3.0 AFFECTED ENVIRONMENT

3.1 General Setting

The proposed LBA tract is within a region which has been evaluated by several federal environmental analyses which describe the existing and affected environment in the area of the recently issued and currently proposed lease-by-applications. These documents contain analyses of the impacts to be expected as a result of surface coal mining and other mineral development activity in this area. They are available for viewing at the Casper District Office of the BLM. The relevant publications are as follows:

- *Part 1: Regional Analysis, Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming, Volumes I and II,* BLM, October 1974.
- *Final Environmental Statement, Eastern Powder River Coal,* BLM, March 1979.
- *Final Environmental Impact Statement, Federal Coal Management Program,* BLM, April 1979.
- *Amendment to Wyoming Land Use Decisions: Eastern Powder River Basin Area Management Framework Plan: Gillette Review Area,* BLM, Wyoming, 1980.
- *Final Environmental Impact Statement, Powder River Coal Region,* BLM, December 1981.
- *Proposed Mining and Reclamation Plan, North Antelope Mine, Campbell County, Wyoming,* Final Environmental Impact Statement OSM-EIS-6, February 1982.
- *Powder River Coal Regional Tract Summaries,* Cheyenne, Wyoming, 1983.
- *Draft Environmental Impact Statement, Round II Coal Lease Sale, Powder River Region,* BLM, January 1984.
- *Platte River Resource Area, Resource Management Plan and Final Environmental Impact Statement,* BLM, July, 1985.
- *Buffalo Resource Area, Resource Management Plan and Final Environmental Impact Statement,* BLM, October 5, 1985.
- *Final Environmental Impact Statement Supplement, Federal Coal Management Program,* BLM, October 1985.

- *Medicine Bow National Forest and Thunder Basin National Grassland Land and Resource Management Plan,* USFS, November 20, 1985.

- *Coal Bed Methane Environmental Assessment, Eastern Campbell County and Western Johnson County, Wyoming WY-061-0-EA064,* BLM, Wyoming, March 1990.

- *Jacobs Ranch Federal Coal Lease Application Environmental Assessment,* BLM, Wyoming, June 1991.

- *Final Environmental Assessment for the West Black Thunder Coal Lease Application,* BLM, Wyoming, March 1992.

- *Final Environmental Assessment for the North Antelope and Rochelle Coal Lease Applications for Powder River Coal Company,* BLM, Wyoming, May 1992.

- *Final West Rocky Butte Coal Lease Application Environmental Impact Statement,* BLM, Wyoming, June 1992.

- *Exxon Pistol Point Coal Bed Methane Project Environmental Assessment,* BLM, Wyoming, September 1992.

- *American Oil and Gas Marquiss Field Coal Bed Methane Project Environmental Assessment,* BLM, Wyoming, October 1992.

- *Final Environmental Assessment of the Eagle Butte Coal Lease Application,* BLM, Wyoming, July 1994.

- *Lighthouse Coal Bed Methane Project Environmental Assessment,* BLM, Wyoming, March 1995.

The Antelope Mine has been specifically evaluated in several federal and state environmental analyses. These documents contain analyses of the impacts to be expected as a result of surface coal mining at the Antelope Mine. They are available for viewing at the Casper District Office of the BLM. The relevant publications are as follows:

- *Proposed Mining and Reclamation Plan, Antelope Mine, Converse County, Wyoming,* Final Environmental Impact Statement OSM-EIS-5, February 1982.

- *Technical Environmental Analysis, Antelope Mine,* WDEQ, Permit 525-T4, November 1, 1988, included in Mining Plan Approval Document for the Antelope Mine, Antelope Coal Company.

The affected environment is also described in detail in the Antelope Mine's 525-T5 Permit Application, which was approved on October 28, 1993 by the WDEQ/LQD. A major revision to this permit was approved by WDEQ/LQD on May 18, 1994. This document is on file and available for public review at the WDEQ/LQD offices in Cheyenne, Wyoming. The detailed environmental baseline information for the current permit area, which has been gathered by ACC and various consultants to comply with the WDEQ/LQD requirements for a mine plan submittal, covers the entire LBA area. This information includes land use, climatology, geology, soils, vegetation, groundwater hydrology, surface water hydrology, archaeology, history, air quality, and wildlife.

These studies have revealed that the following elements of the human environment are either not present in the proposed lease area or would not be affected: areas of critical environmental concern, sole source drinking water, prime or unique farmlands, floodplains unsuitable for mining, riparian areas, wild or scenic rivers, or wilderness.

The LBA tract is substantially similar to the adjacent Antelope Mine, for which detailed site-specific environmental data have been collected and environmental analyses have been prepared by ACC to secure the necessary mining permits. These permits and assessments have been previously reviewed in detail and approved by BLM as providing an adequate environmental impact assessment and employing appropriate environmental stipulations and reclamation measures.

The proposed LBA tract is located north of and adjacent to the existing Antelope Mine as shown on figures 1 and 2. The mine is about 55 miles north of Douglas, Wyoming (see Figure 1). Access to the mine is provided by Wyoming Highway 59 and Converse County Road No. 37. Figure 4 is a detailed map showing features of interest that are located within and near the Antelope LBA tract.

The Antelope Mine and LBA tract are situated in the Powder River structural and topographic basin of northeastern Wyoming. The mine and LBA tract are characterized by rolling hills and uplands which have been dissected by stream activity. Elevations on the tract generally range from 4,600 to 4,700 feet above mean sea level. The climate of the region is semi-arid. Precipitation averages about 13 inches per year, with 75% of the average precipitation occurring during the growing season, which is from April through September. Summer precipitation is often in the form of brief, intense thunderstorms. Annual evaporation exceeds annual precipitation. The prevailing winds are from the northwest quadrant and the mean annual wind speed is about 8 to 10 mph. The Powder River Basin is part of the Northwestern Great Plains Ecoregion of Omernik (Environmental Protection Agency, 1993). The area is characterized as an ecological transition zone between the true short grass plains to the east and the northern desert shrub type to the west. Within the Wyoming portion of the basin, the potential natural vegetation is primarily grama-needlegrass-wheatgrass or wheatgrass needlegrass (Kuchler; U.S. Geological Survey, 1985).

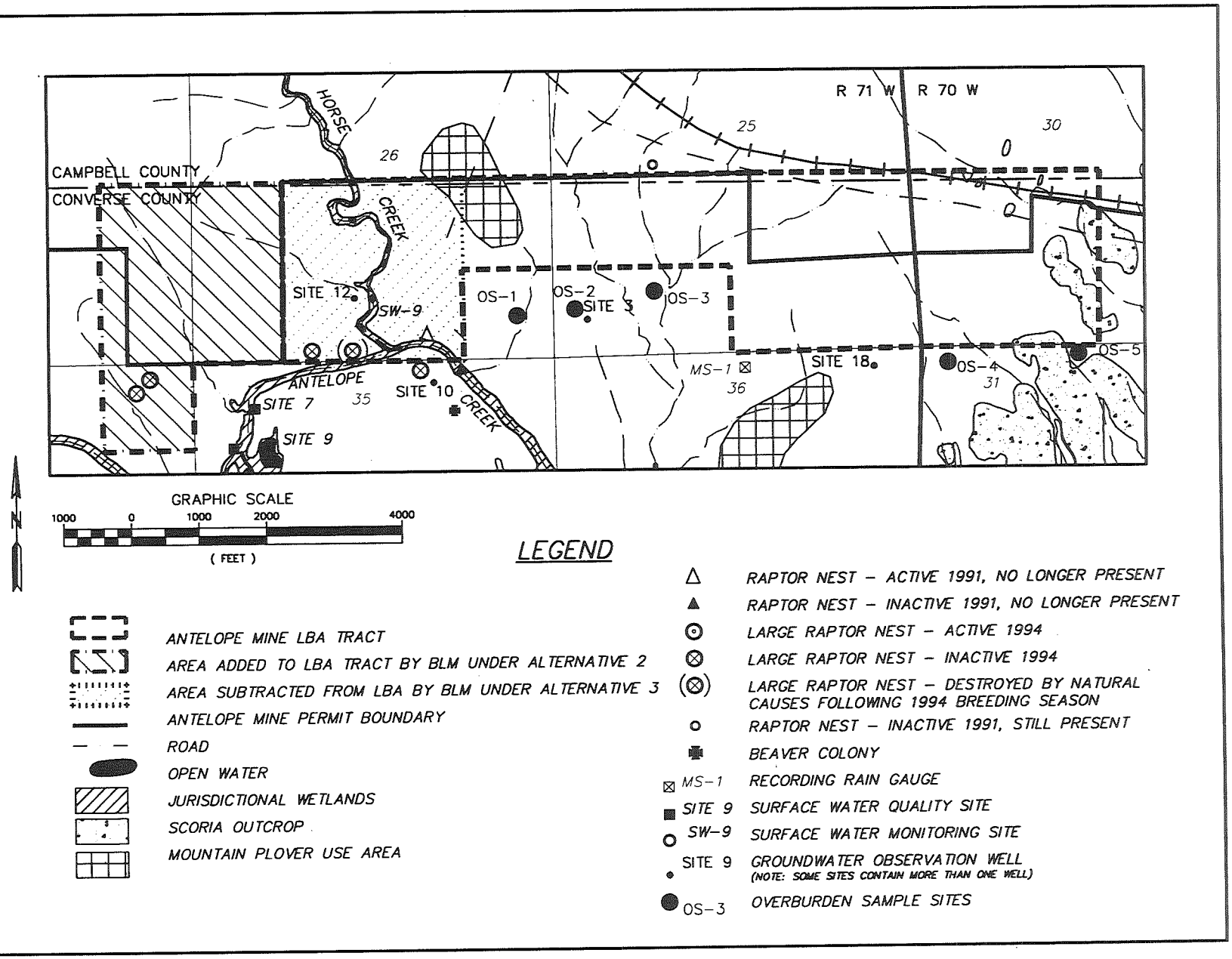


Figure 4. Map of Alternative LBA Tracts

The Antelope Mine permit area is transected by Antelope Creek, an intermittent stream which meanders from west to east. The landscape is further dissected by several small, north-south drainages which are classified as ephemeral, meaning that they flow only in direct response to precipitation or snowmelt runoff events. Figure 5 shows the major hydrologic features of the permit area and LBA tract. Antelope Creek is a tributary of the Cheyenne River, which joins the Missouri River in South Dakota. ACC's approved mining plan avoids disturbing the Antelope Creek Valley.

3.2 Affected Resources

3.2.1 Geology and Topography

The Powder River Coal Field of northeastern Wyoming lies within the boundaries of the Powder River structural and topographic basin. The basin is a broad northwest-southeast trending syncline bounded on the west by the Big Horn Mountains, on the east by the Black Hills, and on the south by the Casper Arch, Laramie Mountains, and the Hartville Uplift. The basin extends northward into Montana. The syncline is asymmetrical and the axis of the syncline (the deepest part of the basin) is west of the geographical center of the basin.

The Antelope Mine is located on the eastern limb of the structural basin and is near the southern end of the basin. The regional dip in the area of the mine is approximately one degree to the northwest. There are local areas where the shallow strata are dipping at higher angles. This is generally due to local folding or faulting.

In general, the coal in the LBA tract is as deep as the coal in the existing leases at the Antelope Mine. This means that approximately as much overburden must be removed from the proposed lease as from the existing leases in order to mine the coal.

Stratigraphic units of interest in the mine area include, in descending order, recent (Quaternary age) alluvial deposits, the Eocene age Wasatch Formation, and the Paleocene age Fort Union Formation (which contains the target coal beds) (see Figure 6). There is no distinct boundary between the Fort Union and Wasatch formations. In fact, one recent paper suggests the upper Fort Union and the Wasatch should be combined and renamed the Kleenburn member of the Fort Union Formation because there is not a valid reason to separate them (Boyd, Wyoming Geological Association, 1994). In the area of the basin where coal is being mined, the contact between the Fort Union Formation and the Wasatch Formation is generally arbitrarily designated as the top of the main coal seam in the Fort Union Formation. This main coal seam, referred to as the Wyodak-Anderson, is the seam being mined in most of the Wyoming Powder River Basin. At the Antelope Mine and LBA there are two minable coal seams, locally referred to as the Anderson and Canyon seams. The upper seam, the Anderson, ranges in thickness from 18 to 44 feet and is thickest in the northern part of the Antelope Mine area. The Canyon seam has a thickness of 30 to 36 feet, but contains numerous splits in the southern half of the Antelope Mine area, forming five separate and relatively thin seams. There are areas within the existing permit area where the Anderson seam has been removed by erosion. Within the LBA tract, both seams are present and each is relatively uniform in thickness. A few miles north and northeast of the LBA area, at the North Antelope Mine, the Anderson and Canyon coal seams coalesce to form the Wyodak-Anderson coal seam.

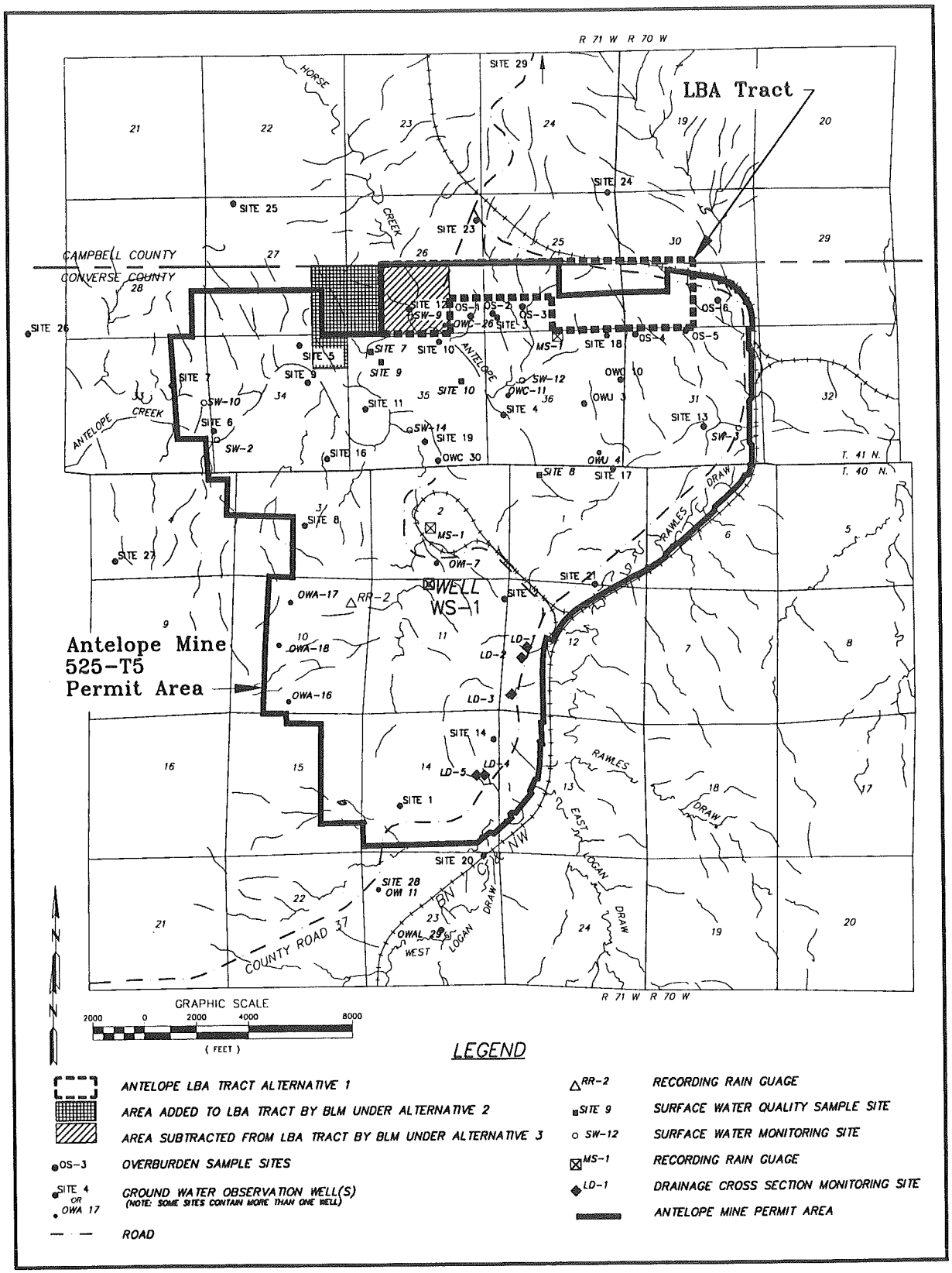
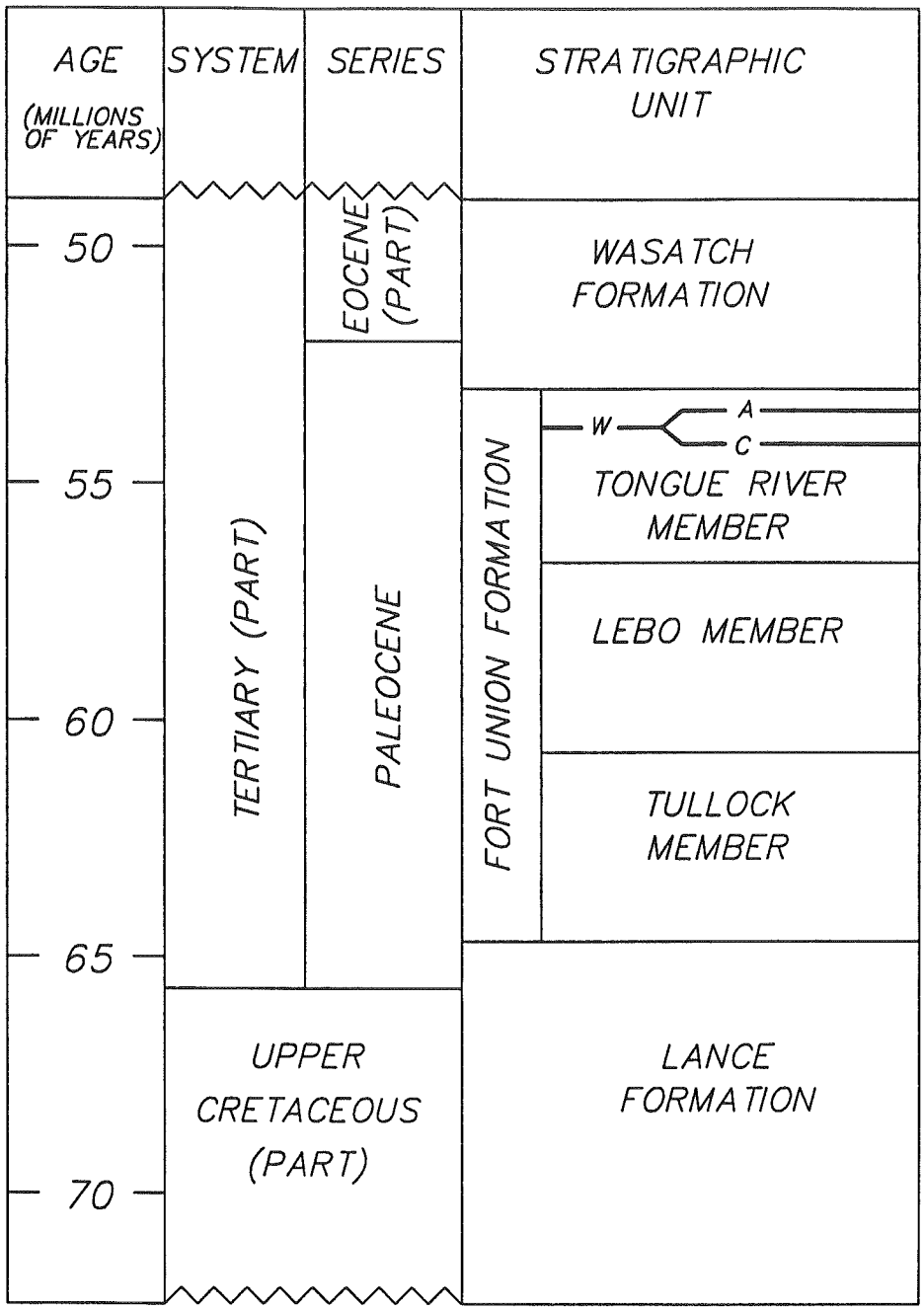


Figure 5. Antelope Mine LBA Hydrologic Features



W – WYODAK COAL SEAM
A – ANDERSON COAL SEAM
C – CANYON COAL SEAM

From Brown, USGS, 1993, & Law, Rice, & Flores, RMAG, 1991

Figure 6. Generalized Stratigraphic Chart for the Latest Cretaceous and Early Tertiary Periods, Powder River Basin, Wyoming

On the extreme eastern part of the LBA area, small areas of scoria (also called clinker) are present because the overburden has been thermally altered from the burning of the Anderson coal seam (see Figure 4). The overburden generally thickens toward the north in the LBA area as the topography rises away from the Antelope Creek valley.

There are Quaternary alluvium and colluvium deposits located along Horse Creek and several of the other minor drainages within the LBA. Within the LBA tract, there are also alluvial deposits located along Antelope Creek (see figures 4 and 5). The alluvial deposits consist of fining-upward sequences with gravel at the base and very fine sand or silt at the top locally (Budai and Cummings, 1984). These deposits have been the subject of AVF investigations and determinations (refer to Section 3.2.2.3).

The Wasatch Formation crops out over much of the surface of the Wyoming Powder River Basin. It consists of interbedded shales, siltstones, thin discontinuous coals, and lenticular sandstones. Where sandstones in the Wasatch Formation are of sufficient porosity and areal extent, they serve as aquifers supplying water for stock and domestic uses.

The Fort Union Formation consists of noncarbonaceous to highly-carbonaceous shales, mudstones, siltstones, lenticular sandstones, and coal. It is approximately 3,100 feet thick in the area of the Antelope LBA tract, based on data from geophysical logs from two exploratory oil wells drilled in the vicinity of the Antelope LBA (the HPC Hedgehog Federal 1-25, SW/4 SW/4, Section 25, T.41N., R.71W.; and the HPC Woods Hedgehog 1-36, SE/4 NW/4, Section 36, T.41N., R.71W.) The Fort Union Formation is divided into three members, the Tongue River, Lebo Shale, and Tullock (in descending order; see Figure 6). The thicknesses listed for these three members in the LBA area in the following discussion are based on correlation of the geophysical logs cited above.

The Tongue River member consists of sandstone, conglomerate, siltstone, mudstone, limestone, coal, and carbonaceous shale. It reaches thicknesses of 1,750 feet in the Powder River Basin (Law, Rice, and Flores; Rocky Mountain Association of Geologists, 1991). In the LBA area, it is approximately 1,400 feet thick, and consists of around 60% sand (Lewis and Hotchkiss; U.S.Geological Survey, 1981). The Anderson and Canyon coal seams are located at the top of this member in the LBA area. Below the Anderson and Canyon coal seams, interbedded shales, siltstones, sandstones, and thin coal beds comprise the rest of the Tongue River member.

The Anderson and Canyon coal seams are subbituminous in rank, and they are generally low sulfur, low ash coal deposits. Glass (Wyoming Geological Association, 1991) reported average ash, sulfur and Btu/pound values of 5.1%, 0.36%, and 8,580, respectively for coal in the eastern portion of the Powder River Basin of Wyoming that is currently being mined. According to a Wyoming State Geological Survey report, (Wyoming State Geological Survey, Vogler et al., 1995), in 1994 the

coal delivered by the Antelope Mine had an average Btu/lb of 8,826, an average ash content of 5.21%, and an average sulfur content of 0.28%. In a geophysical log from an oil well located close to the LBA (HPC Hedgehog Federal 1-25, SW/4 SW/4, Section 25, T.41 N., R.71 W.), the Anderson coal is approximately 40 feet thick, while the Canyon coal is approximately 32 feet thick. At this location, there is approximately 106 feet of overburden above the Anderson coal and approximately 22 feet of interburden between the Anderson and Canyon coals, based on the gamma ray log run in the oil well. An estimate of the thickness, average heating value, ash content, and sulfur content of the coal in the lease application area based on the BLM geologic and engineering report will be included in the sale notice for the tract.

The middle member of the Fort Union Formation is the Lebo Shale Member. It reaches a maximum thickness of approximately 3,000 feet in the Powder River Basin and consists of sandstone, siltstone, mudstone, coal, and carbonaceous shale (Law, Rice and Flores; Rocky Mountain Association of Geologists, 1991). In the lease application area, it is 300 to 400 feet thick and consists of 30% to 40% sand (Lewis and Hotchkiss; U.S. Geological Survey, 1981).

The lower member of the Fort Union Formation is the Tullock, described as follows by Brown (U.S. Geological Survey, 1993). The Tullock Member ranges in thickness from 370 feet in the northwestern Powder River Basin (in Montana) to 1,440 feet in the southeastern Powder River Basin (in northeastern Converse County and northwestern Niobrara County). It consists of fine-grained sandstone, sandy siltstone, shale, rare thin limestone, and coal. Where it crops out along the southeastern edge of the Powder River Basin, east of Bill, Wyoming, the Tullock is primarily siltstone and mudstone (greater than 75%) with minor zones of coal and carbonaceous shale. Thin, lenticular sandstone beds comprise the remainder of the member. In the area of the proposed lease it is approximately 1,300 feet thick and consists of 40% to 50% sand (Lewis and Hotchkiss; U.S. Geological Survey, 1981).

A fourth geologic unit, clinker (also known as scoria), is baked or fused rock formed by prehistoric burning of coal seams. Clinker formed by burning of the Anderson coal seam is present along the outcrop of this seam. There are clinker deposits in the central and eastern parts of the Antelope Mine permit area, and clinker from these deposits is used for mine road surfacing material. Three clinker deposits extend onto the eastern portion of the LBA tract (see Figure 4).

The terrain in the vicinity of the Antelope Mine area is gently rolling. Overall, the Antelope LBA tract is similar to the rest of the current permit area, where slopes range from flat to 34% and average about 5%. Slope analyses would be done for any new areas that would be added to the Antelope Mine permit area if the tract is leased and it is necessary to amend the permit boundary.

Methane, the natural gas used to heat homes, occurs in association with coal beds because it is a by-product of coal maturation. Some of the methane produced by coal beds escapes from the coal beds, migrates upward, and is dispersed in the atmosphere. Some of it is trapped in the coal by overburden pressure and the

pressure of water that occupies fractures in the coal. Generally, there is more methane in coal beds that are deeper and less in shallow coal beds because the lower pressures at shallower depths trap less gas. Under certain geologic conditions, however, methane from coal beds can be trapped at shallow depths both in and above the coal beds. These geologic conditions include low matrix porosity and permeability in the coals, association of the gas with structurally high features in structurally deformed areas, and the existence of effective seals (Law, Rice and Flores; Rocky Mountain Association of Geologists, 1991). Without the existence of these conditions which act to trap the gas in shallow coals or in adjacent sandstones, the gas escapes to the atmosphere.

Methane has historically been reported flowing from shallow water wells and coal exploration drill holes in the Powder River Basin. According to DeBruin and Jones (Wyoming Geological Association, 1989), most of the documented historical occurrences have been in the northern Powder River Basin. Olive (U.S. Geological Survey, 1957) references a water well in T. 54 N., R. 74 W. which began producing gas for domestic use in 1916. Occurrences of methane gas in shallow wells in and around Gillette have also been the subject of newspaper articles in the *Gillette News-Record* over the years (for example: "Gas Accompanies Flow of Water in Railroad's Well," 1/18/36, well located in the railroad yard, depth 740 feet; "Vein of Gas Struck on L.C. Reed Ranch," 5/25/48, location 30 miles northwest of Gillette, depth to gas 262 feet; "Gas Struck in Water Well on Ted Barlow Ranch," 4/5/51, ranch location 13 miles west of Gillette, depth to gas 305 feet; and "City Paying $464,000 to Get Gas Out of Water," 7/10/84, referring to six Fort Union water wells in the city).

Most of the gas generated by the coal beds in the Powder River Basin has gradually escaped to the atmosphere because the coals in the Powder River Basin are at shallow depths, and not much methane is trapped in the coal by overburden and water pressure. The occurrence of producible amounts of methane at shallow depths in the northern part of the Powder River Basin appears to be due to geologic conditions like those described above.

In some areas of the country, most notably in the San Juan Basin of Colorado and New Mexico and the Black Warrior Basin of Alabama, methane from coal beds is being commercially produced in significant quantities. There has been commercial production of coal bed methane in the Wyoming Powder River Basin at Rawhide Butte Field since 1989. Coal bed methane projects are also in testing or commercial stages between Gillette and Wright (BLM, October 1992 and March, 1995) and near the Pumpkin Buttes (BLM, September 1992).

Rawhide Butte Field is located just west of the AMAX Eagle Butte Mine. Methane leakage at the ground surface was known in that general area for many years. The gas accumulation in the coal at Rawhide Butte Field is in an area that is structurally deformed (Law; Wyoming Geological Association, 1976). The coal beds in the basin are interbedded with shales which form effective seals. There is more gas production and less water production from wells in relatively higher structural positions in this field. The increase in production in structurally higher wells is

probably due to proximity of the coal to the top of the water table in that area (Law, Rice and Flores; Rocky Mountain Association of Geologists, 1991). In the late 1980s, methane leakage became a serious hazard at two subdivisions (Rawhide Village and Horizons) located near the AMAX Eagle Butte Mine, and a number of houses had to be moved or abandoned. The state of Wyoming prepared a report on the methane hazards in the subdivisions in support of the governor of Wyoming's appeal to the President of the United States to declare the area a major disaster area (Office of the Governor, et. al, State of Wyoming, 1987). Two of the producing wells in the Rawhide Butte Field were initially drilled at the request of the WDEQ to investigate the methane leakage in the subdivisions. AMAX conducted an investigation of the geologic and hydrologic conditions in the area of Rawhide Village in response to requests from the WDEQ. The purpose of this investigation was to evaluate the impact of future mining operations at the Eagle Butte Mine on the situation at Rawhide Village. The investigation concluded that "there is no evidence that mining activities at the Eagle Butte Mine have caused or aggravated the historic phenomenon of gas seepage in the area of Rawhide Village." This study and its results are included as Appendix 3.5-9 in AMAX's 428-T2 permit renewal document.

The situation that produced the gas seeps in the vicinity of the Eagle Butte Mine is not known to exist in the vicinity of the Antelope Mine. According to Budai and Cummings (1984), in the central part of the Antelope Mine area the Anderson seam does roll over the top of sandstone-siltstone lenses in the interburden. This results in fold-like structures in the Anderson coal which are similar to those described in the vicinity of the Rawhide Butte Field by Law (Wyoming Geological Association, 1976). However, Budai and Cummings (1984), also describe local areas where Antelope Creek and its tributaries have cut into and through the Anderson coal seam, and they show interfingering shale and sandstone beds directly overlying the Anderson. If there is not a continuous shale overlying the coal, there is not an effective seal continuously overlying the Anderson to act as a trap for the gas escaping from the coal. In the Antelope Mine area, there is an absence of prominent rolling in the Canyon coal seam in the mine area that could act as a trapping mechanism for coal bed methane. There is no coal bed methane production in the vicinity of the Antelope Mine at this time.

3.2.2 Water Resources

3.2.2.1 Groundwater

In the area of the Antelope Mine, there are five major geologic units containing groundwater that could be impacted by coal mining. These units are the Quaternary alluvium, the Wasatch overburden, the clinker (or scoria), the Wyodak-Anderson coal seam, and the Fort Union Formation underlying the coal.

The extent of alluvium within the LBA tract is shown on Figure 4. Although some alluvium is present in tributaries to Antelope Creek, the alluvium there is generally thin, fine-grained, and in places dry. Exceptions are near the mouths of these tributary ephemeral streams, where the alluvium of the tributaries coalesces with that of Antelope Creek. In general, the alluvium in the tributary streams does not

constitute a significant aquifer. The alluvium along Antelope Creek is comprised of up to 40 feet of saturated sand and some gravel with numerous lenses or layers of clays and silts.

The Wasatch overburden is not a regional aquifer due to its discontinuous lithology which is a matrix of siltstones and shales interbedded with lenticular sandstones, thin discontinuous coal seams, and clinker deposits. Where saturated, the sandstones and coal seams in the Wasatch can provide water to stock and domestic wells but generally do not have the areal extent of the Wyodak-Anderson coal seam, which is split in the lease application area into the Anderson and Canyon coal seams. The Wasatch contains little water in the Antelope Mine area. Recharge to the Wasatch is from infiltration of precipitation and lateral movement of water from adjacent clinker bodies. Regionally, water is discharged from the Wasatch by evaporation and transpiration, by pumping wells, and by small springs and seeps along stream drainages. No springs or seeps which discharge water from the overburden occur on the LBA tract, and mining the LBA tract under any of the alternatives would not directly affect any springs or seeps.

Regional flow in the overburden is generally toward the south (toward Antelope Creek) in the vicinity of the LBA area, although the flow pattern is poorly defined due to the discontinuous nature of the permeable units in the overburden. The quantity of water involved is small and the rate of movement is slow because the permeabilities within the overburden are low. Martin, et. al (U.S. Geological Survey, 1988) reported that hydraulic conductivity in the Wasatch ranged from 10^{-4} ft/day to 10^{2} ft/day, and geometric means of hydraulic conductivity range from 0.2 ft/day to 0.35 ft/day.

The Wyodak-Anderson coal bed is the most continuous shallow hydrologic unit in the Powder River Basin, although conditions are somewhat different in the vicinity of the Antelope Mine area. At the North Antelope Mine, located several miles northeast of the Antelope Mine, the Wyodak-Anderson is a single coal seam. At the Antelope mine, the single Wyodak-Anderson coal seam has split into two seams, the Anderson (upper) and Canyon (lower). There are areas within the current permit where the Anderson seam has been removed by erosion, and in the southern part of the mine the Canyon seam splits into as many as five separate seams. South of Antelope Creek, the Anderson seam is dry or partially saturated and the Canyon seam is partially saturated. Within the LBA tract and to the north, both coal seams are present and relatively uniform in thickness. In this area both seams are saturated, and the Canyon seam has a significant piezometric head. In fact, in the northeastern part of the permit area, which would include the LBA tract, ACC is implementing plans to dewater the coal seams with wells in advance of mining. This is intended to reduce problems associated with groundwater seepage into the pit.

Within the Powder River Basin, the use of the coal seams as aquifers is due more to their shallow depth, continuity, and thickness than their permeability and quality. Recharge to the coal aquifer occurs primarily from clinker along the outcrop areas. The regional flow pattern in the coal is generally westward and northwestward

from the outcrop toward discharge areas in the northern reaches of the Powder River structural basin (Daddow; U.S. Geological Survey, 1986). Locally, the coal seams discharged to Antelope Creek prior to mining and now also discharge to mining pits at the Antelope Mine and other mines to the north.

Because of its westward dip and relatively small yields, the coal seam ceases to be an economically viable aquifer as overburden thickness increases westward from the outcrop. There has been little use of the coal as an aquifer where it is more than a few hundred feet deep because the shallower sandstones and coal seams in the overlying Wasatch Formation can generally provide adequate water of similar quality more economically. Due to the discontinuities in the Anderson seam, the splits in the Canyon seam to the south, and the proximity of the coal outcrop to the east, the most significant drawdowns in the coal as a result of mining activity at the Antelope Mine will be to the north and northwest of the mine. According to the Antelope Mine permit document on file with WDEQ/LQD (Volume VII, Appendix D6, Hydrology) there are no water users of record withdrawing water solely from the Anderson or Canyon coal seams to the west or northwest of the Antelope Mine within the area subject to impact by the mining operation.

A groundwater analysis was performed by ACC for the recently-approved 525-T5 Term of Permit Mine Plan utilizing the MODFLOW model, a numerical groundwater flow simulation. In their modeling studies of the Anderson seam, ACC used a transmissivity of 2,080 gallons per day per foot (gpd/ft) and a specific yield of 0.05. Assuming a thickness of 38 feet, this transmissivity would correspond to a permeability of about 7.3 feet per day (ft/day). For the Canyon seam, a transmissivity of 3,000 gpd/ft and a storage coefficient of 0.00015 were used. For an average thickness of 33.5 feet, this transmissivity corresponds to a permeability of about 12 ft/day. The U.S. Geological Survey reports an average permeability of about 0.8 ft/day for the Wyodak-Anderson coal seam in the Powder River Basin (Martin, et. al, U.S. Geological Survey, 1988). These figures indicate that the coal seams in the Antelope Mine area are more permeable than the basin-wide average.

The subcoal Fort Union can be divided into three hydrologic units: the Tongue River aquifer, the Lebo Member, and the Tullock aquifer (Law; Wyoming Geological Association, 1976). The Tongue River aquifer consists of lenticular fine-grained shale and sandstone. The Lebo Member, also referred to as "the Lebo Confining Layer," is typically more fine-grained than the other two members and generally retards the movement of water (Lewis and Hotchkiss; U.S. Geological Survey, 1981). The Tullock aquifer consists of discontinuous lenses of sandstone separated by interbedded shale and siltstone. Transmissivities are generally higher in the deeper Tullock aquifer, and many mines in the Powder River Basin have water-supply wells completed in this interval (Martin, et. al; U.S. Geological Survey, 1988). The average transmissivity for this member as reported in McIntosh, et. al (Office of Surface Mining, 1984) is 290 ft^2/day.

Flow patterns in the subcoal Fort Union aquifer are similar to those of the coal, with recharge occurring in outcrop areas east of the coal outcrop and regional flow trending to the west and north.

The clinker (or scoria) is the most permeable geologic unit in the Powder River Basin coal region. It has a high recharge capacity. It can supply large volumes of water to wells, depending on its areal extent and saturated thickness. Saturated clinker is an important recharge source for the coal, and is so permeable relative to coal that drawdowns in coal normally do not appreciably affect water levels in the clinker. Very little saturated clinker is found in the Antelope Mine area. Portions of three clinker deposits extend into the LBA tract, but these deposits cover only about 15 acres (about 2.5%) of the LBA tract (see Figure 4). Several small clinker deposits are present outside the LBA area and where unsaturated are used as borrow sources for mine road surfacing materials and aggregates.

The saturated thicknesses of the various hydrologic units give an indication of the extent of the groundwater resource present in each. At the Antelope Mine, the thickness of saturated overburden varies from 0 to about 50 feet. The Anderson coal seam saturated thickness varies from 0 to about 40 feet. The Canyon seam has only a few feet of saturated thickness in some areas, but in the LBA tract and north from there the seam has a potentiometric head of 150 feet and more. According to Martin, et. al (U.S. Geological Survey, 1988), the subcoal Fort Union aquifers average 2,000 feet thick (all saturated), of which the deeper Tullock member comprises an average of 785 feet.

Water chemistry in the coal aquifer varies as a function of distance from the outcrop. Near the outcrop, where recharge occurs from the clinker and overburden, the dominant ions are calcium, magnesium, sodium, and sulfate. As water moves down-dip away from recharge areas, sulfate is reduced, and the water becomes dominated by sodium and bicarbonate ions. At the Antelope Mine, water from the Anderson coal seam is generally of the sodium-sulfate type, while water in the Canyon seam is of the sodium-bicarbonate type. The sodium-bicarbonate water typically has a lower total dissolved solids concentration (TDS) than does the sodium-sulfate water.

TDS concentrations in the water from the Anderson coal seam on the Antelope Mine vary widely, and based on the most recent data range from about 478 mg/L to about 5,208 mg/L and average about 2,153 mg/L (ACC, December 1993). The 478 mg/L is within the range generally considered suitable for drinking water (recommended limit of 500 mg/L), while the 5,208 mg/L exceeds the recommended limit for livestock water (5,000 mg/L). The average value is slightly in excess of the recommended limit for irrigation water (2,000 mg/L) (WDEQ/Water Quality Division, 1980).

TDS concentrations in the water from the Canyon seam on the Antelope Mine are also variable, ranging from 318 to 2,846 mg/L and averaging 804 mg/L (ACC, December 1993).

Groundwater in the Wasatch Formation is not monitored for water quality in the Antelope Mine area because the formation contains so little water in this area. Two wells completed in the Fort Union below the coal are monitored for water quality, and the TDS concentrations were 384 and 416 mg/L in these wells in 1993 (ACC, December 1993). Water in the alluvium of Antelope Creek generally has higher TDS concentrations than the other shallow aquifers. Recent data showed TDS concentrations from three alluvial monitor wells ranging from 820 to 4,426 mg/L, with an average of 2,877 mg/L (ACC, December 1993).

The primary water supply for the Antelope Mine is obtained from water supply well WS-1 (see Figure 5). Water-supply well WS-1 is completed to a total depth of 2,528 feet and has eight screened intervals between a depth of 1,436 feet and the bottom of the well. In 1993, the production of this well averaged about 33 gallons per minute (gpm). It is estimated that this well could supply a sustained pumping rate of 300 gpm. Total usage for 1993 was 17,419,400 gallons. This water, which meets drinking water standards, is used for dust suppression, equipment and facility cleaning, and employee showers. Additional water for dust control is obtained from pit dewatering. Water for dust suppression on haul roads is obtained from the Old Antelope Pit, Old Best Pit, and the mine pit sump. These sources are expected to provide sufficient water for foreseeable uses for the duration of the mining operation, with or without the LBA.

Water from well WS-1 is a sodium-bicarbonate type with a TDS concentration of about 520 mg/L. This water is generally suitable for domestic, stock, and agricultural purposes. Although water from well WS-1 is sampled annually and analyzed for water quality and fecal coliform, potable and drinking water is provided to the mine by a commercial bottled water contractor.

According to information provided in the Antelope Mine permit document (ACC, Permit 525-T5 Renewal and Revision, Mine Plan, 1993) there are no valid water rights for water-supply wells on the LBA tract.

3.2.2.2 Surface Water

The drainage system on and near the LBA tract is illustrated on figures 4 and 5. The LBA includes a small portion of the valley of Antelope Creek and the lower reaches of Horse Creek, a southward-flowing tributary of Antelope Creek. A short reach of Antelope Creek crosses the LBA tract and drains eastward toward the Cheyenne River. In the vicinity of the LBA, Antelope Creek is a meandering, braided, intermittent stream into which flow small, gullied ephemeral streams. Antelope Creek has an approximate gradient of 0.3% and a 10-year average discharge (1981 to 1991) of 2.8 cubic feet per second. Annual streamflow data reveal a 10-year average inflow of 2,063 acre-feet in Antelope Creek at the west permit boundary and an average outflow of 2,032 acre-feet at the east permit boundary. This indicates that the section of Antelope Creek that traverses the Antelope Mine permit area may be losing surface water to the groundwater and to evapotranspiration (Ecotone, 1992). The water in Antelope Creek and other local channels comes from three general

sources: 1) groundwater contained in the shallow alluvial aquifer, 2) lateral inflow of groundwater from surrounding bedrock, and 3) surface water from the large watershed upstream.

Flow in Antelope Creek during the winter months is very low, and the stream often has no flow due to freezing. In the early spring, Antelope Creek begins to flow in response to ice breakup and snowmelt runoff. The majority of this flow is from upstream drainage with a small percentage of runoff being contributed locally. A small springtime base flow in Antelope Creek occurs from discharging groundwater from the Anderson coal seam in the drainage upstream of Antelope Mine. The total discharge of groundwater from the Anderson coal seam to Antelope Creek or its alluvium in the Antelope Mine vicinity is estimated at 129 acre-feet per year (80 gpm) (ACC Mine Permit Document, Vol. VII, Appendix D6, Hydrology). This discharge is not sufficient to overcome consumptive uses during the summer time, and therefore the stream has extended no-flow periods during each year.

Antelope Creek has a drainage area of approximately 854 square miles above the Antelope Mine. The existing permit area consists of 7,535.76 acres, or about 1% of the Antelope Creek drainage area at this location. The LBA tract comprises an additional 617.2 acres, or about one tenth of one percent of the drainage area of Antelope Creek at this location.

Horse Creek has a drainage area of about 15 square miles. This stream is classified as ephemeral, flowing only in direct response to snowmelt or rainfall runoff events. This stream is typical of small ephemeral drainages for the region, and flow events are closely reflective of precipitation patterns. Flow events of relatively small magnitude can result from snowmelt during the late winter and early spring. Although peak discharges from such events are small, the duration and therefore percentage of annual runoff volume can be considerable. During the spring, general storms (both rain and snow) increase soil moisture, hence decreasing infiltration, and can result in both large runoff volumes and high peak discharges.

Flows and water quality in Antelope Creek and several minor tributaries are monitored on and near the permit area and reported annually. The surface water quality varies with stream flow rate; the higher the flow rate, the lower the TDS concentration but the higher the suspended solids concentration. The surface water is typically a calcium-sodium-sulfate water and generally contains more than 1,500 mg/L of TDS. This water is usually unsuitable for domestic use, marginal for irrigation, and suitable for stock and wildlife (OSM, 1981).

3.2.2.3 Alluvial Valley Floors

The entire permit area and adjacent area, including the LBA tract, have been investigated for the presence of alluvial valley floors. A report of this investigation is contained in the Antelope Mine permit document (Appendix D-11, Alluvial Valley Floors). Along Antelope Creek, the only areas designated as AVFs within the permit are classified as "possible sub-irrigated AVF of minor importance to agriculture." A

total of less than 140 acres of this type of AVF were identified, a very small portion of which is within the LBA tract. Along Horse Creek within the permit area and for a distance of 2 miles upstream (which includes the LBA tract), a very narrow band adjacent to the channel was designated as "possible sub-irrigated AVF for which no material damage is predicted." At the time this designation was made, ACC did not plan to mine through the lower portion of Horse Creek. The material damage conclusion would change if the LBA is issued, since the LBA includes the lower portion of Horse Creek.

The alluvial deposits along Antelope Creek consist primarily of sand and gravel, and groundwater levels in this alluvium show a rapid response to changes in streamflow levels in Antelope Creek. In general, these deposits will not be mined because the Antelope Creek Valley will not be disturbed. Minor effects are predicted where the pits come in close proximity to the valley floor. The alluvial deposits along Horse Creek, some of which will be removed by mining, are generally discontinuous beds of sand, silt and clay. All AVFs in the Antelope Mine permit area, including those along Horse Creek that will be mined, have been declared by the WDEQ/LQD to be insignificant to agriculture, which means they are not precluded from mining (State of Wyoming; Hanson and Valerius, 1988).

3.2.2.4 Wetlands

A jurisdictional wetlands delineation (delineation of wetlands that are within the extent of U.S. Army Corps of Engineers regulatory overview) of the Antelope Mine was conducted for ACC in 1992 (Ecotone, 1992). The project area was comprised of the existing mine permit area and adjacent areas, including the LBA tract. ACC received U.S. Army Corps of Engineer's concurrence for these delineations in a letter dated April 28, 1993. A total of 148 acres of special aquatic sites (geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values) were delineated within the project area. Delineated jurisdictional wetlands are located within the special aquatic sites. In addition to the special aquatic sites, there are approximately 35 miles of active stream channel waters of the U.S. within the mine. The locations of jurisdictional wetlands and stream channels within the LBA tract are shown on Figure 4.

Within the mine as a whole and within the LBA tract, areas of jurisdictional wetlands are restricted to the lowest portions of the alluvial bottomland of Antelope Creek as well as the major ephemeral tributaries. Horse Creek, an ephemeral tributary of Antelope Creek which flows through the LBA tract, contains approximately 5 acres of jurisdictional wetlands, including two wet meadows and several aquatic beds lying in a narrow channel about 4,000 feet in length.

3.2.3 Soils

The entire permit area and a large adjacent area, which includes the LBA, was subjected to a complete first order soils inventory as a part of the original mine

baseline studies (Commonwealth Associates, Inc., 1980). The soils baseline studies covered a total area of about 16,000 acres, compared with a permit area of 7,535.76 acres. The results of this investigation are presented in Volume VIII, Appendix D7, Soils, of the Antelope Mine permit document. The soils information has been used by ACC to estimate the volume of suitable soil to be stripped and salvaged for use in reclaiming the disturbed lands. For the entire disturbed area, the average topsoil depth that will be replaced on reclaimed lands is about 2 feet.

A total of 44 soil types, soil complexes, or other units occur within the baseline study area. Seventeen of these mapping units are located within the LBA tract. The 1980 soil baseline assessment in the mine permit document contains complete physical descriptions and laboratory data for these soils. The following is a list of the soils series/map units found on the 617.2-acre LBA tract. The soils considered hydric are so noted (Soil Conservation Service, 1991).

Soils developing predominantly in stream laid alluvium

- Cushman sandy loam, 0-6% slopes
- Glenberg sandy loam, 0-3% slopes
- Haverson loam, 0-3% slopes

Soils developing predominantly in alluvial fan deposits

- Absted-Arvada-Bone complex, 0-6% slopes (hydric in depressions)
- Dillingson loam, 3-6% slopes
- Kim loam, 0-3% slopes
- Kim loam, 3-6% slopes
- Ulm clay loam, 0-6% slopes (hydric)
- Zigweid loam, 3-6% slopes
- Zigweid clay loam, 3-6% slopes

Soils developing predominantly in residuum

- Razor clay loam, 0-16% slopes
- Samsil clay, 0-15% slopes
- Shingle clay loam, 0-15% slopes
- Thedalund clay loam, 0-6% slopes
- Sear-Wibaux complex, 0-15% slopes
- Shingle-Samsil complex, 3-30% slopes
- Rock outcrop-Shingle-Samsil-Tassel complex, 3-30% slopes

Soil observations were taken at 158 sample points in suspected wetlands as a part of the 1992 wetlands delineation survey for the Antelope Mine (Ecotone,

1992). Predominant soil textures at these sample locations were sandy clay loam, silty sand, and sandy loam. Of the 158 sample points, 94 points exhibited positive indicators of hydric soils.

The most abundant soil type on the LBA tract, as well as on the entire permit area, is the Rock outcrop-Shingle-Samsil-Tassel complex on 3% to 30% slopes. Another soil unit covering large areas is the Shingle-Samsil complex on 3% to 30% slopes. ACC has determined, on the basis of their soils inventory, that a total of 1,322,450 cubic yards of topsoil would be salvageable within the LBA tract for use in reclamation. For a disturbed area of about 462.2 acres, this equates to an average topsoil thickness of 1.8 feet.

Table 5. Comparison of Topsoil Suitability Criteria and Mine Overburden Parameters

Topsoil suitability parameter (1)	Suitable for topsoil	Marginal topsoil	Unsuitable for topsoil	Mine overburden near the LBA tract (2)	Mine overburden from areas not near the LBA tract
pH	5.5 - 8.5	5.0 - 5.5 8.5 - 9.0	< 5.0 > 9.0	7.3	7.3
EC (conductivity, mmhos/cm)	0 - 8	8 - 12	> 12	2.7	2.7
Saturation percentage	25 - 80	< 25, > 80	--	--	--
Texture	--	clay, silty clay, sand	--	--	--
SAR (sodium adsorption ratio)	0 - 10	10 - 12 (fine-textured soil) 10 - 15	> 12 (fine-textured soil) > 15	4.8	6.1
Selenium (parts per million)	< 0.1	> 0.1	--	0.23 (3) 0.16	0.19 (3) 0.13
Boron (parts per million)	< 5.0	--	> 5.0	0.37	0.29
Coarse fragments (percent volume)	< 25	25 - 35	> 35	--	--

Notes: (1) From WDEQ/LQD Guideline No. 1, Table I-2.
(2) Statistical mean values for overburden samples from the six sampling sites shown on Figure 4.
(3) Two selenium concentrations are those calculated by two different methods.

Extensive sampling and testing of overburden has been completed at Antelope Mine. The six existing overburden sampling sites that are located closest to the LBA tract are shown on Figure 4. Table 5 (above) includes a comparison of current WDEQ/LQD topsoil suitability criteria to the statistical mean values for test parameters for overburden from the six sampling sites shown on Figure 4 and to mean values for overburden from all other mine sampling sites. WDEQ/LQD may permit use of overburden as cover soil during mine reclamation if the overburden meets topsoil

suitability criteria and if the volume of stripped topsoil is not adequate. The data in Table 5 (above) indicates that, if required, overburden from within the existing mine lease boundary and from the LBA tract may be suitable for use as cover soil during reclamation.

3.2.4 Vegetation

As with the soils, baseline vegetation studies were conducted on a large study area that includes the current permit area, the LBA, and a considerable surrounding area (Commonwealth Associates, Inc., 1980). The baseline vegetation studies are reported in the Antelope Mine permit document as Appendix D8, Vegetation, Vol. IX. The total area covered in the vegetation baseline studies was about 16,000 acres, or more than twice the area within the current permit boundary.

Seven vegetation types were identified in the vegetation baseline studies, of which six are found within the LBA. All are native rangeland vegetation types; there is no cultivated land on the permit area. The following is a brief description of the vegetation types on the LBA. These seven vegetation types are underlined in the following discussion.

The blue grama upland vegetation type typically occurs in large expanses on the uplands of the southern and western portions of the permit area, with smaller occurrences located throughout the area on alluvial fans and terraces in the larger valleys. This vegetation type covers scattered areas within the LBA which comprise about 90 acres or 1% of the total LBA tract as applied for. Major species are blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), needle-and-thread (*Stipa comata*), and plains pricklypear (*Opuntia polyacantha*). About half the foliage cover is blue grama. This vegetation type occupies the moderately deep to deep, level to somewhat sloping, loam, clay loam, and sandy loam soils.

The birdsfoot sagebrush upland type is located principally on the uplands and alluvial fans in the western and southern portions of the baseline study area. This type is found in areas scattered throughout the LBA tract and covers about 132 acres or 21% of the LBA tract as applied for. Major species include birdsfoot sagebrush (*Artemisia pedatifida*), western wheatgrass, blue grama, and plains pricklypear. About half of the foliage cover is birdsfoot sagebrush and blue grama. The vegetation is low growing and sparse, resulting in this type having the greatest amount of bare soil of the vegetation types present in the baseline study area. The birdsfoot sagebrush upland type occurs on shallow to deep, level to moderately sloping, clay and clay loam soils.

The silver sagebrush lowland vegetation type occupies large areas on the lower stream terraces along Antelope Creek and to a lesser extent the smaller draws to the north and south. Silver sagebrush is found along Horse Creek and Antelope Creek within the LBA tract and covers about 32 acres or 5% of the LBA tract as applied for. Dominant species include silver sagebrush (*Artemisia cana*), needle-and-thread, western wheatgrass, and blue grama. The silver sagebrush type occurs on the deep,

level to sloping loamy sands, loams, and sandy loams which are developing in stream-laid alluvium. Scattered clusters of cottonwood trees (*Populus deltoides*) were mapped within the silver sagebrush lowland vegetation type, particularly along Antelope Creek in the downstream (eastern) portions of the baseline study area. The Antelope Creek riverwash channel is included in the silver sagebrush vegetation type. In the western half of the baseline study area, most of the channel is barren sand which is continually shifting with the seasonal rise and fall of streamflows. The eastern portion of the channel bottom contains small- and medium-sized rocks with small areas of vegetation consisting of annuals and short-lived perennials.

The greasewood lowland vegetation type occurs along Antelope Creek and in small areas of draws on the second terraces and alluvial fans. This vegetation type is found in two small areas of the LBA tract and covers only about 8 acres or 1% of the LBA tract as applied for. Major species include blue grama, western wheatgrass, greasewood (*Sarcobatus vermiculatus)*, needle-and-thread, and Gardner saltbush (*Atriplex gardneri*). The greasewood lowland type occupies deep, level to somewhat sloping fine sandy loams which are highly alkaline.

The clinker hills in the eastern third of the baseline study area, including the eastern portion of the LBA tract, are vegetated by the bluebunch wheatgrass roughland vegetation type. Bluebunch wheatgrass covers the clinker hills within the eastern LBA tract, and these hills comprise about 26 acres or 4% of the LBA tract as applied for. Prominent species include blue grama, bluebunch wheatgrass (*Agropyron spicatum*), big sagebrush (*Artemisia tridentata*), and needle-and-thread. This type is confined entirely to the steep, shallow, very channery soils (soils that include thin, flat fragments of limestone, sandstone, or schist up to 6 inches in diameter) on the porcelanite (clinker) hills, although small inclusions of other vegetation and soils in the hills are included in this type.

The most extensive vegetation type in the baseline study area and on the LBA tract is the blue grama roughland. This type is a heterogenous group of communities of the other six vegetation types which are too small and irregular to map individually. This vegetation type covers about 330 acres or 54% of the LBA tract as applied for and is found in all portions of the tract. Predominant species are blue grama, western wheatgrass, big sagebrush, birdsfoot sagebrush, buckwheat (*Eriogonum* spp.), greasewood, plains pricklypear, and saltbush (*Atriplex* spp.). This vegetation type occurs on the sloping to steep uplands which are characterized by small scale and irregular topographic variations including sloping to rolling uplands, valley side slopes and smaller eroded upland drainages. The soils are generally shallow, rolling to very steep loams, clay loams, sandy loams, and undeveloped rock outcrops.

The big sagebrush draw vegetation type does not occur on the LBA tract. It occurs on the bottoms of the upper reaches of shallow draws, mainly in the southern and western parts of the baseline study area.

The recent wetlands delineation study of Antelope Mine (Ecotone, 1992) identified six wetland vegetation types in the mine, including upland shrub, upland

meadow, riparian forest, wet meadow, marsh, and open water/aquatic bed/ unconsolidated bed vegetation. The report also quantifies the jurisdictional wetlands areas covered by each type of vegetation. Upland shrub vegetation and upland meadow vegetation are not found within jurisdictional wetlands except as a secondary component of wetland ground cover, as in some riparian forest areas. Locations of jurisdictional wetlands within and near the LBA tract are shown on Figure 4.

Riparian forest vegetation occupies lower stream terraces and point bars as well as sandy islands within stream channels. This type of vegetation includes plains cottonwood trees over upland meadow-type ground cover in areas located outside jurisdictional wetlands or over hydrophytic ground cover within jurisdictional wetlands. A few riparian forest areas include sandbar willow and peach-leaf willow. Riparian forest vegetation covers about 4 acres of jurisdictional wetlands within the mine, or about 3% of total mine wetlands.

Wet meadow vegetation occupies the lowest terrace level along steam channels as well as areas along vegetated channel banks and is typically found within jurisdictional wetlands. Wet meadow vegetation occurs along all sections of Antelope Creek and along major tributaries, with cover widths varying from 10 feet to more than 350 feet. This type of vegetation generally lacks an overstory of trees or shrubs, and forb and grass species dominate. Species include sedges, Baltic rush, alkali muhly, alkali bluegrass, prairie cordgrass, alkali cordgrass, saltgrass, spikerush, smooth scouring rush, American licorice, and yellow dock. Wet meadow vegetation covers about 83 acres of jurisdictional wetlands within the mine, or about 56% of total mine wetlands.

Marsh cover occurs where water is ponded for longer periods of the growing season and typically occupies the lowest positions within stream channels. A large portion of the banks and channels of Antelope Creek is occupied by marsh vegetation. Species include soft-stem bulrush, three-square bulrush, spikerushes, American sloughgrass, duckpotato arrowhead, sedges, common cattail, and white-water buttercup. Marsh vegetation covers about 7 acres of jurisdictional wetlands within the mine, or about 5% of total mine wetlands.

Open water/aquatic bed (inundated bed)/unconsolidated bed (intermittently exposed bed) vegetation occurs primarily in the deeper portions of stream channels and at beaver dams. This cover type occurs in a mosaic with wet meadow and marsh. Plant species include various species of algae, white-water buttercup, and scattered bulrush and spikerush. Open water/aquatic bed/unconsolidated bed vegetation covers about 54 acres of jurisdictional wetlands within the mine, or about 36% of total mine wetlands.

3.2.4.1 Threatened or Endangered Plants

In August 1994, Mr. B. E. Nelson of the Rocky Mountain Herbarium in Laramie, Wyoming found the listed threatened plant Ute Lady's Tresses (*Spiranthes diluvialis*) on a sandy bank area of Antelope Creek near a cattail marsh located approximately

25 miles upstream of Antelope Mine. This plant is typically found in moist soils along with grasses and sedges. Mining within the proposed LBA tract would not disturb delineated wetlands that are potential habitat for this plant along Antelope Creek but would disturb wetlands along Horse Creek, an ephemeral tributary of Antelope Creek. A survey of the LBA tract for Ute Lady's tresses was conducted on August 2, 1995, by Walter Fertig of The Nature Conservancy at the request of ACC. The survey area covered the portion of Horse Creek included in the LBA tract, as well as a 500 foot buffer north of the northern LBA boundary and the portion of Antelope Creek that is inside the LBA tract. No populations of Ute lady's tresses were found at the site during the field survey, and no special management actions were recommended at the site as the survey indicated that suitable habitat is not likely present for this species in the LBA area (The Nature Conservancy, 1995).

According to a December 1992 Wyoming Natural Diversity Database search, there are no other federally listed threatened or endangered plant species known to occur in Converse or Campbell County; likewise, no species strongly likely to be listed (in the form of Category C1 species) are known to occur in Converse County (The Nature Conservancy, 1992). No rare, threatened or endangered species and no species of interest to Wyoming Natural Diversity Database at the state level have been found on the Antelope Mine permit area or the LBA tract.

3.2.5 Ownership And Use Of Land

The surface on the Antelope LBA tract is owned by Antelope Coal Company and the United States of America. The federally owned land is part of the Thunder Basin National Grassland, administered by the USFS. Surface landownership for the Antelope Mine permit area and the LBA tract and adjacent areas is summarized in Table 6 and is shown on Figure 7. Powder River Coal Company owns a tract of land immediately adjacent to the LBA tract which could be affected by overstripping or surface disturbance (see Figure 7). ACC intends to negotiate a surface agreement with Powder River Coal Company that covers overstripping for the revised LBA mine plan. If an agreement is not negotiated, a small amount of coal along this property boundary could be unrecoverable.

The premining land uses of the Antelope Mine permit area are described in the Land Use Baseline Study, Volume IV, Appendix D1 of the mine permit document. The land within the LBA tract is currently used for livestock grazing, wildlife, and transportation (County Road 37 and BN/C&NW railroad rights-of-way). Prior to mining, the entire current permit area of 7,535.76 acres was used for livestock grazing and wildlife with the exception of 75 acres of miscellaneous roads and abandoned mines. Coal mining on one federal coal lease included in the Antelope Mine dates back to the 1930s (see Figure 8).

The grazing capacity of native rangeland in the area is a function of topography, soils, and other factors and is related to the vegetation types discussed in Section 3.2.4. Grazing capacity is the highest in the big sagebrush draw (which does not occur on the LBA tract) and silver sagebrush lowland vegetation types with 0.6 and

0.5 animal-unit months (AUMs) per acre, respectively. The lowest grazing capacity is in the birdsfoot sagebrush upland with 0.1 AUMs per acre. The blue grama upland, blue grama roughland, and the bluebunch wheatgrass roughland vegetation types have a grazing capacity of about 0.2 AUMs per acre. The greasewood lowland vegetation type has a grazing capacity of about 0.3 AUMs per acre.

Table 6. Summary of Surface and Mineral Ownership Within Antelope Mine and the Alternative LBA Tracts (1)

Current Permit Area

Owner	Surface ownership (ac)	Mineral ownership (ac) (2)
Thunder Basin National Grassland (U.S.A.)	3,534	5,915 -- all minerals 799 -- coal only
State of Wyoming	814	814 -- all mineral
Antelope Coal Company	3,188	0
Ollie M. Kane et. al	0	188 -- other minerals
H. R. Matheson et ux	0	192 -- other minerals
J. and F. Dilts	0	108 -- other minerals
W. W. Dauner et. al	0	319 -- other minerals

LBA Tract -- Alternative 1

Owner	Surface ownership (ac)	Coal ownership (ac)
Thunder Basin National Grassland (U.S.A.)	455	617
Antelope Coal Company	162	0

LBA Tract -- Alternative 2

Owner	Surface ownership (ac)	Coal ownership (ac)
Thunder Basin National Grassland (U.S.A.)	661	823
Antelope Coal Company	162	0

LBA Tract -- Alternative 3

Owner	Surface ownership (ac)	Coal ownership (ac)
Thunder Basin National Grassland (U.S.A.)	455	455
Antelope Coal Company	0	0

Notes: (1) Areas are approximate.
(2) "Other minerals" include all minerals except coal.

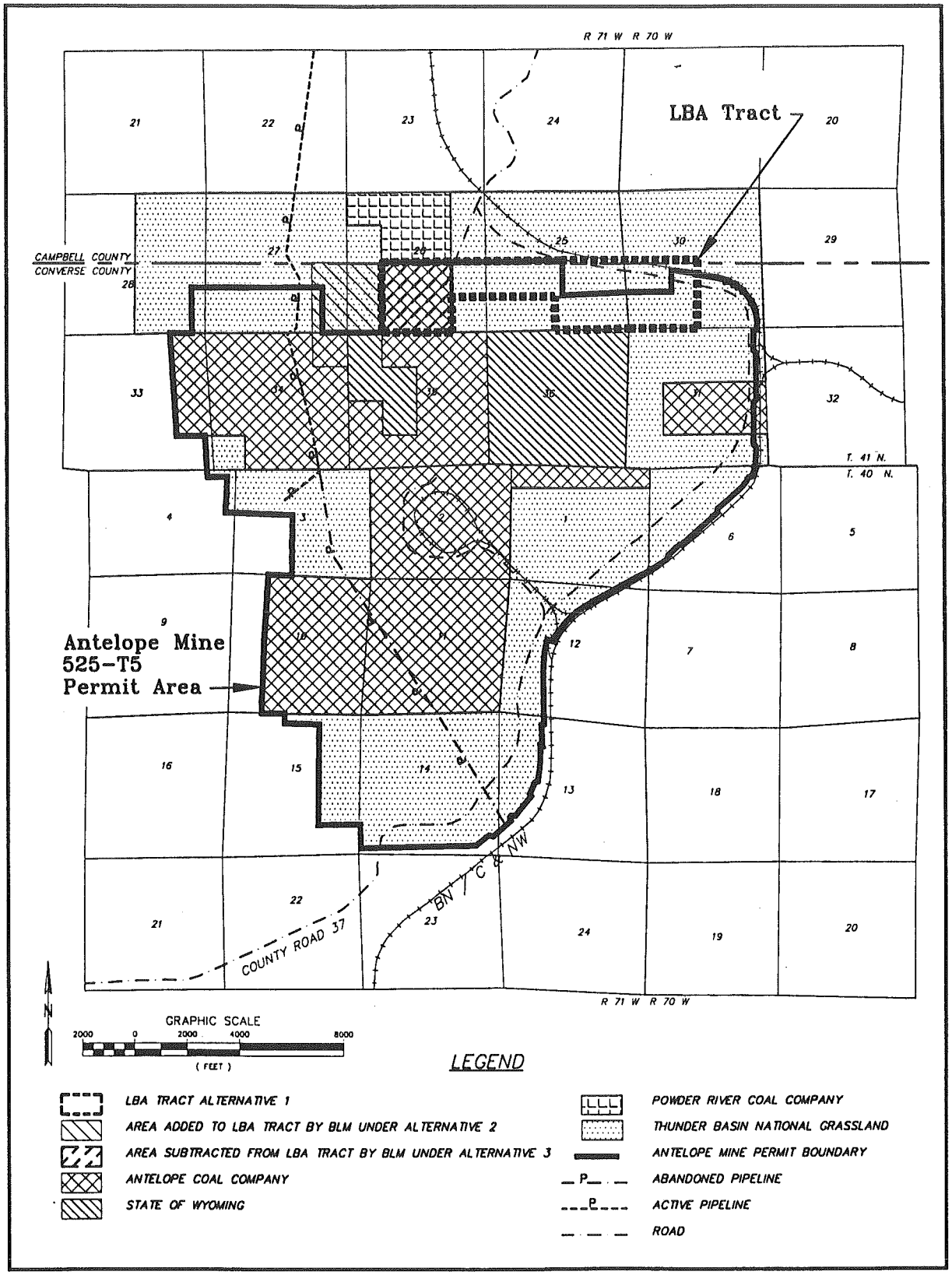
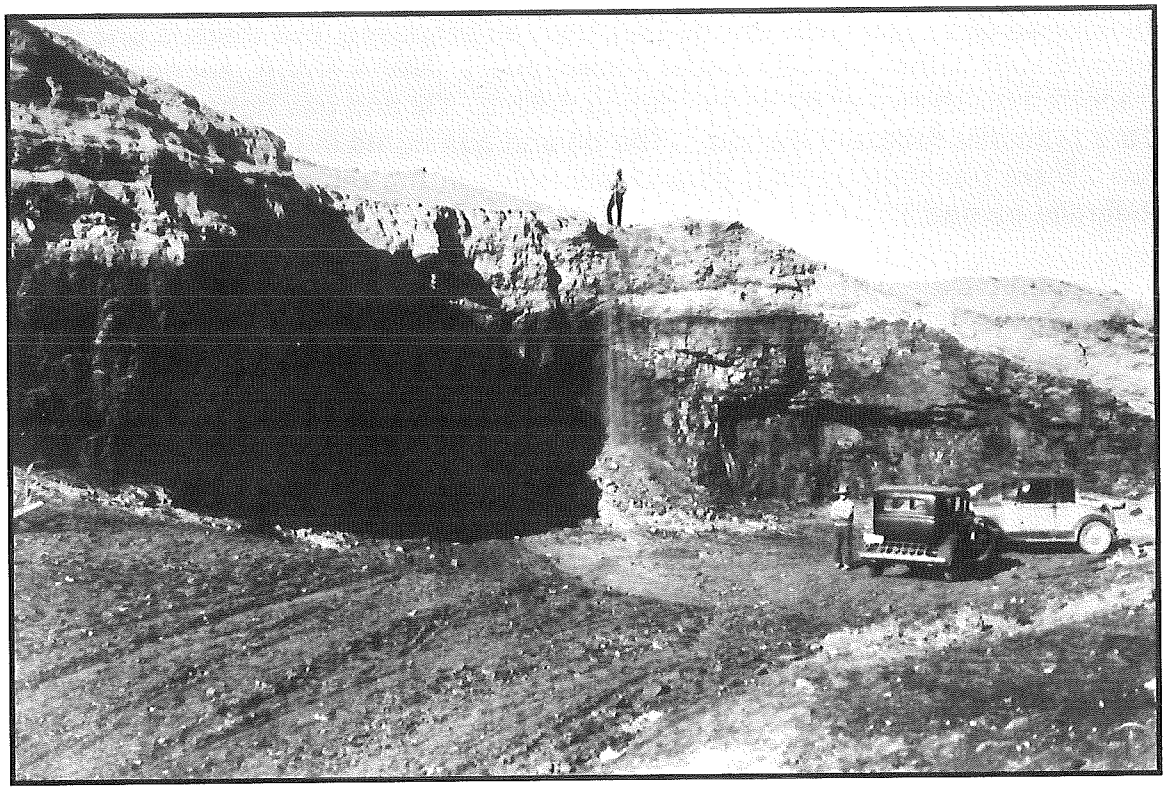
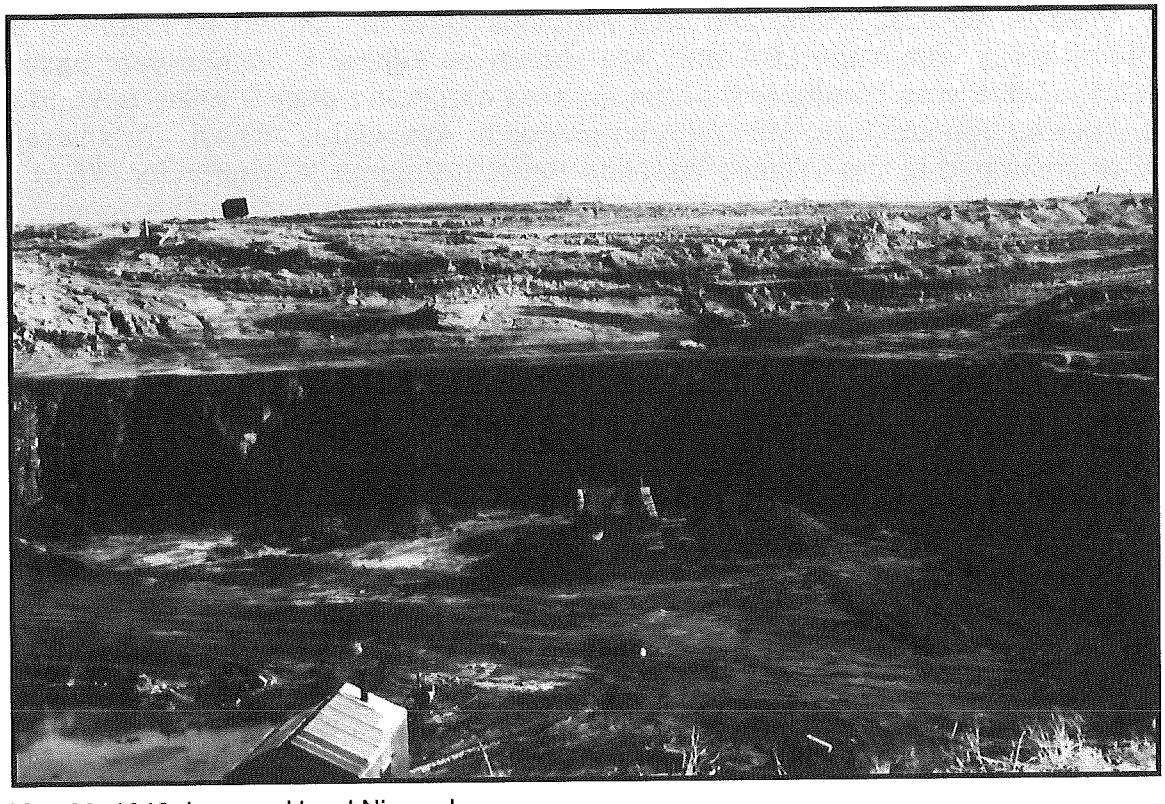


Figure 7. Surface Ownership Map of Antelope Permit and LBA Area Vicinity

Figure 8. Historical pictures of Federal Coal Lease B-031719, Antelope Mine Area



October 15, 1932; Lessees: Felix Niemcyk and Elmer Gladson



May 26, 1949; Lessee: Hazel Niemcyk

There are currently no producing oil or gas wells on the LBA tract. There are no abandoned oil or gas wells on the LBA tract as proposed, but there is one dry and abandoned well within the LBA under Alternative 2 (NW/4 NW/4, section 34). This well reported no shows of oil or gas during drilling. Oil and gas rights underlying the tract are primarily federally owned. (The oil and gas rights in Lots 11, 14 and 15 of section 26 are privately owned, oil and gas rights in the remainder of the LBA tract are federally owned.)

Two buried pipelines cross the Antelope Mine permit area. One pipeline passes to the west of the LBA tract and is not expected to be disturbed by mining in the LBA. This pipeline will be relocated according to existing agreements when the need arises. The other crosses the LBA tract but has been abandoned and will be removed as stipulated by the existing agreement between the original owner (Phillips Petroleum) and ACC. A portion of Converse County Road 37 which formerly crossed the mine area was relocated to the alignment shown on Figure 7 in 1993. The BN/C&NW Railroad was discussed previously (see Section 1.2).

No occupied dwellings occur on the proposed lease area. The nearest is a set of ranch buildings adjacent to Antelope Creek about 19,000 feet (3.6 miles) east of the southeast corner of the LBA. Because much of the land surface within the LBA is in public ownership, administered as part of the Thunder Basin National Grassland, it is available for public uses such as hunting and other recreational activities.

3.2.6 Wildlife

Wildlife features within and near Antelope Mine are shown on Figure 9, and wildlife features within the LBA tract are shown on Figure 4. A one-year baseline study of wildlife was conducted within an area extending over 2 miles beyond the current permit boundaries in 1980 (Commonwealth Associates, 1980). This baseline study is described in the Wildlife Baseline Report, Volume X, Appendix D9 of the Antelope Mine permit document. Since 1982 the ongoing, annual wildlife monitoring program for the mine has also covered the LBA tract. The monitoring survey results are presented annually to the WDEQ/LQD in the required reports. The ongoing monitoring activity [including big game, raptors, upland game birds and migratory birds of high federal interest (MBHFI)] covers nearly 60 square miles, or some 37,800 acres, and includes lands within a large perimeter around the Antelope Mine permit area that completely encompasses the LBA tract. During the initial baseline studies, a total of 125 wildlife species were observed. Since that time, 79 additional species have been observed, bringing the total number of observed species to 204. In 1992, 99 species of wildlife were observed on the Antelope Mine study area. This included 21 mammal species, 74 bird species, and 4 species of reptiles and amphibians. The following descriptions of habitats, faunal occurrences, and faunal abundance are drawn from both the baseline studies and the annual monitoring reports.

The LBA tract is primarily a dissected upland area with a small amount of bottomland along Antelope Creek and the lower reaches of Horse Creek. Wildlife use is closely related to topography and vegetation types.

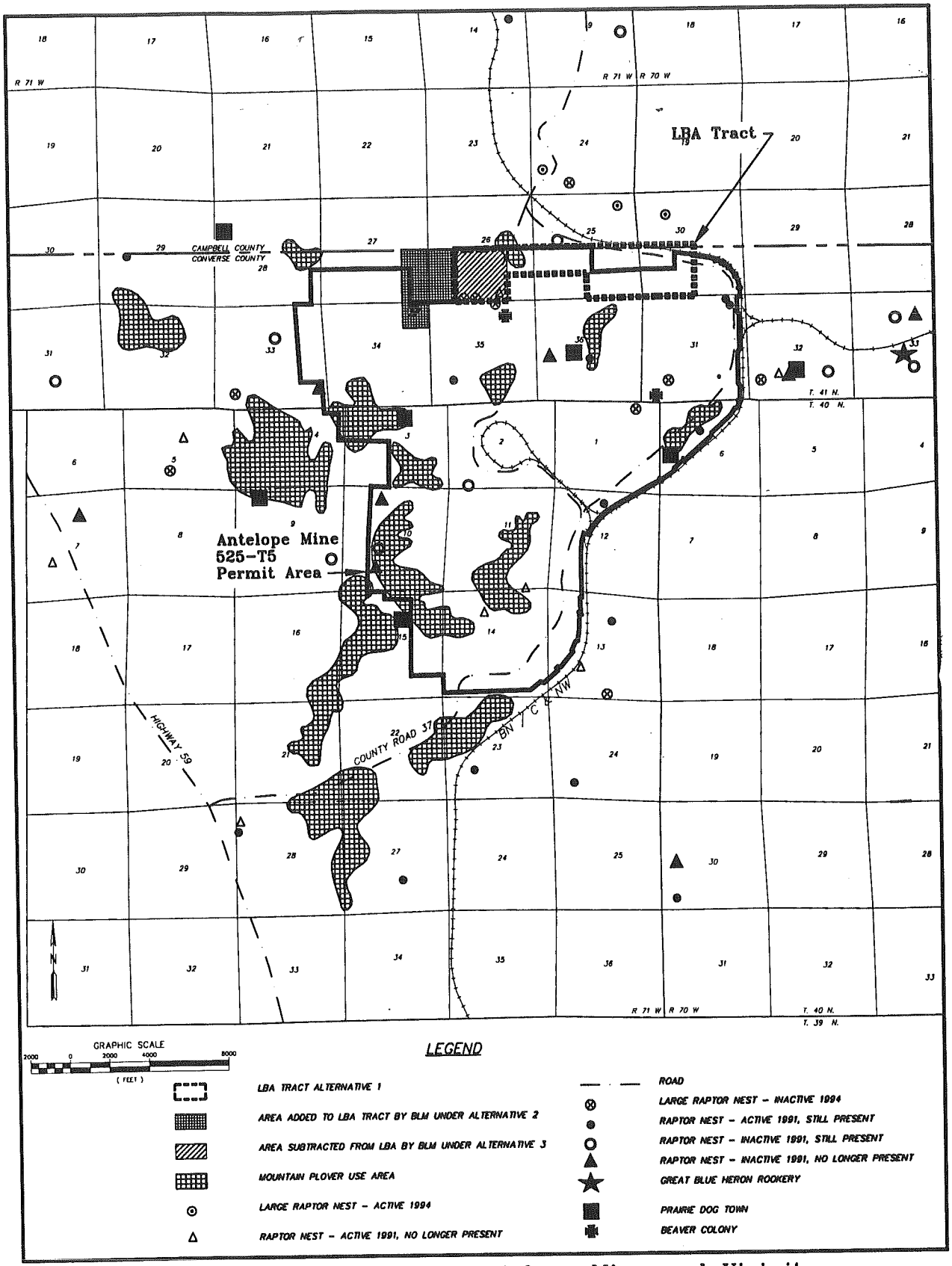


Figure 9. Wildlife Features of the Antelope Mine and Vicinity

Three big game species occur in the vicinity of the LBA: pronghorn, mule deer, and white-tailed deer. No critical big game habitat is recognized by the Wyoming Game and Fish Department (WGFD) in this area. Antelope Mine's seasonal trend counts for both pronghorn and deer are conducted along set driving routes that pass through the LBA. These counts provide big game herd composition and habitat use data in seasons other than winter.

Pronghorn are, by far, the most common big game species in the area. Mine permit maps indicate that the entire LBA tract under any of the three alternatives is classified as winter/yearlong habitat (habitat used by a portion of the pronghorn population yearlong and into which a significant influx of animals occurs during the winter) within the WGFD Lance Creek Herd Unit. The total occupied Lance Creek Herd Unit habitat is 4,329 square miles, of which 640 square miles are classified as winter/yearlong habitat and 3,451 square miles are classified as yearlong habitat (habitat used by a substantial portion of the pronghorn population yearlong). About 0.9% of the total occupied Lance Creek Herd Unit habitat area is within the disturbance boundaries of surface coal mines, with about 0.2% of the total occupied Lance Creek Herd Unit habitat area within the Antelope Mine disturbance boundary. The LBA tract occupies from about 0.02% to about 0.03% of the total occupied Lance Creek antelope habitat and covers from about 0.11% to about 0.20% of winter/yearlong Lance Creek antelope habitat, depending on the alternative that is chosen.

The WGFD estimated the post-hunting pronghorn population in 1992 was 23,566, and the 1992 objective was 27,000. The 1992 population of the entire hunt area equates to a population density of between 5 and 6 animals per square mile. The severe winter of 1992-1993 took a heavy toll on the pronghorn population in this hunt area, reducing the number of animals to 13,648 by the end of the winter (a reduction in population density to about 3 animals per square mile). Winter survey data for the Antelope Mine study area for January 1993, a moderately harsh winter, showed a total pronghorn count of 189 animals, which equates to a density of about 3 animals per square mile in the survey area. Winter survey data for the mine study area for March, 1994, a relatively mild winter, showed a total pronghorn count of 370 animals, equivalent to a density of 6 animals per square mile. Density for the last four complete ground coverage winter surveys has ranged from about 2.5 animals per square mile in 1987 to 7 animals per square mile in 1988. Variations in numbers are primarily a function of weather conditions.

Overall antelope habitat use remains dominated by the upland communities (blue grama upland vegetation, blue grama roughland vegetation, and birdsfoot sagebrush) typical of pronghorn preference. These types of vegetation predominate on about 552 acres or about 89% of the LBA tract as applied for.

Mule deer are present in the vicinity of the LBA tract in small to moderate numbers year-round. The tract is within the Thunder Basin Herd Unit, which has 3,065 square miles of occupied habitat. The WGFD estimated the 1992 post-season population to be 17,812 (5.8 animals per square mile); the herd objective is 13,000

(4.25 animals per square mile). Currently, the LBA tract is classified by WGFD as yearlong mule deer range.

Data from Antelope Mine's baseline and annual monitoring programs show that mule deer occur in far fewer numbers and considerably more restricted areas than pronghorn. Deer numbers also vary as a function of weather conditions. The 1993 winter big game count found 66 mule deer within the Antelope Mine study area (the permit area plus a 2-mile surrounding, contiguous area). This equates to an average of about 1 deer per square mile. The respective numbers for the 1994 winter big game count were 12 mule deer and an equivalent average of 0.2 deer per square mile. Ground conditions were less favorable for observations of mule deer during the 1994 survey. Favored habitat for mule deer is in the Antelope Creek riparian area in the central part of the permit area.

On a few occasions in the past several years, white-tailed deer have been recorded near Antelope Mine and the LBA tract. This species is uncommon in the vicinity of the Antelope Mine, and while sightings are logged, white-tailed deer are not specifically part of the annual wildlife monitoring. There are no recognized elk herd units in the vicinity of the LBA, and no elk are known to occur in the vicinity of the LBA tract.

ACC's wildlife baseline studies done in 1980 and subsequent annual monitoring since 1982 have identified 73 individual raptor nest sites within the study area, including man-made platforms and relocation sites, of which 45 large raptor nests have been located within the permit area. These totals include three new raptor nests discovered during the 1994 wildlife monitoring efforts. None of the new nests occur on the LBA area (ACC, Permit 525-T5, WDEQ/LQD Annual Report, October 1993-September 1994). Eleven large raptor nests were determined active in 1993. Two of these were destroyed by natural forces during the winter of 1993-1994. Six of the large raptor nests were active on the study area during the 1994 breeding season; none of these occurred on the LBA area. The locations of these nests are indicated on Figure 9, along with the locations of other key wildlife features within the study area. The raptor survey area includes the existing permit area, the LBA tract, and a considerable surrounding area as described above. Results of annual surveys are presented each year in the Antelope Mine's annual report to WDEQ/LQD. As Figure 4 shows, there are raptor nests on the LBA tract. A mitigation plan for raptor nests in the area has been developed by ACC in consultation with the U.S. Fish and Wildlife Service (USFWS) and the USFS. The raptor mitigation plan must be updated with each 5-year permit renewal or any time a major change in the mining or reclamation plan occurs. A raptor mitigation plan update would be required if the LBA is leased. Federally (USFWS and USFS) approved buffer zones, designed to reduce or eliminate human disturbances near active golden eagle nest sites, are currently in place for all nests on or within 2 miles of the Antelope Mine permit area, a region which includes the LBA tract.

Figures 4 and 9 show the location of the five raptor nests occurring on the LBA during the 1991-1994 period. Three of these nests occur within the area which

would be subtracted under Alternative 3. One of these is a red-tailed hawk nest that was in a tree that was cut down by beavers prior to the 1992 breeding season. The other two include a great-horned owl nest that was active from 1991-1993 but inactive in 1994, and a red-tailed hawk nest that was active when discovered in 1992, but either inactive or an alternate since that time. The latter nest was destroyed by natural causes following the 1994 breeding season (Powder River Eagle Studies letter dated July 31, 1995). The remaining two nests are located in the area that would be added to the lease under Alternative 2. They are golden eagle nests which are part of the same territorial complex. These two nests have alternated status as active/alternate during the 1991-1993 period; the complex was inactive during the 994 breeding season. There is an inactive ferruginous hawk nest to the north of the LBA boundary. This nest was new in 1986 but since that time the hawks have used alternate nest sites in Section 24, across the railroad tracks from the LBA (ACC, WDEQ/LQD Annual Report, Permit 525-T5, October 1993-September 1994).

Golden eagles and great-horned owls are the only year-round resident raptor species on the study area. Surveys for early nesting raptor species are conducted in March and April while nesting surveys for other species begin in June. Monitoring of raptor nesting activities are conducted monthly beginning in June of each year, and continue until fledging of active nests. Past nest sites are monitored and potential nesting habitats are surveyed annually, searching for newly established nest sites. The 1993 raptor breeding season was adversely impacted by wet, windy, relatively cool spring/summer weather. Although prey species were at or near maximal levels, only 13 raptor territories were documented occupied in 1993 and only 4 raptor pairs fledged young (ACC, WDEQ/AQD Annual Report, Permit 525-T5, October 1992 - September 1993). The 1994 raptor breeding season was adversely affected by a significantly decreased prey base. Population levels of lagomorph prey species experienced a dramatic cyclical decline phase during the winter of 1993-1994. Consequently, only eight raptor territories were documented occupied, and only four raptor pairs fledged young on the Antelope Mine study area (including the LBA) in 1994 (ACC, WDEQ/LQD Annual Report, Permit 525-T5, October 1993 - September 1994).

Mourning dove is the most prevalent species of upland game birds in the vicinity of the LBA. The proposed tract is within the area that has been surveyed by Antelope Mine for sage grouse leks annually since 1982. There are no leks on the proposed tract, and no sage grouse were observed on the entire study area during a recent annual report period. Lek searches in late April and early May, 1994 revealed no sage grouse breeding activities on the Antelope Mine study area. Four wild turkey observations occurred during a recent annual monitoring period. In December, 1992, a flock of 36 birds were observed feeding in a riparian tree area along Antelope Creek, at the far east edge of the study area. Two birds were observed feeding in a reclaimed site within the active mine area in April, 1993. In late May, single male turkeys were observed twice, one in a greasewood area along Antelope Creek north of the mine office complex and the other in a reclaimed area in the southern portion of the active mine area. Early morning spring 1993 searches along Antelope Creek

revealed no wild turkey breeding activities within the Antelope Mine study area, and no turkeys were observed during 1994 monitoring activities (ACC, WDEQ/LQD Annual Reports, Permit 525-T5, October 1992 - September 1993, and October 1993 - September 1994).

There was no successful waterfowl nesting documented on the Antelope Mine study area during 1993 or 1994. Nesting habitat remains available, weather permitting, in upland pond sites and along Antelope Creek.

The USFWS and WDEQ have expressed concern about 17 avian species or subspecies in the Powder River Basin coal region. These are classified as "migratory birds of high federal interest" (MBHFI). During the baseline studies and the annual monitoring performed since 1982, field surveys have been performed to document the occurrence and status of MBHFI at Antelope Mine. The annual surveys for MBHFI are conducted on and within 2 miles of the permit area, a region which includes the LBA tract.

Thirteen of the seventeen species of MBHFI have been recorded through time in the Antelope Mine study area (see Table 7). No additional species of MBHFI were observed during 1994 monitoring activities. Of the species that have been recorded, only the mountain plover has been identified as being of concern to the USFWS at the Antelope Mine site. This concern stemmed from the fact that nesting mountain plover have been identified in the wildlife baseline study area. Two other species, golden eagle and ferruginous hawk, are addressed under raptors above.

As shown on Figure 9, a number of mountain plover habitat areas exist within and near Antelope Mine. Part of one mountain plover habitat area extends into the LBA tract (see Figure 4). The last year of recorded mountain plover use of this area was 1989. ACC conducted a 4-year mountain plover monitoring program, incorporating comprehensive company monitoring in conjunction with a 2-year intensive contract study by the USFWS-Cooperative Wildlife/Fisheries Research Unit (Oelklaus, W., 1989, and Parrish, T., 1988). These studies drew upon historic observations at the mine to augment new findings in documenting: 1) mountain plover distribution in the permit area as well as the surrounding region, 2) population size, and 3) extent and use of suitable breeding habitat. Both reports referenced above compared new data with the historic literature on mountain plover, and both reports concluded that development of the Antelope Mine could occur without impacting the region's mountain plover population. Because of the special concerns regarding the mountain plover, ACC takes measures to protect and reclaim appropriate habitat and to monitor the success of these measures as agreed to in the management plan approved by the USFWS.

Monitoring of mountain plover has taken two approaches at the Antelope Mine. Mine personnel and representative consultants conduct annual intensive searches of all parts of the mine permit area, previously identified mountain plover use areas, and contiguous areas within ½ mile. This monitoring is conducted annually from mid-April until the end of August and will be continued until the end of mining. Coverage is

Table 7. MBHFI Status in Northeast Wyoming and Expected Occurrence Near Antelope Coal Mine

SPECIES	SEASONAL STATUS/BREEDING RECORDS IN NE WYOMING	NO. OF YEARS SIGHTED IN 10 YEARS OF MONITORING	EXPECTED OCCURRENCE IN ANTELOPE MINE AREA
White pelican	Summer/Nonbreeder	2	Rare
Double-crested cormorant	Summer/Breeder	4	Uncommon
Canvasback	Summer/Breeder	3	Uncommon
Ferruginous hawk	Summer/Breeder	10	Common
Golden eagle	Resident/Breeder	10	Common
Bald eagle	Winter/Nonbreeder	10	Common in Winter
Osprey	Summer/Breeder	0	Rare
Prairie falcon	Resident/Breeder	10	Common
American peregrine falcon	Migrant/Historical breeding records	2	Rare
Richardson's merlin	Resident/Breeder	5	Uncommon
Whooping crane	Never Recorded	None	Very Rare
Sandhill crane	Migrant/Nonbreeder	0	Rare
Mountain plover	Summer/Breeder	10	Common
Long-billed curlew	Summer/Breeder	2	Rare
Burrowing owl	Summer/Breeder	1	Rare
Lewis' woodpecker	Summer/Breeder	1	Rare
Dickcissel	Summer/Breeder	0	Rare

Compiled from Wyoming Game and Fish Department (1982), includes Campbell and Converse Counties.

Sighting Record References: From Antelope Coal Company Permit 525-T5 Annual Report, October 1992 - September 1993

most exhaustive in the habitats and areas previously utilized by the birds. Each observation is recorded separately, noting location, habitat, behavior, numbers, age, weather, time and date. Yearly results are compiled and discussed in the mine's annual report.

The monitoring and intensive contract studies of the mountain plover have helped to:

- determine the current status of mountain plover in the southern Powder River Basin of Wyoming,
- evaluate the habitat used by the mountain plover to nest, rear young, and flock in the latter part of the summer,
- determine the behavioral attributes of the mountain plover utilizing the areas in the southern Powder River Basin, and
- make recommendations for reclamation of areas that allow the continued support of a mountain plover population.

A habitat recovery and replacement plan for mountain plover was developed and approved by the USFWS on August 7, 1990 for lands to be disturbed by development of the Antelope Mine. This plan has been incorporated into the ACC WDEQ/LQD mining permit.

Other wildlife resources of particular interest in the study area include a great blue heron rookery along Antelope Creek downstream from the mine area and two beaver colonies (see locations on Figure 9). The heron rookery was established in 1992 and was again active in 1993. Both beaver colonies are located at groundwater discharge points along Antelope Creek. According to ACC's annual monitoring reports, these beaver colonies have significantly enhanced the area for numerous species of wildlife and plants. Their most significant contribution is the retention and availability of water throughout the summer and fall. While this reach of Antelope Creek is classified as intermittent (surface flow not present all year), both colony ponds retained water throughout the year. Beyond the water availability to wildlife and livestock, the raised water table and its availability along and downstream from the colonies is resulting in more lush vegetative growth, including establishment of cottonwood trees. Additionally, pond storage capacities serve to attenuate storm flows, decreasing flood event quantities and extending flow periods (ACC, WDEQ/LQD Annual Report, Permit 525-T5, October 1992 - September 1993). As stated previously, ACC does not intend to mine the area along Antelope Creek.

3.2.6.1 Threatened or Endangered Wildlife

The USFWS has determined that there is potential habitat for three threatened or endangered (T or E) animal species in the area of the LBA: the bald eagle, peregrine falcon, and black-footed ferret (C.P. Davis, September 22, 1994 letter to

BLM). Bald eagles are relatively common winter visitors in northeastern Wyoming. The only roosting habitat (wooded canyons or large tree groves) that exists on or within 1 mile of the proposed lease area is the riparian zone along Antelope Creek that will remain largely undisturbed. Bald eagles have commonly been observed on and near the area during the winter surveys, but no unique source of prey occurs there.

No suitable nesting habitat (cliffs) for peregrine falcons exists on or near the LBA. Peregrines may pass through the area during migration, but there is no unique source of prey to attract them to the area. Peregrine falcons have been observed in the vicinity of the Antelope Mine or proposed lease area in two years of the ten years of monitoring (see Table 7).

Black-footed ferrets have been known to reside almost exclusively in prairie dog towns. No ferrets have been sighted in the vicinity of the Antelope Mine, although seven active prairie dog towns exist within the wildlife baseline study area (see Figure 9). Special searches for black-footed ferrets were conducted in July and September 1980. No sign of this species was found. No prairie dog towns occur on the LBA tract.

3.2.7 Cultural Resources

The entire Antelope Mine permit area plus a surrounding area, which includes the proposed LBA under all three alternatives, has been subjected to a Class III cultural resource inventory (Greiser et. al, Historical Research Associates, 1982, and Webb et. al, Mariah Associates, Inc. 1993). The inventory was conducted in several surveys prior to and including the baseline effort.

A Class III survey is a professionally conducted, intensive inventory of a target area, designed to locate all cultural properties which have surface and exposed profile indications. Cultural properties are recorded and sufficient information collected on them to allow evaluation for possible inclusion on the National Register of Historic Places (NRHP). That determination is made by the managing federal agency in consultation with the State Historic Preservation Office (SHPO).

Once a Class III survey is completed, site-specific testing or limited excavation is utilized, if necessary, to gather additional data which will: 1) determine the final evaluation status of a site and/or 2) form the basis of additional work that will be conducted during implementation of a treatment plan if the site is eligible for the NRHP. A treatment plan is then developed for those sites that are eligible for the NRHP and are within the area of potential effect. Treatment plans are implemented prior to mining and can include such mitigative measures as avoidance (if possible), large scale excavation, complete recording, Historic American Building Survey/Historic American Engineering Record documentation, archival research, and other acceptable scientific practices.

By letter of August 10, 1988, the Wyoming State Historic Preservation Office (SHPO) confirmed acceptance of the final report of the primary cultural resource data

collection program for the Antelope Mine permit (Marceau, T.E.; State of Wyoming, August 10, 1988 letter to OSM). This approval letter confirmed that the cultural resources inventory and report meets the research design standards established for this project and adequately documents the significant data in the study area. Subsequent surveys have been conducted to include permit revisions, coal exploration, or to investigate or mitigate a site not found in the original surveys. In January 1992 SHPO provided clearance of a triangular area north of the Converse County line bounded by the railroad right-of-way to the north and County Road 37 to the west (this was prior to the relocation of this road) (Gary Stephenson; State of Wyoming, January 24, 1992 letter to BLM). In February 1992 SHPO provided clearance of the six sites left unmitigated under the 1988 clearance (Gary Stephenson, February 24, 1992 letter to WDEQ/LQD). The remaining site mentioned in the February 1992 clearance letter (not within the LBA area) was a site not discovered in the original surveys. This site was mitigated and the mitigation was approved by SHPO in 1993 (John T. Keck; State of Wyoming, May 21, 1993 letter to WDEQ/LQD).

Table 8. Status of Known Cultural Sites Within the LBA Tract

SITE	TYPE	LOCATION	NRHP STATUS
48CO-451	Prehistoric	Lease	Ineligible
48CO-452	Prehistoric	Lease	Mitigated
48CO-453	Prehistoric	Lease	Ineligible
48CO-455	Prehistoric	Lease	Mitigated
48CO-457	Prehistoric	Lease	Mitigated
48CO-462	Prehistoric	Lease	Ineligible
48CO-464	Prehistoric	Lease	Ineligible
48CO-465	Prehistoric	Lease	Ineligible
48CO-488	Prehistoric	Lease	Ineligible
48CO-502	Prehistoric	Lease	Mitigated
48CO-503	Prehistoric	Lease	Ineligible

A total of 11 cultural sites were identified on the proposed LBA area (see Table 8, above). These included five open lithic sites; three open camps with groundstones; one open camp and hearth; one open camp, groundstone and hearth; and one stone enclosure. Four sites on the LBA area have been mitigated, and none of the sites is eligible for the NRHP. Results of the survey suggest that the proposed tract will have no effect on any significant cultural resources. Cultural resource clearance has been received for the entire LBA area under any leasing alternative (1, 2 or 3). An area north of the LBA tract in Campbell County has been subjected to a cultural resource inventory for areas around coal exploration drill holes.

3.2.8 Native American Consultation

Native American consultation and coordination as required by the Archeological Resources Protection Act and the American Indian Religious Freedom Act was conducted at the time of the draft EA public review period, and will be conducted during the time of the final EA public review period. When the draft and final EAs are released, affected tribes are sent certified letters requesting their comments concerning any religious or cultural areas within or near the LBA tract.

3.2.9 Paleontological Resources

The sedimentary Eocene Wasatch and Paleocene Fort Union formations are exposed in the vicinity of the LBA tract. Both are known to contain fossil remains. Vertebrate fossil remains were described from the Wasatch Formation of the Powder River Basin in the early 1900s and include specimens of fish, turtle, champosaur, crocodile, alligator and mammals. The Fort Union also contains fossils of plants, reptiles, fish, amphibians and mammals. No significant paleontological localities have been recorded on federal lands in or near the project area which is within the BLM Platte River Resource Area and the Thunder Basin National Grassland (BLM, 1985; US Forest Service, 1985).

Paleontological resource surveys of the Antelope Mine area were conducted in conjunction with the archeological surveys, and the results of those surveys are included in the archeological reports (Greiser et. al, Historical Research Associates, 1982, and Webb et. al, Mariah Associates, Inc., 1993). In the future, paleontologic surveys on federal lands should be conducted by a professional paleontologist. The surveys to date found no significant fossils. Fossil plants were observed during the surveys, but no vertebrate fossils have been located prior to or during the course of mining at the adjacent Antelope Mine.

3.2.10 Visual Resources

The Antelope Mine facilities and some mining activity are currently visible from County Road 37. Under the mine plan for the existing leases, mining has approached and will approach this public road closely at times and be plainly visible to passers-by. This would also be true of the proposed tract, where mining would approach the relocated county road. Most of the people travelling this road are commuting to work at Antelope Mine or the nearby North Antelope and Rochelle coal mines. In several places in nearby Campbell County, mining is readily visible from public roads. These locations often attract tourists who are curious about the Powder River Basin and its large surface coal mines. Several mines have constructed viewing platforms and conduct tours to accommodate interested tourists and other persons.

For management purposes, the BLM conducts an inventory that evaluates visual resources on all land under its jurisdiction. Once inventoried, these lands are classified into various visual resource management classes. These classification ratings range from I to V as follows:

Class I - Natural ecologic changes and very limited management activity is allowed. Any contrast (activity) within this class must not attract attention.

Class II - Changes in any of the basic elements (form, line, color, texture) caused by an activity should not be evident in the landscape.

Class III - Contrasts to the basic elements caused by an activity are evident but should remain subordinate to the existing landscape.

Class IV - Activity attracts attention and is a dominant feature of the landscape in terms of scale.

Class V - This classification is applied to areas where the natural character of the landscape has been disturbed to a point where rehabilitation is needed to bring it up to the level of one of the other four classifications.

When development is proposed, the degree of contrast between the proposed activity and the existing landscape is measured. This is called a contrast rating. In this process, various factors such as form, line, color, texture variety, contrast, and lighting are evaluated.

The lands included in the tract are generally classified as visual resource management Class V with some Class IV. The natural character of the landscape on and adjacent to the LBA tract is already interrupted by numerous disturbances. A recently relocated county road, remnants of the former county road, the relatively new BN/C&NW railroad, and existing mining activity are visible from most sites on the tract. Mining activity would not encounter any BLM visual classification that would prohibit or restrict surface coal mining. Contrast would remain virtually unchanged.

The USFS has classified the visual resources on lands within the Thunder Basin Natural Grassland that are under USFS management. The USFS visual resource management classes are as follows:

Preservation - P - Only ecological changes are permitted. Human alterations and management activities, except for very low scenic-impact recreation facilities are prohibited.

Retention - R - Allows human alterations and managements activities that are not visually evident.

Partial Retention - PR - Human alterations and management activities must remain visually subordinate to the characteristic landscape.

Modification - M - Human alterations and management activities may dominate the original characteristic landscape, but they must borrow from naturally established form, line color and texture so completely and at such scale that the scenic characteristics are those of natural occurrences within the surrounding area.

Maximum Modification - MM - Human alterations and management activities of vegetative and landform may dominate the characteristic landscape, however when viewed as background, the visual characteristic must be of those of natural occurrences within the surrounding area.

The five objectives listed above are the measurable standards for the visual management of national forests. The proposed lease area is required to meet the visual quality objective of modification within three years after completion of the project except for riparian areas, playas, floodplains, and wetlands which are required to meet partial retention within one year after completion of the project.

3.2.11 Noise

An individual's judgement of the loudness of a noise correlates well with the A-weighted sound level (dBA) system of measurement. The A-weighted sound level, or A-scale, has been used extensively in the U.S. for the measurement of community and transportation noises. Figure 10 relates A-scale decibel (db) readings to equivalent sounds of daily life. Existing noise sources in or near the proposed LBA are: a county road, a railroad track, coal mining activities, wind, and agricultural activities. From these sources, the current noise level or loudness (commonly measured in decibels) is estimated to be in the range of 40 to 60 db and possibly higher, depending on time of day and location. Mining would increase the noise level to a range of 85 to 95 db where actual operations are occurring.

3.2.12 Air Quality

The air quality of the Powder River Basin area is generally good with an average annual geometric mean (the nth root of the product of n numbers) for total suspended particulates (TSP) concentrations of 15 micrograms per cubic meter ($\mu g/m^3$). Average particulate concentrations in the basin are therefore one-tenth the maximum allowable concentration in Wyoming (see Table 9). Visibility for more than 60 miles is common. Significant reductions in visibility are generally weather-related, although major forest fires to the west and northwest have impaired visibility in the Powder River Basin in past years.

The basic regulatory framework which governs air quality in Wyoming is the Environmental Quality Act, the accompanying Air Quality Rules and Regulations, and the State Implementation Plan approved by the Environmental Protection Agency (EPA) under the Clean Air Act. This regulatory framework includes state air quality standards, which must be at least as stringent as National Ambient Air Quality

HOW IT FEELS	EQUIVALENT SOUNDS	DECIBELS	EQUIVALENT SOUNDS	HOW IT SOUNDS
Danger to hearing ↑	50 hp siren (100 ft)		Jackhammer	
Near permanent damage level from short exposures		130	Chainsaw	135 dB(A) Approx. 64 times as loud as 75dB(A)
	Jet engine (75 ft)		Fire cracker (15 ft.)	125 dB(A) Approx. 32 times as loud as 75dB(A)
Pain to ears	Turbo-fan jet at takeoff power (100ft)	120	Rock and roll band	
			Unmuffled motor bike (2-3 ft.)	115 dB(A) Approx. 16 times as loud as 75dB(A)
Uncomfortably loud	Scraper-loader	110		
	Jet fly over (1000 ft)		Car horn	105 dB(A) Approx. 8 times as loud as 75dB(A)
Discomfort threshold		100	Unmuffled cycle (25 ft.)	
	Noisy newspaper press		Garbage trucks and city buses	95 dB(A) Approx. 4 times as loud as 75dB(A)
Very loud	Air compressor (20 ft)	90		
Conversation stops	Power lawnmower		Diesel truck (25 ft.)	
	Steady flow of freeway trafic	80	Garbage disposal	85 dB(A) Approx. 2 times as loud as 75dB(A)
			Food blender	
Intolerable for phone use	10-HP outboard motor		Muffled jet ski (50 ft.)	75dB(A)
	Automatic dishwasher	70		
Extra auditory physiological effects	Vacuum cleaner		Passenger car 65 mph (25 ft)	
	Window air conditioner outside at 2 ft.	60	Busy downtown area	
	Window air conditioner in room			55 dB(A) Approx. 1/4 as loud as 75dB(A)
Quiet		50	Normal conversation	
	Occasional private auto at 100 ft.			45 dB(A) Approx. 1/8 as loud as 75dB(A)
Sleep interference	Quiet home during evening	40		
	Bird calls			35 dB(A) Approx. 1/16 as loud as 75dB(A)
	Library			
Very quiet ↓	Soft whisper 5 ft.	30		
		20	In a quiet house at midnight	
	Leaves rustling	10		

Adapted From ABC's of Our Noise Codes published by Citizens Against Noise, Honolulu, Hawaii

Figure 10. Relationship Between A-Scale Decibel Readings and Sounds of Daily Life

Standards, and allowable increments for the prevention of significant deterioration (PSD) of air quality. The air quality standards which apply to coal mining are listed in Table 9.

Table 9. Regulated Air Emissions for Wyoming

Emissions	Averaging Period	Wyoming Standard ($\mu g/m^3$)	National Standard ($\mu g/m^3$)
Total suspended particulates (TSP)	24-hour[a]	150	---
Particulate matter finer than 10 microns (PM_{10})	24-hour[a] annual[b]	150 50	150 50
Nitrogen oxides (NO_x)	annual[b]	100	100
Photochemical oxidants (O_3)	1-hour[a]	160	235
Sulfur dioxide (SO_2)	3-hour[a] 24-hour[a] annual[b]	1,300 260 60	--- 365 80
Carbon monoxide (CO)	1-hour[a] 8-hour[a]	40,000 10,000	40,000 10,000

[a] Standards not to be exceeded more than once per year.
[b] Annual arithmetic mean not to be exceeded

The PSD program is designed to protect air quality from significant deterioration in areas already meeting state standards. In other words, an increase or increment is allowed above baseline pollution levels so long as the state standard is not exceeded. The size of the increment allowable under PSD depends on the area's designation as a Class I, II, or III area, with Class I areas allowed the smallest increment and Class III the largest. The mine area is Class II, as is all of Wyoming outside the national parks and wilderness areas. The Class I area that is closest to Antelope Mine is Wind Cave National Park in southeastern South Dakota. This national park is approximately 80 miles east of the mine. The PSD regulations do not currently affect coal mining because surface coal mines are not one of the 28 EPA-listed major emission sources and point-source emissions from these mines do not exceed the emissions threshold of 100 tons per year.

Particulates are the most significant emission source at surface coal mines. The large areas of disturbed land, blasting, crushing, loading, and hauling of coal

associated with mining all produce dust. Wyoming's PSD standards for particulates are identical to federal standards, except that Wyoming has not adopted Class III standards (see Table 10).

The initial federal particulate standard was the TSP standard, which is based on measuring all particle sizes. Recently, the federal standard was amended to PM_{10}, which measures particles 10 micrometers or less in diameter. Wyoming has kept the 24-hour TSP standard in addition to the PM_{10} standard. The current PM_{10} particulate standards in Wyoming are an annual average of 50 $\mu g/m^3$ and 24-hour average of 150 $\mu g/m^3$. The current Wyoming TSP standard is a 24-hour average of 150 $\mu g/m^3$ for TSP. The 24-hour standards are not to be exceeded more than once per year.

Table 10. Maximum Allowable Increases for Prevention of Significant Deterioration of Air Quality: Particulates

EMISSION	AVERAGING TIME	MAXIMUM ALLOWABLE INCREMENTS OF DETERIORATION (μg per cubic meter)		
		Class I	Class II	Class III
Total Suspended Particulates (TSP)	Annual Mean	5	19	37
	24-hour[1]	10	37	75

[1] Maximum allowable increment may be exceeded once per year at any receptor site.

The various motor vehicles used in mining and transporting coal and people also produce carbon monoxide, nitrogen oxides, sulfur dioxide and, by secondary processes, ozone, though these are seldom at levels to cause regulatory concerns at Wyoming's surface coal mines. The Wyoming standards for these parameters are shown in Table 9.

A detailed description of the air quality of the Powder River Coal Region was prepared for the BLM in 1983 (PEDCo, 1983). Prior to and subsequent to that study, air quality monitoring has been conducted in the areas where mining is occurring. In November 1990, the state of Wyoming submitted a proposed revision to the State Implementation Plan to the EPA. One purpose of the revision was to modify Section 24, which covers PSD. Prior to submitting the proposed revision to the EPA, the WDEQ/Air Quality Division (AQD) held a series of public hearings. During one of the hearings, the WDEQ/AQD presented testimony documenting that the air quality resource had not been diminished from 1980 through 1988, although coal production increased significantly during that period. Air quality data from that report is provided as Table 11. During the period covered in the WDEQ/AQD report, the number of mines producing coal in the Wyoming portion of the Powder River Basin increased from 10 to 16 while annual coal production escalated from 58.8 million tons to 139.1 million tons. The number of mines monitoring air quality increased from 12 to 16. The number of actual monitoring sites varied from a low in 1980 of 29 to a high of 46 in 1986. In 1988 there were 45 operating sites. Some of these sites include

more than one sampler, so the number of actual high volume air samplers is greater than the number of monitoring sites. Data collection has continued since this report was prepared, but the report has not been updated.

In an effort to summarize the monitoring data in comparative form, averages of the geometric means from all sites were calculated for each calendar year for this study. The averages ranged from a high of 30.8 $\mu g/m^3$ in 1980 to a low of 20.5 $\mu g/m^3$ in 1986. Over 23,000 samples were collected during the period covered by this study.

Table 11. Summary of WDEQ/AQD Report on Air Quality Monitoring in Wyoming's Powder River Basin, 1980-1988

YEAR	NUMBER OF MINES PRODUCING/ MONITORING	# SITES	COAL PRODUCED (MMTPY*)	OVERBURDEN (MMBCY*)	TSP AVERAGE OF ALL GEOMETRIC MEANS ($\mu g/m^3$)	ANTELOPE MINE GEOMETRIC MEAN TSP ($\mu g/m^3$)
1980	10/12	29	58.8	93.2	30.8	----
1981	11/13	34	68.9	108.0	30.4	----
1982	11/15	43	81.4	120.7	23.1	9.6
1983	13/15	41	88.0	157.2	24.3	11.6
1984	14/15	44	106.8	166.6	24.3	14.0
1985	16/15	45	113.8	196.3	24.3	17.0
1986	16/16	46	114.6	169.6	20.5	14.4
1987	16/16	45	124.6	180.9	25.6	19.4
1988	16/16	45	139.1	209.8	29.3	22.9

Notes: 1. Mines include Buckskin, Rawhide, Eagle Butte, Fort Union, Clovis Point, Wyodak, Caballo, Belle Ayr, Caballo Rojo, Cordero, Coal Creek, Jacobs Ranch, Black Thunder, North Antelope/Rochelle, Antelope, and North Rochelle.
2. Antelope Mine's first year of operational monitoring data was 1982
3. From WDEQ/AQD, 1989 (This study has not been updated).

*MMTPY = million tons per year, MMBCY = million bank cubic yards

Table 11 shows that the average of the geometric means went up during 1987 and 1988. The cause of this increase is not clear. Speculation is that it was due to mining activity approaching monitoring sites and to dry conditions due to the regional drought. The third quarter of 1988 could have been impacted by emissions from the forest fires in Yellowstone Park.

The WDEQ/AQD has researched air quality data in the Powder River Basin. The data set includes numerous monitoring sites where TSP monitors are co-located with PM_{10} monitors. Since 1985, the historic data set consistently indicates that PM_{10} is 30% of TSP at sites near mining activities. This correlation is the basis of all emission inventories conducted in the Powder River Basin by AQD since 1985. These emission

inventories are, in turn, the basis of all permits approved by the WDEQ/AQD since 1985.

The rightmost column in Table 11 shows the annual geometric mean TSP concentrations for the Antelope Mine. Before the TSP annual standard was replaced by the PM_{10} standard, the TSP annual standard was 60 $\mu g/m^3$. As the table shows, the annual averages are well below this former standard. Assuming that PM_{10}, which was not monitored during the years shown in Table 11, was about 30% of the TSP values (as explained above), and further assuming that the geometric and arithmetic means are similar, it can be inferred from Table 11 that the Antelope Mine has historically been well within the current annual PM_{10} standard of 50 $\mu g/m^3$. The 1989-1994 TSP data from nearly 1600 samples collected at the Antelope Mine indicates that emissions have remained within the current standard. From 1989 to 1994, the TSP geometric means for the Antelope Mine, in micrograms per cubic meter, using the same averaging techniques applied to Table 11, are as follows: 1989 = 20.91; 1990 = 25.63; 1991 = 25.16; 1992 = 24.23; 1993 = 25.86; and 1994 = 31.79 (ACC, WDEQ/AQD Annual Reports for the calendar monitoring years 1989 through 1994.)

The information presented by the WDEQ/AQD indicates that air quality in the Wyoming portion of the Powder River Basin did not deteriorate while coal production increased nearly 2.5 times in the 1980-1988 period. This is due in part to the conditions that are attached to air quality permits. These conditions stipulate control measures that must be implemented by the mine operators in order to meet air quality standards. These measures include increased sprinkling, use of approved chemicals to control dust, limiting the amount of disturbed area, temporary vegetation of disturbed areas, and contemporaneous reclamation.

The removal of coal on the Antelope LBA tract will eventually require blasting and mining operations near the relocated County Road 37 and the BN/C&NW railroad right-of-way. This has the potential to affect highway travelers and trains if blasting and/or fugitive dust cause visibility impairment or if flyrock approaches the right-of-way. These issues will be addressed in the mine's blasting plan and in the air quality permit which must be obtained from WDEQ/AQD if the lease is issued. Throughout the life of the Antelope Mine, the active pit was frequently within ½ mile of County Road 37 prior to its relocation in 1993 without creating dust- or blasting-related problems.

3.2.13 Transportation Facilities

County Road 37, two pipelines, and a railroad main line pass through or near the Antelope LBA tract. Transportation facilities are shown on Figure 7 (in Section 3.2.5). County Road 37 formerly ran through the Antelope Mine area. It was relocated to its present position, adjacent to the railroad around the eastern edge of the mine, in 1993 to facilitate coal recovery. In this present location it runs parallel to the railroad main line. It would not be economically feasible to relocate it again, with or without the LBA tract. Thus this is considered a permanent relocation of

County Road 37. The railroad right-of-way and relocated county road make some of the coal within the LBA area unrecoverable, due to unsuitability for mining (as discussed in Section 1.2), or for economic reasons. As discussed in Section 3.2.5, there are two pipelines that traverse the Antelope Mine area.

3.2.14 Socioeconomics

The proposed lease area lies in Converse County within the Powder River Basin in northeastern Wyoming. The major Converse County community of Douglas is located approximately 55 miles to the south via County Road 37 and Highway 59.

Douglas is the county seat for Converse County. It is the major trade center and the largest community within the affected area of the proposed coal lease. Douglas is the home of most Antelope Mine employees and is the community within the region that is most likely to attract new area residents due to its current population level along with services and shopping amenities that exceed those of lesser populated communities within commuting distance of the Antelope Mine and proposed lease area.

Douglas had a population of 5,076 in 1990 according to the 1990 census, relative to a 1990 population for Converse County of 11,128 (U.S. Department of Commerce, 1990). Glenrock, a smaller community in Converse County with a 1990 population of 2,153 people, is about 25 miles west of Douglas and is not currently nor likely to become the home of a significant number of Antelope Mine employees. Wright, Wyoming, about 30 miles northwest of the Antelope Mine in Campbell County, and rural Campbell and Converse counties are home to about 20% of the Antelope Mine employees.

Converse County ranked 14 in population among counties within the state in 1990 with a total population of about 11,128. With a total area of about 4,250 square miles, Converse County's population density was about 2.6 persons per square mile in 1990, compared to an average of slightly over 4.6 persons per square mile for the state. The 1990 census placed the state's population at 453,588 (U.S. Department of Commerce, 1990).

According to the 1990 census, Converse County contained 5,234 housing units that year, of which 2,267 were in Douglas (U.S. Department of Commerce, 1990). Vacant housing units for sale or rent in Douglas in 1992 were estimated to total about 59 units, including 24 single-family homes, 30 mobile homes and 5 multi-family units (Douglas, Wyoming Community Profile, 1992). The overall vacancy rate is about 2.6%. As a maintenance tract, sale of the Antelope Mine LBA lease would not directly create additional jobs. However, current available housing in Douglas would be sufficient to accommodate over 50 additional workers.

Converse County's economy is based largely upon coal mining, oil and gas extraction, energy production (specifically power generation), and agriculture. Converse County's 1993 mineral valuation on 1992 production equalled $189.6

million. The 1993 state total was $3.62 billion. Coal valuation in 1993 totaled $28.4 million for Converse County and $1.12 billion for the state. Thus, Converse County represented about 5.2% of the state's total 1993 mineral valuation and about 2.5% of the state's total coal valuation (State of Wyoming; Department of Revenue, 1993).

The 1992 oil production in Converse County was valued in 1993 at $139 million, or about 1% of the state's output of $1.39 billion. The 1992 natural gas output in Converse County was valued in 1993 at $14.3 million, which is about 2% of Wyoming's $866 million valuation for 1993 (State of Wyoming; Department of Revenue, 1993).

Converse County placed third among Wyoming counties in oil production with 7.2 million barrels (bbls) in 1992. Natural gas production in the county totaled 9,283 million cubic feet (MMCF) in 1992. By comparison, the state's oil production totalled 84.6 million bbls in 1992; natural gas production was 765,254 MMCF in 1992 (State of Wyoming; Department of Commerce, 1993).

Table 12. Historic Coal Production for Wyoming and Converse County

YEAR	1988	1989	1990	1991	1992	1993	1994
Wyoming*	163.5	171.1	183.9	193.9	189.5	209.9	236.9
Percent Change	---	+4.4	+7.0	+5.2	-2.3	+10.8	+14.3
Converse Co.*	5.7	6.1	7.9	8.2	8.5	10.2	11.4
Percent Change	---	+7.0	+29.5	+3.8	+3.7	+20.0	+11.8
Campbell Co.*	135.7	143.8	154.7	164.9	159.6	181.9	205.5
Percent Change	---	+6.0	+7.6	+6.6	-3.2	+14.0	13.0
Campbell & Converse Co.*	141.4	149.9	162.6	173.1	168.1	192.1	216.9
Percent Change	---	+6.0	+8.5	+6.5	-2.9	+14.3	+12.9

*Production is in Millions of Tons
Source: Wyoming State Geological Survey/Wyoming Geo-Notes, No. 46, May, 1995; and State of Wyoming/Annual Report of the State Inspector of Mines, January, 1995.

Recent coal production figures for Wyoming, and for Campbell and Converse counties are shown in Table 12 (above). Converse County's coal production increased from about 6.1 million tons of coal in 1989 to about 11.4 million tons in 1994, an increase of 78% in five years. The county's output consistently represented 4% to 5% of the state's total coal output during those five years. State output increased from 171 million tons in 1989 to 236.9 million tons in 1994, making Wyoming the largest coal producer among the 50 states. The Wyoming State Geological Survey is predicting annual increases of about 4.5% in Wyoming coal production through 1998 (Wyoming State Geological Survey, May, 1995). Antelope

Mine produced 3.5 million tons of coal in 1989, 5.2 million tons in 1990, 5.4 million tons in 1991, 5.7 million tons in 1992, 7.2 million tons of coal in 1993, and 8.3 million tons in 1994.

Employment in Wyoming's coal mining industry has remained relatively constant during the same five year period. Employment totaled 4,560 in 1989, 4,623 in 1990, 4,663 in 1991, 4,648 in 1992, 4,553 in 1993, and 4,571 in 1994. In comparison, Converse County employed 230 in 1989, 272 in 1990, 271 in 1991, 269 in 1992, 279 in 1993, and 301 in 1994 within the coal mining sector (Wyoming State Geological Survey; 1990, 1991, 1992, 1993, 1994, 1995). The Antelope Mine employed 52 persons in 1989, 99 in 1990, 97 in 1991, 94 in 1992, 103 in 1993, and 119 in 1994.

The average unit valuation of coal sold in Converse County, Wyoming has declined from $4.88 per ton in 1989 to only $3.34 per ton in 1993 (State of Wyoming; Department of Commerce, 1994). The statewide average price of coal in 1993 was $7.44, compared to $8.63 in 1989. The statewide average is heavily skewed upward by prices for coal from the southern coal fields. The average price paid for coal from northeastern Wyoming mines has declined from $7.02 per ton in 1989 to $6.18 in 1993 and is expected to continue to decline for the near future (Wyoming State Geological Survey, February 1994). The average coal price reflects a composite of historic contract prices that have escalated over time, new contract sales, open market (spot) coal sales, and renegotiated longer-term contracts. Contracts at $12.00 to $14.00 per ton are expiring and being replaced by spot market sales and shorter term contracts. Spot market, short-term contracts, and renegotiated longer-term contracts (all under $5.00 per ton) comprised 5% of Wyoming's production in 1985, with a substantial increase to 37% in 1992, and a projected additional increase to 51% by 1995 (Wyoming State Geological Survey, May 1993). Spot prices in the Wyoming Powder River Basin rose in early 1994 as a result of a shortage of coal in the basin (Riley; Casper Star Tribune, March 14, 1994). The shortage was due to cold weather, rail disruptions, and other market factors. These conditions no longer exist and spot prices are returning to pre-1994 levels. The accepted bid for one recent spot coal solicitation was $4.44/ton freight-on-board (F.O.B.) for coal from the Jacobs Ranch Mine, and a coal contract running through 1997 was awarded to the Caballo Mine at a price of $4.05/ton F.O.B. (Wyoming State Geological Survey, February, 1995).

The 1993 Wyoming Income and Employment Report (State of Wyoming; Department of Administration and Information, Division of Economic Analysis, 1993) shows that Converse County's agricultural sector employed 473 in 1987, 461 in 1988, 457 in 1989, 453 in 1990, and 445 in 1991. This compares to state figures of 13,036, 12,746, 12,590 and 12,528, and 12,306 respectively.

Labor force data for selected years are presented in Table 13. Average annual unemployment in Converse County was 5.8% in 1990, 5.4% in 1991, 5.7% in 1992, and 5.8% in 1993. This compares to average statewide figures of 5.4 and 5.1, 5.6 and 5.4% for years 1990 through 1993, respectively. Average annual unemployment

in the county was 345 in 1993 (State of Wyoming; Department of Employment, Research and Planning Division, April 1994).

Table 13. Labor Force Data for Selected Years for Wyoming and Converse County

YEAR	WYOMING	CONVERSE
1980	278,019	7,694
1985	278,287	6,781
1990	268,138	5,770
1992	278,680	6,130

Source: Wyoming Income, Employment, and Gross State Product Report, State of Wyoming, Department of Administration and Information, Division of Economic Analysis, September, 1994.

Total personal income in Converse County was $156.1 million in 1987, $157.0 million in 1988, $157.3 million in 1989, $159.0 million in 1990, and $166.9 million in 1991. This represented a 0.55% increase from 1987 to 1988, a 0.24% increase from 1988 to 1989, a 1.06% increase in from 1989 to 1990, and a 5.0% increase from 1990 to 1991. State personal income for those years totaled about $6.38 billion, $6.57 billion, $6.92 billion $7.45 billion and $7.80 billion, respectively, which is a 3.04% increase from 1987 to 1988, a 5.34% increase from 1988 to 1989, a 7.62% increase from 1989 to 1990, and a 4.70% increase from 1990 to 1991 (State of Wyoming; Department of Administration and Information, December 1993). In Converse County, total personal income earned from all mining (including oil extraction) totaled $31.5 million in 1987, $36.1 million in 1988, $31.2 million in 1989, $26.0 million in 1990, and 26.9 million in 1991. Total personal income in the county's agricultural sector was $5.09 million in 1987, $7.15 million in 1988, $5.00 million in 1989, $7.09 million in 1990, and $10.74 million in 1991 (State of Wyoming; Department of Administration and Information, December 1993).

By comparison, earnings by place of work for the state totaled $4.62 billion in 1987, $4.78 billion in 1988, $4.93 billion in 1989, $5.24 billion in 1990, and $5.50 billion in 1991. Earnings from coal mining amounted to about $238.57 million in 1987, $251.02 million in 1988, and $257.15 million in 1989. Earned income from oil and gas extraction statewide was about $319.17 million in 1987, $333.72 million in 1988, and $318.52 million in 1989. The state's agricultural sector produced earnings of over $101 million in 1987, over $132 million in 1988, nearly $122 million in 1989, and $158.5 million in 1990 (State of Wyoming; Department of Administration and Information, 1991).

In 1991 the largest industries in Wyoming in terms of employment were services, retail trade, and the government sector, with 59,993, 46,631 and 60,286 occupied positions, respectively. These three sectors accounted for 61.8% of all the

occupied jobs in Wyoming in 1991. That same year, the mining sector in Wyoming had 20,756 occupied jobs. This was well below the 41,880 jobs in the mining sector at its peak in 1981, but 1991 was the third year in a row that the number of jobs in the mining sector increased. In 1991, the mining sector accounted for 7.7% of all occupied jobs in Wyoming (State of Wyoming Department of Administration and Information, December 1993).

Coal mining has changed a great deal since the 1970s, and new technologies have been a major contributor to those changes. The national labor force in the coal mining industry grew during the 1970s, but declined during the 1980s. Since 1973 overall production has risen while employee numbers have decreased. The employment decline followed heavy industry investments in capital between 1973 and 1979. Through 1976 the majority of capital investment was for boosting productivity and output. Output per employee has increased dramatically due to improved technology. The cutbacks in the number of employees needed to produce large quantities of products have left in place a skilled workforce, most with many years of experience. Jobs in mining now frequently require technical training in operating computers or other specialized equipment (U.S. Department of Labor, Bureau of Labor Statistics, October, 1992).

The state's per capita personal income averaged $13,363 in 1987, $14,123 in 1988, $15,046 in 1989, $16,467 in 1990, and $16,968 in 1991. In these same years, Converse County per capita income averaged $12,427, $13,024, $13,658, $14,440 and $14,895 respectively (State of Wyoming; Department of Administration and Information, 1993).

Douglas, Wyoming has two elementary schools, one junior high school, one high school, one junior college (a branch campus of Eastern Wyoming College), one private school, and one vocational school (Wyoming Law Enforcement Academy). Four rural schools serve the outlying area around Douglas. In 1992, the elementary and junior high schools had a teacher-pupil ratio of 1:14, while the high school had a teacher-pupil ratio of 1:15. The number of enrolled students in Douglas in the 1991-92 school year was 1,799 (Converse County Economic Development Council, 1992). This number has declined from a peak of 2,119 in 1982-83, following a general decline in the minerals industry. Current school staff includes 112 teachers, 9 administrative staff, 10 support staff and 52 classified staff, and the annual school budget is about $8.1 million (Douglas, Wyoming, undated).