbance.

Historic use of the project area was limited by terrain and lack of perennial water sources. The Pine Butte Variant of the Overland Trail bounds the northern portion of the study area. The Rock Springs to Browns Park Freight Road and the Rock Springs to Hiawatha Road transverse the western border of the project area with parts of the routes now identified as WYO 430. Rifes Road to Bitter Creek also parallels the western boundary of the study area trending north and then east toward the Union Pacific Railroad at Bitter Creek, Wyoming. The historic Cherokee Trail bounds the southern edge of the area. The Outlaw Trail may transverse the project area traveling between Rock Springs and Green River, Wyoming, and Brown’s Park, Colorado. No sites associated with the trail have been documented although local outlaw lore places notorious bandits such as Butch Cassidy and the Sundance Kid in the area. Some grazing and limited ranching activities are identified by the historic debris scatters and historic record.

3.12 SOCIOECONOMICS

3.12.1 Introduction

Area socioeconomic conditions potentially affected by the Proposed and No Action alternatives include the local economy (primarily employment and earnings in the oil and gas industry and other sectors of the economy), population, housing, and local government facilities and services, primarily law enforcement and emergency response services, however, the Proposed Action would also contribute to the overall natural gas industry-related demand for facilities and services currently being experienced in Sweetwater County and its communities. The Proposed Action would also generate local, state and federal tax revenues.

For a detailed analysis of Sweetwater County population, employment, earnings and personal income trends through the year 2000, see the socioeconomic technical support document available for review at the Rock Springs Field Office. For a detailed analysis of population, employment, poverty and demographic trends for the City of Rock Springs, see the socioeconomic technical support document. The county and community profiles contained in these appendices were compiled using the *Economic Profile System*, which has been developed through a joint effort between the Sonoran Institute and the BLM. Copies of the *Economic Profile System* including databases and users manual are online at www.sonoran.org. A Technical Report including data from the Sonoran Institute concerning Sweetwater County, Wyoming, will be made available upon request.

In some cases, the data presented in Section 3.12 differ from the data contained in the technical support document, because different data sources, data series and methods were used to take advantage of more current information.

The area of analysis for potential socioeconomic impacts is Sweetwater County, Wyoming. As will be discussed below, the recent surge in natural gas development in the Green River Basin and throughout Wyoming is resulting in economic and population growth for Sweetwater County and its municipalities. Rock Springs has long been a regional oil and gas service center. Relatively sustained level of gas prices and advances in gas exploration and drilling technology have resulted in renewed interest in both conventional and unconventional gas reserves in the Green River Basin, in Wyoming and throughout the Rocky Mountain West. This interest has in turn resulted in growth in the oil and gas service industry in Sweetwater County, particularly over the past year.

Economic and demographic statistics are typically not available in real time; most lag current events by a year or more. Consequently, information about socioeconomic conditions in Sweetwater County during 2003 and early 2004 is primarily anecdotal, except for some 2003 employment statistics.

3.12.2 Economic Conditions

An area's economic base is comprised of activities which bring money into the local economy from other areas of the state, nation and world. Sweetwater County has a natural resource-based economy which is diversified, but relies heavily on natural resource extraction and processing. Basic sectors include oil and gas production and processing, trona mining and the manufacturing of soda ash and related products, coal mining and electric power generation, fertilizer manufacturing, agriculture, and transportation (primarily the Union Pacific railroad). Also, the portions of the retail and service sectors which serve visitors (travel, tourism and recreation) can be considered basic to Sweetwater County (PIC 1996).

3.12.2.2 Employment, Unemployment and Labor Force

Sweetwater County total full and part-time employment grew from the 1990 level of 22,856 jobs to 24,804 jobs in 2001, growing by 1,948 jobs or about 9 percent. There was some volatility during the period, however. In 1994 total employment peaked at 25,177jobs (WEAD n.d. [a]). These employment statistics, compiled by the US Bureau of Economic Analysis, represent full and part-time jobs located in the county. Some Sweetwater County jobs are filled by persons living outside the county.

Local area labor force, employment and unemployment statistics are compiled by the Wyoming Department of Employment and represent county residents who are employed or unemployed. According to these statistics, Sweetwater County resident employment was about two percent lower in 2002 (18,851) than in 1990 (19,231). As with the number of jobs discussed above, resident employment was substantially higher during 1994-1995 period. The 2002 Sweetwater County labor force (employed residents plus residents looking for work) ended the period at 19,790, about three percent lower than the 1990 level (20,348), after having dropped 802 or four percent between 2001 and 2002. The unemployment rate decreased from 5.5 percent in 1990 to 4.6 percent in 2001, but even with the 4 percent drop in employment between 2001 and 2002 the unemployment rate increased only to 4.7 percent, 0.1 percent higher than 2001 (WDE n.d.). The relatively stable unemployment rate in spite of decreasing employment reflected either out-migration (workers leaving Sweetwater County) or people withdrawing from the active labor force, either through retirement or ceasing to actively look for work, or some combination of these factors.

However, recently monthly statistics demonstrate substantial increases in employment and decreases in unemployment in Sweetwater County. December 2003 resident employment was 20,263, about 6 percent higher than December 2002 employment (19,103). The December 2003 Sweetwater County unemployment rate was 3.6 percent, 1.2 percentage points lower than the December 2002 rate of 4.4 percent. It should be noted that December is traditionally a low month for employment; indications are that employment was even higher in the months preceding December (WDERP 2004).

It should also be noted that the increases in employment described above include only resident employees. It is likely that many natural gas service employees in Sweetwater County are residents of other counties and states. Additionally, there appears to be a shortage of labor in Sweetwater County, many advertised positions go unfilled for long periods of time. (Robbins 2004).

3.12.2.3 Earnings

Sweetwater County earnings by place of work increased from $633 million in 1990 (1990 dollars) to $902 million in 2001 (2001$), a 42 percent increase over the eleven year period (WEAD n.d. [b]). This increase compares to a 68 percent increase in earnings for the State of Wyoming during this period. However, when adjusted for inflation, Sweetwater County earnings increased by about 24 percent during this period.

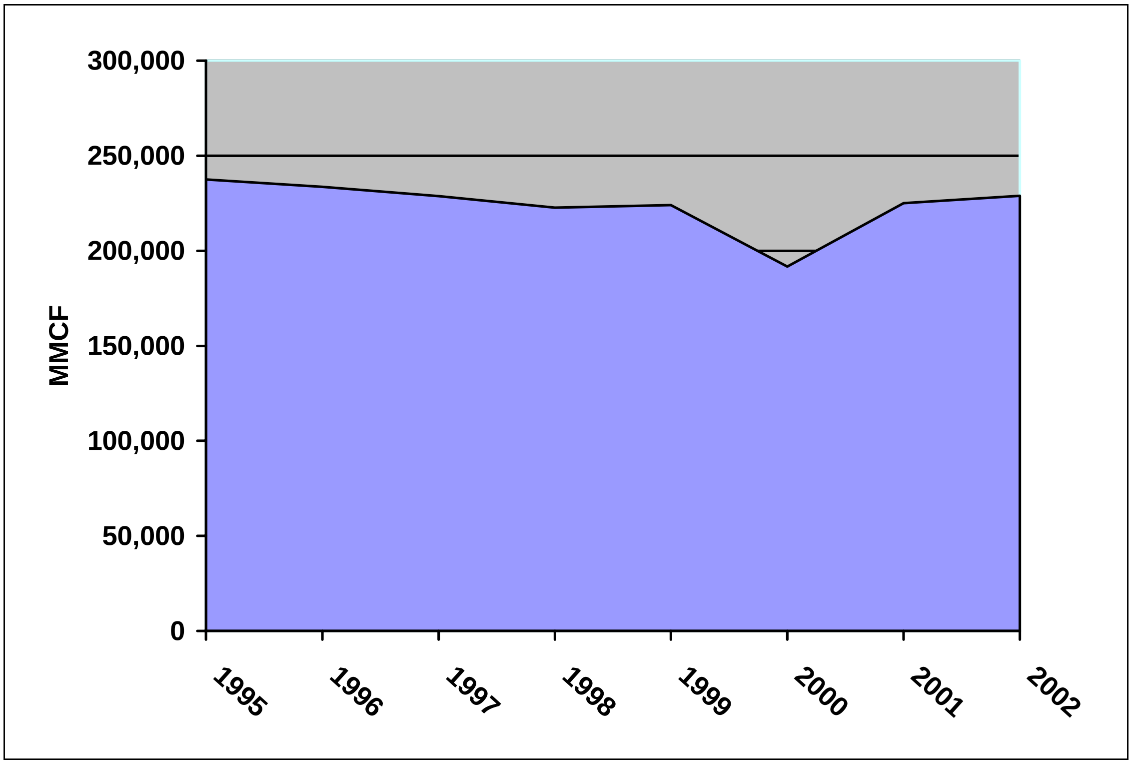
3.12.2.4 Recent Oil and Gas Activity

Production and approved applications for well drilling permits (APD) are two measures of oil and gas activity. As shown in Figure 3-19, annual natural gas production in Sweetwater County decreased from 238 million MCF in 1995 to 192 million MCF in 2000, but has since increased to about 229 million MCF in 2002. Sweetwater County production accounted for about 13 percent of all natural gas produced in Wyoming during 2002 (WOGCC 1995-2002).

Approved APDs reflect both current and potential future oil and gas activity. Increased drilling may result in increased production if drilling efforts are successful and commodity prices increase or stabilize at economic levels. Sweetwater County approved APDs have increased dramatically in recent years (see Figure 3-20 below), 534 APDs were approved in the county during 2001, but that number declined to 401 in 2002.

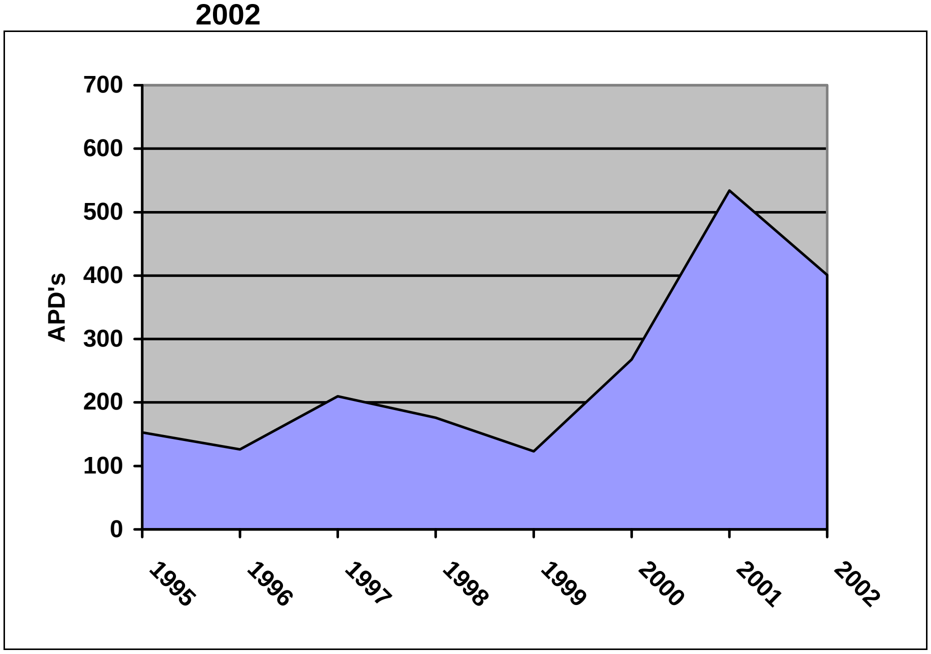
In 1995, there were a total of 1,544 producing wells (oil and gas) in Sweetwater County. By 2002, that number had increased to 2,521 a 63 percent increase over the 7 year period (see Figure 3-21). The acceleration of natural gas exploration, drilling and production which has occurred in Sweetwater County and adjacent areas of Wyoming and other Rocky Mountain states has correspondingly resulted in substantial expansion of the natural gas service industry in Sweetwater County (Robbins 2004).

Figure 3-19. Natural Gas Production for Sweetwater County 1995 – 2002



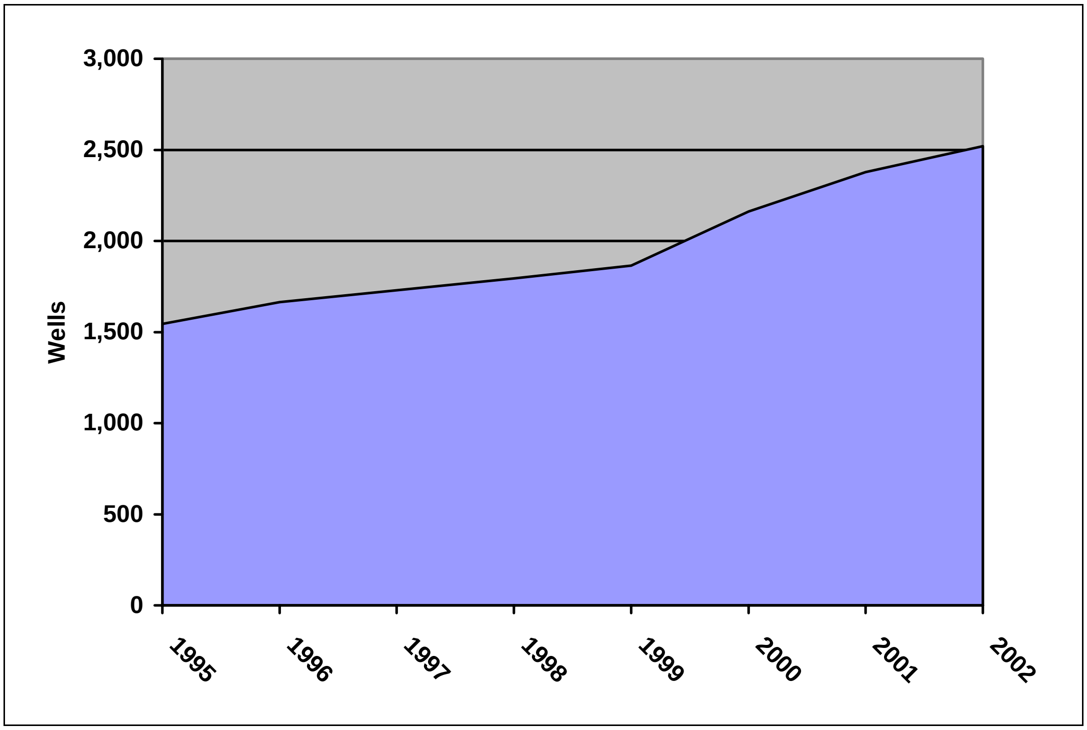
Source: WOGCC 1995-2002

Figure 3-20. Approved Sweetwater County Applications for Permits to Drill (APDs): 1995 – 2002



Source: WOGCC 1995-2002

Figure 3-21. Producing Oil and Gas Wells in Sweetwater County 1995 – 2002



Source: WOGCC 1995-2002

3.12.3 Population Conditions

Population levels in Sweetwater County have been volatile over the past 20 years. Sweetwater County population in 2000 was almost 10 percent lower than its 1980 level of 41,723. It is estimated that Sweetwater County population continued to fall in 2001, losing 2 percent of population, but rebounded to 37,194 in 2002 (refer to Figure 3-22) (WEA n.d. [c] & [d]).

Rock Springs, the largest community in the county, lost almost 2 percent of total population between 1990 and 2000, despite showing a 3 percent increase in 1995 (see Table 3-19). Rock Springs lost another 2 percent of population between 2000 and 2001 but recovered about one percent in 2002. Similarly, Green River, the county's second largest city and county seat lost 7 percent of its population between 1990 and 2000, despite a slight increase in the early years of the decade. Green River similarly continued to lose population in 2001 (another 2 percent) but made slight gains (1 percent) in 2002.

The most recent population forecasts available from the Wyoming Division of Economic Analysis projects that population levels in Sweetwater County will decrease 5 percent by 2010, to 35,400 (WEAD n.d. [d]); however, employment statistics and information obtained from Sweetwater County officials are that county population increased substantially during 2003 as a result of the increase in natural gas-related employment (Gordon 2004, Kot, 2004).

3.12.4 Housing

The nature of natural gas drilling and field development activities (relatively short duration tasks performed primarily by contractors) typically results in demand for temporary housing resources such as motel rooms and mobile home and recreational vehicle (RV) spaces near the project area. There are a substantial number of temporary housing resources (motels and RV parks) available in Rock Springs including 15 motels with over 1,100 rooms and 30 mobile home parks with over 1,900 pads (PIC 1997).

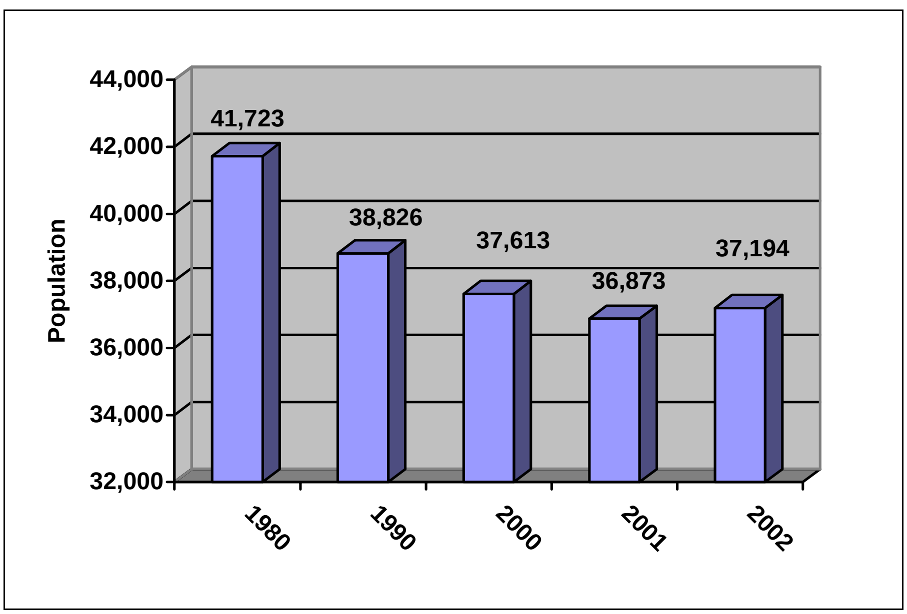
However, as Sweetwater County oil and gas service firms respond to increased natural gas development in the county, they are expanding their workforce and employees are seeking longer-term housing resources in the area. Vacancies in longer-term rental units (rental houses and apartments) in the Rock Springs/Green River area of Sweetwater County have been absorbed and most realtors and apartment owners have waiting lists (Robbins 2004, Scheer 2004).

Another indication of the growth in Sweetwater County is the absorption of homes for sale. Homes listed for sale in the Rock Springs/Green River multi-list service have decreased from several hundred several years ago to below 50 in each community, excluding homes under contract (Scheer 2004).

3.12.5 Community Facilities, Law Enforcement and Emergency Management Services

Because population in Sweetwater County, Rock Springs and Green River is substantially below historic high levels of the 1980's, county and municipal infrastructure has, in general, capacity to serve more people than currently reside in the county and its major cities. However, the contractions in population over the last decade resulted in corresponding contractions in county, municipal and human service agencies. As a result, these service agencies are having difficulty responding to the recent increases in demand associated with the increase in natural gas-related employment and population. The Sweetwater County Commissioners have begun the process of identifying natural gas-related service demand and approaching state government for assistance in responding to the demand (Gordon 2004, Kot 2004).

Figure 3-22. Sweetwater County Population: 1980, 1990, 2000 – 2002



Source: WDEA n.d. [c].

Law enforcement in the area surrounding the PRPA is provided by the Sweetwater County Sheriff's Department. No routine patrols are provided in the area, rather deputies respond on an as needed basis. Over the past year, calls for law enforcement services in and near natural gas fields have increased, including responses to traffic accidents, rig accidents and search and rescue calls in remote areas of the county (Scofield 2004).

Table 3-19. Population Estimates 1990 - 2002: Sweetwater County, Rock Springs and Green River

	1990	1995	2000	2001	2002
Sweetwater County	**38,823**	**40,635**	**37,613**	**36,873**	**37,194**
Rock Springs	**19,050**	**19,687**	**18,708**	**18,267**	**18,464**
Green River	**12,711**	**12,778**	**11,808**	**11,517**	**11,628**

Source: WEAD n.d. [d].

Emergency management in Sweetwater County is coordinated by the Sweetwater County Emergency Management Agency (SCEMA), which operates under Federal Emergency Management Agency (FEMA) and EPA guidelines. SCEMA is the agency designated by the Sweetwater County Commissioners to analyze potential hazards, assess emergency response capabilities, plan for and respond to potential events and mitigate the effects of emergencies or disasters. SCEMA coordinates with response agencies, industry, elected officials and volunteer agencies to accomplish its mission of limiting injuries, loss of life and damage to property.

The portion of Sweetwater County that includes the PRPA is served by emergency response organizations (fire suppression, emergency medical and ambulance) located in Rock Springs. Routine injuries are treated at Memorial Hospital of Sweetwater County. Cases requiring specialized treatment are transported to Salt Lake City by air ambulance services dispatched from Salt Lake City, Utah or Craig and Grand Junction in Colorado (Valentine 2003).

3.12.6 Local, State and Federal Government Fiscal Conditions

Fiscal conditions most likely to be affected by the Proposed Action and alternatives include the following:

- county, school and special district ad valorem property tax revenues,
- state, county and municipal sales and use tax revenues,
- state severance tax revenues,
- federal mineral royalties.

3.12.6.1 Ad Valorem Property Tax Revenues

Oil and gas companies pay ad valorem property taxes on production and facilities, with certain exemptions.

In Sweetwater County, fiscal year (FY) 2003 assessed valuation was over $1.2 billion, 17 percent less than the previous year, and 2003 property tax revenues were $78.2 million, about 16 percent lower than 2002. These declines followed declines of 0.2 percent in assessed valuation and 0.7percent in property taxes during the previous year. Natural gas is assessed on the previous year's production. FY 2003 assessed valuation from 2002 natural gas production totaled $350 million or about 30 percent of total assessed valuation, which was about 39 percent less than the 2002 natural gas valuation of $578 million (WTPA 2002 & 2003). Current mill levies within the unincorporated portion of Sweetwater County which contains the PRPA total 71.26 mills, including 49.666 mills for State and local schools, a 12 mill county levy, .349 for weed and pest control, a 5 mill community college levy, 2.696 mills for county fire protection and 1.55 mills for Solid Waste District #1.

3.12.6.2 Sales and Use Tax

Wyoming has a statewide four percent sales and use tax. Sweetwater County collects an additional one percent general-purpose local-option sales and use tax and a 0.5 percent specific purpose local-option tax, dedicated to construction of a new county jail. FY 2003 sales and use tax collections in Sweetwater County totaled about $60.56 million, about 2 percent higher than the previous year. Of the total, about 86 percent is attributable to sales tax (WEAD 2003).

About 28 percent (less administrative costs) of the statewide four percent sales and use tax collections and all of the general purpose local option collections (also less administrative costs) are distributed to the county and its incorporated municipalities according to a population-based formula.

3.12.6.3 Wyoming Severance Taxes

The State of Wyoming collects a six percent severance tax on oil and natural gas. Severance tax revenues are distributed to the Wyoming Mineral Trust Fund, General Fund, Water Development Fund, Highway Fund, Budget Reserve Account, and to counties and incorporated cities and towns. In FY 2003, severance tax distributions totaled $429 million, about 43 percent higher than FY 2002 (CREG 2003a). Of the total, about 54 percent was attributable to severance taxes on natural gas.

3.12.6.4 Federal Mineral Royalties

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, the School Foundation fund, the Highway fund, the Legislative Royalty Impact Account, and cities, towns and counties. In FY 2003, a total of $476 million in federal mineral royalty funds were distributed to Wyoming entities (CREG 2003b).

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).

The PRPA is relatively distant from population centers, so no populations (including low-income or minority populations) would be subjected to health or environmental impacts of development.

3.13 TRANSPORTATION

The regional transportation system serving the PRPA includes an established system of state highways and county roads. Local traffic on federal land is also served by improved and unimproved BLM and oil and gas field roads. Refer to Figure 3-23 for the transportation network.

3.13.1 Access to the Project Site

Access to the project site is provided by I-80, Wyoming State Highway 430 (WYO 430), and Sweetwater County Roads (SCR) 4-24, 4-76, 4-77 and 4-19. Table 3-20 displays traffic data, where available, for the highway access routes to the project area.

Federal and State Highways. Current traffic volumes on Wyoming federal and state highways are listed in Table 3-20. The Wyoming Department of Transportation (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. The federal and state highways proving access to the PRPA are currently rated A, and traffic on these highways could increase substantially before level of service standards would be exceeded.

WYO 430 is a two lane-paved highway with narrow shoulders and steep side slopes. Although the highway is in relatively good condition, it is an older highway and the design is not up to current standards. For example, some bridges are narrower than current standards.

Table 3-20. Highway Access to the Project Site.

Highway	Segment	1991 AADT	2000 AADT	2001 AADT	Level of Service
WYO 430	SCR 26 Intersection	290 (60 trucks)	250 (40 trucks)	170 (40 trucks)	A
	SCR 36 Intersection	280 (50 trucks)	150 (35 trucks)	130 (35 trucks	A

Source: WYDOT 2001

Sweetwater County Roads. The Sweetwater County Road and Bridge Department is responsible for maintaining over 1,400 miles of county roads. Four Sweetwater County roads provide access to the PRPA: SCR 4-24, SCR 4-76, SCR 4-77, and SCR 4-19 (Gibbons 2004).

- SCR 4-24 (Patrick Draw Road) would provide access from WYO 430 and traverse the northern portion of the PRPA for about two miles. After exiting the project area on the north, SCR 4-24 extends northward about 30 miles to intersect with I-80. Although the northern portions of SCR 4-24 have been constructed and maintained for oil and gas field use, the portions in and near the PRPA currently receive considerably less industrial use.

- SCR 4-77 would provide access to the middle and southern sections of the PRPA. SCR 4-77 is also a native material road, seldom maintained by the county, constructed and maintained for ranch and grazing access.

- SCR 4-19 (Bitter Creek Road) would provide access to the southern portion of the PRPA about one quarter mile east of its intersection with WYO 430. SCR 4-19 traverses the southern portion of the project area for about 5 miles and exits the eastern boundary near Granary Draw, traveling about 40 miles further east and north to connect with I-80. SCR 4-19 is heavily used by oil and gas traffic in the northern segments, but less so in and near the PRPA.

3.13.2 BLM and Private Roads within the Project Area

A number of developed and undeveloped roads provide access to federal, state and private land within the PRPA. Like county roads, these roads are used by oil and gas operators, ranchers and grazing operators, and recreation visitors.

- SCR 4-24 intersects with an unnamed road that travels east and then south along the eastern boundary of the project area along Scheggs Draw.

- SCR 4-77 connects with two unnamed roads providing access to the north and to the east along East Draw.

- An unnamed road travels east from WYO 430 just south of the intersection with SCR 81. This road enters the PRPA and travels north and east, traversing the area south of Rifes Rim and dividing into north and south roads about one-half mile before exiting the eastern boundary of the project area.

- SCR 4-76 would provide access to a half-section of state owned land on the eastern boundary of the PRPA: about one-half mile of SCR 4-76 would be within the PRPA. SCR 4-6 was constructed and maintained for ranch and grazing access and occasional recreation use. It is constructed of native material and seldom maintained by the county.

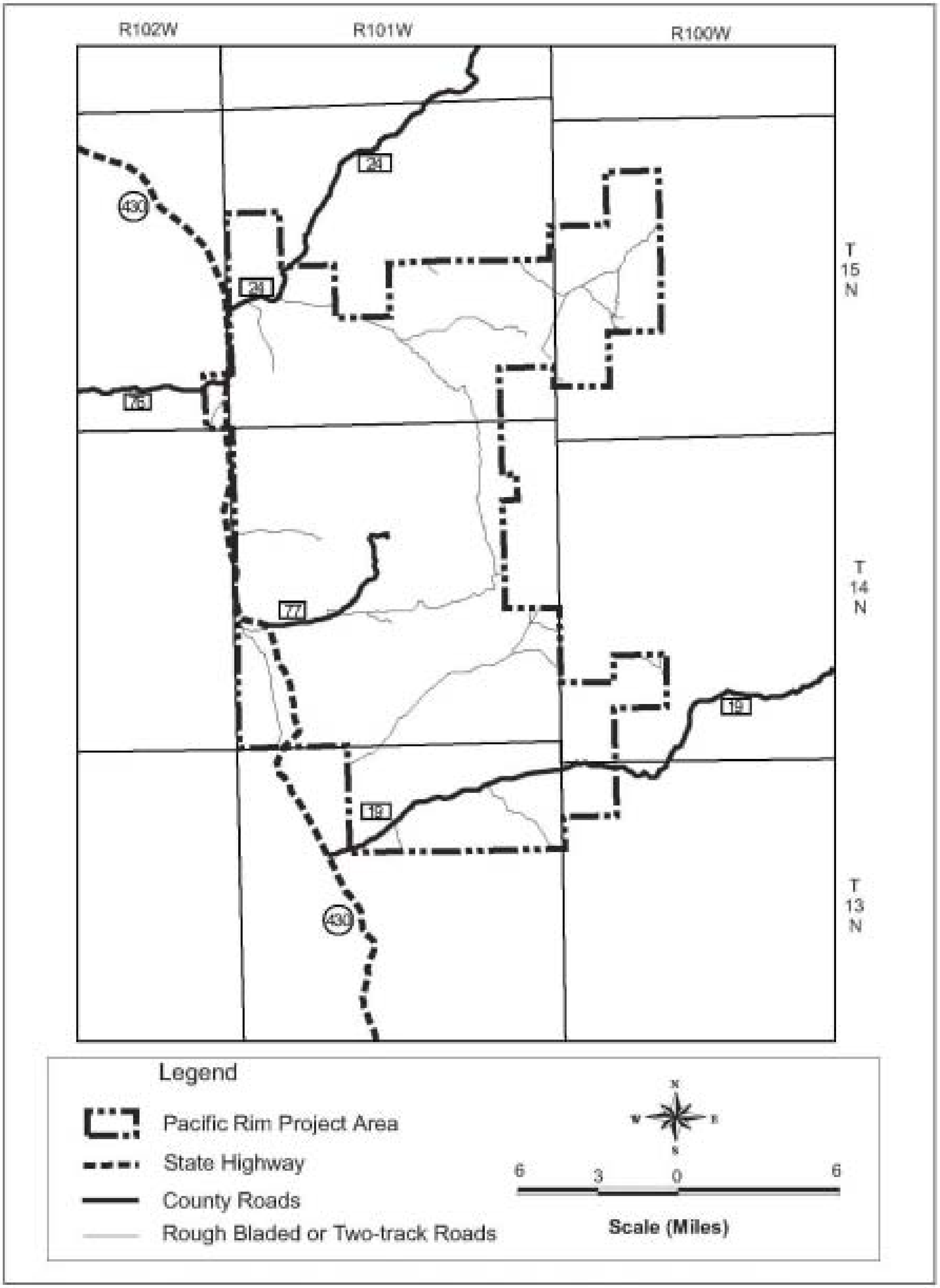


Figure 3-23. Transportation Network on the PRPA.

3.14 HEALTH AND SAFETY

Existing health and safety concerns in and adjacent to the PRPA include hazards associated with existing oil and gas exploration and operations. Occupational hazards associated with oil and gas operations generally affect workers in the fields and at oil and gas facilities. Two types of workers are employed in oil and gas fields: oil and gas workers, who had a1998 annual accident rate of 4.0 per 100 workers, and special trade contractors, who had a non-fatal accident rate of 8.9 per 100 workers (U.S. Department of Labor, Bureau of Labor Statistics 2000). These rates compare with an overall private industry average for all occupations of 6.2 per 100 workers.

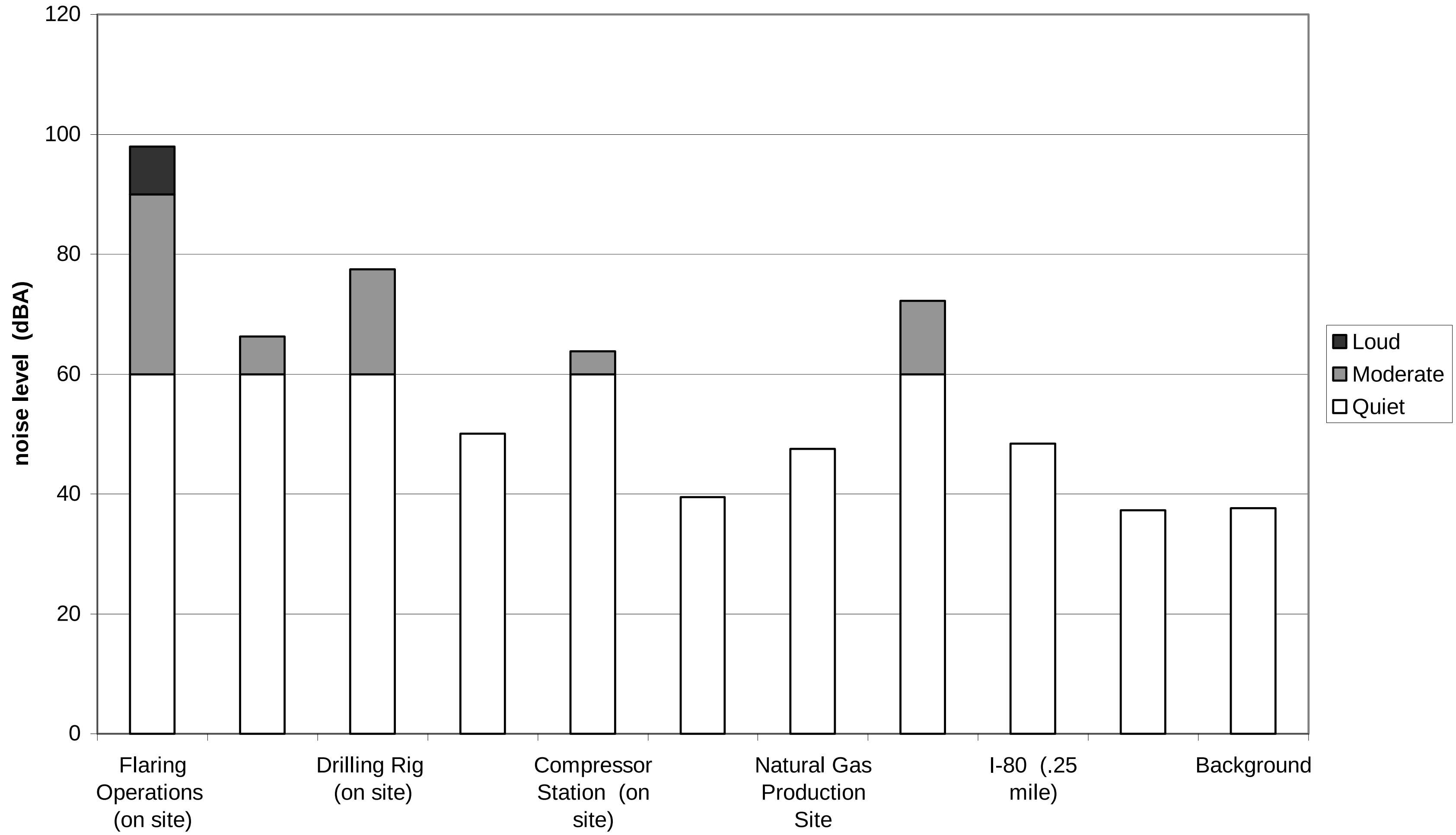
There are also existing low-level risks associated with natural gas pipelines, although these risks are statistically very small. Nationwide, injuries associated with gas transmission pipelines averaged 14 per year from 1990 through 1996, fatalities averaged one per year and incidents such as ruptures averaged 79 per year (U.S. Department of Transportation 1998). Finally, there are risks associated with hazardous materials used or stored at oil and gas facilities. The USDI-BLM, OSHA, USDOT and Wyoming OGCC and OHSA each regulate certain safety aspects of oil and gas operations.

Currently within the PRPA there are risks associated with vehicular travel on improved and unimproved county, BLM and private roads; with firearms accidents during hunting season and by casual firearms use such as plinking and target shooting; and with natural events such as flash floods, landslides, earthquakes and range fires, which can also result from human activities.

3.15 NOISE

On-going drilling and production operations and related traffic create most sound disturbances within and in the immediate vicinity of the PRPA. Aircraft overflights (generally at high altitudes) and localized vehicular traffic on WYO 430 and county, BLM and two-track roads in the project area also create short-term, localized sound disturbances. For a comparison of typical noise values, refer to Figure 3-24.

Figure 3-24. Typical Noise Levels near Oil & Gas Operations



Data taken from Continental Divide EIS (BLM, 1999)