6.0 CUMULATIVE IMPACTS

Cumulative environmental impacts are those which result from the incremental impacts of an action added to other past, present, and reasonably foreseeable future actions, regardless of who is responsible for such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7). This EIS addresses cumulative impacts as the incremental impacts that would result from mining and mining-related activities at the proposed Rocky Butte Mine when added to the impacts that would result from mining and mining related activities at other regional coal mines.

Some cumulative impacts have necessarily been addressed in Chapter 4 of this EIS as dictated by the types of impacts being examined. For example, air quality impacts must, from both a practical and regulatory standpoint, be evaluated with full consideration of the adjacent operating mines. Hydrologic impacts have also been analyzed in light of the fact that the Rocky Butte Mine is adjacent to a cluster of existing mines and is in an area now undergoing water-level drawdowns in the shallow aquifer system.

The Rocky Butte tract has been considered in two of the four regional coal leasing EIS's in the Powder River Basin. This section examines the predicted coal and coal-related developments and their related impacts as presented in these four regional EIS's in light of the coal development and related impacts that have already occurred. Specific emphasis is placed on developments in Campbell County, Wyoming.

There are currently 7.797 billion tons of federal coal underlying 102,426 acres under lease in the Wyoming portion of the Powder River Basin. The six LBA's received to date propose to add approximately 1.035 billion tons of federal coal underlying 8,428 acres. This amount of coal would be offered over the next 3 to 4 years, and even though offered, some may not be leased due to many factors. The amount of coal in these LBA areas represents an increase of 13 percent of leased federal coal and an increase in acreage of 8.2 percent. Since the 1990 coal production for the Wyoming portion of the Powder River Basin was 162.6 million tons, the coal underlying the proposed leases represents approximately 6.4 years of reserves for the basin as a whole. The 1990 coal production for Campbell County was 154.7 million tons. The coal which would be added by the six pending LBA's is therefore equivalent to about 6.7 years of production at the 1990 Campbell County production rate.

6.1 Actual and Predicted Coal Activity in the Eastern Powder River Region

This section presents a review of the cumulative analysis which is contained in each of four regional EIS's prepared during the 1970s and early 1980s. The four analyses are:

- Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming, BLM, October 1974.
- Final Environmental Impact Statement, Eastern Powder River Coal, BLM, March 1979.
- Final Environmental Impact Statement, Powder River Coal Region, BLM, December 1981.
- Draft Environmental Impact Statement, Round II Coal Lease Sale, Powder River Region, BLM, January 1984.

This review provides an assessment and analysis of cumulative environmental impacts based on the current coal production outlook and presently anticipated levels of regional development activity. The analysis reviews cumulative impacts identified in the above-referenced EIS's as compared to actual development activity which occurred. This cumulative analysis also incorporates data, monitoring results and research done since the EIS's were done, or in response to impacts identified in these EIS's which will provide further assessment of cumulative impacts resulting if the lease-by-applications currently pending before BLM are approved.

The coal region in which the current lease-by-applications are located can be defined as the Eastern Powder River Coal Region and is generally considered to include Campbell and Converse

Counties in Wyoming. In the 1970s and early 1980s there was a great deal of interest and activity in mining existing leases and acquiring new federal coal leases. As a result, the four referenced regional EIS's were prepared, and each identified and discussed the regional, cumulative impacts resulting from coal development, coal-related development, and other regional activities based on reasonably foreseeable development scenarios at the time. All the mines currently operating, including those requesting LBA's, in the Eastern Powder River region were specifically addressed in one or more of the referenced EIS's, as shown in Table 6-1. Each regional EIS contained predictions of mining activity into the future, including the number of mines, production levels, and acreage requirements.

Table 6-1. Mine Sites Addressed in Prior Regional Coal Development EIS's

Mine	Operator	1974 EIS	1978 EIS	1981 EIS	1984 DEIS
Antelope	Antelope Coal Co.	x		x	x
Belle Ayr	Amax Coal Co.	x	x	x	x
*Black Thunder	Thunder Basin Coal Co.	x	x	x	x
Buckskin	Triton Coal Co.		x	x	x
Caballo	Carter Mining Co.		x	x	x
Caballo Rojo	Mobil Coal Producing		x	x	x
Clovis Point/East Gillette	Kerr-McGee Coal Corp.		x	x	x
Coal Creek	Thunder Basin Coal Co.		x	x	x
Cordero	Cordero Mining Co.	x	x	x	x
Dave Johnston	Pacificorp	x	x	x	x
Dry Fork	Dry Fork Coal Co.			x	x
*Eagle Butte	Amax Coal Co.	x	x	x	x
Fort Union	Fort Union Ltd.			x	x
*Jacobs Ranch	Kerr-McGee Coal Corp.	x	x	x	x
Keeline	Neil Butte Co.			x	x
*North Antelope	Powder River Coal Co.	x	x	x	x
North Rochelle	Shell Mining Co.			x	x
Rawhide	Carter Mining Co.	x	x	x	x
*Rochelle	Powder River Coal Co.	x	x	x	x
*Rocky Butte	Northwestern Resources Co.			x	x
Wyodak	Wyodak Resources Dev.	x	x	x	x
TOTALS:		11	15	20	20

* LBA application on file

Coal-related developments, such as power plants, coal gasification, and other coal conversion industries were predicted. Other regional activities such as oil and gas, uranium, and any other known major development activities were also predicted. An analysis was developed to identify and evaluate impacts of all of these activities taken together.

Table 6-2 shows what activity has actually taken place in the region, and also shows the cumulative total of the activity that has actually taken place added to the activity predicted based on the LBA's which are currently pending before BLM. The table also illustrates the predictions of coal, coal-related and other regional development activity upon which the cumulative impact analysis for each of these regional EIS's is based.

Table 6-2 shows that the actual level of development which occurred by 1990 is within the range of predictions made in the referenced EIS's. The 1979 EIS was the closest prediction, which is explained by the fact that the 1981 and 1984 EIS's were assuming high levels of new leasing and new development of pending preference right lease applications. Market conditions have not favored the development of new mines.

Table 6-2. Cumulative Regional Activity, Eastern Powder River Coal Region (Campbell and Converse Counties, Wyoming)

	1990 Actual Activity	1990 Actual Activity + LBA's	1974 Predictions Of 1990 Activity	1979 Predictions Of 1990 Activity	1981 Predictions Of 1990 Activity	1984 Predictions Of 1990 Activity
Number of Producing Mines	18	19	14	15	40[1]	37[1,2]
Number of Power Plants	3	3	6	2	3	3
Number of Gasification Plants	0	0	2	1	0	0
Leased Federal Coal (Millions of Tons)	7,796.5	8,831.5	Not Available	Not Available	Not Available	Not Available
Acres of Leased Federal Coal	102,426	110,854	93,075	Not Available	Not Available	Not Available
Coal Production (Millions of Tons Per Year)	162.6	178.6	150	174.3	332.9[1]	292.1[1,2]

1. Calculated from Wyoming and Montana totals in EIS. This EIS covered the entire Powder River Basin.
2. Baseline or "No Action" alternative used from this EIS as the 1984 was not finalized and, therefore, the actions proposed were never taken.

Sources of 1990 data: 1990 Annual Mine Reports for Eastern Powder River Region mines and BLM Casper District records.

Many of the impacts of the development activities are related to the amounts of surface disturbance, new employment, and resources consumed by the activity. Table 6-3 shows the 1990 predictions for each regional EIS as to acres disturbed and reclaimed, employment, and population. This table also illustrates surface disturbance and reclamation, employment and population that actually had occurred or existed in 1990.

Cumulative surface disturbance to date is about 32,000 acres. This is within the range of predictions of the referenced EIS's and, with all the pending LBA's added, represents less than one tenth of one percent of the region. The acreage disturbed has been specifically analyzed in the referenced EIS's, and no unique soils or vegetation types were identified as being impacted. The disturbed acreage is being reclaimed, with about one third of the already-disturbed area having been contoured, topsoiled and reseeded.

Table 6-3. Cumulative Surface Disturbance, Employment and Population -- Actual and Predictions -- Without the Lease-By-Applications, Eastern Powder River Coal Region (Campbell and Converse Counties)

	Actual 1990 Levels	1974 Predictions of 1990 Levels	1979 Predictions of 1990 Levels	1981 Predictions of 1990 Levels	1984 Predictions of 1990 Levels
Acres Disturbed	31,744	13,887	22,794	43,550[1]	40,900[1,2]
Acres Reclaimed	9,199	4,132	12,666	24,200[1]	22,800[1,2]
Coal Employment	2,862	5,200	3,899	11,900	11,500[2]
Total Population	40,498	65,600	59,400	69,000	62,300[2]

1. Calculated from Montana and Wyoming totals in EIS. This EIS covered the entire Powder River Basin.
2. Baseline or "No Action" alternative used from the DEIS as the 1984 EIS was not finalized, and therefore the actions proposed were never taken.

Sources of 1990 data: 1990 Annual Mine Reports for Eastern Powder Basin Mines, BLM Casper District Records, 1990. Census Results for Wyoming Counties/Municipalities, "Annual Report of Mines of Wyoming" through December 31, 1990.

Cumulative transportation impacts are related to coal production and employment levels and are therefore well within the level of impacts identified in the referenced EIS's.

Table 6-4 presents a comparison between actual 1990 coal production in Campbell County and the predicted 1990 level of production as evaluated in the 1981 regional EIS. That EIS contained predicted coal production levels by mine (or by lease tract) for the seventeen Campbell County coal mines that were in operation or permitted in 1981, the nine additional properties under lease in 1981, and for eight additional Campbell County tracts proposed for bidding in the 1982 Eastern Powder River Basin lease sale. As the table shows, actual production in Campbell County in 1990 was 154.7 million tons, or about 47 percent of the 1990 level as predicted in the 1981 regional EIS.

6.2 Actual and Predicted Coal Activity in Campbell County

Of the new lease tracts proposed for sale in 1982, four (Little Rawhide, Duck Nest Creek, Fortin Draw and Spring Draw) became maintenance tracts for existing mines. No mine has been permitted for the other four leases, one of which is the Rocky Butte lease.

Table 6-5 provides a comparison between the hypothetical Rocky Butte tract mine developed for the 1981 regional EIS and the Rocky Butte Mine as currently proposed by NWR, including the WRB tract. The mine and reclamation plan for the Rocky Butte tract as described in the 1981 regional EIS was more fully described in the Rocky Butte Tract Profile (BLM, 1981). Table 6-5 indicates that the current proposal has a larger coal reserve, reflecting both the addition of the WRB tract and more complete geologic information based on additional drilling done since 1981. The recovery factor is also larger in the current proposal, reflecting development of a more detailed mine plan and the fact that the 90-percent recovery assumed in the 1981 tract profile is believed to be conservatively small by current standards.

The coal production rates for the two scenarios are similar (15.1 million tpy in the 1981 tract profile vs. 16 million tpy in the NWR proposal). Disturbed area has increased from 5,000 acres predicted in the 1981 tract profile to 7,333 acres in the NWR mine plan. This increase is probably reflective of the more complete mine plan available from the NWR proposal.

Table 6-4. Comparison Between 1990 Campbell County Coal Production by Mine As Predicted in 1981 Regional EIS and As Actually Occurred

Mine Name	Operator	1990 Production Predicted in 1981 Regional EIS[2] (mmtpy)	Actual 1990 Production[3] (mmtpy)
EXISTING MINES (AS OF 1981)			
Black Thunder	Thunder Basin Coal Co.	20.0	27.9
Jacobs Ranch	Kerr McGee Coal Corp.	14.0	16.7
Belle Ayr	Amax Coal Co.	19.0	15.5
Eagle Butte	Amax Coal Co.	20.0	15.4
Caballo	The Carter Mining Co.	12.0	14.3
Cordero	Cordero Mining Co.	15.0	12.9
Rochelle	Rochelle Coal Co.	11.0	12.0
Rawhide	The Carter Mining Co.	24.0	11.4
Caballo Rojo	Mobil Coal Producing	15.0	8.6
North Antelope	North Antelope Coal Co.	1.6	8.2
Buckskin	Triton Coal Co.	1.5	7.7
Wyodak	Wyodak Resources Development Corp.	5.0	2.9
Dry Fork	Dry Fork Coal Co.	8.0	0.8
Coal Creek	Thunder Basin Coal Co.	10.0	0.1
Ft. Union	Fort Union Coal Co.	1.2	0.0
North Rochelle	Shell Mining Co.	8.0	0.0
Clovis Point	Kerr McGee Coal Corp.	4.0	0.0
PROPOSED MINES ON EXISTING LEASES (AS OF 1981)			
Pronghorn	Mobil Coal Producing	5.0	0.0
East Gillette	Kerr McGee Coal Corp.	11.0	0.0
South Rawhide	Fort Union Coal Co.	7.0	0.0
Wildcat Creek	Gulf Oil Co.	10.0	0.0
Wymo	Wymo Fuels, Inc.	4.4	0.0
South Gillette	Peabody Coal Co.	2.0	0.0
Thunderbird	El Paso Energy Co.	3.5	0.0
Thunderbird II	Wold and Jenkins	5.2	0.0
Wildcat Creek Area	Consolidation Coal Co.	4.5	0.0
	SUBTOTAL	241.9	154.7
NEW TRACTS FOR 1982 LEASE SALE			
Rocky Butte	Northwestern Resources Co.	15.5	0.0
Timber Creek	NA	6.5	0.0
Keeline	NA	6.8	0.0
Kintz Creek	NA	8.1	0.0
Little Rawhide[1]	Amax Coal Co.	20.0	0.0
Duck Nest Creek[1]	Amax Coal Co.	10.5	0.0
Fortin Draw[1]	Wyodak Resources Development Corp.	5.0	0.0
Spring Draw[1]	Triton Coal Co.	14.3	0.0
	SUBTOTAL	86.7	0.0
GRAND TOTALS		**328.6**	**154.7**

[1] Leased as production maintenance tracts for existing mines.
[2] BLM, 1981
[3] Wyoming Coal Information Committee, 1991.

Table 6-5. Comparison Between Rocky Butte Mine Proposal as Assumed for 1981 Regional EIS and as Proposed by NWR

Item	Proposed Action from 1981 EIS[1]	Proposed Action for WRB EIS (excludes Option A)
Total strippable reserves (million tons)	502	625
Recoverable reserves (million tons)	452	608
Percent recovery	90	97
Mine life (years)	30	42
Annual production rate (million tons)	15.1	16
Mining method	truck/shovel	dragline and truck/shovel
Total disturbed area (acres)	5,000	7,333
Employment (peak)		
- during construction	230	279
- during mining	580	500
Water requirements (acre-feet per year)	318	320
Water supply wells destroyed	20	20
Particulate emissions (tons/year)	1,946 to 3,908	1,644 to 3,102
Maximum particulate concentration increase ($\mu g/m^3$ annual geometric mean)	55	43
Trains per year (round trips)	1,510	1,600
Maximum increase in vehicles per day (round trips)	243	250-300

[1] Information taken from Tract Profile for Rocky Butte Tract prepared by BLM as supporting document for the 1981 Round II Coal Lease Sale EIS.

Predicted employment requirements are similar for the two mine plans, with the 1981 EIS prediction slightly smaller during the construction period and about 16 percent larger during peak production.

Water requirements are similar for both predictions. The primary difference is that the 1981 tract profile predicted that a water-supply well would be drilled to a depth of 2,000 feet into the sub-coal Fort Union Formation to provide 16 acre-feet annually (10 gallons per minute) of potable water. The NWR proposal assumes that potable water will be purchased from a bottled-water service and all other water requirements will be obtained by ground water collected in the mine, overburden dewatering wells, and surface runoff collected in sediment-control ponds.

Under both scenarios 20 water wells would be destroyed by mining activities. Air quality modeling done as part of NWR's permitting activities shows that particulate emissions should be less than what was predicted in the 1981 tract profile. Because coal production rates and predicted employment requirements are similar for the two scenarios, the predicted levels of train and vehicle traffic are also similar.

From the foregoing discussion it is concluded that the mine plan proposed by NWR, which would be enabled under the Proposed Action, is substantially similar to the hypothetical mine plan presented in the 1981 tract profile for the Rocky Butte lease tract. This hypothetical mine plan was incorporated into the 1981 regional EIS to evaluate both the mine-specific and cumulative impacts of the Rocky Butte mine.

Actual developments in the Campbell County coal mining industry, including coal production, disturbed acreage, and traffic, are within the ranges predicted in the four regional EIS's. Employment levels, and therefore population, are well below earlier predictions, an indication that productivity (in terms of coal produced per employee) is higher than was predicted a decade ago. Therefore many of the conclusions reached in the 1981 EIS, which ultimately led to the sale of the Rocky Butte lease tract in 1982, are still valid and even on the conservative side.

The following sections update the cumulative impact analyses for the Rocky Butte Mine in light of developments and changes that have occurred since the 1981 regional EIS was prepared and new data that are available from an additional 10 years of mining and reclamation experience in the region.

6.3 Geology and Mineral Resources

The Powder River Coal Region encompasses an area of about 20,000 sq mi and contains nearly 240 billion tons of subbituminous coal resources (BLM, 1979). The 127,000 acres in Campbell County within coal mine permit areas comprise about 1 percent of this region and contain about 3 percent of the coal resource. Campbell County has a total surface area of about 4,760 sq mi, of which some 4 percent is within current mine permit boundaries. The Eastern Powder River Basin, which includes all of Campbell County and a portion of Converse County, consists of approximately 7,800 sq mi (BLM, 1979).

Within the permit boundaries, the geology will be disrupted, with the coal recovered and the overburden and topsoil removed and replaced. The natural stratification of these shallower layers will be destroyed, and the replaced spoils will be a more homogeneous mixture of sands, silts and clays. The coal reserves mined represent a small percentage of the total resource but a large percentage of the shallowest (hence, most economically recoverable) reserves in the county and region.

6.4 Topography

After mining and reclamation are complete, the topography within about 1 percent of the Powder River Coal Region, about 2 percent of the Eastern Powder River Basin (EPRB) and about 4 percent of Campbell County will be flatter than before mining. The reduced relief and subdued topography can have benefits such as reduced erosion and increased precipitation infiltration. However, the flatter topography can be less attractive to some observers. Also, some topographic features that are beneficial to wildlife (e.g., breaks, incised drainages, rock outcrops, and playas) can not be entirely mitigated during reclamation. This would result in the loss of habitat on up to 4 percent of the county, decreasing bio-diversity and wildlife carrying capacities.

6.5 Soils

A total of approximately 111,000 acres on 19 mines including the proposed Rocky Butte mine (Table 6-2) will be progressively disturbed by surface coal mining. This represents approximately 2 percent of the entire EPRB. All of these areas will in time be reclaimed by planting appropriate species to restore soil productivity and prevent erosion, making the cumulative impacts to soils negligible.

6.6 Vegetation

Cumulative impacts to vegetation from strip mining were evaluated for the entire EPRB which encompasses all of Campbell County and the northern portion of Converse County (BLM, 1979). The analysis was based on information contained in the permits to mine for each mine in the Powder River Basin.

Cumulative effects of strip coal mining on vegetation within the EPRB will be negligible or minor because all mines are required to meet state reclamation success standards to obtain bond release (WDEQ-LQD, 1986). Furthermore,

reclamation plans for all mines propose to replace the major types of vegetation originally found within the permit area for the mine in the approximate acreage the types occupied prior to mining.

Collectively, the mines are projected to disturb about 111,000 acres, or two percent of the EPRB (Table 6-6). At the end of 1990, 31,744 acres (28.6 percent of the projected value and 0.6 percent of the EPRB) had been disturbed by coal mining. Of this disturbed land, about 9,200 acres had been reclaimed, leaving 22,540 acres disturbed. The proposed Rocky Butte Mine would add an average of 1,850 acres to this disturbance at any given point in time and would represent four to eight percent of the total disturbance. These values will fluctuate depending on production levels and reclamation schedules.

Table 6-6. Total Acres and Percentages of Projected and Actual Disturbance of Vegetation Types Within the Eastern Powder River Basin (EPRB), the Rocky Butte Permit Area, and Within the Total Permitted Acreage of All Mines in the EPRB, Converse and Campbell Counties, Wyoming.

	Projected Disturbed				Actual Disturbed to Date			
EPRB[1] (Acres)	Rocky Butte (Acres)	Rocky Butte (Percent of EPRB)	All Mines[2] (Acres)	All Mines (Percent of EPRB)	All Mines (Acres)	Percent of Projected Disturbed	All Mines (Percent of EPRB)	Area Reclaimed[2] (Acres)
4,978,560	7,333	0.1	111,000	2.2	31,744	28.6	0.6	9,199

[1] Source: BLM (1979)

[2] Data presented in this table were compiled from mine permits held by WDEQ, Cheyenne; and the permit, in preparation, for the Rocky Butte project. Due to variability in permit presentation of vegetation data, acreage presented herein represent a general summary of data for all mines in the EPRB.

Big sagebrush is the most common vegetation type in the EPRB, covering 84.1 percent of the land area of the region (Table 6-7). Ponderosa pine woodland, riparian areas, and cropland are next most abundant, occupying 577,328 acres, or 13.6 percent of the EPRB. Other vegetation types, such as greasewood grassland, lowland grassland, pasture, saline big sagebrush, scoria/roughlands and silver sagebrush, although uncommon, are also found in the EPRB.

Approximately 38 percent of all cropland in the EPRB disturbed by mining would be disturbed by the Rocky Butte mine. However, effects of losses of agricultural lands on regional productivity due to all mines, including Rocky Butte, would be minimal (Section 4.1.14). Because cropland is the principal vegetation type in the Rocky Butte project area, the contribution of Rocky Butte to impacts on other vegetation types is proportionally small.

While most vegetation types that will be impacted can be restored using conventional reclamation procedures, the scoria/roughlands type would be difficult to restore because the scoria buttes and ridges where the type occurs will be lost during mining. Thus, a cumulative effect of mining the EPRB will be the permanent loss of approximately 11,300 acres of scoria/roughlands type vegetation. However, Rocky Butte would not affect this type. Additionally, areas dominated by sagebrush would be lost for 10 to 20 years or more until sagebrush of similar heights and density becomes established on these areas. Minor vegetation types, including those associated with saline soils or other areas where soil conditions are undesirable or difficult to duplicate, probably would not be restored. For example, there would be a net loss of approximately 1,100 acres of the saline big sagebrush type, 299 acres of which would be disturbed by Rocky Butte.

Table 6-7. Areas and Percentages of Projected Disturbance of Vegetation Types within the EPRB, Rocky Butte Permit Area, and Within the Total Permitted Acreage of All Mines in the EPRB, Campbell and Converse Counties, Wyoming.

Vegetation Type	Acreage Occupied by Type, EPRB (Acres)	Disturbance of Type		Rocky Butte Portion of EPRB Disturbed (Percent)	Disturbance of Type		All Mines Portion of EPRB Disturbed (Percent)
		Rocky Butte (Acres)	Rocky Butte[2] (Percent)		All Mines[3] (Acres)	All Mines[2] (Percent	
Big Sagebrush and Upland Grassland	4,188,150	1,901	<0.1	<0.1	66,700	1.6	1.3
Cropland	124,464[4]	3,752	3.0	0.1	10,000	8.0	0.2
Disturbed	NA[5]	89	NA	<0.1	8,400	NA	0.2
Greasewood Grassland	82,960	0	0	0	1,100	1.3	<0.1
Lowland Grassland	NA	124	NA	<0.1	1,700	NA	<0.1
Pasture	NA	327	NA	<0.1	1,800	NA	<0.1
Riparian/Reservoirs	224,500	52	<0.1	<0.1	2,700	1.2	<0.1
Saline Big Sage	NA	299	NA	<0.1	1,100	NA	<0.1
Scoria/Roughlands	27,300	0	0	0	11,300	41.4	0.2
Silver Sage	36,900	789	2.1	<0.1	2,700	7.3	<0.1
Ponderosa Pine Woodland	328,400	0	0	0	0	0	0
Other Types	90,350	0	0	0	3,500	3.9	<0.1
TOTALS	4,978,560	7,333	--	0.2	111,000	--	2.2

1 Source: BLM (1979).
2 Relative to the acreage occupied by the type in the EPRB.
3 Data presented in the table were compiled from mine permits held by WDEQ, Cheyenne; and the permit, in preparation, for the Rocky Butte project. Due to variability in permit presentation of vegetation data, acreages presented herein represent a general summary of data for all mines in the EPRB.
4 Computed - Cropland occupies 2.5% of land in the EPRB (BLM 1979).
5 Data not available.

Due to a reduction in relief and in the number of vegetation types and plant species that would be reestablished, there would be a regional loss of vegetative diversity which would persist for years after closure of all mines. Geomorphic processes and natural succession would slowly create topographic and vegetative heterogeneity, such that permanent impacts to diversity would be minor or negligible.

6.7 Water Resources

Surface coal mining affects both the surface- and ground-water systems. These effects have been monitored over the years of mining activity. The potential and actual extent of these effects have also been the subject of several regional studies. This new data is identified and assessed in this cumulative analysis.

6.7.1 Ground Water

The cumulative impact of surface coal mining on ground water is an issue which was raised during scoping conducted for the currently proposed coal leasing.

Concern over the effects of large-scale surface coal mining on ground water around the mines has resulted in the establishment of a monitoring program which is administered by the State of Wyoming. Each mine is required to monitor ground-water levels in the coal itself as well as in shallower aquifers in the area surrounding their operations. There are also requirements for drilling monitoring

wells in the backfill areas of the mines in order to measure the recharge in these areas. The Gillette Area Groundwater Monitoring Organization (GAGMO), which was formed in 1980, assembles the hydrogeologic monitoring data collected by the coal mining companies operating in the EPRB of Wyoming, from the Buckskin Mine north of Gillette to the Antelope Mine in northern Converse County. GAGMO is composed of the companies with operating or proposed mines in that area, the Wyoming DEQ, the Wyoming State Engineer's Office, the BLM, and the OSM, which joined in 1991. Each year, GAGMO contracts with an independent firm to publish the results of the monitoring for that year. In 1991 GAGMO published two reports, an annual report for 1990 and a ten-year report. The ten-year report summarizes the data accumulated during the last ten years of monitoring in the GAGMO study area (Hydro-Engineering, 1991). According to the GAGMO ten-year report, 646 monitoring wells were operated at 21 coal mine sites (seventeen active mines sites and four inactive or never-mined sites) in 1990. The Dave Johnston Mine located near Glenrock and the Rocky Butte lease are not currently part of GAGMO.

The major ground-water issues are:

- The effect of the removal of the coal aquifer and any overburden aquifers within the mine area, and replacement of these aquifers with spoil material.
- The extent of the temporary lowering of static water levels in the aquifers around the mine due to dewatering associated with removal of these aquifers within the mine boundaries.
- The effect of the use of water from the sub-coal Fort Union Formation by the mines. Most mines in the PRB have water-supply wells completed in the sub-coal Fort Union Formation.
- Change in water quality as a result of mining.

The cumulative effects of large-scale surface coal mining for each of these issues are discussed in the following paragraphs.

The effects of replacing the coal aquifer and overburden with a spoil aquifer is the first major ground-water concern. The following discussion of recharge, movement, and discharge of water in the spoil aquifer is excerpted from the Powder River Basin CHIA, a regional study of surface coal mining impacts in the Powder River Basin prepared by the USGS (Martin, et al., 1988):

The potential for recharge to the backfilled spoil would be greater than in areas not disturbed by mining. The natural bedding will be destroyed, creating a more isotropic condition in the spoil, resulting in generally greater vertical permeability than exists in undisturbed areas. The infiltration capacity of the backfilled and reclaimed spoil will be greater than that of the undisturbed Wasatch aquifer and Wyodak coal aquifer. However, the infiltration rate for reclaimed soils is less than that for natural soils due to the lack of root structure and other paths for vertical movement of water. After several years, infiltration rates for reclaimed soils will increase to approximately the same rates as for undisturbed soils. As infiltration rates increase to approximate premining conditions, ground-water recharge rates also will increase to approximate premining conditions.

Although the recharge potential of the reclaimed mine areas will increase, the actual recharge rate after reclamation probably will approximate or be somewhat greater than premining recharge. Actual recharge will depend on how well the surface contours are restored. A flatter average slope of the reclaimed land would increase the potential recharge by decreasing the rate of runoff from reclaimed areas. Recharge will increase locally where water is allowed to pond in surface impoundments. Also, some increase in recharge along re-constructed channels probably will occur during the infrequent periods of surface runoff.

Postmining recharge rates and mechanisms will not change in areas where lateral movement of ground water from adjacent clinker is a major source of recharge. This is because, in general, the clinker will not be disturbed by mining operations. After mining and reclamation have been completed, water will move laterally from clinker to the spoil aquifer.

Recharge to the spoil aquifer will be from infiltration of precipitation, lateral flow from the undisturbed clinker and the Wasatch aquifer and Wyodak coal aquifer, and leakage from surface-water impoundments and stream channels. Estimates of the time required for the ground-water system to re-

establish equilibrium varies from a few tens of years to hundreds of years. The anticipated potentiometric surface of the spoil aquifer will resemble a composite of the premining potentiometric surfaces in the Wasatch aquifer and Wyodak coal aquifer. After equilibrium is re-established, ground-water flow patterns will approximate premining conditions. Discharge from the spoil aquifer will flow into the undisturbed Wasatch aquifer and Wyodak coal aquifer to the west (regional flow) or to reclaimed stream channels (local flow).

According to the GAGMO ten-year report, 56 backfill monitor wells had been drilled as of 1990. The report listed the current water levels in these wells and compared them to the 1980 water-level elevations, which were estimated from the 1980 coal water-level contours. Of these 56 backfill wells, six (10.7 percent) were dry (the water levels in those locations were below the total depth of the well), 29 (51.8 percent) reported water at levels less than the water levels estimated for 1980, and 21 (37.5 percent) reported water at levels equal to or higher than those estimated for 1980. The presence of water in 89 percent (50 of the 56) of the backfill wells drilled as of 1990 indicates that recharge is occurring in the backfill.

Since reclamation is done concurrently with mining, and the monitoring data indicate that recharge of the backfill is occurring, it is not anticipated that additional significant impacts will occur as a result of the leasing proposed in the LBA's received to date nor in the opening of the Rocky Butte Mine.

Clinker, the baked and fused rock formed by prehistoric burning of the Wyodak-Anderson coal seam, is believed to be the major recharge source for the spoil aquifer, just as it is for the coal. Although some clinker is mined for road surfacing material, saturated clinker is not generally mined since abundant clinker exists above the water table and does not present the mining problems that would result from mining saturated clinker. There is little clinker in the Rocky Butte mine area. Therefore, the major recharge source for the spoil aquifer is not being disturbed by mining and will not be affected by the Rocky Butte Mine.

The second major ground-water issue is the extent of water-level drawdown in the coal and shallower aquifers in the areas surrounding the mines. Most of the monitoring wells reported by GAGMO (578 wells) are completed in the coal beds, in the overlying sediments, or in sand channels or interburden between the coal beds. These wells range from 9 feet to 420 feet in depth. The changes in water levels in the coal seams after ten years of surface coal mining are shown in Figure 6-1, which was taken from the 1991 GAGMO ten-year report. This map shows the actual area where drawdown in the coal seam has been greater than five feet in ten years in comparison with the predicted worst-case five-foot drawdowns derived from ground-water modeling done by the mines. Wyoming DEQ/LQD policy is to have the mining companies determine the extent of the five-foot drawdown contour. In general, drawdowns do not extend east of the mines because the mines are located on or near the coal outcrop line. The actual ten-year five-foot drawdown contours have not exceeded the predicted worst-case drawdowns in any of the mines, and, in most cases, the drawdown contours are well within the mines' predicted worst-case drawdowns.

Drawdowns extend farther in the coal than in the shallower aquifers because the coal is a confined aquifer and because it is areally extensive, whereas the shallower aquifers (sandstone in the Wasatch, alluvium, and clinker) are generally discontinuous and of limited extent. Therefore, the area in which the shallower aquifers have experienced a five-foot drawdown would be smaller in each case.

The actual five-foot drawdown levels are also well within the cumulative drawdown predicted by the USGS in the Powder River Basin CHIA (Martin, et al., 1988). This study predicts the approximate area of five-foot or more water-level decline in the Wyodak-Anderson coal aquifer which will result from all anticipated coal mining. All anticipated coal mining as referred to in the CHIA includes 16 surface coal mines operating at the time the report was prepared and six additional mines proposed at that time. The proposed mines include two mines which are now producing, one mine which did produce for a short time but is currently inactive, and the proposed Rocky Butte mine. The study assumes that water-supply wells in the coal may be affected as far away as eight miles from mine pits, although at this distance the effects would be minimal. Wells in the

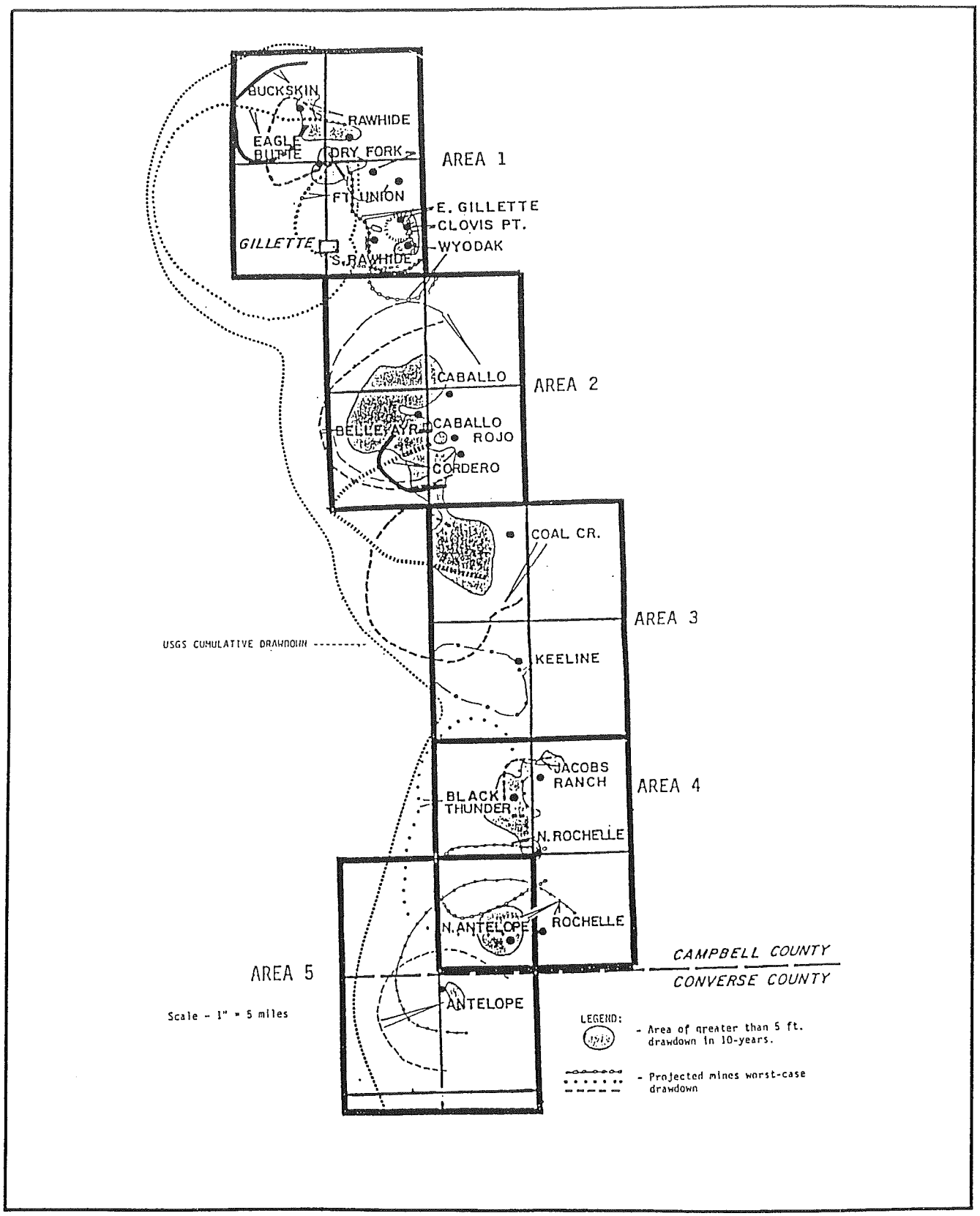

Figure 6-1. Comparison Between the 1990 Cumulative Drawdowns and the Mines Worst-Case and the USGS Predicted Drawdowns (Modified from Hydro-Engineering, 1991)

Wasatch are generally considered to be impacted by drawdowns only if they are within 2,000 feet of a mine pit (Martin, et al., 1988, p. 29).

Based on the above assumptions Martin, et al. (1988) show that there are about 3,000 wells in the area subject to impact by current and anticipated mining in Wyoming's Powder River Basin. Of these, about 1,200 wells are outside the actual mine areas (i.e., will not be removed by mining). About 1,000 of these wells supply water for domestic or livestock uses, and about 200 supply water for other uses. The remaining 1,800 wells are used by coal-mining companies: about 1,700 wells are monitor wells only, and the other 100 are used for water supply and/or dewatering at mine sites.

Of the 1,200 water-supply wells in the area potentially subject to impact, about 580 are completed in Wasatch aquifers, about 100 in the Wyodak-Anderson coal aquifer, and about 280 in strata below the coal. There is no completion data available for the remainder of these wells (about 240). They could be completed in any of the above aquifers.

Since the actual ten-year drawdowns lie well within the cumulative drawdown predicted by Martin, et al. (1988), the cumulative impacts to water wells have not reached the levels described in that report.

The USGS, in cooperation with the Wyoming State Engineer's Office, has recently completed an evaluation of ground-water level changes in the vicinity of Gillette (Crist, 1991). The study area for that report included an area of about 220 square miles around Gillette, where energy-related developments have caused a dramatic population increase since about 1960. This report states that water levels in the Wasatch Formation around Gillette declined by about 9 feet between 1965 and 1974 and now appear to be rising. This is probably because the City of Gillette stopped using its Wasatch wells after 1981, when the city started using its Madison pipeline. Data from 18 observation wells completed in aquifers below the Wasatch indicate declining water levels. Pumpage for municipal use by Gillette and for public supply by local subdivisions is the principal cause of water-level decline from 1972 to 1985 in the upper Fort Union (i.e., the Fort Union from the base of the Wyodak-Anderson Coal down to 750 feet below that level). A water-level measurement in 1985 indicates that the water levels in this zone have stabilized. Water-level changes in the lower part of the Fort Union Formation (i.e., more than 750 feet below the Wyodak-Anderson Coal) are not well documented due to a lack of data.

The additional ground-water impacts which would be expected as a result of extending mining as proposed in the LBA's received to date including the Rocky Butte mine would be to extend the drawdowns in the areas surrounding the proposed new leases. The actual drawdown contours for the mines which have proposed LBA's to maintain their current operations are well within the cumulative drawdown anticipated in the report by Martin, et al. (1988), and some recharge was already occurring in 14 of the 15 backfill wells which had been drilled by those mines by 1990. Therefore, additional significant impacts in water-level drawdown for the maintenance leases are not anticipated. The results of ground-water modeling of the Rocky Butte Mine is described in Section 4 of this EIS and includes cumulative impact analyses.

Potential water-level decline in the sub-coal Fort Union Formation is the third major ground-water issue. According to the Wyoming State Engineer's records, fourteen mines hold permits for 42 wells which are between 400 feet and 10,000 feet deep. That number does not represent the actual number of wells potentially completed in the Tullock Member, because the zone of completion of these wells is not always specified and not all of the wells are currently producing (for example, three of the permits are held by an inactive mine, and one of the wells Black Thunder has permitted has not been used since 1984).

Water-level declines in the Tullock Member have been documented in the Gillette area. These declines are most likely attributable to withdrawal at subdivisions and trailer parks in and near the city of Gillette (M.A. Crist, USGS, written communication, 1987, in Martin, et al., 1988, p. 30). Most of the water-level declines in the sub-coal Fort Union wells occur within one mile of the pumped wells (Ibid). The mine facilities in the Powder River Basin are separated by distances of a mile or more, so little interference between mine supply wells would be expected. For the Rocky Butte Mine, it is anticipated that drinking water will be purchased from a bottled-water service and other water requirements will be

met by overburden dewatering, pit inflows, and sediment-control ponds. A deep Fort Union well would be drilled only in the unlikely event that these sources prove insufficient.

In response to concerns voiced by regulatory personnel, several mines which have deep Fort Union water-supply wells have conducted impact studies of the sub-coal Fort Union Formation. The OSM commissioned one cumulative impact study of the sub-coal Fort Union Formation to study the effects of mine facility wells on this aquifer unit (McIntosh, et al., 1984). Kaman-Tempo (1983) performed a similar study for NERCO, and Western Water Consultants, Inc. (WWC) performed similar studies for Amax (WWC, 1983a) and Phillips Coal (WWC, 1983b). Conclusions from all these studies are similar and may be summarized as follows:

- Because of the discontinuous nature of the sands in this formation, and because most large-yield wells are completed in several different sands, it is difficult to correlate completion intervals between wells.

- In some areas, most notably around the City of Gillette where the city and several subdivisions are utilizing water from this formation, regional water levels are probably declining. (Note: Gillette is using this water as a back-up source at this time.)

- Because large saturated thicknesses are available in this aquifer unit, generally 500 feet or more, drawdowns of a few hundred feet in the vicinity of a pumped well would not dewater the aquifer.

The mines adjacent to the currently proposed maintenance-tract LBA's all have permits from the State Engineer for deeper wells. Extending the lives of these mines would result in additional water being withdrawn from the Tullock Member. The additional water withdrawals would not be expected to extend the area of water-level drawdowns over a significantly larger area because of such factors as leakance and recharge which tend to make drawdown curves asymptotic with time.

The Tullock Member of the Fort Union Formation is the lowermost unit in the formation, and it crops out at the surface east of the area being mined. Therefore, recharge to the Tullock Member from the outcrop area is not affected by mining.

The fourth issue of concern with ground water is the effect of mining on the water quality. Specifically, what effect does mining have on the water quality in the surrounding area, and what are the potential water quality problems in the spoil aquifer following mining?

Ground-water quality in areas surrounding the mines is not impacted during mining. While the pits are open, ground-water flow directions are toward the pit, and there would be no mechanism for contaminants to migrate off-site even if contaminants were introduced into the ground water.

In the regional study of the cumulative impacts of coal mining, the median concentrations of dissolved solids and sulfates were found to be larger in water from spoil aquifers than in water from either the Wasatch overburden or the Wyodak-Anderson coal aquifer. This is expected because blasting and movement of the overburden material exposes more surface area to water, increasing dissolution of soluble materials, particularly when the spoil materials were situated above the saturated zone in the premining environment. However, as discussed in Section 4.1.5, the ground water in the spoils is expected to be suitable for livestock use, similar to the use-suitability of premining ground water, and should improve over time. On the basis of studies done in North Dakota, it was estimated that at least one pore volume of water must leach the spoil before the dissolved-solids concentration in the water would be similar to the premining dissolved-solids concentration (Houghton, et al., 1987). The time required for one pore volume of water to pass through the spoil aquifer is greater than the time required for the postmining ground-water flow system to re-establish equilibrium.

The first water to flow out of the spoils into the surrounding aquifers may temporarily degrade the water in these aquifers, particulary the coal. This effect should be temporary, although long-term, and there are some indications that conditions exist in the coal to reduce some of the dissolved constituents (Martin, et al., 1988, p. 93). In time, the soluble constituents will be leached out and a new equilibrium water quality will be established.

6.7.2 Surface Water

There are two potential issues relating to cumulative surface-water impacts:

- Possible changes in runoff rates due to changes in precipitation infiltration rates.
- Possible changes in surface-water quality.

Some studies indicate that soil infiltration rates are smaller on reclaimed lands than on premining lands. A reduction of up to 29 percent has been found, with this reduction declining over time until the postmining infiltration rates recover to premining levels (Martin et al., 1988, p.106). However, the reduction in topography after reclamation will provide enhanced opportunity for precipitation infiltration and will likely more than offset this temporary decrease in soil infiltration rates.

Surface-water quality should not be significantly affected by mining based on UGSG studies of the Belle Fourche River Basin (Bloyd, et al., 1986, pp.33-41). Sediment yield should not increase in streams. Although reclaimed soils may be more erosive for a few years after reclamation, the larger sediment production would not be delivered to streams due to sediment deposition due to flatter slopes on reclaimed lands and sediment trapping by mandated sedimentation ponds.

6.8 Alluvial Valley Floors

Effects on AVFs can include several of the ground and surface water changes listed above. Alluvial aquifers can be subject to water-table drawdowns, channels subject to changes in flow patterns, and the interaction between surface water and ground water can be altered. Impacts to designated AVFs are not permitted unless the AVF is insignificant to farming or unless the permit to affect the AVF was issued prior to the effective date of SMCRA. It is not anticipated that any AVFs will be affected by the Rocky Butte Mine.

6.9 Fish and Wildlife

Cumulative impacts to key wildlife species resulting from the proposed action and other mining activities in the area are presented in Table 6-8.

Approximately 42,846 acres of sagebrush/upland grass habitat would be disturbed as a result of the proposed action and other coal mining activities within the 650,200 acres occupied by the Hilight pronghorn antelope herd (Table 6-8). Only 6,917 acres (1.1 percent) of pronghorn habitat would be disturbed by the proposed Rocky Butte Mine. While approximately 6.6 percent of the total herd area would be disturbed by the proposed action and other coal mining activities, it is likely that some areas within existing mine permits are classified by the WGFD as unoccupied by pronghorn, and many newly reclaimed areas at these mines are probably used by the species. However, mines located within the area occupied by the Hilight herd are situated more within winter/yearlong range than other range types. While only about 6.6 percent of the total herd area would be disturbed by the proposed action and other area coal mining activities, approximately 25 percent of the winter/yearlong range type would be disturbed (personal communication, Joe White, WGFD, Cheyenne, 1992). Alterations within this range type (i.e., conversion of winter/yearlong range to primarily summer range) could result in increased winter die-off of antelope during severe winters, if insufficient habitat is available. Cumulative impacts to antelope resulting from the proposed action and other coal mining activities for the Hilight herd would be moderate to major until vegetative diversity is restored.

Of the approximately 1,968,000 acres of mule deer-occupied areas within the Thunder Basin herd, only 39,443 acres (2.0 percent) of suitable mule deer habitat occur within existing and proposed mining operations (Table 6-8). Losses to the Thunder Basin white-tailed deer herd amount to less than 0.8 percent of the 332,900 acres occupied by that species. Only 4,269 acres (0.2 percent) of mule deer habitat and 52 acres (<0.1 percent) of white-tailed deer habitat would be disturbed by the proposed Rocky Butte project. Cumulative impacts to both mule deer and white-tailed deer populations would, therefore, be minor during the years that mining operations continue in the area.

Phillips and Beske (1990) quantified the number of active raptor nests at approximately 590 in Campbell and northern Converse Counties, Wyoming (Table 6-8). Whereas approximately 111,000 acres (3.1 percent) of the 3,596,355 acres in the region (7,333 acres on the Rocky Butte project area) and

Table 6-8. Cumulative Wildlife Impacts from Surface Mining in the EPRB, Wyoming, 1991.

Species	Occupied Area (Acres)	Acreage of Disturbance Within Occupied Habitats (Rocky Butte/All Mines)	Percent Loss (Rocky Butte/All Mines)
Pronghorn Antelope	650,200[1]	6,917/42,846[2]	1.1/6.6
Mule Deer	1,968,000[3]	4,269/39,443[4]	0.2/2.0
White-tailed Deer	332,900[5]	52/2,700	<0.1/0.8
Raptors	3,596,355[7]	7,333/111,000	0.2/3.0
number of known nests	590[7]	6/50[7]	1.1/8.5
Sage Grouse	4,225,050[9]	4,347/69,400	0.1/1.6
number of known leks	28[11]	2/5[11]	7.1/17.8

[1] Hilight herd unit.
[2] Includes native and cropland vegetation types on all mine permit areas within the Hilight herd unit.
[3] Thunder Basin herd unit.
[4] Includes native and cropland vegetation types on all mine permit areas within the Thunder Basin herd unit.
[5] Thunder Basin herd unit and riparian habitat on the proposed Rocky Butte Mine permit area.
[6] Includes riparian habitat on all EPRB mine permit areas (see Table 6-7).
[7] Includes Campbell and northern ¼ of Converse counties (adapted from Phillips and Beske, 1990).
[8] Includes entire disturbed area of all mine permits in EPRB (see Table 6-6).
[9] Includes all sagebrush and upland grass vegetation types in EPRB (BLM, 1979).
[10] Includes all sagebrush and upland grass vegetation types on all mine permits in EPRB (see Table 6-7).
[11] Adapted in part from BLM (1979).

approximately 50 raptor nests (six on the project area, 5 active in 1991) would be disturbed as a result of the proposed action and other surface mining activities in the region, raptor mitigation measures identified in mine-specific permits, EA's and EIS's effectively reduce potential nesting losses to zero. Furthermore, only a portion of the 111,000 acres slated for disturbance would be disturbed at any one time, as reclamation would be an ongoing process. Regarding sage grouse, approximately 69,400 acres (1.6 percent) of the 4,225,050 acres of sagebrush/upland grass habitat in the EPRB, and five (17.8 percent) of the 28 known leks would be disturbed as a result of the proposed action and other surface mining activities in the region (Table 6-8). Only 4,347 acres (0.1 percent) and two known leks (7.1 percent) would be disturbed by the proposed Rocky Butte Mine. Since only a portion of the area would be disturbed at one time, habitat losses would be minor for the species. However, if only 28 leks occur in the EPRB and five of these leks would be disturbed, impacts to sage grouse could result from the combined effects of the proposed project with other surface mining activities in the region over the life-of-mine activities. Since many of the sage grouse leks in the area have been identified as a result of surveys conducted in conjunction with mine permitting activities, many of the known leks are associated with existing mining operations; numerous additional leks likely occur in the region that have not been identified. Additionally, some of the leks identified within disturbance areas may no longer exist, further reducing the potential cumulative impacts to the species.

Minor cumulative impacts from the proposed action and similar activities in the region could occur for some MBHFI (i.e., ferruginous hawk, golden eagle, and burrowing owl), T&E species (i.e., bald eagle), State sensitive/priority species (i.e., upland sandpiper), and other species breeding in the area (e.g., waterfowl, predators, etc.). The relatively small area (2.2 percent) of the EPRB impacted as a result of current and proposed mining activities in the area combined with standard practices limit impacts to these species.

Topographic moderation resulting from mining activities has decreased wildlife habitat diversity in the region, and has resulted in a decrease in carrying capacity for some species. This cumulative impact may be major and permanent for some species if suitable habitats are not restored.

6.10 Historical, Archeological and Paleontological Resources

All cultural resource sites that cannot be avoided must be mitigated. Thus, no cumulative impacts will occur.

6.11 Recreation

The additive effects of 18 existing coal mines and three proposed mines within the EPRB (including the proposed Rocky Butte Mine) could have major effects on recreational activities, such as hunting, for the life of the mines. However, if hunting is limited or prohibited on mine sites, opportunities for wildlife observation may increase in some areas, concurrent with expected increases in wildlife abundance in areas prohibiting hunting.

Pronghorn antelope hunting is a major land use and deer hunting a negligible recreational activity for the Rocky Butte site. Total harvest figures for Rocky Butte are not available; however, a harvest of 1,119 antelope occurred on Hunt Area 24 (Table 3-6). About four percent (9,647 acres) of Hunt Area 24 (225,000 acres) is within the proposed mine site.

Six operating coal mines (Caballo, Belle Ayr, Caballo Rojo, Cordero, Coal Creek, and Jacobs Ranch) are within antelope Hunt Area 24 and mule deer/white-tailed deer Hunt Area 21. The total permit area occupied by the six mines is 54,150 acres, representing 24 percent of the land within Hunt Areas 21 and 24. However, only four percent of Hunt Areas 21 and 24 have been disturbed to date.

Each mine has the option of closing the entire site to hunter use or opening selected areas. Some mines currently do allow bow hunting and black powder (muskets) in some areas. If hunting is restricted or prohibited on major areas of the mine sites, herd sizes could exceed WGFD target values, and animal populations could experience large die-offs during severe winters.

6.12 Air Quality

The TSP standard was based on all particle sizes which could be trapped using a high volume air pump and a particular type of filter. Recently, the federal standard was amended to account for the greater health risk due to particles less than 10 micrometers in diameter (the PM_{10} standard). The particulate standard change from TSP to PM_{10} is more lenient toward mining activities since mining produces mostly larger particles. Monitoring has indicated that at similar distances from the active pit, PM_{10} levels are roughly 30 percent those of TSP. The Wyoming DEQ has kept the 150 $\mu g/m^3$ 24-hour TSP standard in addition to the new 150 $\mu g/m^3$ 24-hour PM_{10} standard. The new annual average standard is 50 $\mu g/m^3$ PM_{10}.

Tables 6-9 and 6-10 use the TSP standard in order to assess how well the previous regional impact assessments fit the current actual impacts. While it was not possible to predict with exact certainty which specific mines would be developed and what their sizes would be, the overall number and productivity of the mines in the Eastern Powder River Basin was projected for the period 1979 to 1990 with reasonable accuracy in the regional EIS's.

Particulate emissions are controlled by the amount of regulation imposed as well as by coal production. Actual emission rates are less than the projected emission rates since regulations have become more strict during this time period. In particular, treatment of haul roads and stockpiles, covering of conveyors, and more rapid revegetation of disturbed areas have become the norm rather than just being used in special cases.

As can be seen from Tables 6-9 and 6-10, the ambient concentrations across the region are usually well below past and current standards. With the major current standard being for finer particles which settle out more slowly, the area of potential cumulative impacts (the area where monitoring would pick up concentrations of 1 $\mu g/m^3$ as a result of all contributing sources) may be greater.

Table 6-9. Particulate Concentration by Mine in the Eastern Powder River as Projected for 1990 and as Measured for 1990 for the Annual Ambient Air Quality Standard

Mine Name	Projected 1990 Annual Avg. TSP Concentration[1] ($\mu g/m^3$)	Measured 1990 Annual Avg. TSP Concentration[2] ($\mu g/m^3$)
Antelope	30-40	29
Belle Ayr	30-40	40
Black Thunder	30-40	46
Buckskin	20-40	33
Caballo	30-40	33
Caballo Rojo	30-40	29
Clovis Point	20-40	Idle
Coal Creek	30-40	22
Cordero	30-40	43
Dave Johnston	30-40	28
Dry Fork	20-40	28
Eagle Butte	30-40	32
Fort Union	20-40	29
Jacobs Ranch	30-40	40
North Antelope/Rochelle	30-40	31
Rawhide	20-40	30
Wyodak	20-40	29
AVERAGE[3]	20-40	33

[1] The technical report for the 1984 DEIS projected that mines south of Gillette would be between 30 and 40 $\mu g/m^3$ and those north of Gillette would span a greater range of between 20 and 40 $\mu g/m^3$.
[2] Wyoming DEQ.
[3] Average of all sites making measurements in 1990 with 40 or more observations.

Since most large particles from mining processes drop out of the air quickly, cumulative impacts tend to occur only when the actual mine activities are within about 10 miles of each other. The trend over the past 10 years and with the currently proposed maintenance tracts is for activities at the mines to spread apart, increasing the distance between them.

Section 4.0 of this EIS presents an analysis of the cumulative impacts of the Rocky Butte Mine and neighboring mines on regional air quality. The selection of mines, time periods, and other modeling parameters was done in consultation with Wyoming DEQ.

6.13 Visual Resources

Cumulative visual impacts from other mines in the area would be nonexistent as far as Rocky Butte mine area is concerned due to local topography. Cumulative impacts would result from more of the

Table 6-10. Particulate Emissions by Mine in the Eastern Powder River Basin as Projected for 1990 and as Estimated from Actual Mining Activities in 1990

Mine Name	Projected 1990 Particulate Emission Rates (tons/year)[1]	Actual 1990 Particulate Emission Rates (tons/year)[2]
Antelope	NA	228
Belle Ayr	4520	2127
Black Thunder	3744	1912
Buckskin	1276	531
Caballo	3651	1126
Caballo Rojo	NA	2701
Clovis Point	1492	Idle
Coal Creek	3432	1383
Cordero	9241	2477
Dave Johnston	961	NA
Dry Fork	NA	750
Eagle Butte	3096	1101
Fort Union	NA	278
Jacobs Ranch	3149	1869
North Antelope/Rochelle	2318	471
Rawhide	2218	1388
Wyodak	682	338
Total	39780	18680

[1] PEDCo, 1983.
[2] Tentative figures from various regional EIS's, to be checked with the Wyoming DEQ.

area south of Gillette being visually impacted by mining activities, but this would be obvious only by driving throughout the area or observing it from the air, rather than from any given point on the ground surface. These cumulative impacts would be eliminated as the mines within the area cease operations and reclamation is completed.

6.14 Noise

Because of distances involved between mining operations, noise impacts are not expected to be cumulative.

6.15 Transportation Facilities

Cumulative effects of the Rocky Butte Mine on local and regional transportation facilities are addressed in Section 4.0 of this EIS.

6.16 Land Use and Ownership

Because all mines plan to restore mined lands to approximate premining land uses, most permanent cumulative impacts of mining on land use in Campbell County would be negligible. Cumulative impacts on agricultural land uses due to construction

and coal production would be minor or moderate (Table 4-3). Assuming that 20 percent of affected land in Campbell county would be affected in any given year, loss of production would range from 1,910 to 4,093 AUMs for cropland, or about three percent of the average crop production for Campbell County. Approximately 67 percent of the loss of production from cropland would occur due to the Rocky Butte project. Potential losses of grazing land and pasture land due to all mines would be 2,499 to 4,998 AUMs and 235 to 353 AUMs, respectively. However, the Rocky Butte project would contribute only five to six percent to these losses.

There may be a net loss in residential land use in non-urban areas; however, growth in urban areas may be stimulated (Section 4.1.15). The Rocky Butte Mine could potentially conflict with two producing oil wells (J.F. Rourke #4:5 and Wolf #34-34:34), and oil production could be temporarily cut off during mining operations. Should this occur, it is estimated from decline curves (Petroleum Information Corporation, 1992) that an average of 5,383 BOPM would be lost during the four years of mining operations. This represents 0.25 percent of Campbell County's 1991 oil production of 2,176,774 BOPM (Wyoming Department of Revenue, 1991). The impact to Campbell County's oil production from Rocky Butte mining operations would not be significant, however, the impact could be significant to the oil and gas lessees and royalty owners with an interest in these two wells. The cumulative loss of oil production arising from other area coal mines, proposed or in operation, is not known. Similarly, Rocky Butte would not contribute to county-wide cumulative impacts on roads, because impacts would be mitigated during mining operations.

6.17 Socioeconomics

This section describes the cumulative socioeconomic impacts associated with the proposed project. Baseline, or without the Rocky Butte project, employment and population projections are presented for Campbell County. The baseline scenario is developed in order to evaluate the incremental impacts associated with the project within the context of likely future socioeconomic conditions. Cumulative impacts were derived by adding the forecasted impacts of the project to the baseline conditions projected for the county.

6.17.1 Baseline Socioeconomic Projections

The Campbell County economy is currently dominated by mineral (primarily coal) and energy-related activity. Future baseline socioeconomic conditions of the county will reflect the influence of anticipated developments in these industries. For example, a further decline in the state's oil industry will influence employment prospects in Campbell County. However, recent federal Clean Air legislation appears to have heightened at least the short term market prospects for coal produced in Campbell County.

6.17.2 Mineral and Energy-Related Developments

In addition to the Rocky Butte project, a number of mineral and related developments are anticipated in Campbell County. The Dry Fork Mine, located northeast of Gillette, began operation in 1990 and produced about 815,000 tons of coal (Geological Survey of Wyoming, 1991). The output of the mine is dedicated to the coal requirements of the Laramie River Power Station. In 1990, 37 people were employed at the mine. However, during the anticipated life of the mine, an average annual level of 313 employees is expected (OSM, 1988).

Three new coal mines, in addition to Rocky Butte, have been proposed for Campbell County. These include the East Gillette Federal mine to be located east of Gillette and the Wymo and Keeline mines to be located in southern Campbell County near the town of Wright. These mines are currently in various stages of the planning process. The East Gillette Federal mine is owned by Kerr-McGee. Wymo is owned by Kansas City Power and Light, and prospects for developing the project appear dim (Wyoming Geological Survey, 1991). The Keeline Mine, owned by Ranchers Energy, was permitted and is approaching the five-year permit renewal. It was never constructed and WDEQ/LQD is terminating the permit. Employment levels arising from the development of these mines are unknown.

Campbell County leads all other Wyoming counties in oil production and ranks seventh in natural gas production. The outlook for oil production in Wyoming is not promising (Wyoming

Oil and Gas Conservation Commission, 1991). At the state level, oil production has declined about four to five percent annually in recent years (Ibid.). This is due primarily to the age, 50 to 70 years, of the major oil fields in the state. Continued low oil prices have slowed exploration and will likely cause further declines in state and Campbell County oil production. Thus, employment gains for this industry are not anticipated; declines are more likely.

Black Hills Power and Light has proposed the construction of a new 80 megawatt generating station near the existing Neil Simpson station located east of Gillette (Black Hills Power and Light, 1991). The station is currently in the permitting and preliminary design phase. Construction is scheduled to begin in 1994 and last three years. A peak construction-phase work force of 300 to 400 persons is anticipated. The station is scheduled to go on line in 1997 and will permanently employ about 45 persons, most of whom will likely be Campbell County residents.

6.17.3 Baseline Employment Projections

Baseline employment projections were derived by the following process:

- Adjustment of current (1989) estimates of Campbell County employment by economic sector for county residency and full time employment equivalency (Stearns Catalytic Corporation, 1984).
- Adjustment of Wyoming Department of Administration and Information employment forecasts for Campbell County for residency and full time employment equivalency (Wyoming Department of Administration and Fiscal Control, 1988).
- Adjustment of projections for employment expansions in the mining sector which are not fully accounted for in the Wyoming Department of Administration and Information forecasts (Geological Survey of Wyoming, 1991).

The baseline employment projections indicate that between 1990 and 2000, the resident Campbell County labor force will increase by nearly 5,000 persons, and resident, full-time employment will increase by about 4,200 jobs (see Table 6-11).

The annual unemployment rate is assumed to remain constant at about six percent during the forecast period.

The rate of employment growth is projected to slow during the forecast period. On average, county-wide employment is projected to grow at annual rate of 2.7 percent.

6.17.4 Baseline Household and Population Projections

Projections of occupied households and population were derived directly from employment and labor force forecasts. Households were estimated by assuming a worker-to-household ratio of 1.6. Population was estimated by applying a persons-per-household factor to the projected number of households. The number of persons-per-household in Campbell County in 1990 was 2.95. On the basis of recent historical trends, the number of persons per household is projected to decline to 2.90 by the year 2000 (see Table 6-12).

6.17.5 Cumulative Employment and Population Projections

This section presents the cumulative employment and population projections for Campbell County and the City of Gillette. County populations are allocated to the City of Gillette on the basis that 60 percent of the county population currently resides in the city. Cumulative projections are composed of the previously described baseline projections and the direct and indirect employment and population impacts forecasted for the Rocky Butte project. The incremental impacts of the project are discussed in Section 4.1.15.

As a result of the project, employment in Campbell County would increase from 2.7 percent to 4.9 percent over baseline employment levels. With the proposed project, employment in the county would grow by nearly 3.3 percent annually during the forecast period (Table 6-13).

As a consequence of the proposed Rocky Butte Mine, the population level in Campbell County would exceed baseline conditions by nearly five percent in the year 2000. The population increase in Gillette

Table 6-11. Projected Baseline Labor Force and Employment, Campbell County

Year	Projected Labor Force	Projected Employment	Percent Change Employment
1991	16,310	15,330	3.0
1992	16,820	15,810	3.1
1993	17,330	16,290	3.0
1994	17,830	16,760	2.9
1995	18,330	17,230	2.8
1996	18,830	17,700	2.7
1997	19,330	18,170	2.7
1998	19,830	18,640	2.6
1999	20,310	19,090	2.4
2000	20,790	19,540	2.4

Table 6-12. Projected Baseline Population, Campbell County and City of Gillette

Year	Campbell County	City of Gillette
1990	29,370	17,635
1991	30,010	18,006
1992	30,900	18,540
1993	31,790	19,074
1994	32,640	19,584
1995	33,520	20,112
1996	34,370	20,622
1997	35,210	21,126
1998	36,050	21,630
1999	36,860	22,116
2000	37,670	22,602

Note: The population of Campbell County is projected to increase by nearly 8,300 persons, or 2.5 percent annually, during the period between 1990 and 2000. The City of Gillette's population is projected to increase by almost 5,000 persons during the same period.

Table 6-13. Cumulative Employment Impacts, Campbell County

Year	Employment	Percent Change over Baseline with Rocky Butte
1991	15,330	0.0
1992	15,810	0.0
1993	16,737	2.7
1994	17,448	4.1
1995	17,876	3.8
1996	18,440	4.2
1997	19,034	4.8
1998	19,442	4.3
1999	19,980	4.7
2000	20,504	4.9

would exceed baseline conditions by more than six percent by the year 2000 (Table 6-14).

Because nearly all of the direct mine employees and the indirect service workers would reside within the Gillette urban area, the city would experience a proportionately larger impact relative to baseline conditions than the county as a whole. This is considered reasonable in light of the 5-percent annual growth projected for the county's coal industry by the Geological Survey of Wyoming (1991). Actual City of Gillette population levels in the future will be directly tied to the city's annexation policies, which are subject to change.

Table 6-14. Cumulative Population Impacts, Campbell County and City of Gillette

Year	Campbell County Population	Percent Change over Baseline	Gillette Population	Percent Change over Baseline
1991	30,010	0.0	18,006	0.0
1992	30,900	0.0	18,540	0.0
1993	32,541	2.4	19,714	3.4
1994	33,830	3.7	20,599	5.2
1995	34,705	3.5	21,122	5.0
1996	35,725	3.9	21,777	5.6
1997	36,790	4.5	22,473	6.4
1998	37,514	4.1	22,878	5.8
1999	38,481	4.4	23,499	6.3
2000	39,423	4.7	24,097	6.6

6.17.6 Cumulative Economic Impacts

The principal economic impacts arising from the proposed Rocky Butte project would be increased employment opportunities, personal income and consumer expenditures and housing in Campbell County. The cumulative employment impacts are discussed above.

Under the baseline conditions, personal income (as measured by the U.S. Bureau of Economic Affairs in constant 1991 dollars) in Campbell County is projected to increase from about $500 million in 1990 to more than $640 million by the year 2000 (Wyoming Department of Administration and Information, Division of Economic Analysis, 1991b). As a result of the proposed project, personal income in the county would exceed baseline income by two to three percent during the forecast period.

Baseline retail purchases in Campbell County are forecasted to increase from nearly $134 million in 1990 to about $177 million by the year 2000. Retail spending by direct mine workers and indirect service workers would increase retail sales in Campbell County by about 2.6 percent to 3.3 percent over the projection period. Services purchased in the county, increasing from about $212 million in 1990 to more than $280 million in 2000, would experience similar percentage increases.

Currently, there is little available capacity in the Gillette area housing stock. Furthermore, housing demand in Gillette will increase by about 185 units per year under baseline conditions. To maintain an adequate housing stock, about 195 units should be added annually during the forecast period. As a consequence of the Rocky Butte project, an additional 525 housing units would be required by the year 2000.

This analysis does not project the supply/demand relationship for specific unit types. Such an analysis should be performed prior to project construction. Based on historical experience, most mine employees would prefer permanent, owner-occupied dwelling units. This would also likely be the case for the local service work force. The temporary construction work force would likely reside in temporary housing such as apartments and mobile homes.

Cumulative impacts on the housing market, especially the temporary housing market, could be a concern. A number of projects are anticipated in the near future which would cause shortages in the temporary housing unit market without appropriate response from the local housing industry. The local housing industry will need to respond with sufficient lead times to larger demands than in the recent past. Careful monitoring and ongoing analysis of the housing market would be desirable.

6.17.7 Cumulative Infrastructure and Public Sector Financial Impacts

Annual average water use in Gillette is currently about 6.0 mgd. Assuming current water use patterns continue, average daily water use by the year 2000 could total 7.2 mgd. This represents a twenty percent increase over current usage and is considered a moderate to significant impact.

Peak period water demand could be a concern because actual peak use exceeds the system's design capacity by about five percent. However, the Gillette Utility Department staff believe that peak use can be sufficiently attenuated through practicable conservation measures.

Sewage treatment currently ranges from 2.2 to 2.5 mgd, well below the system's 3.85 mgd capacity. The system was designed to cost-effectively serve approximately 40,000 persons. Although population growth will require additional investment in the plant, the cumulative population growth projected for the city would likely not impact the system negatively.

The city-owned and operated electrical system currently has in place sufficient capacity to serve a peak of 40 megawatts. Capacity and other system expansions will likely be necessary to serve projected baseline population growth. The extent to which the incremental growth arising from the Rocky Butte project would impact the future operations of the system is not known with certainty, although it is believed to be moderate.

6.17.8 Public Safety

The Gillette Police Department is currently understaffed by five uniformed officers (Gillette Police Department, 1991). These and new positions will

need to be staffed in order to provide police protection for the baseline population growth projected for Gillette. Assuming a ratio of 1.5 officers per 1,000 residents, the police department would require two additional officers as a result of the Rocky Butte project, and nine additional officers overall. Since this excludes the five officers the City presently lacks, staff increases, including support staff and equipment, will clearly be needed with or without the Rocky Butte Mine.

The rural portion of Campbell County is served by the Campbell County Sheriff's Department. Because most of the projected baseline and incremental population growth will occur in Gillette, additional resources required by the department will be relatively modest. However, the peak period construction work force may cause unique problems for the department (Campbell County Sheriff's Department, 1991).

Because the city-county fire department is funded largely through property taxes, it directly benefits by increases in county assessed valuation. Under baseline conditions, perhaps two full-time and 25 volunteer firefighters will need to be added to the department assuming the current ratio of personnel to population served. The incremental requirements due to Rocky Butte would be six additional volunteer firefighters.

6.17.9 Health Facilities and Services

The Campbell County Memorial Hospital is currently staffed by 30 physicians and a number of visiting physicians. Assuming the current ratio of one physician per 1,000 population, county baseline population growth will require eight additional physicians. One additional physician would be required as a result of the proposed Rocky Butte mine.

In addition to population levels, the mental health needs of Campbell County and Gillette are determined by a host of social factors over which little control can be exerted. However, mental health services in the county will likely expand in accordance with population growth (Northern Wyoming Regional Counseling Center, 1991). In comparison with baseline conditions, the additional requirements which might arise as a result of the proposed project would not be significant.

Several contradictory influences make forecasting social services needs complex (Wyoming Department of Family Services, 1991). For example, the expansion of job opportunities would imply a reduced need for social services such as AFDC. However, the prospects for landing lucrative coal mining jobs may attract job seekers who would require at least temporary services from the Department of Family Services and city and county governments. On the whole, cumulative impacts could be a concern during the construction phase but should be manageable.

6.17.10 Educational Facilities

Enrollment in the Campbell County School District has fluctuated since the mid-1980's with no net increase since the 1986-1987 academic year. However, under baseline conditions, school enrollment is projected to increase by about 2.6 percent per year. The effect of the proposed project would be to increase annual enrollment above the baseline by four percent to 4.8 percent (see Table 6-15). Increased enrollment under the baseline may require the construction of new schools, but the incremental impact associated with the Rocky Butte mine would be negligible. With the county's high property tax base, sufficient funds should be available.

6.17.11 Public Sector Fiscal Conditions

The fiscal position of both the city and county governments is currently quite strong due to the prevalence of mineral-related revenues.

Under baseline conditions, mineral assessed valuation due to the expanded coal production is projected to increase by more than four percent annually between 1991 and 2000. The impact of the proposed project would be to increase mineral assessed valuation up to 4.5 percent beyond baseline conditions. Because nearly all of the Rocky Butte direct mine and local service employees are projected to settle in Gillette, the county should experience minimal, if any, budgetary impacts. The City of Gillette does not directly benefit from mineral-related increases in assessed valuation. However, the city does receive a substantial amount of money from mineral royalties and severance taxes. In the past, the city has diverted these monies from the general fund to cover cash shortfalls in certain

enterprise funds. Furthermore, the city receives a substantial portion of sales and use tax revenues distributed in Campbell County.

Mineral royalty, severance taxes, and sales and use taxes are allocated to the city on the basis of the city's percent of total county population. This allocation is based on the results of the 1990 census and is fixed until the next census is taken in 2000. If the city's percentage of total county population increases during this ten-year period, the city will need to serve these new residents without a commensurate increase in revenues. Combined with declining mineral royalty and severance tax revenues, the cumulative fiscal impacts may be moderate.

6.17.12 Cumulative Impacts on Social Well-Being

The social well-being of Campbell County residents relates to the ability of residents to maintain a desirable quality of life and is highly dependent on the availability of employment opportunities, access to public services and adequate health care and access to cultural recreational and other aesthetic resources.

The current social well-being of county residents could be considered good. Per capita income is among the highest in the state. County residents have access to a number of cultural and recreational amenities. Furthermore, the county economy is regaining ground lost in the mid-1980's, which was a priority for local citizens.

The proposed project would enhance the employment opportunities for county residents, and personal income would increase as the project begins operations. Furthermore, the mine presents an opportunity to attract long-term residents to the county which would add to the social stability of the community. These represent positive impacts on the social well-being of county residents.

Gillette was selected to host the National High School Finals Rodeo for a three-year period beginning in 1993. According to city officials, this is the largest rodeo in North America (David Spencer, 1991). In addition, the city will host the Cowboy State Games in 1991 and 1992. Both of these events will bring a large number of visitors to the area. In concert with baseline growth and projected growth associated with the Rocky Butte project, the delivery of certain services such as police protection and mobility could be significantly impacted. Temporary lodging may be problematic as the rodeo begins at the same time construction of the proposed project commences. Although potential impacts could result, they are short term in nature and should not be significant.

Table 6-15. Campbell County School District Enrollment

Academic Year	Baseline Enrollment	Cumulative Enrollment
1991-1992	8,135	8,135
1992-1993	8,382	8,608
1993-1994	8,622	8,968
1994-1995	8,870	9,193
1995-1996	9,110	9,480
1996-1997	9,350	9,782
1997-1998	9,590	9,991
1998-1999	9,822	10,267
1999-2000	10,054	10,536