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Hard Rock Bureau

August 1995

Volume II
Draft Environmental Impact Statement
Zortman and Landusky Mines
Reclamation Plan Modifications and Mine Life Extensions

Historic Ruby Mill near the town of Zortman

The Bureau of Land Management is responsible for the stewardship of our public lands. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times. Management is based on the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include recreation; rangelands; timber; minerals; watershed; fish and wildlife; wilderness; air; and scenic, scientific, and cultural values.

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Draft
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Zortman and Landusky Mines

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and Mine Life Extensions

August 1995

Volume II

CHAPTER 3.0

AFFECTED ENVIRONMENT

INTRODUCTION

In order evaluate the potential impacts resulting from the Proposed Action or the other Alternatives described in Chapter 2, it is necessary to understand the current environmental condition of the project study area. The study area for this project varies for each environmental resource, but it is generally the area encompassed by the Little Rocky Mountains. This Chapter describes the natural resources and economic and social conditions found in the project study area.

3.1 GEOLOGY

The Zortman and Landusky mines are found within the Little Rocky Mountains of north-central Montana. Gold mining has taken place in the Little Rocky Mountains for over 100 years; as a result, an extensive database of information exists concerning the geology of the Little Rocky Mountains and the ore deposits contained therein. This section of the Affected Environment describes the regional geologic setting of the Little Rocky Mountains, the mineralogic associations and occurrences of the study area, and the structural forces which have played a major role in both the shape of the mountains and the locations of ore deposits. Subsections have been developed to address local geology in areas of particular importance such as Goslin Flats, where mine disturbance has not previously occurred, and geologic conditions which may control or influence other resources of importance such as ground water.

3.1.1 Regional Setting

3.1.1.1 Topography

The Little Rocky Mountains are within the Northern Great Plains geographic region, which is distinguished by rolling prairies that are dissected or broken up by drainage systems. Plains mountains disrupt the landscape abruptly in this region. The plains mountains, including the Little Rocky Mountains, are called "Island Mountain Ranges" because they rise up out of the relatively flat plains like islands in the ocean. Other island mountain ranges in this region include the North and South Moccasin Mountains, the Bearpaw Mountains, the Sweet Grass Hills and the Judith Mountains.

The Little Rocky Mountains rise in dramatic relief more than 2,500 feet above the surrounding plains. Old Scraggy Peak, located about 1.5 miles east of the Zortman Mine, is the highest point in the Little Rocky Mountains at approximately 5,700 feet above mean sea level (msl). In contrast, Goslin Flats south of the Town of Zortman, is at an elevation of approximately 3,800 feet msl and the plains further south and east are significantly lower. Ft. Peck Lake, east of the Little Rocky Mountains, is about 2,300 feet msl. The topography within the Little Rocky Mountains is rugged, marked by high outcrops of erosion resistant rocks and steep, V-shaped valleys with little accumulation of soil or alluvial materials.

The plains surrounding the Little Rocky Mountains are relatively flat but they have been dissected by surface water runoff channels, resulting in steep cliffs and badlands-type topography in some areas. Southwest and south of the Little Rocky Mountains, the topography is strongly influenced by the drainage of the Missouri River. Intermittent streams and coulees coalesce to form tributaries of the Missouri River, and the topography becomes more broken as the drainages easily incise through the relatively soft sedimentary rocks which make up most of this region.

3.1.1.2 Geologic Setting

The Little Rocky Mountains are found in a region exhibiting geologic extremes in rock types, history of rock formation and emplacement, and age of materials. The regional geology includes upland prairie which has been glaciated as recently as 10,000 years ago, to the nearly 3 billion year old rocks exposed in mountainous areas (BLM 1992b).

The oldest rocks in the region are Precambrian Era (>650 million years old) metamorphic gneisses and schists. Metamorphic rocks are those which have been altered in texture or composition due to temperature, pressure, and/or chemical processes. These very old rocks outcrop only in some of the mountain ranges, including the Little Rocky Mountains, where magma upwelling from below the earth's surface has pushed older rocks up through younger strata.

Thick sequences of Paleozoic Era (570 to 240 million years ago) sedimentary rocks are found in the mountain ranges and on the plains. Sedimentary rocks are those which have formed by the accumulation of sediments or minerals precipitated from water. These rocks are predominantly limestones and dolomites which typically formed in marine environments, but sandstones and shales also occur. These are the rock types which usually don't contain much gold or precious metals, but they are still important in mining because they can be used in construction or as reclamation materials. Limestones, dolomites, and other "calcareous" rocks (those containing significant amounts of calcium carbonate) are very useful because they can neutralize or buffer water which has been acidified by mine operations. These rocks are very resistant to erosion and form some of the spectacular cliffs in the mountain ranges; they also contain some important cave formations, such as Azure Cave on the south side of the Little Rocky Mountains.

Mesozoic Era (240 to 66 million years ago) rocks are also sedimentary in this region. Sedimentary rocks from the Jurassic period of the Mesozoic are typically calcareous sandstones and shales. Gypsum and coal have been mined from Jurassic sediments in the region. Cretaceous period rocks are sedimentary, with the different rock formations representing episodes of advance and retreat of a large inland sea which covered much of North America at that time. These sediments include sandstones, shales, and limestones. Coal and bentonite have been mined from various Cretaceous formations. Thick carbonaceous shales from the Cretaceous have also provided a source of oil and gas development in the region.

The geology and topography of the region has been greatly influenced by two activities during the Cenozoic Era (66 million years ago to the present). Extensive igneous activity occurred during the early Cenozoic (known as the "Tertiary" period), resulting in the formation of the Island Mountain Ranges described earlier. This igneous activity in Montana appears to follow the structural controls of a regional feature known as the Great Falls Tectonic Zone. Described by O'Neill and Lopez (1985), the Great Falls Tectonic Zone is a belt of northeast-trending geologic features that can be traced from the Idaho Batholith in north-central Idaho and western Montana, across the overthrust belt structures of southwestern Montana, through central Montana and into southwestern-most Saskatchewan, Canada. Geologists believe the Great Falls Tectonic Zone controlled the intrusion patterns and orientation of Late Cretaceous to early Tertiary igneous intrusions and dike swarms, including those of the Little Rocky Mountains and other area mountain systems.

More recently, during the "Quaternary" period of the Cenozoic, massive glaciers advanced and retreated over much of the region leaving glacial deposits and debris in most of the area north of the Missouri River. Erosive forces have continued to alter the region's landscape, removing bedrock from mountainous areas and depositing it as unconsolidated deposits in valleys and plains.

3.1.2 Geology of the Little Rocky Mountains

The Little Rocky Mountains were formed by the emplacement of an igneous intrusion during the Tertiary period, approximately 65 million years ago. The Little Rocky Mountains are an elliptical dome 10 miles long. The Little Rocky Mountains are known as "intrusive" igneous rocks because they solidified below the surface, whereas "extrusive" or volcanic igneous rocks were extruded onto the surface in a liquid state and solidified during cooling. Other rocks exposed in the area are sedimentary or metamorphic, as described in the previous section. Surface materials include soil derived by the breakdown of bedrock in the area; alluvium, which is generally the material deposited from running water and other erosive forces; and, in the northern part of the Little Rocky Mountains, debris from glacial activity. The southern portion of the Little Rocky Mountains appears to have escaped glaciation, as evidenced by the sharp topography (V-shaped valleys) and absence of glacial deposits. Sub-surface bedrock underlying these rocks range in age from Precambrian to those of Tertiary age. Figure 3.1-1 displays the general surficial geology of the Little Rocky Mountains.

The domed shape of the Little Rocky Mountains is well illustrated in Figure 3.1-2. The youngest bedrock, the Tertiary-age igneous rock in the middle of the figure, has pushed up older, once horizontal rocks of varying age and origin. The oldest rocks exposed are the Precambrian metamorphics including schists, gneisses, and quartzites. The Precambrian metamorphics were originally sedimentary or volcanic rocks rich in the minerals quartz and feldspar. Alteration to the presently seen metamorphic assemblage presumably occurred during Precambrian time, as the younger overlying sedimentary rocks do not appear to have suffered alteration.

The rock types shown in Figure 3.1-2 are younger with increasing distance from the Precambrian rocks near the

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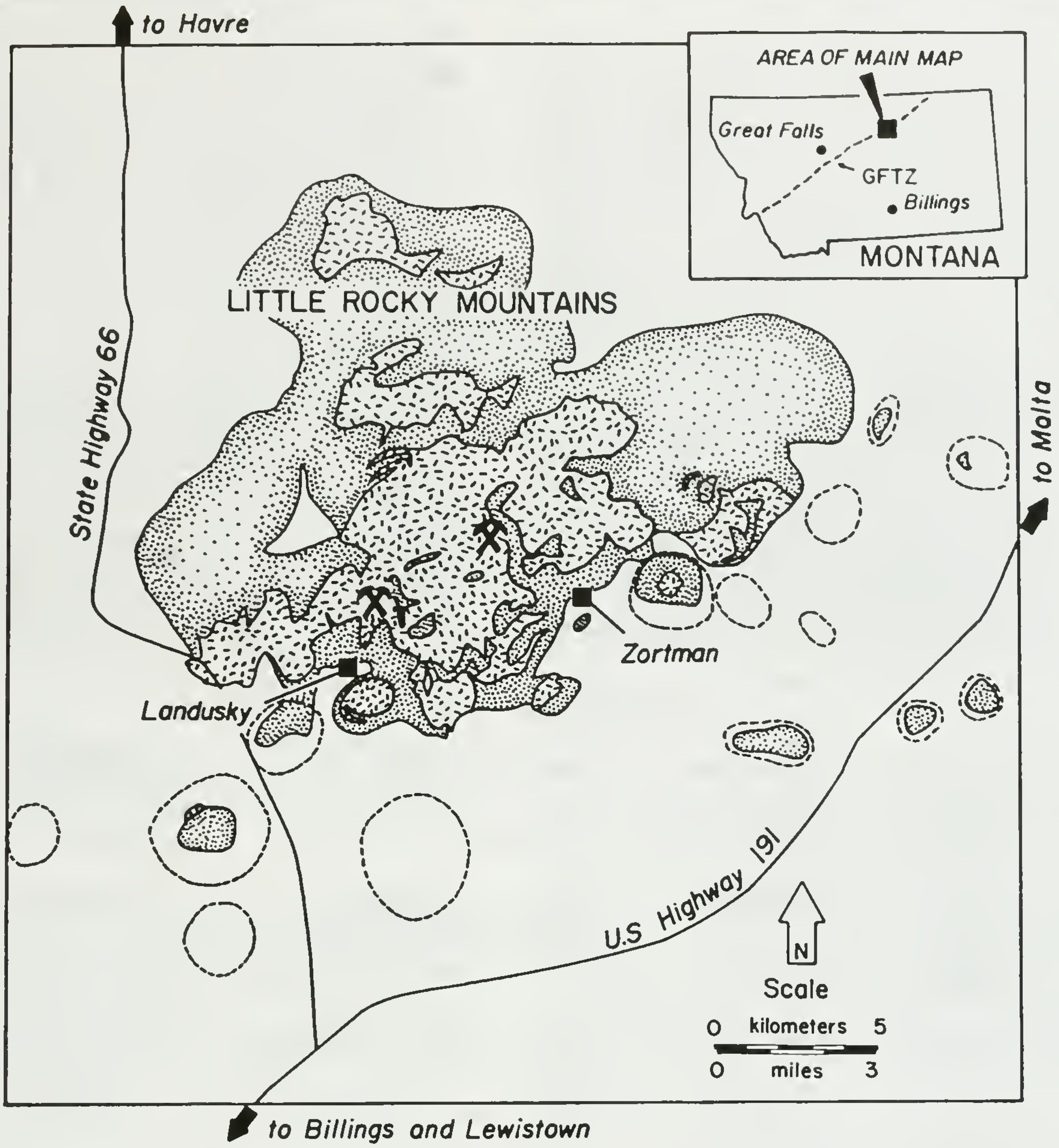


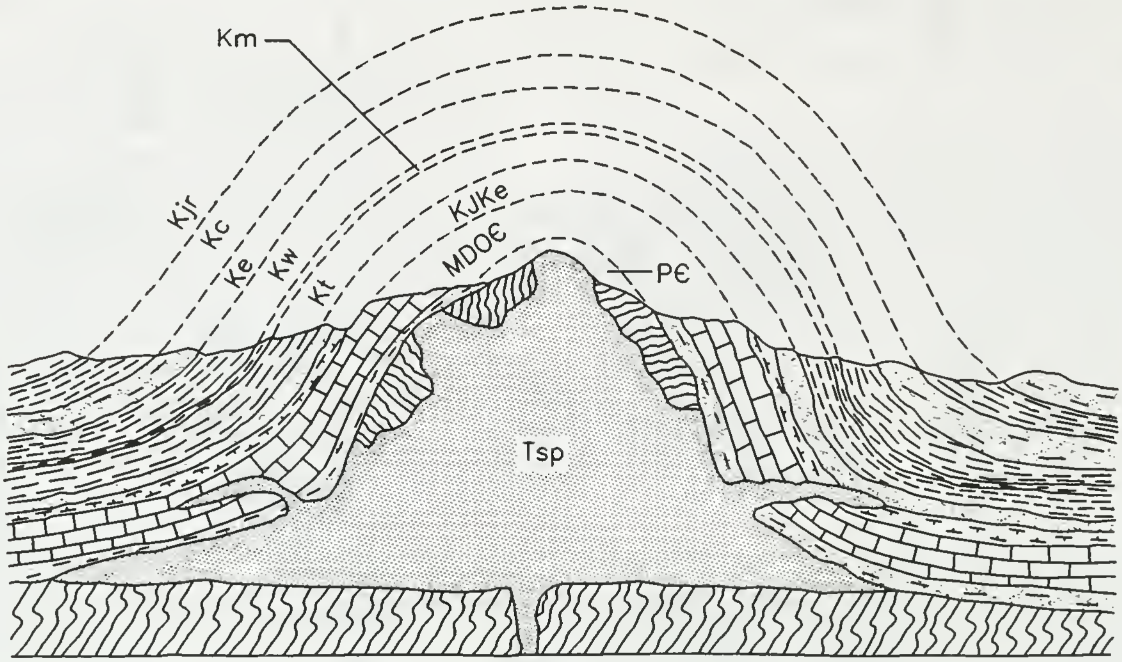
LEGEND

▨	TERTIARY PORPHYRIES	◌	DOMES
☐	MESOZOIC (AND LATER) ROCKS AND SEDIMENTS (EXCLUDES TERTIARY PORPHYRIES)	⚒	MINE AREAS
▒	PRE-MESOZOIC ROCKS	GFTZ	GREAT FALLS TECTONIC ZONE

SOURCE: FROM RUSSELL 1991

GENERAL SURFICIAL GEOLOGY OF THE LITTLE ROCKY MOUNTAINS

FIG. 3.1-1



LEGEND

SYMBOL	TYPE ROCK	FORMATION AND LITHOLOGY	RELATIVE AGE (YOUNGEST TO OLDEST)
Tsp ░	IGNEOUS	INTRUSIVE SYENITE PORPHYRY	TERTIARY
Kjr ▤	SEDIMENTARY	JUDITH RIVER FORMATION SANDSTONES AND SHALES	CRETACEOUS
Kc ▤	SEDIMENTARY	CLAGGETT FORMATION SHALES	CRETACEOUS
Ke ▤	SEDIMENTARY	EAGLE FORMATION SANDSTONES AND SHALES	CRETACEOUS
Kw ▤	SEDIMENTARY	WARM CREEK FORMATION SHALES	CRETACEOUS
Km ▤	SEDIMENTARY	MOWRY FORMATION SHALES	CRETACEOUS
Kt ▤	SEDIMENTARY	THERMOPOLIS FORMATION SHALES	CRETACEOUS
KJKe ┬┴	SEDIMENTARY	KOOTENAI FORMATION SANDSTONES AND JURASSIC-AGE SANDSTONES AND LIMESTONES	CRETACEOUS AND JURASSIC
MDOЄ ▦	SEDIMENTARY	VARIOUS LIMESTONES OF THE MADISON GROUP, INCLUDING MISSION CANYON AND LODGEPOLE FORMATIONS	MISSISSIPPIAN
PЄ ▨	METAMORPHIC	GNEISS, SCHIST, AMPHIBOLITE	PRECAMBRIAN

SOURCE:

FROM RESPONSE TO COMMENTS
REVIEW #3, 1993.

GENERALIZED CROSS-SECTION THROUGH THE LITTLE ROCKY MOUNTAINS

FIG. 3.1-2

center of the dome. Most of the Paleozoic sedimentary rocks in this area were created in a marine environment. These sedimentary rocks are more resistant to erosion and may form prominent buttes, ridges, and cliffs. The deepest (and oldest) of the sedimentary formations is the Flathead sandstone. It is overlain by approximately 3,000 feet of limestones and dolomites, with lesser amounts of shale, sandstone, and conglomerate. The top sequence of Paleozoic rocks consists of Madison Group limestones, which are found in much of Montana. Most Paleozoic rocks in this area, particularly the Mission Canyon and Lodgepole limestones of the Madison Group, are very resistant to erosion and form the dramatic cliffs seen in some high rock outcrops.

The Mesozoic rocks in the area consist primarily of shales, with lesser amounts of sandstones, conglomerates, and limestones. In general, the Mesozoic rocks represent terrestrial and near-marine environments, when sediments from earlier ages were eroded and redeposited in valley floors, river and stream beds, and outwash plains. These sediments are found as bedrock at or near the surface in the areas around the Little Rocky Mountains. A fairly complete stratigraphic section, from Pre-Cambrian metamorphic basement rocks to Cretaceous (Bearpaw Shale) is exposed along the flanks of the mountains.

Younger rocks of the current Cenozoic era are igneous intrusives. The igneous rocks in this area are known as syenite porphyries. Emplacement of the Cenozoic intrusive rocks resulted in the formation of the Little Rocky Mountains, as described at the beginning of this section. In addition, intrusion of the igneous rocks mobilized and deposited elements such as gold in sufficient concentrations as to make mining often economically viable.

3.1.3 Mineralogy and Mining History

The reason gold and other precious metals have been found in the Little Rocky Mountains is directly related to the solidification history of the igneous porphyry rocks. After upwelling and emplacement of the igneous magmas, a hydrothermal system dominated by low pH, low salinity waters heated by the igneous magma developed (Russell 1991a). This hot, acidic water caused widespread alteration in rocks of the Zortman/Landusky Mining District. Hydrothermal flow of the heated waters was channeled along the existing structural trends of the intrusive rocks. Gold, silver, and associated minerals such as pyrite were dissolved in the hot water because of the low pH. Changes in pressure, fluid chemistry or reductions in temperature, could cause the pH of the water to increase, resulting in precipitation of gold and minerals. The minerals were typically distributed within the structural channels, often in dikes or veins of quartz, or along fracture zones of crushed and broken rock called breccias. Metal sulfide minerals and gold were also disseminated throughout the rocks. Ironically, some of the current environmental problems at the Zortman and Landusky mines result from what is essentially a reversal of this process. As the minerals in waste rock and ore are exposed to air and water during mining, the sulfides react to form sulfuric acid and lower the pH of the water. This acidification process partially dissolves minerals back into solution. A more extensive explanation of this condition, called Acid Rock Drainage, is found in Section 3.2.2.

Vein lode deposits of gold were first discovered in the Little Rocky Mountains in 1892. The vein deposits are typically the most heavily enriched in gold or other precious metals; hence, they are the most valuable deposits. They were also relatively easy for the lone prospector or small operation to mine, because mining only required that the "vein" be followed.

Natural erosional forces also created new, localized areas of concentrated gold. Rain, snow, and seasonal weathering of the mountains and mineralized zones breaks up rock in the higher elevations and carries it down into stream channels, valleys and basins. Deposits of eroded material from mineralized zones are called placers. Placer deposits were often the first and best indicators to the old prospectors of the last century that ore zones could be found in the higher areas of mountain regions. This is the case for the Little Rocky Mountains. The first placer deposits were developed in Alder Gulch in 1884, and the first lode claims in this area were patented in 1892.

Some very rich "bonanza-type" gold ore has been produced in the Little Rocky Mountains from the vein deposits described above; however, most production has come from relatively low grade ore (typically ranging from 0.022 to 0.028 ounces per ton, although even lower grades have been mined at Landusky). The mineral deposits occur in the altered syenite porphyries, and are associated with high-angle faults or fractures, the channels along which mineralized hydrothermal waters had access. At the Zortman Mine, gold mineralization has been concentrated at the intersections of north and northwest-trending mineralized fractures, and occurs as finely disseminated particles. To date, the most important ore bodies have been within the porphyry-hosted "breccia" dikes, the rock-type resulting from crushing and grinding along a fault or fracture. Sulfide mineralization in the OK Breccia, a mineralized breccia

15 to 100 feet wide emplaced along a northwest-trending fracture, extends from the surface to an average depth of 500 feet. In the Landusky area, economically viable gold deposits are found where the number and/or extent of fractures is greatest. These systems on the Landusky side parallel the inferred southwest to northeast trend of the Great Falls Tectonic Zone.

At both mines, the oxidized portion of the ore bodies has been of most interest to the mining companies, because the gold and silver concentrates in oxidized zones. Oxidation of the ore generally has occurred nearest the surface, and along fractures which have transported rain, surface water, and shallow ground water deeper in the ore zones. Gold and silver are easy to separate from the host rock in oxidized ores using cyanide heap leach processes. When occurring along natural fractures, these metals require only blasting and leaching to recover. The gold and silver in unoxidized zones is more tightly bound in the geochemical matrix of the rock, thereby making it more difficult to release the minerals from the ore using heap leaching processes. The precious metals-bearing minerals are spatially associated with sulfide mineralization. Iron sulfides are the most abundant species, including minerals such as pyrite, marcasite, arsenopyrite, and others.

3.1.4 Structural Geology

As previously discussed, the outline of the Little Rocky Mountains is elongated to the northeast, along the projected path of the Great Falls Tectonic Zone. The numerous domes and intrusives coalesce in the interior of the Little Rocky Mountans to form a central, larger dome complex.

3.1.4.1 Little Rocky Mountains

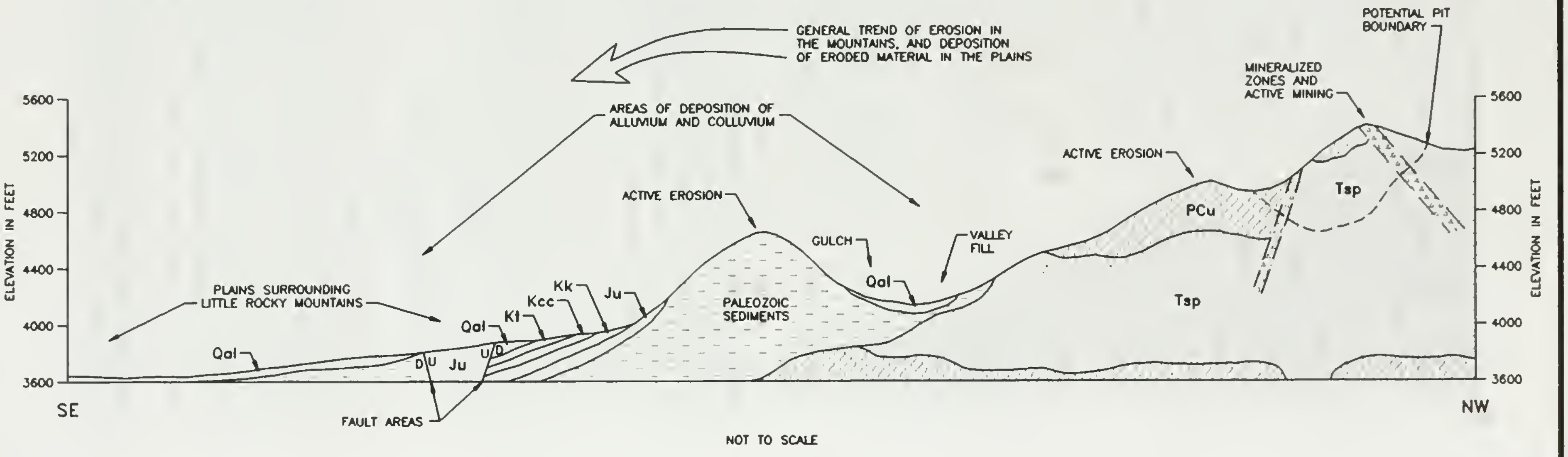
The Little Rocky Mountains were originally interpreted to be laccoliths, a term used to describe igneous intrusions with flat bases and domed roofs which arch the overlying sediments according to the shape of the igneous dome. Recent mapping indicates that the mountains consist of a central core of igneous rocks which is bounded by domed sedimentary units and flanking igneous domes along fault zones. Russell (1991b) cites field indications that the intrusions were not emplaced concordantly, or parallel to the sedimentary formations which were already in place. In addition, he notes that active mining and exploration drilling in the Zortman and Landusky pits has failed to reach a floor or bottom to the intrusion. This cumulative evidence suggests the porphyries were not intruded as laccoliths but as stocks, a type of igneous intrusion which is relatively small in size and which cuts across formation boundaries. The structure of the intrusion found in Figures 3.1-2 and 3.1-3 displays features of a laccolith (mushroom shaped with a relatively flat floor) and a stock (the intrusion is small and cuts across some lithologic boundaries).

The major controls on the geologic structure of the area are steeply-dipping, north-northwest trending fractures. Most faults *between* the intrusions and surrounding sedimentary rocks are steeply dipping (i.e., more vertical than horizontal) with a relatively large component of up or down movement. Most faults *within* intrusions are described as shears, suggesting more lateral than vertical movement along the fractures. As noted previously, these fault structures had a major influence on localization of mineral deposits. Faults, joints, and fractures can also play an important role for ground water transport in the Little Rocky Mountains, particularly in controlling the direction of flow.

3.1.4.2 Goslin Flats

The Zortman mine expansion's proposed heap leach facility would be located in the Goslin Flats, an area approximately one mile south of the Town of Zortman, on the eastern flank of Saddle Butte. Goslin Flats has received erosional debris from the mountains to the north and west. The predominant lithologies which provide alluvial material to the Flats are shales, siltstones, limestones, and sandstones, all sedimentary rocks which have been folded and faulted by earth movement, and therefore no longer lie flat on the surface as originally deposited. These faults occurred during emplacement of the igneous intrusions, including the Little Rocky Mountains, during the late Cretaceous possibly 70 million years ago. This tectonic activity ceased during the early Tertiary, and no further activity has occurred which would cause activation of these faults or additional movement.

Zortman Mining, Inc. has drilled several borings and excavated a number of test pits in the Goslin Flats area to determine the depth of alluvium and character of the underlying bedrock. A relatively thin layer of topsoil typically covers one to two feet of colluvium, the material deposited as a result of downslope movement from the adjacent high areas. The soil and colluvium are described in Section 3.5.2. Underlying alluvial deposits range in thickness from approximately a few feet to 35 feet or more, with deposits greater than 48 feet found near Ruby Creek. The alluvium typically consist of variable amounts of gravel, sand, silt and clay. Older alluvium, overlying the bedrock formations,



L E G E N D

Qal	QUATERNARY UNCONSOLIDATED DEPOSITS
▨	TERTIARY BRECCIA
☐	TERTIARY SYENITE PORPHYRY
Kt	THERMOPOLIS SHALE
Kcc	CUT CREEK SANDSTONE
Kk	KOOTENAI SANDSTONE
Ju	JURASSIC SEDIMENTS, UNDIFFERENTIATED
▤	PALEOZOIC SEDIMENTS, INCLUDING LIMESTONES OF THE MADISON GROUP
▨	PRECAMBRIAN GNEISS SCHIST, QUARTZITE

NOTE: THIS ILLUSTRATION PRESENTS A GENERALIZED VIEW OF TYPICAL TOPOGRAPHY AND SUBSURFACE GEOLOGY IN THE VICINITY OF THE ZORTMAN AND LANDUSKY MINES. THE HGHEST MOUNTAINS ARE FOUND WHERE IGNEOUS INTRUSIONS HAVE UPLIFTED OVERLYING AND SURROUNDING SEDIMENTS AND METAMORPHIC ROCKS. ACTIVE MINING OCCURS AT THE FRACTURES AND CONTACT AREAS WITH MINERALIZED ZONES. THESE ARE ALSO THE ROCKS THAT ARE MOST LIKELY TO CAUSE ACIDIC DRAINAGE WHEN DISTURBED BY MINING ACTIVITIES. SURROUNDING SEDIMENTARY ROCKS, SUCH AS THE PALEOZOIC LIMESTONES OF THE MADISON GROUP, TEND TO HAVE HIGHER CONCENTRATIONS OF CALCIUM CARBONATE WHICH REDUCE ACIDIC RUNOFF FROM THE IGNEOUS OR METAMORPHIC ROCKS.

THIS FIGURE ALSO SHOWS HOW ROCKS FROM THE HIGH COUNTRY ARE REDISTRIBUTED BY EROSIVE ACTION TO LOWER AREAS. WIND, RAIN, AND OTHER PHYSICAL AND CHEMICAL FORCES BREAK DOWN THE ROCKS IN THE MOUNTAINOUS AREAS. THESE ARE CARRIED BY SURFACE WATER FLOW OR GRAVITY TO LOWER AREAS AS ALLUVIUM OR COLLUVIUM. THEREFORE, THE STREAM VALLEYS IN THE LITTLE ROCKY MOUNTAINS AND SURROUNDING PLAINS HAVE ACCUMULATIONS OF SOIL, SAND, GRAVEL, AND OTHER UNCONSOLIDATED MATERIALS WHICH MAY BE USEFUL IN THE CONSTRUCTION AND RECLAMATION OF MINE FACILITIES.

SIMPLIFIED GEOLOGIC CROSS-SECTION

FIG. 3.1-3

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usually consists of gravels and cobbles with thin lenses of silty clay and stratified sand.

Below the alluvial material is the Thermopolis Formation shale, underlain by the Kootenai Formation sandstone. The shale is described in the Plan of Operations (Golder Associates 1993) as typically calcareous with occasional siltstone and limestone beds. The calcareous nature of the Thermopolis shale is a consideration in evaluating the overall suitability of the Goslin Flats for a heap leach system, since a calcareous chemistry would help to buffer leachate (i.e., reduce acidity) which discharges from the facility. Under the Thermopolis shales are various shallow dipping, siltstone, sandstone, and shale units of the Kootenai Formation.

Another feature of the shale concerns its effective friction angle, or the capacity for overlying lithologies to resist slipping on the shale. This engineering factor is important to the leach pad design because significant pressure will be placed on the shale from the weight of loading approximately 200 vertical feet of ore. Increasing the potential for slippage is that shale is very fine grained, composed largely of clay minerals that align in horizontal layers. In addition, groundwater perched on top of the shale would probably increase the potential for slippage at the shale/alluvium contact. The engineering viability of this location is discussed in more detail in Section 4.1.6.

3.1.5 Surficial Geology

The rocks found at the surface in the Little Rocky Mountains are generally illustrated in Figure 3.1-1. These are primarily crystalline igneous or metamorphic rocks in the core of the complex, with tilted sedimentary deposits flanking the core. These rocks were described earlier. Other surface materials include unconsolidated alluvium, glacial debris, and soil which were deposited in late Tertiary or even more recently in Quaternary time, within approximately the last 10,000 years. Alluvial deposits resulting from erosional activity, generally consisting of gravel, sand, and silt, occur in two areas:

- slightly inclined surfaces on bedrock that slope away in all directions from the base of the Little Rocky Mountains, and
- on recent flood plains of several streams which flow only intermittently.

These deposits contain fragments of materials derived from outcropping bedrock units, and consist of various sized fragments of the igneous porphyry, metamorphic quartzite and schist, and sedimentary limestone, dolomite, and sandstone. There are large accumulations of rock debris at the bottoms of hills and ridges.

Figure 3.1-3 is a simplified geologic cross section which illustrates how natural erosive forces have typically shaped the terrain and controlled the surficial geology within the Little Rocky Mountains, near the Zortman and Landusky Mines. To understand what a geologic cross section is, consider as an example how a layer cake looks before it has been sliced. You can see the surface of the cake, but you cannot know what the inside looks like. When the cake is cut in half, and one of the halves removed, all the layers are exposed from the side. This is how a geologic cross section displays the topography of the earth's surface and the rock types, faults, folds and other features of interest in the area being studied.

The igneous intrusion responsible for the mountain building in the Little Rocky Mountains is shown at the far right side of the figure. Mining would occur at mineralized zones within or on the boundaries of this intrusion. The far left-hand side of the cross section displays a lower area, typical of the plains or pediments on the edge of the Little Rocky Mountains, where erosional debris from the sediments uplifted in the central complex (right side of the cross section) have been deposited. The unconsolidated deposits of the plains and other topographically low areas can be important to the Zortman and Landusky mining activities. Rock debris may be useful as rip-rap, coarse alluvium can be used as aggregate and in road base, and sand deposits could be used as underpad for liners and in the leach facility for drainage. Those sediments which are calcareous and won't generate acid are of use as reclamation materials since the calcium carbonate can buffer. The particular uses for these materials and the amount of materials potentially needed for mining activities were discussed in Chapter 2.

3.1.6 Geologic Hazards

The Little Rocky Mountains are situated in an area of low earthquake hazard. Based on the probabilistic earthquake acceleration and velocity map for the United States (Algermisson et al. 1990), the Little Rocky Mountains are located within the lowest risk area designated. There are no known unstable areas, although landslides/rockslides are always a potential hazard where steep slopes and ridges are common, such as in the interior of the Little Rocky Mountains. Although faults are present as described in the previous section, none are believed to be currently active, or to have been active in recent times.

Another localized hazard at the Landusky and Zortman Mines is related to previous mining activities. Underground (stope) mining was prevalent in the Little Rocky Mountains until Zortman Mining, Inc. applied open-pit mine and large scale ore processing technology to the area. As a result, a relatively large network of underground shafts and tunnels exists; some of these underlie roads or other areas and facilities used for current mining activities. The hazard presented by the underground mine workings is that there may be insufficient ground support underneath the active mining operations, resulting in surface slumps similar to those commonly associated with sinkhole formations. ZMI has instituted a program to identify areas of hazard to reduce potential injuries or property damage.

Ore and waste rock containing sulfide minerals have been mined previously, and the proposed mine would move more sulfide-bearing rocks. A geologic hazard related to this mining activity is Acid Rock Drainage, or ARD. ARD can be produced when ore or waste rock containing sulfide minerals comes in contact with air and water. Section 3.2.2 of this document includes an expanded discussion of water resources and geochemical conditions leading to acid rock drainage.

3.1.7 Geologic Resources

The primary geologic resources of economic importance in or near the Little Rocky Mountains are the gold and silver, and other lesser metals, mined at the Zortman and Landusky Mines. Other geologic resources in the area include oil and gas, clay, rock aggregate, and limestone.

3.1.7.1 Precious Metals

Section 3.1.3 provided a summary of the mining history in the Little Rocky Mountains and the mineralogic associations of precious metals, particularly gold and silver, within the igneous intrusions and hydrothermal fracture zones. As outlined in Section 2.6, approximately 20 million tons of gold and silver bearing ore have been removed from the Zortman Mine by ZMI during the years 1979 to 1994, and about 100 million tons of ore have been removed from the Landusky Mine by ZMI during the same years. Table 3.1-1 provides a breakdown of the estimated gold and silver production from the Little Rocky Mountains Mining District from the years 1860 to 1990.

Additional resources of gold and silver exist within the Little Rocky Mountains, including that found in ore which ZMI has proposed to mine as part of the Proposed Action described in Section 2.9. Section 2.9.6 identified other, reasonably foreseeable deposits, including one in Pony Gulch which has been estimated to contain about 2 million tons of ore. Lower grade ores which are not economically feasible to mine using current technology are also present in the Little Rocky Mountains.

3.1.7.2 Clay Minerals

Certain clays minerals, such as bentonite, have commercial value in a wide variety of products. Other clays which may not have commercial applications comparable to bentonite can be used in a variety of applications, including the mining construction, operations and reclamation activities conducted at the Zortman and Landusky Mines. The following section provides a description of these materials.

Bentonite

Bentonite is composed of clay minerals which have the peculiar capacity to absorb water and swell in volume. It is generally formed by the alteration of volcanic ash which has been deposited in a marine environment. The formation in this area which has commercial deposits of bentonite is the Bearpaw Shale of the Late Cretaceous Montana Group. The absorption and swelling properties of bentonite deposits determine the commercial use of the product. Bentonite has been used in the production of brick, drilling fluids, fertilizer, pottery, and a number of applications. Until the late 1970s the general use of bentonite in the region was pit run bentonitic shale for sealing stock ponds and canal lining (BLM 1992b).

The closest deposits to the Zortman Mine are approximately 10 miles east of the Little Rocky Mountains (Jim Mitchell 1993). American Colloid Company operated a bentonite processing plant in Malta from 1978 to 1986, refining bentonite mined from an open-pit mine south of Malta in outcrops of the Bearpaw shale. There is little bentonite mining or processing occurring in this area at the present time, and the potential for future bentonite mining is uncertain since much bentonite use is associated with oil and gas production processes. Some oil and gas production wells are still active in the region, but exploration levels are quite low and new wells are not commonly being brought into production.

Clay

Other clays are found in shale deposits, including some near the Zortman and Landusky Mines. While these deposits don't have the commercial application of bentonite they are valuable for use in various mining

TABLE 3.1-1

ESTIMATED GOLD AND SILVER PRODUCTION LITTLE ROCKIES MINING DISTRICT

(in Troy ounces)

				Disseminated Deposits	
Time Period	Placer Gold	Vein Gold	Vein Silver	Gold	Silver
1860-1905	N/A	N/A	N/A	N/A	N/A
1893-1908	N/A	47,500	N/A	N/A	N/A
1908-1942	N/A	312,500	N/A	N/A	N/A
1928-1948	326	N/A	N/A	N/A	N/A
1946-1977	N/A	20,000	1,500,000	10,500	25,000
1979-1987	-	-	-	543,900	1,214,600
1988	-	-	-	111,100	247,400
1989	-	-	-	106,400	223,800
1990	-	-	-	109,600	652,170
1991	-	-	-	116,300	954,400
1992	-	-	-	113,000	771,600
1993	-	-	-	108,500	535,700
1994	-	-	-	109,500	461,200
Totals	326	380,000	1,500,000	1,328,800	5,085,870

Estimated Total Gold Produced: 1,709,126	Estimated Total Silver Produced: 6,585,870
Estimated Value of Produced Gold: $683,650,400[1]	Estimated Value of Produced Silver: $39,515,220[2]

N/A = Not Available

[1] In current dollars, with gold valued at $400/Troy ounce

[2] In current dollars, with silver valued at $6/Troy ounce

Source: BLM 1992b

operations, particularly those where barriers are needed to prevent the migration of leachate (i.e., leach pad liners) or to prevent infiltration of surface water (i.e., reclamation covers). The reason clays provide high quality barriers is they have little ability to transmit water through the mineral layers making up the rock. A couple of clay sources have been identified by ZMI for potential use during reclamation and expanded mining operations.

3.1.7.3 Limestone

Limestone is used in the construction industry for producing lime, in mining and industrial chemical processes to control pH, and in agriculture as a soil conditioner. There are vast limestone resources in central and western Montana, much of it within the Madison Group of Mississippian-age sedimentary formations. The limestone mining that has occurred in the vicinity of the Little Rocky Mountains has typically been restricted to small, isolated quarries.

Limestone is very hard and resistant to processes of physical weathering such as freezing and thawing, or wind erosion. However, limestone is soluble in water and it's dissolution provides conduits for ground water flow, often through larger openings such as fractures and joints. In fact, the Madison Group of limestones serves as the major deep aquifer surrounding and underlying the Little Rocky Mountains (see Section 3.2.4).

Limestone has been and would continue to be used in reclamation activities for both the Landusky and Zortman Mines, in the construction of drains or other facilities where material with a high net neutralization potential (i.e., reduces leachate acidity) is needed. Large outcrops of limestone occur near the Zortman and Landusky Mines which are easily recognizable as prominent cliffs and bluffs. The limestones which would be used in mining and mine reclamation activities would come from the Devonian-age Jefferson Formation.

The King Creek quarry site is located about 1/4 mile northwest of the Landusky Mine's Queen Rose pit in the NE¼ of Section 15, T25N, R24E (see Figure 2.6-3 in Section 2.6). The King Creek quarry is on private land and was previously mined by different parties. ZMI was permitted to mine about 50,000 tons of limestone from this site in 1993 for the King Creek cleanup project and for other mine operational uses. Also on the Landusky side, similar material could be mined at the Montana Gulch quarry, located in NW¼, SW¼ of Section 22, T25N, R24E. This site is on BLM administered lands within the current Landusky permit boundary.

Limestones for use in Zortman facilities and reclamation would be mined at a quarry in the NE¼, SW¼ of Section 6, T25N, R25E, approximately 1/2 mile north of the Ross Pit (see Figure 2.6-3 in Section 2.6). ZMI has estimated this source contains approximately one million tons of limestone. Limestone is also available in Section 17, T25N, R25E, although plans do not call for a quarry to be developed at this location.

3.1.7.4 Unconsolidated Surface Resources

Unconsolidated materials are found as deposits downgradient of areas which are being eroded. As shown on Figure 3.1-3, bedrock from mountainous areas is physically and chemically eroded and transported, by gravity or surface water flow, to lower areas. These materials will collect in depressions, valleys, and especially plains where surface water flow in drainages slows because of a decreased gradient. The reduced water speed causes gravel, sand, and other unconsolidated materials to drop out of the water.

Sand and gravel quarries are found on private and public land throughout this area. Ready sources of these materials are provided by the sedimentary formations which comprise the geology everywhere except in the mountain ranges. As described earlier, unconsolidated materials can be useful in construction of mine facilities, road base, in drains and even as capillary break in reclamation covers. However, the degree of importance is based primarily on the suitability of waste rock for use in these facilities. Because waste rock from the mine pits has to be moved and managed, it is more efficient to use this material in construction and reclamation applications where possible, thereby limiting other mining (i.e., limestone, sediments, alluvium, etc.) efforts and costs. If sufficient, suitable waste rock (i.e., non acid generating) is available for these purposes there will be little need to mine sand and gravel from unconsolidated deposits.

3.1.7.5 Other Geological Resources

Oil and Gas

The nearest commercial oil production is the Cat Creek and Rattlesnake Butte Oil Fields in Petroleum County, approximately 50 miles south of the Zortman Mine operations.

The closest natural gas deposit is the Leroy gas field in northern Fergus County, approximately 35 miles southwest of the Little Rocky Mountains. The Bowdoin Field, located in northeastern Phillips County, has over

800 active wells, and produced over 2,700 MMCF in 1987 (Montana Department of Natural Resources and Conservation 1987).

The igneous complex of the Little Rocky Mountains provides poor potential for viable hydrocarbon deposits. However, some sedimentary formations on the flanks of the Little Rocky Mountains could serve as source and host rocks for hydrocarbons. To date, two oil exploration wells have been drilled in the Township near the Zortman Mine (T25N, R25E) with poor results.

Coal

Coal has been reported at one location in the Jurassic Morrison Formation on the flank of the Little Rocky Mountains uplift near Zortman (BLM 1992b). This coal is not considered to be a significant reserve, and there is estimated to be a very low probability for commercial development.

Paleontological Resources

Paleontological resources (vertebrate, invertebrate, and plant fossils) are present in various locations in the area surrounding the mine. These are not noted to have any particular commercial or geologic significance. The Judith River Formation contains small quantities of dinosaurs, crocodilian and turtle fossils, as well as occasional mammal remains. The Bearpaw shale, which has significant outcrops south of the Little Rocky Mountains, contains fossils of dinosaurs, fish, and invertebrate species.

Invertebrate fossils and some fish are found in Paleozoic Era formations. The Mississippian-age limestones of the Madison Group contain invertebrate fossils, as do the sedimentary units from the Devonian.

Caves

Numerous caves exist in the limestone formations of this region, many of which have been identified in the bluffs and outcrops of the Island Mountain Ranges. Caves in the limestones of the Madison Group were probably formed during a period when the seas retreated and somewhat acidic meteoric waters percolating through the rock created solution channels and cavities.

Azure Cave is a well documented site located in outcrops of the Mission Canyon limestone of the Madison Group. It is found approximately 1 mile west of the proposed Goslin Flats Leach Pad, about 2 miles south of the Zortman Mine. The Bureau of Land Management has determined that this resource has significant value due to its geologic and mineralogic features, and biologic community. Section 3.7 discusses in more detail the prominent geologic and biologic features of Azure Cave, including its designation as an Area of Critical Environmental Concern.

3.2 WATER RESOURCES AND GEOCHEMISTRY

This section addresses the water resources aspects of the project and the mining related geochemical processes that have the potential to degrade the water quality. The water resources section also serves to identify "baseline" water quality for the Little Rocky Mountains and any changes to surface water and groundwater water quality that have occurred since 1979, during the 16 years of open pit mining activity.

Organization of Section

- Section 3.2.1 describes the location of the water resources study area and the rationale behind its division.
- Section 3.2.2 "Geochemistry/Acid Rock Drainage" describes the chemical and physical processes associated with mining that have the potential to adversely impact the water resources of the area. This section also describes the geochemical testing procedures and the acid generating character of the various rock types at the mines.
- Sections 3.2.3 and 3.2.4 describe the physical nature of the surface water and groundwater systems in the Little Rocky Mountains.
- Section 3.2.5 "Water Quality" contains a detailed drainage by drainage review of the surface water and groundwater quality conditions within the Little Rocky Mountains.
- Section 3.2.6 "Surface Water Groundwater Interaction" describes the relationship between the surface water and groundwater in Little Rocky Mountains, identifying the pathways along which any water quality impact may travel.
- Having described in detail the present water quality situation in the Little Rocky Mountains, Section 3.2.7 "Beneficial Uses" identifies the location and nature of any end users of the resource. This section aims at recognizing presently impacted uses and any potential use.
- Finally Section 3.2.8 reviews water quality criteria applicable to water resources in the Little Rocky Mountains and where these criteria have been exceeded, both prior to 1979 and after 1979 during mining operations. Section 3.2.9 summarizes existing water quality conditions for the Little Rocky Mountains in tabular form.

3.2.1 Project Study Area

Present day mining facilities are located in the headwaters of several watersheds in the Little Rocky Mountains, as shown in Figure 1-3. Surface water drainages in the Little Rocky Mountains are divided between the Milk and Missouri rivers. The water resources study area consists of drainages and aquifers affected or with the potential to be affected by existing or proposed mine development. The study area is further divided into two sections based on whether the drainage receives recharge from either the Zortman or Landusky mining operations.

3.2.2 Geochemistry/Acid Rock Drainage

3.2.2.1 General Geochemical Processes

Cyanide heap leach gold mining sites have the potential to result in water quality degradation through two general types of geochemical processes:

- Generation of alkaline seepage - cyanide-related processes

  The normal use of cyanide, lime, and other reagents in leach mining processes generates leachates that are normally contained, but which have the potential to leak or spill from facilities into local waters and soil. Such fluids are usually high pH (9.0 or above), and may have elevated concentrations of cyanide, nitrogen, and sulfur compounds, along with elevated concentrations of some metals (i.e., iron, arsenic, molybdenum, copper, selenium). The cyanide compounds tend to break down relatively rapidly into non-toxic forms when in contact with air, water, and sunlight. Hence, most spills of cyanide compounds result in relatively short-term acute problems. However, the breakdown of some metal cyanide complexes such as copper cyanide can result in an increase in toxicity because of the release of some metal ions such as copper. Some metal-cyanide compounds may remain stable in fine-grained sediments for decades. Table 3.2-1 summarizes some characteristics of the various forms of cyanide potentially present at mining sites and the analytical tests employed to determine their presence. Additional details on the use of process-related chemicals are presented in Section 3.14.

- Production of acid water - acid rock drainage

ARD problems may take years to develop but, if untreated, can lead to very long-term water quality degradation. Details are presented in the following section.

TABLE 3.2-1

CYANIDE ANALYTICAL TESTS AND CHEMICAL FORMS

Name of Analytical Test	Forms of Cyanide Measured and Comments
Free Cyanide	Uncomplexed cyanide and hydrocyanic acid (CN^- and HCN). Most toxic form of cyanide.
Weak-acid Dissociable (WAD) Cyanide	Free cyanide plus the less stable complexes of cyanide, including cyanide complexes of cadmium, copper, nickel, silver, and zinc. While stable at pHs above 8.5 to 9.0, WAD cyanide complexes readily dissociate at lower pHs. Judged to be less toxic than free cyanide.
Total Cyanide	Free cyanide, WAD cyanide and most metal and organic complexes of cyanide, including highly stable complexes such as iron-cyanide and cobalt-cyanide complexes. However, depending on concentrations and forms of cyanide present, the total cyanide test may not measure certain complexes. Not fully recovered are cyanide complexes of gold, cobalt, platinum, and palladium. Organic complexes such as cyanate and thiocyanate may not be measured in some samples.
Cyanide Amenable to Chlorination	Cyanide forms which can be oxidized by chlorination processes (used by water treatment plants and some mining operations). Test measures the difference between total cyanide concentrations before and after chlorination.
Cyanate	Measures organic cyanate (CNO^-) ions. Less toxic than free cyanide.
Thiocyanate	Measures organic thiocyanate (SCN^-) ions. Less toxic than free cyanide. Thiocyanate may form in samples containing sulfide and other forms of cyanide if samples are preserved at high pH without first removing the interfering sulfide.

NOTE: Table summarizes data from various sources, including the following:

American Public Health Association, 1989, Section 4500-CN Cyanide, in Standard Methods for the Examination of Water and Wastewater, 17th ed., American Public Health Association, Washington, DC.

Engineering-Science, 1986. Appendix B, in Heap Leach Technology and Potential Effects in the Black Hills, EPA Contract No. 68-03-6289, U.S. EPA, Denver, CO, September 30, 1986.

U.S. Department of the Interior, 1986, Environmental Handbook for Cyanide Leaching Projects, Energy, Mining and Minerals Division, National Park Service, June, 1986.

Acid Rock Drainage (ARD) Generation

Acid Rock Drainage (ARD) - Acid Rock Drainage (ARD) is a term used to describe acidic leachate, seepage, or drainage that results from the breakdown of sulfide materials, such as pyrite or fool's gold, when exposed to air and water. This breakdown or reaction of sulfide minerals occurs naturally at or near the earth's surface, as evidenced by the common presence of yellow-orange stains or deposits around exposed pieces of iron, marshy sediments, or at the edges of hot springs. ARD can also be generated in non-mining settings such as natural springs that may have pHs of near 2.0. Such springs usually are located in the vicinity of outcrops of sulfide bearing rock. Natural bacteria present in most surface sediments greatly accelerate the ARD-forming processes. These reactions yield low pH (acidic), high sulfate water that has the potential to mobilize metals (most commonly iron, copper, aluminum, manganese, zinc, arsenic, and nickel) contained in the geological materials that are contacted.

Theoretically, the formation of ARD and resulting degradation of water quality would not occur if metal-sulfide minerals remain buried in the oxygen-poor environments under which they were formed. Problems arise when these minerals react with the oxygen in air, as when they are excavated, broken up and transported to, or exposed at the earth's surface during mining. It is important to recognize that not all operations that expose sulfide-bearing rock will result in ARD. For example, acid drainage will not occur if the sulfide minerals are nonreactive, the rock contains sufficient alkaline material to neutralize any acid generated, or the climate is arid and there is insufficient rainfall infiltration to generate leachate. Mining activities increase the surface area of minerals available for reaction with water and air. As such, local surface and groundwater often show increases in dissolved and suspended constituents even without the formation of acidic conditions.

ARD has been associated with mining throughout recorded history. Indirect references to water quality degradation have been reported from mines in the Greek and Roman empires more than 2,000 years ago. Many Norwegian copper mines have documented more than 300 years of roughly continuous ARD problems.

Mine tailings, waste rock piles, drainage from underground workings and open-mine pits are the main sources of ARD at mine sites. Sulfide-rich ores that have been leached with cyanide may prove to be long-term generators of ARD. The development of ARD from mine-related sources may take years to decades before it becomes noticeable, often long after mine closure.

ARD can negatively impact the health of fish, other aquatic animals and plants in affected streams. Also, ARD can potentially impact the health of wildlife, livestock, and humans if consumed in sufficient quantities from impacted surface or groundwater sources.

3.2.2.2 Existing Conditions

At the initiation of modern mining at Zortman/ Landusky in 1979, it was believed that ARD would not be a significant issue: "The proposed mine pits would not mine into the sulfide ore body, but rather the oxide ore body which is not conducive to acid drainage. Acid drainage is therefore, not considered a potential threat from the proposed projects." (Montana DSL Draft EIS 1979b adopted as FEIS, pg. 75-76).

However, as modern mining has progressed, water quality results have shown that geologic materials at both the Zortman and Landusky mines are presently generating acid in some areas. Additional details on the water quality impacts are presented in subsequent sections. These data indicate that most of the major drainages show some degree of impact from mining-related activities. Further evidence of the geochemical reactivity of the site rocks is presented in the Highwall Runoff Investigation (Shafer and Associates 1993b). This study was performed during the spring and summer of 1993 at the Zortman Mine to characterize internal pit drainage and evaluate the effectiveness of proposed bench reclamation techniques for both sulfide and oxide benches. Analysis of highwall runoff at 11 sampling stations showed pH ranges of 2.3 - 6.7 and 2.3 - 6.0 for two sampling events. As expected, the stations with the highest sulfide content yielded runoff with the lowest pH values. Six of eleven stations sampled yielded runoff with pH values below 3.0 during the first sampling event (Shafer and Associates 1993b). Similar results were reported in Schafer and Assoc. 1994.

3.2.2.3 Rock Types

The geologic materials present at the Zortman and Landusky mines are shown on Table 3.2-2a and 3.2-2b and are discussed in greater detail in Section 3.1, Geology and Sections 2.8.1 and 2.8.3. This table shows rock types and relative amounts of ore and waste rock to be mined under the company proposed action. The predominant rock types at the Zortman Mine are:

- **Tertiary Intrusives** - Tertiary syenite porphyries comprise the largest percentage of rock to be mined from the Zortman pit complex, at about 65 percent of the total rock volume. Quartz monzonite is another Tertiary intrusive, making up about 6 percent of the rock mined. The Tertiary intrusives would contribute approximately 72 percent of the ore processed, with the remainder

TABLE 3.2-2a

ZORTMAN MINE ROCK TYPES PROPOSED FOR MINING

Relative Age and Rock Type	Percent of Rock to be Mined	Percent Ore	Percent Waste
Tertiary: Syenite Porphyries	65%	36%	29%
Precambrian: Amphibolites	13%	6%	7%
Precambrian: Felsic Gneisses	8%	6%	2%
Tertiary: Monzonite	6%	4%	2%
Quartzite, Breccia, & Cambrian Shale	8%	5%	3%
Total	100%	57%	43%

TABLE 3.2-2b

LANDUSKY MINE ROCK TYPES PROPOSED FOR MINING

Relative Age and Rock Type	Percent of Rock to be Mined	Percent Ore	Percent Waste
Tertiary: Porphyries and Breccias	81%	41%	40%
Paleozoic: Sedimentary rock	16%	9%	7%
Archean: Metamorphics	3%	2%	1%
Total	100%	52%	48%

classifying as waste rock or material suitable for reclamation purposes.

- **Precambrian Metamorphics** - Approximately 20 percent of the rock to be mined would consist of metamorphic rocks from the Archean, primarily amphibolites (13 percent) and felsic gneisses (8 percent). About half of this material would be suitable for ore processing, with the remainder classifying as waste rock or material suitable or reclamation purposes.

In addition to the rock types listed above, minor amounts (8 percent) of quartzite, breccia, and Cambrian shale would be mined, with approximately 5 percent of this material suitable as ore.

Geologic materials present at the Landusky Mine are shown on Table 3.2-2b. This table shows rock types and relative amounts of ore and waste rock proposed to be mined. The predominant rock types at the Landusky Mine are:

- **Tertiary Intrusives** - ZMI has estimated that 81 percent of the rock mined would consist of Tertiary felsic porphyries and associated breccias.

- **Paleozoic Sediments** - Approximately 16 percent of the rock to be mined would be from Paleozoic sedimentary formations, with approximately 9 percent of this material containing sufficient amounts of precious metals to be worth processing as ore. The bulk of the Paleozoic rock is unmineralized Emerson Formation, consisting of limestones, marls, and calcareous shales which would all be handled as material suitable for reclamation and construction purposes. These lithologies show less alteration, less mineralization and have lower average sulfur content than the igneous rocks.

- **Archean Metamorphics** - About 3 percent of the rock to be mined would be composed of approximately equal amounts of schists, gneisses and amphibolites. Archean rocks have comprised a significant portion of the rocks mined at Landusky in recent time, but the proposed mining would result in removal of greater amounts of Tertiary and Paleozoic rocks as illustrated in Table 3.2-2b.

3.2.2.4 Geochemical Testing

Geochemical testing has been performed on over one thousand samples of ore, spent ore, waste rock, and other unmineralized local rock types at both the Zortman and Landusky mines. These tests can be useful in determining which geologic materials may act to neutralize acid production or which materials may generate acid upon exposure to air and water. Results were used to evaluate the adequacy of ZMI's definition of non acid generating (NAG) waste rock to see if the criteria should be modified. The discussion provided in Section 3.2.2.6 includes rationale as to why ZMI's proposed definition is too lenient and the agencies' previous definition, developed in the Landusky EA, is too conservative.

Total sulfur

Total sulfur gives some indication as to the abundance of reactive sulfides associated with a certain rock. If all sulfur is reactive then total sulfur can be used to evaluate its acid producing potential (AP).

Paste pH testing

Paste pH evaluates the existing pH of the rock material. A paste pH above 7.0 may be indicative of high percentages of alkaline minerals. Such high pHs might also be seen in alkaline rock with sulfide that has not yet reacted.

Static testing

Static tests typically involve measurement of the Acid Neutralizing Potential (ANP or NP) of a sample, as well as its Acid Generating Potential (AGP or AP). The NP is a reflection of the abundance of minerals that consume acid, such as most carbonate minerals, some hydroxides, and silicates such as feldspars, amphiboles, and clays. The balance or difference between NP and AP indicates the net tendency of a material to either produce or consume acid. The Net Neutralization Potential (NNP) is defined as the difference between the NP and the AP. Theoretically, NNP values are negative for potentially acid-forming samples and are positive for potentially acid consuming samples.

Static test results are interpreted in several ways in the geochemical literature. Some of the most commonly used criteria and Agency evaluation criteria are shown on Table 3.2-3. Due to inherent inconsistencies in interpreting static data, samples with an NNP greater than +20 and 3 times more NP than AP, i.e. an NP:AP ratio greater than 3, are conservatively considered to be those with a low potential to generate acid. Samples with an NP:AP ratio of less than 1 and an NNP of less than -20 are considered to have a strong potential to generate acid. The geochemical reactivity of samples which fall in between these two categories is uncertain and may have the potential to generate net acidity (B.C. AMD Task Force, 1989; Saskatchewan Environment, 1992; and Hutchison and Ellison, 1992). These criteria

TABLE 3.2-3

EVALUATION CRITERIA FOR ACID-BASE ACCOUNTING ANALYSES

	B C AMD Task Force[5]	
	NNP[1]	NP[2]:AP[3]
Strong Acid Generation Potential		
Group 1	< -20 $TCaCO_3/KT$[4]	< 1.0
Uncertain Acid Generation Potential		
Group 2	$-20\ TCaCO_3/KT \leq NNP \leq 20\ TCaCO_3/KT$	$1.0 \leq NP{:}AP \leq 3.0$
Low Acid Generation Potential		
Group 3	$> 20\ TCaCO_3/KT$	$NP{:}AP > 3.0$

		Agency Evaluation Criteria[6]		
	Paste PH	NNP	NP:AP	Total Sulfur
Group 1	< 6	$< -20\ TCaCO^3/KT$	< 1.0	$> 1\%$
Group 2	N/A	$-20\ T/KT \leq NNP < O$	N/A	$0.2\% \leq S_{TOT} \leq 1\%$
Group 3	≥ 6	$\geq 0\ T/KT$	≥ 1	$\leq 0.2\%$

1 - Net neutralization potential
2 - Acid neutralization potential
3 - Acid generating potential
4 - Acid generating potential per kiloton of waste
5 - BC AMD Task Force (1989)
6 - Miller (1995)

should be considered as rough guidelines for prediction of net acid generation from specific geologic materials. The following quotation is instructive.

> *"Despite the theoretical simplicity, static tests can not be used to predict the quality of drainage emanating from waste materials at any future time. Acid generation processes and therefore drainage quality are time-dependent and functions of a large number of complex factors such as mineralogy, rock structure and climate. For this reason, static tests should be treated as a qualitative predictive method; that is, they can only indicate whether or not there is a potential for generation of net acidity at some unknown time" (B.C. AMD Task Force 1989)*

Static data for Zortman/Landusky geologic materials suggest that kinetic testing is needed to interpret static results from samples that fall within the uncertain acid generation potential category (see Table 3.2-3). That is, samples having NNP values less than +20 and an NP:AP ratio between 1 and 3 should be tested for their potential to generate acid over time. Static results for Zortman/Landusky indicate that there is acid producing potential especially for the igneous rock types, therefore kinetic testing was performed to further assess the potential.

Kinetic testing

The objective of kinetic testing is to assess the acid generation potential with greater confidence. The goal is to develop a list of readily applicable rock characteristics that can be used to identify rock that is not going to generate net acidity. Geochemical kinetic tests involve accelerated weathering of samples under laboratory controlled conditions by leaching moist, hot air through the material in a cell and analyzing the leachate which exits the cell. These leach cycles can be conducted indefinitely but are usually performed for at least 20 weeks. These are referred to as humidity cells in the literature. Whereas static tests provide some information on overall potential acid generation independent of time, kinetic tests explicitly define reaction rates through time under the specific conditions of the test that is applied. However, general geochemical literature does not clearly demonstrate that kinetic testing is capable of providing highly accurate or precise long-term predictions about acid generation and metal liberation. Such tests provide a relatively short-term, qualitative appraisal of the potential oxidation of the samples in question. Kinetic test data often poorly predict actual future water quality numbers because the minerals that supply buffering (i.e., carbonates) generally react rapidly, while the minerals that supply acidity (i.e., pyrite) react relatively slowly. Many tests are only indicative of the rapid reactions.

Most short-term, kinetic tests are conducted at private laboratories, usually for a 20-week period. These tests are conducted on relatively small samples (250 to 1000 grams) of crushed, sieved, smaller-grained material, and leached with large quantities of water for each rinse cycle. Simulation of the effects of average precipitation on the coarser-sized material is not attempted. Therefore, these tests only provide semi-quantitative information on drainage water quality because they do not attempt to reproduce site conditions. Details of the short-term (20-week) test method used are described in the Zortman Extension Application, Vol. 6, Appendix 12; and Saskatchewan Environment, 1992 page 5-28 and 5-29. This test method is referred to in the literature as the Modified Humidity Cell.

Long-term, laboratory kinetic tests that attempt to simulate field conditions especially the annual precipitation and particle size, will often leach larger samples (kilograms) of run-of-mine material for over a year. Since these tests are more expensive, they are conducted at the minesite where larger samples can be more easily accommodated and leachates can be analyzed at lower cost. Such tests may yield more reliable reaction rate data but may not simulate long-term water quality. An example of the method used for these tests is given in Saskatchewan Environment, 1992 page 5-29 to 5-31. This test method is referred to as the SRK Modified Humidity Cell.

On-site, pilot-scale, field tests are performed to confirm the potential to generate acidity, determine the rates of acid generation, sulphide oxidation, neutralization, and metal depletion and to test control/treatment techniques. This type of long-term, field-scale test is more likely to yield reliable reaction rate data and predictions of long-term water quality than the previously mentioned lab tests.

All three types of kinetic testing were conducted for the Zortman/Landusky materials. Short and long-term testing is completed. Additional tests are in progress to corroborate laboratory results and compare the different methods.

3.2.2.5 Ore Test Results

Static Testing

Static tests were performed on approximately 277 Zortman ore samples. The results are summarized in Table 3.2-4. Similar static data for Landusky ores are shown on Table 3.2-5. These data indicate that most of the Zortman and Landusky ores have a strong potential to generate acid. However, results indicate that ore from the Pony Gulch area contains substantial net neutralizing potential in the 500 to 800 T $CaCO_3$/KT ore range.

Considerable caution should be applied when using mean ABA or percent sulfur values; they often mask extremely different individual values. Also, it is unrealistic to perform a mass balance calculation of mean AP versus mean NP to determine whether a mix of lithologies would be acid generating or not. This approach assumes that all of the materials react, and at the same rate. This is almost never the case.

Kinetic Testing

Short-term (20-week) kinetic testing was performed on several types of spent ore to evaluate the potential of these materials to produce acid and release metals. These results confirmed the indication given by the static results that all ore would be acid-forming either initially or after an undefined period of time. Blended amendments did not succeed in affecting the acid production significantly, but only served to delay the time before acidic conditions would prevail. This is demonstrated in the field as leachates from some existing rinsed leach pads already show a tendency toward acidity. The exception was the ore associated with the Pony Gulch deposit. This material was found to have significant buffering capacity and, when layered in the cell with the reactive ore, the cell did not produce acidic leachate under the conditions of the short-term kinetic test.

Unamended sulfide and sulfide:oxide blended spent ore are likely to release elevated metal concentrations where the pH drops below about pH 4.0. Spent ores, whether amended or not, may release elevated concentrations of nitrates and selected metals that are mobile at alkaline pHs, i.e., arsenic, chromium, selenium, molybdenum, uranium. These metals were not determined in the humidity cell analyses.

These kinetic test results indicate that, immediately after cessation of pad flushing, spent ores will likely have alkaline pHs considerably above pH 7.0. However, subsequent leachates may become acid as remnant sulfides react.

3.2.2.6 Waste Rock Test Results

Static Testing

A series of tests were performed on approximately 568 Zortman and 716 Landusky waste rock samples. Two dominant rock types, syenite and amphibolite, were investigated with more intensity because they comprise the majority of waste rock that would be produced for the mine expansion. Results are summarized in Tables 3.2-6, 3.2-7, 3.2-7a and 3.2-7b. These data were generated from widely-spaced development drill holes, so there is an inherent margin of error in some of the calculations. These tables are not meant to indicate that the materials and volumes listed will behave or react chemically in any specific manner. The tables are provided to give the reader an idea of relative abundance and average net neutralizing potential (NNP) for each sample group. The zeros given in some categories reflect the assumption that only a limited amount of that category waste is present. It is likely that more closely-spaced developmental drilling will confirm the presence of these less abundant waste rock types.

In general, material from Landusky has a slightly higher average total sulfur and, because of the greater presence of carbonate rock types, a higher average NP and NNP than that from Zortman. Results also indicate that, when both mine sites are considered together, three geochemical groupings exist based on rock type, iron sulfide types and occurrences, total sulfur content, paste pH, and NNP:

1. The Archean amphibolite/mafic gneiss and Paleozoic sedimentary shale, limestone, and dolomite,

2. The Tertiary igneous syenite porphyry, and

3. The other Tertiary igneous rocks (breccia, monzonite, trachyte), and the Archean quartzites and felsic gneisses.

Zortman Short-term Kinetic Testing

Series humidity cells. Short-term kinetic testing was conducted for 20 weeks for sixteen humidity cells. Eight series humidity cells were conducted to evaluate the applicability of blending certain rock types with others and to simulate the proposed and alternative reclamation covers as mitigation for acid rock drainage. Two dominant rock types were investigated because, in

TABLE 3.2-4

AVERAGE NNP VALUES BY LITHOLOGY AND PERCENT TOTAL SULFUR FOR ZORTMAN ORE

Lithology	% Total Sulfur	Class Average NNP (t/1000t)	n	Estimated Total Tons	% Total Quantity
Syenite Porphyry	<0.2	0	41	0	0.0%
	0.2-0.5	-9	22	23,000,900	28.8%
	>0.5	-50	78	27,002,000	33.8%
Subtotal		-31	141	50,002,900	62.5%
Monzonite	<0.2	-1	16	0	0.0%
	0.2-0.5	-10	12	2,020,600	2.5%
	>0.5	-66	18	4,215,800	5.3%
Subtotal		-48	46	6,236,400	7.8%
Felsic Gneiss	<0.2	-1	5	0	0.0%
	0.2-0.5	-7	6	2,614,600	3.3%
	>0.5	-114	38	6,100,700	7.6%
Subtotal		-82	49	8,715,300	10.9%
Amphibolite	<0.2	4	15	0	0.0%
	0.2-0.5	-7	2	3,324,900	4.2%
	>0.5	-53	12	4,987,300	6.2%
Subtotal		-34	29	8,312,200	10.4%
Quartzite	<0.2	0	6	0	0.0%
	0.2-0.5	22	3	505,500	0.6%
	>0.5	-46	3	1,179,500	1.5%
Subtotal		-26	12	1,685,000	2.1%
Unclassified	--	--	--	5,048,200	6.3%
TOTAL		-39	277	80,000,000	

Not volume weighted

Source: ZMI Drilling Programs, 1990 and 1993.

TABLE 3.2-5

AVERAGE NNP VALUES BY LITHOLOGY AND PERCENT TOTAL SULFUR FOR LANDUSKY ORE

Lithology	% Total Sulfur	Class Average NNP (t/1000t)	n	Estimated Total Tons	% Total Quantity
Syenite Porphyry	<0.2	2	90	0	0.0%
	0.2-0.5	-7	67	1,571,700	20.7%
	>0.5	-35	240	3,667,200	48.3%
Subtotal		-27	397	5,238,900	68.9%
Monzonite	<0.2	NS	NS	0	0.0%
	0.2-0.5	-9	2	0	0.0%
	>0.5	-18	4	0	0.0%
Subtotal		--	6	0	0.0%
Trachite Porphyry	<0.2	2	47	0	0.0%
	0.2-0.5	-8	13	182,700	2.4%
	>0.5	-36	51	182,700	2.4%
Subtotal		-22	111	365,400	4.8%
Felsic Gneiss	<0.2	4	7	0	0.0%
	0.2-0.5	-8	6	60,700	0.8%
	>0.5	-82	22	242,900	3.2%
Subtotal		-67	35	303,600	4.0%
Emerson Shale	<0.2	4	2	132,600	1.7%
	0.2-0.5	-5	1	796,000	10.5%
	>0.5	-51	9	398,000	5.2%
Subtotal		-18	12	1,326,600	17.5%
Unclassified	--	--	--	365,500	4.8%
TOTAL		-26	561	7,600,000	100.0%

Not volume weighted

Source: ZMI 1993 Drilling Program.

TABLE 3.2-6

AVERAGE NNP VALUES BY LITHOLOGY AND PERCENT TOTAL SULFUR FOR ZORTMAN WASTE ROCK

Lithology	% Total Sulfur	Class Average NNP (t/1000t)	n	Estimated Total Tons	% Total Quantity
Syenite Porphyry	<0.2	1	74	7,429,400	12.4%
	0.2-0.5	-7	64	14,734,395	24.6%
	>0.5	-38	205	18,008,705	30.0%
Subtotal		-23	343	40,172,500	67.0%
Monzonite	<0.2	2	36	0	0.0%
	0.2-0.5	-9	21	1,569,600	2.6%
	>0.5	-27	48	1,569,600	2.6%
Subtotal		-14	105	3,139,200	5.2%
Felsic Gneiss	<0.2	2	17	0	0.0%
	0.2-0.5	-3	23	718,700	1.2%
	>0.5	-67	33	1,676,900	2.8%
Subtotal		-30	73	2,395,600	4.0%
Amphibolite	<0.2	19	14		0.0%
	0.2-0.5	15	5	2,860,600	4.8%
	>0.5	-17	9	6,674,700	11.1%
Subtotal		6	28	9,535,300	15.9%
Quartzite	<0.2	2	7	0	0.0%
	0.2-0.5	-7	4	500,000	0.8%
	>0.5	-85	4	768,700	1.3%
Subtotal		-23	15	1,268,700	2.1%
Unclassified	--	--	4	3,488,700	5.8%
TOTAL		-21	568	60,000,000	

Not volume weighted

Source: ZMI Drilling Programs, 1990 and 1993.

TABLE 3.2-7

AVERAGE NNP VALUES BY LITHOLOGY AND PERCENT TOTAL SULFUR FOR LANDUSKY WASTE ROCK

Lithology	% Total Sulfur	Class Average NNP (t/1000t)	n	Estimated Total Tons	% Total Quantity
Syenite Porphyry	<0.2	7	75	220,000	3.1%
	0.2-0.5	-3	149	513,400	7.3%
	>0.5	-20	276	5,331,600	76.2%
Subtotal		-11	500	6,065,000	86.6%
Trachite Porphyry	<0.2	0	2	0	0.0%
	0.2-0.5	-5	4	65,000	0.9%
	>0.5	-32	25	151,600	2.2%
Subtotal		-27	31	216,600	3.1%
Felsic Gneiss	<0.2	15	12	0	0.0%
	0.2-0.5	-4	12	0	0.0%
	>0.5	-62	32	0	0.0%
Subtotal		-33	56	0	0.0%
Amphibolite	<0.2	50	7		0.0%
	0.2-0.5	59	5	0	0.0%
	>0.5	-12	1	0	0.0%
Subtotal		49	13	0	0.0%
Quartzite	<0.2	0	1	0	0.0%
	0.2-0.5	-5	3	15,000	0.2%
	>0.5	-53	10	55,600	0.8%
Subtotal		-39	14	70,600	1.0%
Emerson Shale	<0.2	162	34	0	0.0%
	0.2-0.5	121	25	261,100	3.7%
	>0.5	103	11	274,000	3.9%
Subtotal		138	70	535,100	7.6%
Unclassified	--	--	32	112,700	1.6%
TOTAL		5	716	7,000,000	100.0%

Not volume weighted

Source: ZMI 1993 Drilling Program

TABLE 3.2-7a

LANDUSKY MINE WASTE ROCK SUMMARY OF TOTAL SULFUR, PASTE pH, AND NNP DATA BY LITHOLOGY

Lithology	n	Total Sulfur (%)			Paste pH (units)			NNP (T/KT)		
		Min	Max	Average	Min	Max	Average	Min	Max	Average
Syenite	500	0.00	2.87	0.58	3.4	9.6	8.0	-84.7	73.5	-10.7
Monzonite	29	0.01	1.97	0.46	5.5	9.4	8.1	-61.6	53.7	-4.5
Trachyte	31	0.15	2.50	1.08	5	9.2	7.6	-73.1	68.3	-26.5
Felsic Gneiss	56	0.01	6.37	1.30	3.9	9.3	6.5	-199.1	88.7	-32.9
Amphibolite	13	0.02	0.54	0.22	7.9	9.1	8.6	-11.9	86.9	48.9
Emerson Shale	70	0.01	1.69	0.29	6.9	9.2	8.5	-32.2	678.8	138.5
Quartzite	14	0.18	3.70	1.41	6.3	8.7	7.9	-110.6	-0.5	-39.2
Breccia	3	3.00	15.30	9.96	2.7	4.4	3.4	-478.1	-190.0	-311.3
ALL SAMPLES	716	0.00	15.30	0.68	2.7	9.6	7.9	-478.1	678.8	1.0
All samples with ZMI proposed cutoff for Alternatives 2 and 4	139	0.00	0.19	0.09	5.4	9.5	8.3	-5.7	678.8	47.7
All syenite samples with agency cutoffs*	57	0.00	0.19	0.08	6.6	9.5	8.5	0.7	71.5	9.2
All amphibolite and sedimentary samples with agency cutoffs*	68	0.01	0.73	0.20	6.9	9.2	8.5	2.7	678.8	142.2

Source: ZMI Data, 1993

* Alternatives 3, 5, 6, and 7

TABLE 3.2-7b

ZORTMAN MINE WASTE ROCK SUMMARY OF TOTAL SULFUR, PASTE pH, AND NNP DATA BY LITHOLOGY

Lithology	n	Total Sulfur (%)			Paste pH (units)			NNP (T/KT)		
		Min	Max	Average	Min	Max	Average	Min	Max	Average
Syenite	343	0.01	9.66	0.86	3.80	10.00	7.7	-301.0	20.0	-23.5
Monzonite	105	0.00	3.29	0.54	4.10	9.40	7.6	-102.0	4.9	-13.6
Trachyte	2	0.57	1.67	1.12	5.30	7.60	6.5	-52.2	-13.4	-32.8
Felsic Gneiss	73	0.01	6.53	1.10	3.30	9.40	7.0	-207.1	40.0	-30.5
Amphibolite	28	0.01	4.09	0.59	6.50	9.00	8.1	-124.0	94.1	6.3
Quartzite	15	0.01	4.70	0.98	n/a	n/a	n/a	-130.0	13.0	-23.4
Breccia	2	0.39	1.63	1.01	3.50	4.70	4.1	-50.7	-12.0	-31.4
ALL SAMPLES	568	0.00	9.66	0.82	3.30	10.00	7.59	-301.00	94.09	-21.2
All samples with ZMI proposed cutoff for Alternatives 2 and 4	147	0.00	0.19	0.08	5.30	10.00	8.4	-6.6	80.9	2.9
All syenite samples with agency cutoffs*	44	0.01	0.17	0.07	7.1	10.0	8.6	0.0	15.0	2.7
All amphibolite and sedimentary samples with agency cutoffs*	18	0.01	0.75	0.16	8.1	8.6	8.3	1.0	80.9	22.0

Source: ZMI Data, 1993

* Alternatives 3, 5, 6, and

combination, they comprise the majority of waste rock that would be produced for the mine extension. Humidity cells, configured in series, were mixtures of the two major waste rock types (Figure 3.2-1). These mixes varied in reactivity from very reactive high sulfur waste to relatively unreactive neutral waste proposed for use in reclamation covers. Tables 3.2-8a and 3.2-8b tabulate results from both the short- and long-term tests.

The uses of limestone or non acid generating waste as a cover and/or an underdrain were also investigated. Cells with mixes of different rock types were placed in series. Leachate exiting from the bottom of one cell was allowed to leach into the next cell and so on until the leachate exited the final cell. Leachate samples were taken after passing through each cell to evaluate the effect of each portion of the series. Lower sulfate and higher pH results indicated that the use of a low sulfur waste as a cover would be preferred rather than the limestone. Results for the low sulfur waste cover with a limestone underdrain were most favorable (Figures 3.2-2a and 3.2-2b).

Only one cell evaluated blending, Cell 22. This cell was 60 % amphibolite, 30 % syenite and 10 % monzonite. Results, although not conclusive, did indicate that if a considerable amount of amphibolite could be blended with the more reactive rock, some buffering would occur. However, due to the limited amount of amphibolite available in the minable portion of the ore body, this mitigation would not be realistic to implement. A more detailed discussion on the kinetic testing is in Volume 6, Appendix 12 of the Zortman Extension Application.

Single humidity cells. Single humidity cells were used to evaluate the individual reactivity of the amphibolite/mafic gneiss and syenite rock types. These two dominant rock types were investigated because, in combination, they comprise the majority of waste rock that would be produced for the mine extension. Eight single humidity cells were conducted (Figure 3.2-3). The rock types of these cells were not mixed, but were tested as individual rock types.

Syenite ranged from 1 to 2 wt % total sulfur in four short-term tests. This range was used to establish the upper total sulfur bracket for this rock type, with respect to suitability as reclamation material. It was found that three syenite samples were reactive and produced lower pH leachates, detectable metal levels, and substantial sulfate either initially or during the 20-week duration of the testing. The material in the one cell (#31, in Table 3.2-8a) which reacted slowly had a relatively high acid neutralizing potential (NP = 47) which maintained the cell at a pH of around 6.0. More detailed discussion is given in Volume 6, Appendix 12 of the Zortman Extension Application. After review of the results from this group of tests, it was determined that, to better define syenite reactivity, a lower range of sulfur values be tested for an extended duration (cells HC-42, 43, 44). Results are discussed in following sections.

Amphibolites tested had sulfur values ranging from 0 to 0.7 wt % (cells 22, 34, 35, 36). Results indicated that for all four cells very low production of sulfate was evident indicating little acid production, and that the alkalinity buffered the pH of the cells between 6 and 7. Levels of metals in leachates collected from the amphibolites ranged from nondetectable to low.

Zortman Long-term Kinetic Testing

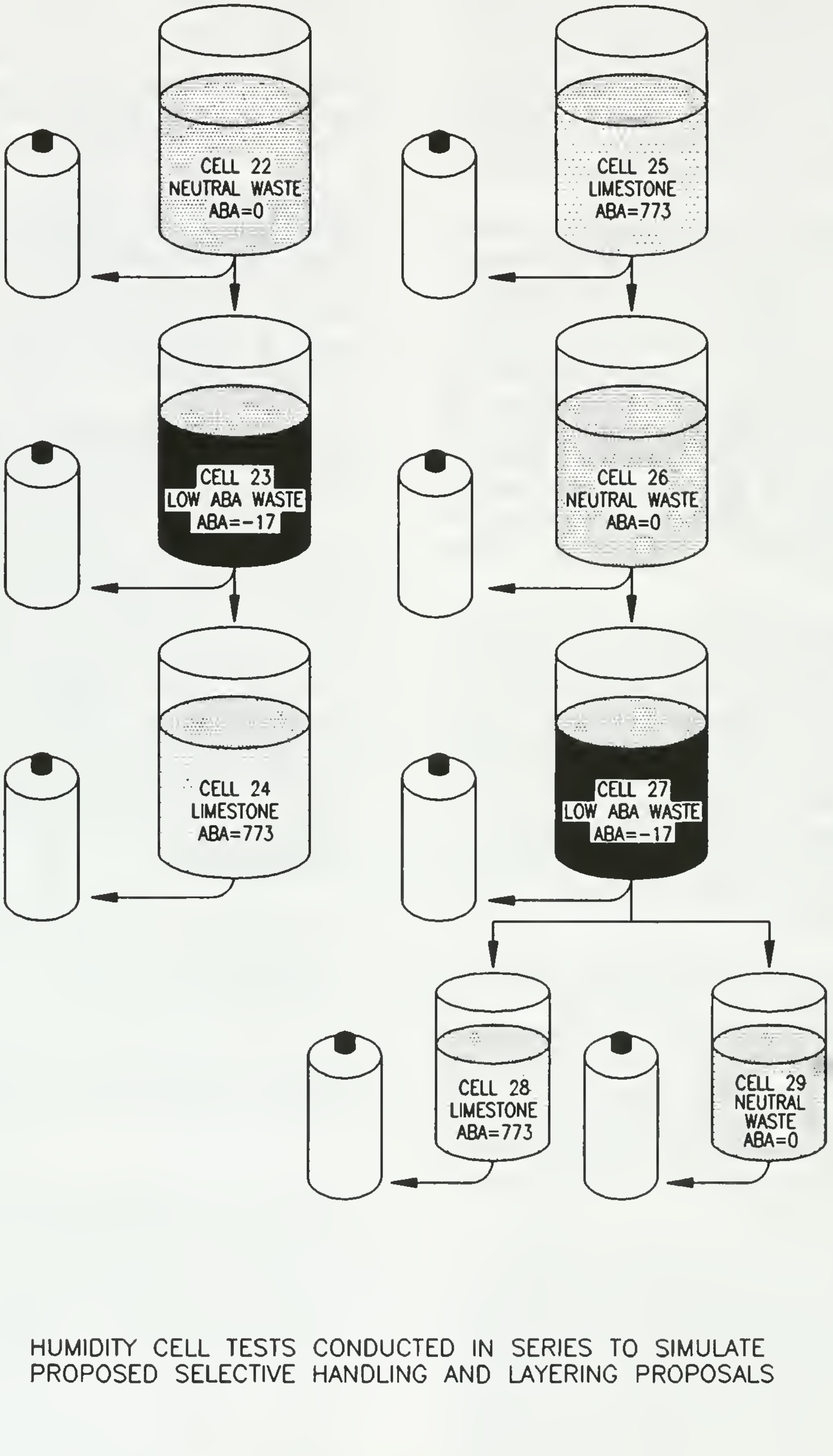
Fifteen additional long-term kinetic tests were conducted over a period of 72 weeks (cells HC-42 through HC-56). Results from long-term testing are compared with the short-term testing in detail in Miller (1995). Cells were leached continuously for the first 23 weeks, allowed to rest for approximately 27 weeks, and then leached again for another 22 weeks. The rock types tested included: syenite, breccia, monzonite, and trachyte; and metamorphic rocks: amphibolite, mafic gneiss, and felsic gneiss. Figures 3.2-4 through 3.2-8 have combined both the short- and long-term test results for comparison with static data. Tables 3.2-8a and 3.2-8b tabulate results from both the short- and long-term tests. All cells, both short-and long-term tests, which met these four criteria:

total sulfur less than or equal to 0.2 %,
paste pH of 6 or greater,
NNP greater than 0, and
NP/AP of 1 or greater

did not develop acid pHs, produce substantial sulfate, or release high levels of metals in the latter half of the leaching sequence (Figures 3.2-7 and 8).

Comparison of Kinetic and Static Results

Archean Amphibolite/Mafic Gneiss and Paleozoic Sedimentary Rocks. Three 45-week humidity cells were conducted for higher sulfur (0.2 to 0.8%) metamorphic rock to establish an upper sulfur limit for suitability. Results indicate that even at higher sulfur values, 0.8 percent or less, this rock category did not develop pHs less than 6.0 (Figure 3.2-4) or produce substantial sulfate or metals under conditions of the tests. This was probably due to the greater neutralizing potential of the metamorphic rock especially when compared to the igneous rocks. For five of the seven cells acidity was markedly reduced or exhausted and the pH of the cell



HUMIDITY CELL TESTS CONDUCTED IN SERIES TO SIMULATE PROPOSED SELECTIVE HANDLING AND LAYERING PROPOSALS

SOURCE: ZORTMAN EXTENSION PROJECT - GEOCHEMICAL KINETIC TESTING OF WASTE ROCK

SHORT TERM
SERIES HUMIDITY CELLS

FIG. 3.2-1

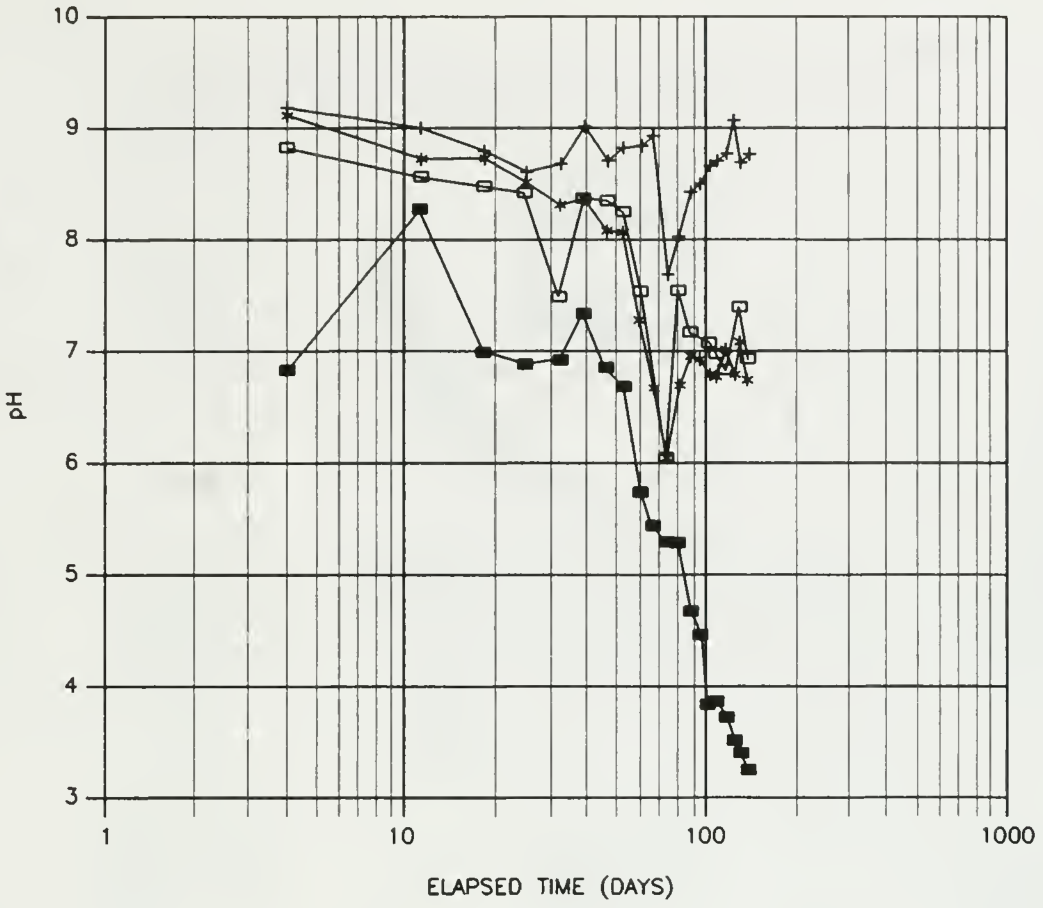
ZOR-WR03

TABLE 3.2-8a
KINETIC TESTING - ZORTMAN WASTE ROCK
SINGLE CELLS SHORT- AND LONG-TERM

Sample description	Cell #	Duration	NP (T/KT)	AP (T/KT)	Total Sulfur (percent)	Paste pH Standard Units	Final pH Standard Units	Sulfate Production Latter Portion of Test (mg/kg/cycle)	NNP (T/KT)	NP/AP (T/KT)
Amphibolite 250 g	36	20 weeks	7	6	0.2	7.2	7.5	7.34	1	1
Amphibolite 250 g	34	20 weeks	24	0	0.01	8.4	7.4	0.97	24	80
Amphibolite 250 g	35	20 weeks	6	0	0.01	5.7	6.2	3.01	6	20
Amphibolite 60% of 750 g	22	20 weeks	21	21	0.67	6.4	6.4	0.76	0	1
Amph\mafic gneiss 2.08 kg	HC-47	45 weeks	120	26	0.82	7.9	7.2	11.63	94	5
Amph\mafic gneiss 2.16 kg	HC-46	45 weeks	67	8	0.24	8.3	7.2	5.27	59	9
Amph\mafic gneiss 2.16 kg	HC-45	45 weeks	85	4	0.14	8.1	7.0	2.36	81	20
Breccia 2.03 kg	HC-53	56 + weeks	0	12	0.39	3.5	3.5	6.71	-12	0
Breccia 2.27 kg	HC-54	56 + weeks	0	51	1.63	4.7	3.1	112.25	-51	0
Felsic gneiss 2.25 kg	HC-55	56 + weeks	49	12	0.37	8.3	7.7	3.19	37	4
Felsic gneiss 2.45 kg	HC-56	56 + weeks	3	52	1.66	4.6	3.2	120.5	-48	0
Monzonite 1.57 kg	HC-50	56 + weeks	0	8	0.25	5.2	4.1	18.63	-8	0
Monzonite 1.98 kg	HC-51	56 + weeks	0	12	0.39	5.6	4.0	15.01	-12	0
Monzonite 2.25 kg	HC-52	56 + weeks	0	25	0.79	4.1	3.2	75.13	-25	0
Syenite 2.19 kg	HC-42	45 weeks	7	5	0.17	7.1	6.8	13.45	2	1
Syenite 2.21 kg	HC-44	45 weeks	28	24	0.78	6.2	6.6	38.45	4	1
Syenite 2.31 kg	HC-43	45 weeks	14	10	0.31	7.9	6.6	17.81	5	1
Syenite 250 g	31	20 weeks	47	62	1.98	6.8	6.0	7.72	-16	1
Syenite 250 g	32	20 weeks	17	44	1.41	2.8	4.2	49.71	-27	0
Syenite 60% of 250 g	30	20 weeks	13	30	0.96	2.8	3.3	145.53	-17	0
Syenite 60% of 750 g	33	20 weeks	22	67	2.14	3.8	4.2	40.19	-45	0
Trachyte 2.12 kg	HC-48	56 + weeks	4	18	0.57	7.6	6.2	9.56	-13	0
Trachyte 2.14 kg	HC-49	56 + weeks	0	52	1.67	5.3	3.5	42.44	-52	0

TABLE 3.2-8b
KINETIC TESTING - ZORTMAN WASTE ROCK
SERIES CELLS SHORT-TERM

Sample description	Cell #	Duration	NP (T/KT)	AP (T/KT)	Total Sulfur (percent)	Phase pH Standard Units	Final pH Standard Units	Sulfate Production Latter Portion of Test (mg/kg/cycle)	NNP (T/KT)	NP/AP (T/KT)
WASTE COVER AND LIMESTONE UNDERDRAIN										
Amphibolite 60% of 750 g	22 cover	20 weeks	21	21	0.7	6.4	6.4	0.76	0	1
Syenite 60 % of 500 g	23 reactive waste		13.0	30.0	0.96	5.8	6.8	2.84	-17.0	0.4
Limestone 250 g	24 underdrain		773	0	0		8.74	4.93	773	773
LIMESTONE COVER AND LIMESTONE UNDERDRAIN										
Limestone	25 cover	20 weeks	773	0	0		9.32	0	773	773
Amphibolite 60 % of 1000 g	26 neutral waste		21.0	21.0	0.67	6.3	8.9	0.54	0.0	1.0
Syenite 60 % of 750 g	27 reactive waste		13.0	30.0	0.96	2.9	5.6	60.29	-17.0	0.4
Limestone	28 underdrain		773	0	0		6.72	63.14	773	773
LIMESTONE COVER AND WASTE UNDERDRAIN										
Limestone	25 cover	20 weeks	773	0	0		9.32	0	773	773
Amphibolite 60 % of 1000 g	26 neutral waste		21.0	21.0	0.67	6.3	8.9	0.54	0.0	1.0
Syenite 60 % of 750 g	27 reactive waste		13.0	30.0	0.96	2.9	5.6	60.29	-17.0	0.4
Amphibolite 60% of 250 g	29 neutral waste		21.0	21.0	0.67	6.7	6.9	65.3	0.0	1.0



SOLUTION pH FROM HUMIDITY CELLS SIMULATING SELECTED ALDER GULCH WASTE ROCK CAPPING AND BASE LAYER ALTERNATIVES

LEGEND

—✳— NO CAP

—■— NEUTRAL CAP/LS BASE

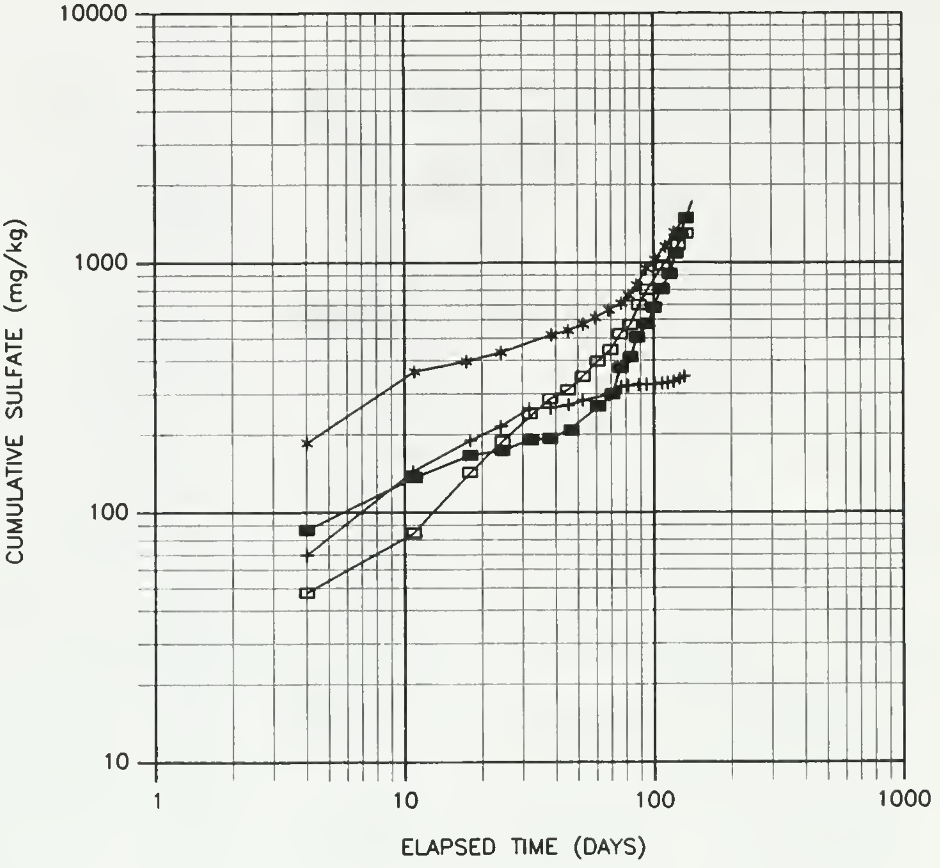
—+— LS CAP/ LS BASE

—□— LS CAP/ NEUTRAL BASE

SOURCE: ZORTMAN EXTENSION PROJECT – GEOCHEMICAL KINETIC TESTING OF WASTE ROCK

ZORTMAN WASTE ROCK CAP/BASE LAYER COMPARISON

FIG. 3.2–2a



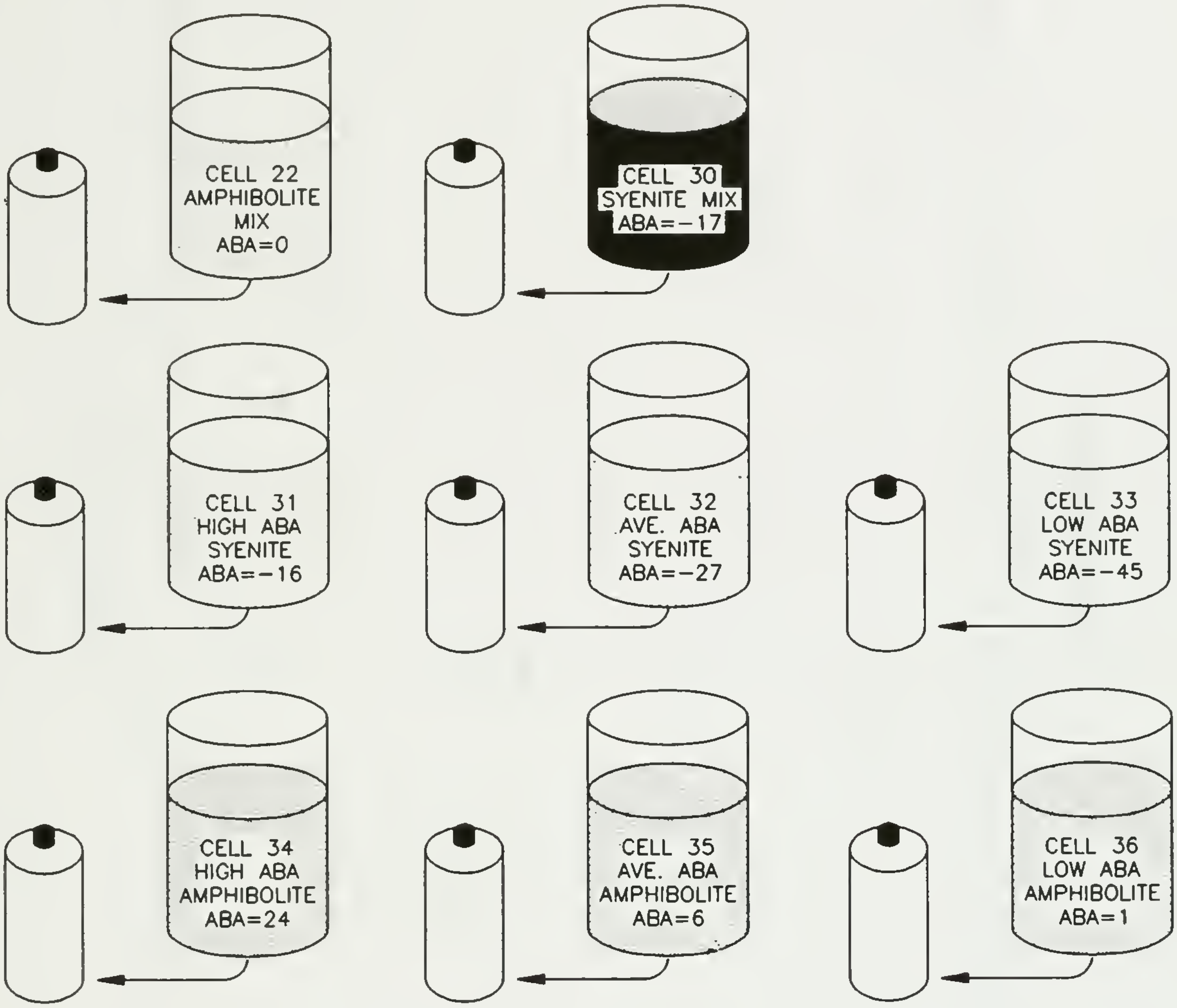
ALKALINITY RELEASE FROM HUMIDITY CELLS SIMULATING SELECTED ALDER GULCH WASTE ROCK CAPPING AND BASE LAYER ALTERNATIVES

SOURCE: ZORTMAN EXTENSION PROJECT – GEOCHEMICAL KINETIC TESTING OF WASTE ROCK

ZORTMAN WASTE ROCK CAP/BASE LAYER COMPARISON

ZOR-WR01

FIG. 3.2-2b

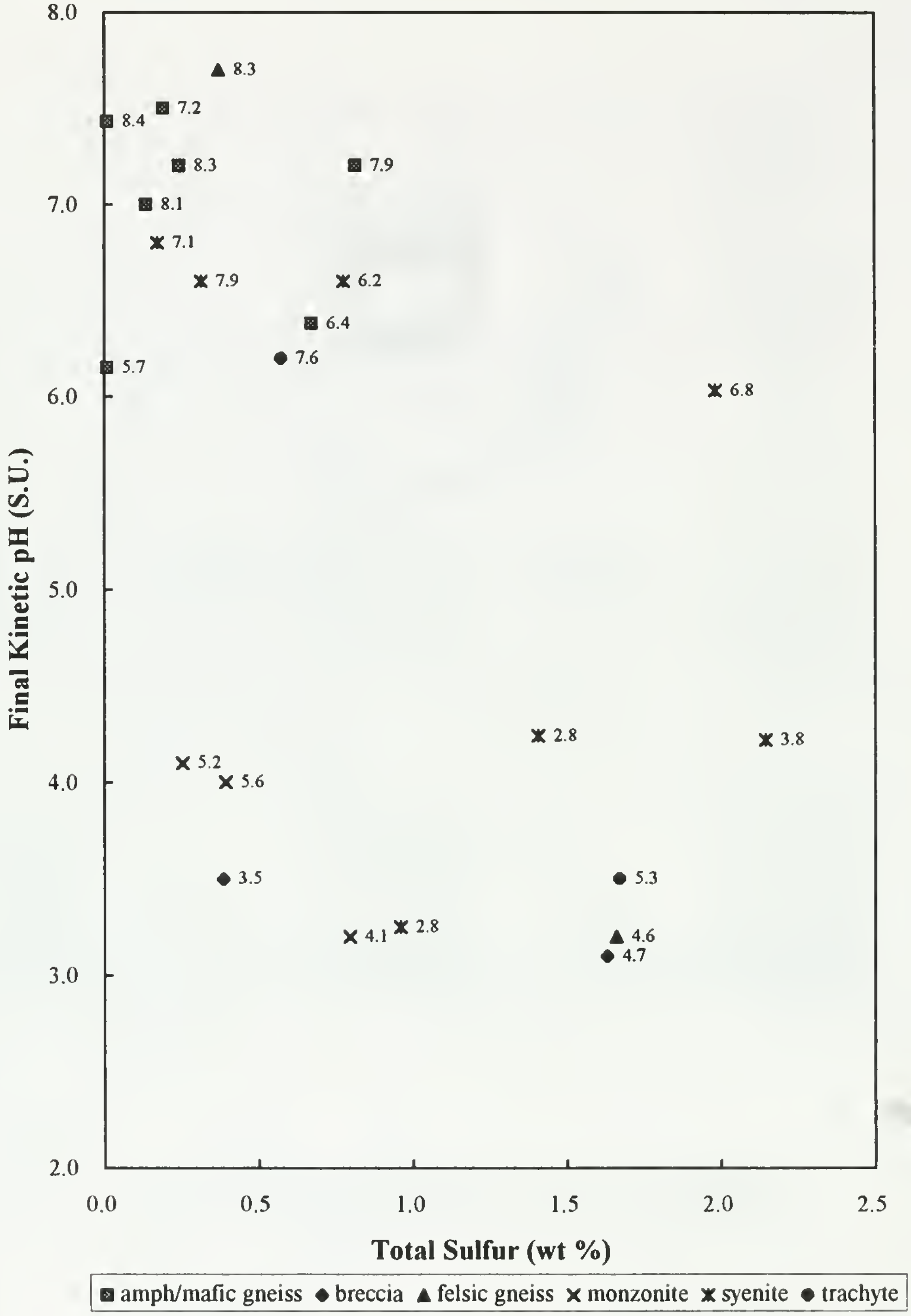


HUMIDITY CELL TESTS OF INDIVIDUAL SAMPLES
REPRESENTATIVE OF SPECIFIC DOMINANT LITHOLOGIES

SOURCE: ZORTMAN EXTENSION PROJECT – GEOCHEMICAL
KINETIC TESTING OF WASTE ROCK

SHORT TERM
SERIES HUMIDITY CELLS

FIG. 3.2–3

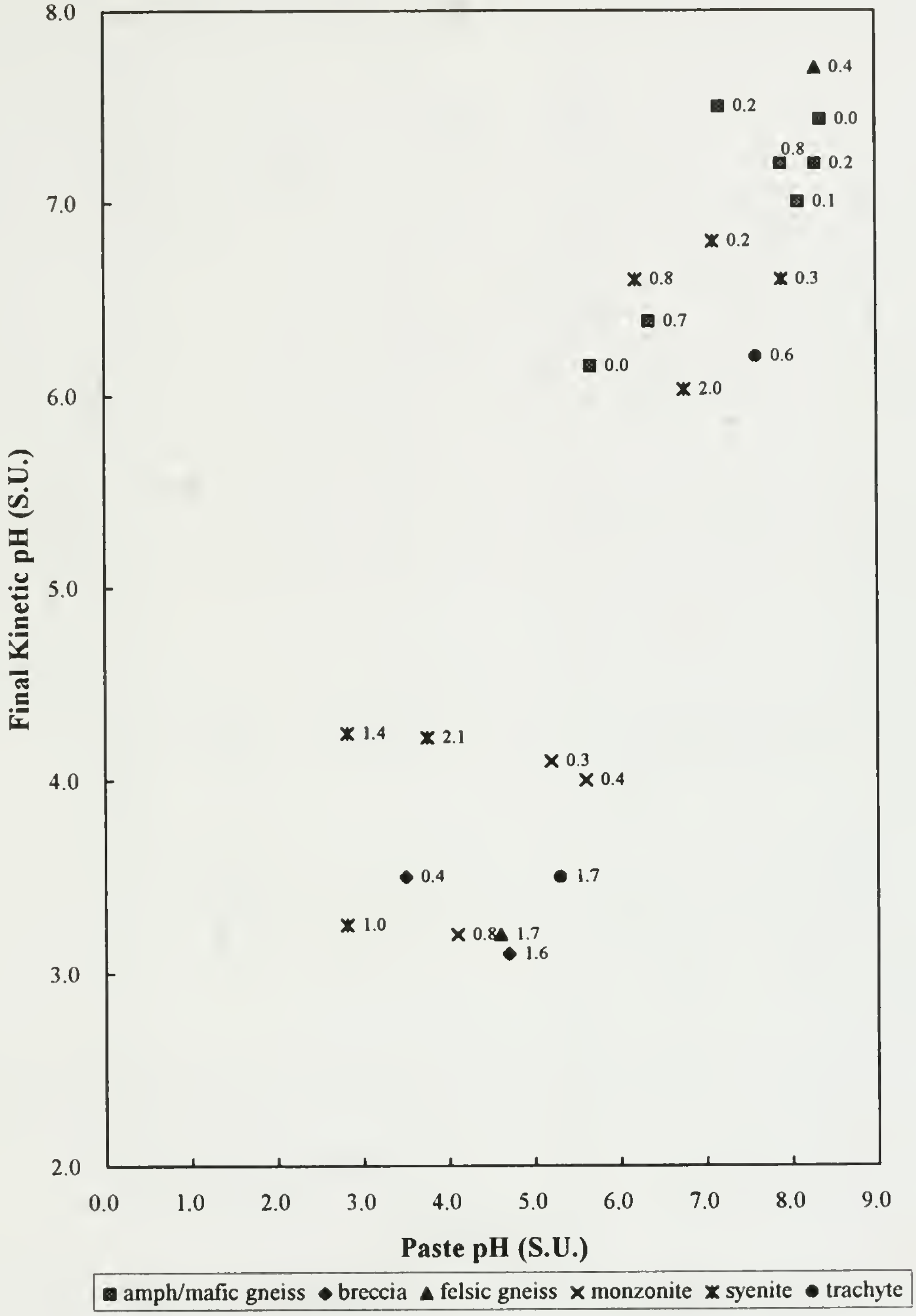


TOTAL SULFUR vs. FINAL KINETIC pH FOR ALL ROCK TYPES – PASTE pH LABEL. ALL AMPHIBOLITE/ MAFIC GNEISS AND ALL LOW SULFUR SYENITES PRODUCED LEACHATE WITH GREATER THAN 6.0 pH AFTER 45 WEEKS OF ACCELERATED WEATHERING.

FINAL KINETIC pH vs. TOTAL
SULFUR FOR ZORTMAN
WASTE HUMIDITY CELLS

ZOR–WR08

FIG. 3.2–4

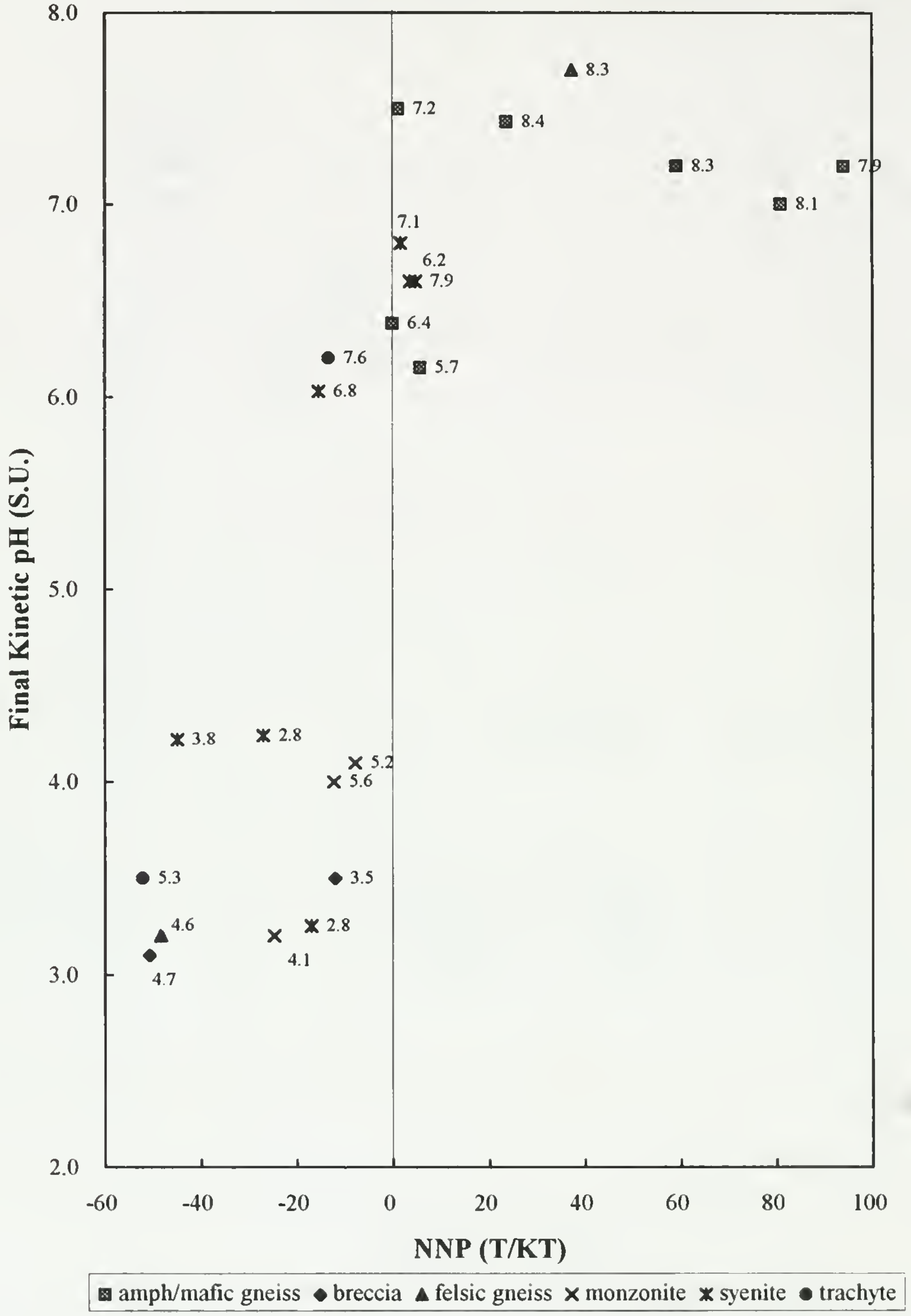


PASTE pH vs. FINAL KINETIC pH FOR ALL ROCK TYPES – TOTAL SULFUR (WT %) LABEL. ALL CELLS WITH PASTE pHs OF 6 OR GREATER PRODUCED LEACHATES WITH GREATER THAN 6 pH AFTER 45 WEEKS.

FINAL KINETIC pH vs.
PASTE pH FOR ZORTMAN
WASTE HUMIDITY CELLS

ZOR–WR09

FIG. 3.2–5

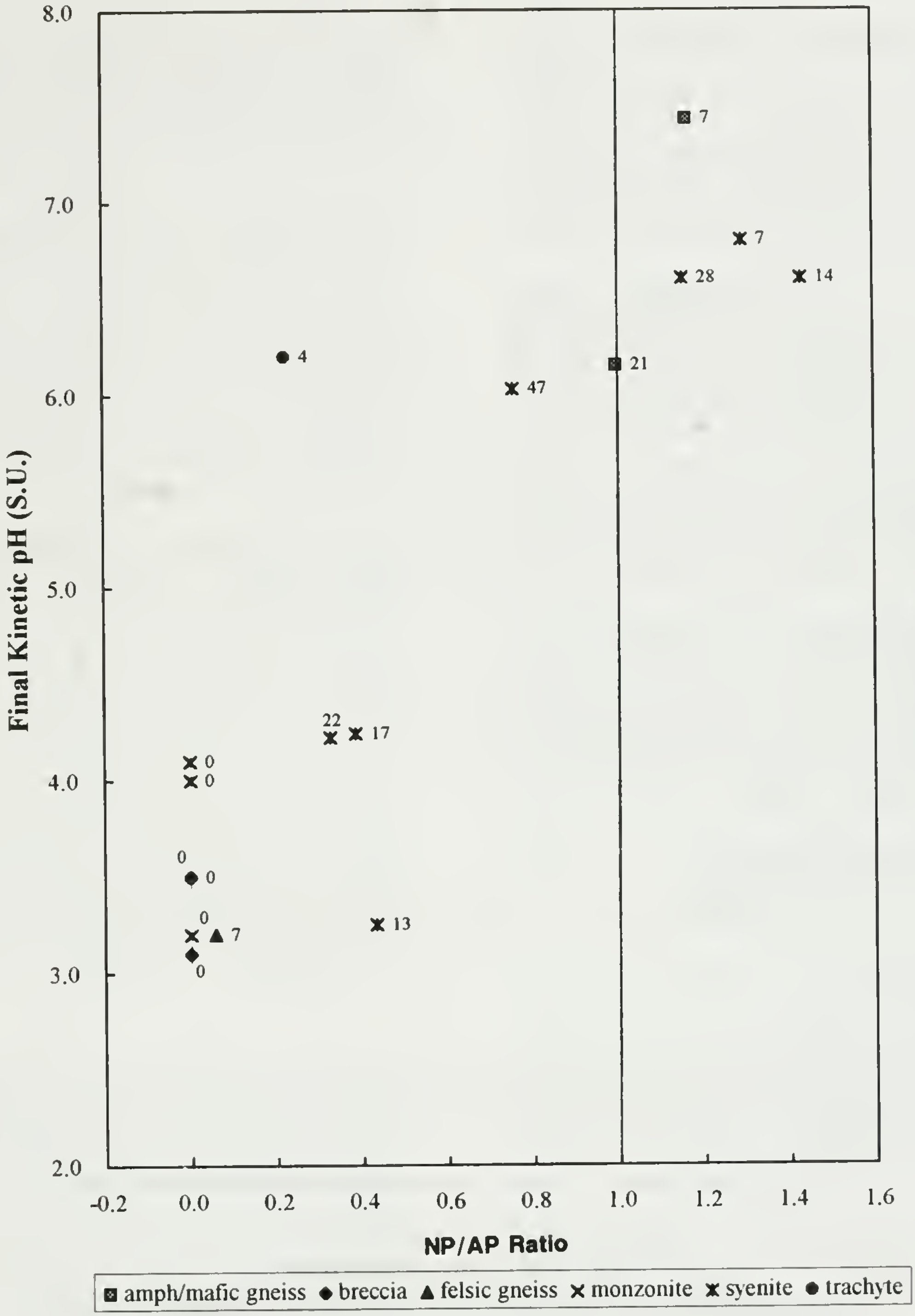


FINAL KINETIC pH vs. NNP FOR ALL ROCK TYPES – PASTE pH (S.U.) LABEL.
NO CELLS WITH AN NNP GREATER THAN 0 PRODUCED ACIDIC CONDITIONS.

FINAL pH vs. NNP
ZORTMAN WASTE CELLS
ALL ROCK TYPES

ZOR–WR07

FIG. 3.2–6

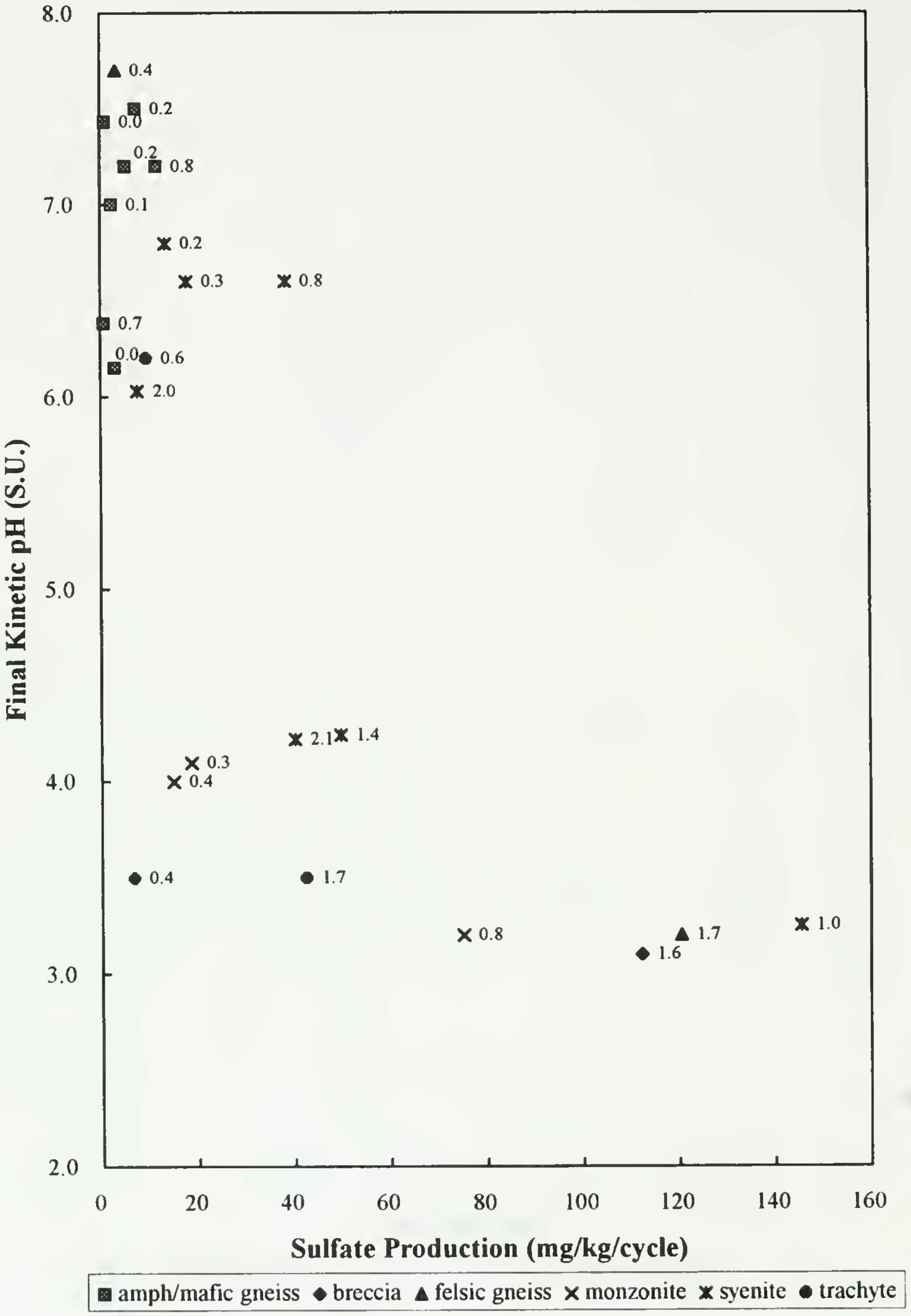


FINAL KINETIC pH vs. NP/AP FOR ALL ROCK TYPES – NP (T $CaCO_3$/T) LABEL. ROCK TYPES WITH NP=0 ALL PRODUCED ACIDIC CONDITIONS. CELLS WITH NP:AP OF GREATER THAN 1 DID NOT.

FINAL KINETIC pH vs. NP/AP
FOR ZORTMAN WASTE NP/AP<3

ZOR–WR05

FIG. 3.2–7



FINAL KINETIC pH vs. SULFATE PRODUCTION FOR THE LATTER PORTION OF THE HUMIDITY CELL LEACHING – TOTAL SULFUR LABEL. NO CELLS WITH LOW SULFUR PRODUCED SUBSTANTIAL SULFATE.

FINAL pH vs. SULFATE
PRODUCTION FOR
LATTER PART OF TEST

ZOR–WR06

FIG. 3.2–8

remained neutral in the latter half of the tests (Miller 1995). Therefore, this rock category would be suitable for construction, fill, and reclamation purposes if the following conditions were met: sulfur values of 0.8 wt % or less, NNP equal to or greater than 0, and a paste pH equal to or greater than 6.0.

Tertiary syenite porphyry. Syenite samples with a total sulfur content of less than 0.2 percent (Figure 3.2-4), a paste pH of 6.5 or greater (Figure 3.2-5), an NNP of 0 or greater (Figure 3.2-6), and an NP:AP of equal to or greater than 1 (Figure 3.2-7) did not produce acidic leachate or substantial sulfate under the accelerated weathering conditions of the test. Likewise neither did they release high levels of metals. Therefore, the portion of this rock type, which meets all criteria, would be considered suitable as reclamation cover material.

Other Tertiary igneous and Archean metamorphic rock. The remaining rock types: quartzite, breccia, monzonite, trachyte and felsic gneiss would be produced in minor volumes. Kinetic testing was not done on the quartzite rock type due to its limited abundance. The breccia and monzonite had low paste pHs, 3.5 to 5.6, and no NP. Figure 3.2-7 shows that, when the sample had little or no NP, the cell would produce acid conditions and sulfate at some time during the test. The trachyte and felsic gneiss had higher paste pHs, 4.6 to 8.3, and low or no NP. These results indicate that it is necessary to evaluate NNP for waste rock to effectively segregate reactive rock. In summary, this rock category produced unfavorable or inconclusive results and, therefore, is probably not suitable for use as construction, fill, underdrain, or reclamation cover material.

Landusky

Geological comparison. Geological/paleoenvironmental comparisons between very similar deposits have been shown to be appropriate in lieu of more extensive baseline kinetic testing. While use of this comparative technique has mostly been directed toward coal mining, recent studies indicate (USFS/DEQ 1995) this technique also applies locally to very similar metal deposits with similar rock types and associated alteration. This method has been used in Montana for homogeneous metal deposits such as the stratabound copper-silver deposits located in northwestern Montana. Mineralogical and static data, as well as extensive site examination and characterization, is needed to confirm the appropriateness of using this technique.

After accessing the existing mineralogical and static data for both Landusky and Zortman, it was determined that the deposits and the associated rock types were very similar. Results indicate, that for each rock type, material from both minesites are very similar with respect to geology and mineralogy (Richardson 1973; Russell 1991b; Russell 1995), iron sulfide types and occurrences (Honea 1992), total sulfur, paste pH, NP, AP, and NNP (Miller 1995). On this basis, a geologic comparison method was used and only limited kinetic testing was conducted on the Landusky materials.

Long-term kinetic testing. Three composited kinetic cells were conducted for Landusky waste material (0.13, 0.31, and 0.57 percent sulfur) taken from the Little Ben pit. All had negative NNPs and paste pHs below 6.0. Two had initially low leachate pHs and the third developed a low pH, less than 5.5, after a period of 24 weeks. No cell met all criteria established for suitable waste given above, thus the testing was terminated. Therefore, the same criteria developed for the Zortman mine would apply for the additional waste to be generated by the Landusky extension.

Continued Long-term Kinetic Testing

A series of additional humidity cell tests is currently underway and is being used more to measure the reproducibility of the test method rather than the reactivity of the material tested. However, results will be used to further corroborate the reactivity of the major rock types, especially the low sulfur fraction.

3.2.2.7 Field Identification of NAG Waste

ZMI presently defines non-acid generating (NAG) waste, blue waste, as rock having a total sulfur content less than 0.2 percent. ZMI proposes similar sorting criteria for the Zortman mine waste (see Section 2.8.2). Kinetic data discussed in the previous section indicate that the use of this single criterion is not sufficient to exclude reactive material, especially when considering certain rock types such as breccia and monzonite.

In the Supplemental EA for Landusky, the BLM and the DEQ identified more stringent criteria for defining NAG waste, partially due to the lack of long-term kinetic data. These criteria are:

- acid neutralization potential three times greater than the acidification potential (NP > 3 AP), and
- net neutralization potential (NNP) greater than +20.

These criteria were implemented and are currently in use. From interpretation of the entire data set, it appears that ZMI's definition of non acid generating waste is too lenient and the agencies' previous definition of NAG waste is too conservative.

Knowing the 1) rock type, 2) the sulfur content, 3) the NP, and 4) the paste pH would allow efficient, effective waste segregation at both minesites. Using the results discussed, the following procedures would result in better sorting:

1. No monzonite, trachyte, breccia, felsic gneiss, or quartzite should be used as construction, fill, underdrain, or reclamation material due to their lack of neutralizing potential and their reactivity even at very low total sulfur values.

2. Every bench level should be mapped to document major rock types and alteration assemblages.

3. For each bench, when in waste rock, every third blasthole should be sampled and tested for total sulfur and paste pH.

4. When the site geologist determines, based on visual examination, that mining will occur in potentially suitable waste rock, every blasthole should be tested for total sulfur, paste pH, and NP.

5. Syenite waste should not be used as underdrain material or as fill in a drainage. For syenite to be used as suitable reclamation material, the cutoff criteria would be less than or equal to 0.2 % total sulfur, a paste pH of 6.5 or greater, and an NNP of 0 T $CaCO_3$/KT or greater. This requires an NP:AP ratio of 1 or greater.

6. Amphibolite/mafic gneiss, shale, dolomite or limestone with a total sulfur content equal to or less than 0.8 % and a paste pH of 6.0 or greater should be considered suitable for construction, fill, and reclamation purposes.

7. Documentation should be made of the rock type, alteration, total sulfur content, paste pH, NP and NP:AP ratio for all blastholes sampled. New data would be merged with the existing data set for further evaluation.

3.2.2.8 Unmineralized Geologic Materials

Clay Pits

Natural clay would be mined from local clay pits for construction of waste rock caps and waste and leach pad liner layers. Clays for the Landusky Mine would come from the Williams Pit, and are from either the Warm Creek or Mowry Formations. Clays for the Zortman Mine could be mined from the Seaford pit and represent the Bearpaw or Thermopolis Formations. These clays contain bentonite, and may contain significant concentrations of trace metals and relatively elevated total sulfur concentrations. Table 3.2-9 shows negative NNPs for all of the clay samples. However, it is unlikely that they would yield acid, since following compaction, they would have very low permeabilities. Also, given the nature of these sediments, it is likely that much of the total sulfur reported is actually present as sulfate and not sulfide.

Limestone Quarries

Limestone for the Zortman Mine would be mined from the LS-1 quarry and for the Landusky Mine from a quarry in the King Creek drainage (see Sections 2.9.2 and 2.9.4). These limestones are likely to have the following NNP ranges:

	NNP values, range
Bighorn dolomite/mudstone	508 to 977
Jefferson (?) mudstone	976
Maywood mudstone	958

The number of unmineralized samples is very limited for all of these lithologies - for the Jefferson and Maywood formations only one sample - thus conclusions about ABA properties are limited. However, the Bighorn, Jefferson and Maywood materials, especially where limey, would have considerable neutralization potential.

Other Unmineralized Lithologies

Much of the unmineralized amphibolite and Emerson shale has low acid generation potential and can supply considerable neutralization if used as remediation material. The average NNP for Landusky amphibolite waste in Table 3.2-7a was 48.9, and for Emerson shale waste was 138.5 T/kT. However, additional ZMI exploration and development data show unmineralized amphibolite NNPs up to 86.9 T/kT and those for shales up to 678.8 T/kT. Research by Kwong (1993) indicates that the minerals composing amphibolites are likely to weather more slowly than common carbonates. As such, the long-term buffering of these rocks should be determined through additional kinetic testing.

Foundation Materials

Several alternatives involve construction of leach pads and a new waste rock repository on Goslin Flats (see Section 2.9-1). These facilities would be placed on foundation materials that are bentonitic clays of the Thermopolis shale. These shales are thick and generally

TABLE 3.2-9

CLAY PIT MATERIALS
ABA CHARACTERISTICS

	Paste pH	Total Sulfur (%)	AP	NP	NNP
			(All in T/kT)		
Seaford Clay Pit	5.9	0.94	29	4.0	-25
Seaford Clay Pit	5.4	0.553	17	1.0	-16
Seaford Clay Pit	5.0	0.465	15	0	-16
Williams Clay Pit	3.2	2.710	85	0	-85
Williams Clay Pit	6.9	0.617	19	5	-14
Williams Clay Pit	6.7	0.642	20	13	-7
Williams Clay Pit	4.2	0.823	25.72	-5.74	-31.46

impermeable. Some interbeds in the Thermopolis are calcareous and would provide buffering capacity, but are unlikely to react with any possible spent ore leachates because of the low permeability of the shale. More importantly, the natural groundwater in these shales is generally of poor quality, i.e., high TDS, sulfate.

3.2.2.9 Geochemical Findings

1. ARD is currently being generated from pit walls and floors, leach pad foundations, and waste rock piles at the Zortman and Landusky mines.

2. The groundwater at Goslin Flats associated with the Thermopolis shale has naturally high TDS alkalinity and sulfate. The proposed leach pad site at Goslin Flats is on Thermopolis shale. This formation does not yield high quality groundwater. This leach pad foundation is unlikely to be a source of acid due to its fine-grained nature and relative impermeability.

3. Clays to be used in construction of caps and liners have relatively low NNPs, but when compacted would have very low permeabilities, Thus the clays are unlikely to be a source of acid. Older clay liners that have recently been excavated at Landusky show little alteration.

4. Ore produced as a result of the Zortman and Landusky mine expansions would have acid producing potential (Schafer 1994). Leachates, from spent ores would likely have alkaline pH's, relatively high TDS concentrations and high concentrations of elements mobile at alkaline pHs such as arsenic, selenium and molybdenum. However, as remnant sulfides react, subsequent leachates would probably become acidic and contaminated with dissolved metals (See 4.2.1.3).

5. Ore from the Pony Gulch deposit, due to its very high net neutralizing potential, could be used to mitigate leach pad effluent if placed at the bottom of the heap.

6. For waste rock at both mines, there is a direct relationship between percent sulfur and NNP. Almost all sulfur is reactive and excluding the limestone, amphibolite, shale and dolomite, the waste has very little neutralizing potential. For both minesites, waste samples having negative NNPs should be considered potentially acid generating. Therefore, use of total sulfur and NNP as parameters for segregating waste would be effective.

7. A correlation between NP:AP and the final humidity cell leachate pH exists. The correlation allows using an NP:AP of 1 or greater as a cut-off for suitable waste.

8. Where the paste pH was 6.0 or above, acidic pHs in humidity cell leachates were not produced. Samples with a paste pH less than 6.0 identified low sulfur rock types which had already gone acid or contained stored oxidation products. Therefore, use of paste pH as a parameter for segregating waste would be appropriate.

9. All low to medium sulfur, 0.8 percent or less, amphibolite appears to be non-acid forming and could be used for construction, fill or reclamation purposes. Additional long-term kinetic testing is in progress to better corroborate the amphibolite reactivity.

10. Syenite waste rock containing less than or equal to 0.2% sulfur and net neutralizing potential of 0 T/kT or greater, does not generate acid in sufficient quantities to affect revegetation, but could affect water quality if this waste is placed where contact with surface water is likely to occur.

11. Breccia and monzonite rock types, currently designated as "blue waste" by ZMI (see Section 2), may generate acid or contain oxidation products sufficient to generate low pH conditions and therefore are not considered suitable for any construction, fill, underdrain or reclamation purposes.

12. For other rock types: trachyte, quartzite and felsic gneiss, static data indicated that these rock types did have the potential to generate net acidity, however kinetic data was inconclusive. Therefore these rock types have been excluded from use as construction, fill, underdrain, or reclamation purposes.

13. Should an insufficient quantity of suitable waste rock exist, unmineralized limestone, dolomite, shale, and amphibolite with high NNPs would be available for construction, reclamation, or remediation activities in sufficient quantity to provide for completion of any alternative.

14. Underdrains and unlined pond systems should be built with unmineralized limestone or dolomite.

3.2.3 Surface Water

Drainages in the Little Rocky Mountains are typically steep and ephemeral (flow for only a short time, on occasion) within their upper reaches, becoming sediment-laden and intermittent (with more occasional flow, but yet discontinuous) once reaching the flanks of the mountains.

The major streams and tributaries in the Zortman Mining area are shown on Exhibit 1 (in EIS map pocket). Ruby Creek is the major drainage in the Zortman Mine area, flowing south approximately 25 miles to the Missouri River. Within the Ruby Creek drainage, several tributaries drain existing mining operations or proposed mine developments. These tributaries are:

- Alder Gulch
- Carter Gulch
- Alder Spur
- Pony Gulch
- Goslin Flats

Tributaries draining the northeastern side of the Zortman Mining operation flowing towards the Milk river are:

- Lodgepole Creek
- Beaver Creek

Most facilities associated with the Zortman mine are located within Ruby Gulch watershed. Existing mining facilities in the Ruby Gulch drainage include the largest portion of the Zortman pits, the 1989 leach pad, portions of the 1979-1982, and the 1985-1986 leach pads, and buttress. Ruby Gulch is also the location of historical disturbance and deposition of approximately 350,000 cy of historic mill tailing.

Above the town of Zortman, Ruby Gulch is intermittent, flowing in and out of the thick deposit of historic mine tailing that fills the valley bottom. Surface water seldom reaches the town of Zortman, except during large precipitation events, or snow melts. During the period from 1989 to 1992, flows measured at location Z-1, in upper Ruby Gulch, ranged from 13 gallons per minute (gpm) to approximately 670 gpm. Flows measured at Z-15, near the central segment of Ruby Gulch, ranged from 0 to 250 gpm during the same years. High flows during unusually large precipitation/runoff events in the spring and summer, transport large amounts of coarse tailing material along Ruby Gulch, through the town of Zortman, and into lower Ruby Creek.

Tributaries to Alder Gulch contain several mining related facilities and would contain the Alder Gulch leach pad under Alternative 5. Alder Gulch also receives some minor drainage from a few historic adits. The uppermost reaches of the main channel of Alder Gulch are ephemeral, the drainage then becomes intermittent flowing only seasonally, or in response to major precipitation events or snow melts. The steep-sided channel consists of sedimentary material ranging in size from fine sand to boulders which have been previously disturbed by placer mining. Surface water flow gradually infiltrates into alluvium as it moves downstream, and as a result Alder Gulch is typically dry once reaching its confluence with Pony Gulch. Runoff from significant rainfall, such as that which occurred in 1986, 1988, and 1993, may transport large amounts of very coarse material down the lower portions of Alder Gulch.

Carter Gulch currently drains the existing Alder Gulch waste rock dump and would be almost entirely filled by the proposed Carter Gulch waste repository under Alternative 5. The drainage is intermittent, incised and contains little sediment in the valley bottom.

Alder Spur receives drainage from 1983/1984 leach pads and portions of the 1979-1982 pads and buttresses. Alder Spur is intermittent, steeply incised and contains little sedimentary material in the valley bottom.

The Pony Gulch drainage does not contain any Zortman Mining related mining facilities but does drain an area of historic mining at the head of its drainage. Pony Gulch is generally intermittent, but contains a 1,000-foot spring-fed reach located about one-half mile upstream of the mouth of the stream, flow in this reach is approximately 5 gpm.

Goslin Flats is a tributary of Ruby Creek located between Whitcomb Butte and Saddle Butte, Goslin Flats joins Ruby Creek approximately three miles southeast of the town of Zortman. No mine workings or facilities are presently located in the Goslin Flats drainage area. Under some Alternatives, a conveyor system would extend from the mine pit area across Alder Gulch to Goslin Flats, and a heap leach pad would be constructed in Goslin Flats (see Chapter 2.0). Channels in the upper portions of Goslin Flats are steep-sided and ephemeral becoming well vegetated and poorly defined in the lower sections. At least three alluvial, spring-fed stock ponds have been constructed in the lower channel. Outflow from these ponds produces small surface flows of approximately 5 to 10 gpm for short reaches, in channels which are otherwise typically dry.

The Lodgepole Creek watershed is the major drainage of the northern slopes of the Zortman Mining area flowing north toward the Milk River. Disturbances to the Lodgepole Creek drainage are limited to a portion of the Ruby and Ross pits; however, mining of these pits has modified this portion of the drainage, diverting precipitation back into the pit complex where it drains internally. The drainage area diverted is estimated at 26 acres, approximately 0.6 percent of the total Lodgepole drainage area. Flow in the upper portion of the Lodgepole Creek is intermittent. Glory Hole Creek, a tributary channel to upper Lodgepole draining the northern portion of current Zortman Mine operations is also intermittent in flow. The volume of flow in Lodgepole Creek generally increases as the stream approaches the Fort Belknap Indian Reservation, deriving additional volume from numerous tributaries upgradient of the Reservation boundary.

Similar to Lodgepole Creek, Beaver Creek is a major drainage for the northern and eastern aspects of the Little Rocky Mountains. Some historic hard rock mining is reported to have taken place in the Beaver Creek drainage, but no present day or proposed mining activity is associated with the catchment. Flow is intermittent in the uppermost reaches, with discharge from several upland channel springs varying seasonally. The channel becomes perennial (runs throughout the year) approximately one mile downstream in a reach containing numerous beaver dams, which store significant quantities of water. Flow in Beaver Creek at the Reservation boundary is perennial.

3.2.3.2 Streams and Tributaries - Landusky

The major streams and tributaries in the Landusky area are shown on Exhibit 2 (in EIS map pocket). The southern portion of the Landusky mining area is drained entirely by Rock Creek and its tributaries. Major tributaries to the upper Rock Creek include:

- Sullivan Creek
- Mill Gulch
- Montana Gulch

Tributaries draining the northern portion of the Landusky mining operation are:

- Swift Gulch
- King Creek

The upper portion of Sullivan Creek is ephemeral, with a narrow, steep channel composed of gravels and cobbles. The major mining related facility located in this drainage is the 1991 (Sullivan Park) heap leach pad.

The Mill Gulch drainage area currently contains the 1987 (Mill Gulch) leach pad, the Mill Gulch waste dump, as well as the Landusky processing facility. The expanded 1987/1991 leach pad could be partially located in Mill Gulch and Sullivan Creek watersheds. Mill Gulch is an ephemeral stream in its upper and lower reaches, but has a middle segment that is intermittent. An alluvial spring located in this middle segment, flows at approximately five to ten gallons per minute for most of the year and causes Mill Gulch to flow for about 1,000 feet before infiltrating into the creek bed gravels. Mill Gulch is steep for most of its length, attaining a relatively flat gradient at its confluence with Rock Creek at Landusky. The channel is typically narrow, with a bed consisting of gravels, cobble, boulders, and occasional bedrock.

Facilities found within the Montana Gulch drainage include the 1983, 1984 and 1985/1986 leach pads, the Montana Gulch Waste Rock Dump, and the Gold Bug Pit/Waste Repository. Montana Gulch is an ephemeral, steep drainage in its upper reaches, and at its confluence with the Gold Bug adit discharge becomes perennial. The streambed in the middle and lower portions of Montana Gulch varies from bedrock to fine sandy sediments. The Gold Bug adit, while essentially a groundwater source contributes a relatively constant flow (between 0.75 and 1.0 cfs or about 337 - 449 gpm) and contributes the majority of the base flow in Montana Gulch and Rock Creek for a distance of approximately three miles (DSL 1979a).

Below the confluence of Montana Gulch, Rock Creek becomes intermittent and contains numerous beaver dams. Base flow in Rock Creek is a combination of Gold Bug adit water (Montana Gulch), springs located on the Kolczak Ranch, and springs near the Little Rocky Mountains Camp.

King Creek joins South Bighorn Creek approximately 2 miles from the King Creek headwaters. South Bighorn flows for close to 3/4 of a mile before its confluence with the south fork of the Little Peoples Creek. Little Peoples Creek then exits the Little Rocky Mountains just southeast of the town of Hays.

Upstream of South Bighorn Creeks confluence with King Creek there is another tributary locally known as Swift Gulch which drains a portion of the northern side of the Landusky mining operation. Mine disturbances within this drainage are limited to a portion of the Queen Rose pit and some roads.

The King Creek drainage basin contains the August pit, portions of the Gold Bug and Queen Rose Pits, and a portion of the Montana Gulch waste rock repository. King Creek's upper segment is steep, ephemeral, and intersects a number of past mining disturbances, including the August mine, waste dump, tailing and associated roads. During high flow periods, King Creek and its smaller tributaries have in the past actively eroded tailing within the drainage, creating a steep-sided and unstable creek channel easily eroded during subsequent high flows. ZMI removed an estimated 75 percent of the tailing derived from the historical mining activities in the early to mid 1980's. In 1993, ZMI removed the majority of the remaining tailing from the upper reaches of King Creek above the tailing dam in an effort to further reduce the amount of tailing washing downstream. An investigation (WESTECH 1978) showed that King Creek was flowing about 20 gallons per minute as it entered the Fort Belknap Indian Reservation, and that tailing are a significant part of the stream channel well into the Reservation.

3.2.4 Groundwater

Occurrence and distribution of groundwater in the Zortman and Landusky mine areas is closely related to both local and regional geology. Groundwater resources are influenced by several geohydrological units, including syenite porphyry (the host rock of the gold deposits), the Madison formation (limestone) and recent alluvial deposits.

The major aquifer surrounding the Little Rocky Mountains is the Madison Group. The Madison Group (also called the Madison Limestone where it is not divided) is composed of two formations in the study area (see Figures 3.1-1, 3.1-2). The lower is the Lodgepole Formation, and the upper is the Mission Canyon Formation. In the Little Rocky Mountains, the Lodgepole Limestone is about 478 feet thick, and the Mission Canyon Limestone is 325 feet thick (Feltis 1983). The Mission Canyon Limestone forms great ridges at the outer rim of the Little Rocky Mountains, as well as several prominent ridges and buttes within the mountainous area and in the foothills (Feltis 1983).

It is observed that, in general, groundwater within the Little Rocky Mountains flows radially away from the topographic highs. Groundwater is recharged throughout the Little Rocky Mountains including the open pit areas. Some of this recharge, discharges to surface water in seeps throughout the length of the drainages and from springs on the flanks of the Little Rocky Mountains. In lower portions of the drainages with proposed operations, the Mission Canyon Limestone lies near the surface, or is exposed as in Ruby and Alder Gulches near the town of Zortman. Outcrops of Madison Limestone also occur within the Landusky mining area along the stream bottoms of Mill Gulch, Rock Creek and Montana Gulch, in sections ranging from 500 to 3,000 feet in length (Knectel 1959). Although some recharge to the Madison Group occurs from precipitation on the flanks of the Little Rocky Mountains and by infiltration from streams, the principal regional source of recharge for the Madison Group are the vast outcrops of the Big Snowy and Little Belt mountains further to the south (Feltis 1983). In Goslin Flats, south of Zortman, the alluvium is underlain by more than two hundred feet of low permeability Thermopolis shale which in turn overlies the Madison Group limestone.

Alluvium varies in thickness throughout the length of the gulches of the Little Rocky Mountains. For example, in Alder Gulch, alluvial material varies in thickness from 10 feet at its headwaters, to as deep as 50 feet below its confluence with Pony Gulch. Bedrock is primarily fractured syenite porphyry near the head of the drainages. Cretaceous shales and siltstones occur once the drainage system enters flat prairie at the periphery of the Little Rocky Mountains (see Section 3.1).

Water level data are gathered by ZMI from all monitoring wells during sampling events; monitoring well locations are shown on Exhibits 1 and 2 (EIS map pocket). Monitoring wells located within the Little Rocky Mountains are predominantly located near to or at the base of the valleys. This distribution makes the definition of a bedrock potentiometric surface (groundwater surface pattern) difficult and potentially unreliable. However, given the steep topography it is expected that the groundwater potentiometric surface will generally reflect the surface topography with flow from topographic highs to valley lows. Deviations from this pattern are noted at higher elevations within the porphyry syenite, where the mine pits, numerous historical mine adits and shafts have intersected water-bearing zones and highly fractured mineralized rock. The direction and rate of groundwater flow in the bedrock is also affected by faults, hydrothermal alteration, geologic contacts, and variabilities in porosity.

Observations of groundwater seepage at the head of Ruby Gulch suggest that a significant portion of the groundwater recharged in the pits flows southeasterly towards Ruby Gulch, possibly along fractured rock pathways resulting from faulting of the porphyry intrusive rock. Some of the groundwater draining into the bedrock may also drain to the north, although no geochemical evidence (ARD contamination) of such a flow is observed at the available surface water and groundwater monitoring stations to the north of the pit complex. The third component of groundwater flow is a deep near vertical recharge route into the porphyry bedrock and eventually to the sedimentary formations surrounding the Little Rocky Mountains.

At Landusky the exposure of historical mine workings in the pits, and the large volumes and near constant flow of water from the Gold Bug Adit, suggest it must be having a substantial effect on the water table in the vicinity of the Gold Bug Pit.

A recent study of the groundwater conditions for the proposed expansion of the August Pit indicates that the northeast oriented shear zones are the principal features controlling groundwater flow in that area. Further to the southwest, it appears the August Drain Adit is providing an efficient drainage outlet for the intrusive rocks. In addition, the high water level elevation measured in 95LH-010, at 4,633 feet may indicate the water in the Suprise Shear Zone is draining naturally toward the northwest, toward Peoples Creek (Water Management Consultants, 1995). In general, groundwater elevations in the vicinity of the August Pit range from about 4,625 feet to 6,634 feet (approximately 190 feet below the current ground surface). A zone of higher (perched) groundwater elevations has been encountered in the Narrows Fault Zone. Water elevations in this area are at approximately 4,770 feet, some 140 to 150 feet above the water elevation in the main shear zone. Spring L-5 in King Creek may be the result of discharge from this perched groundwater (Water Management Consultants, 1995).

Monitoring wells constructed in alluvium and bedrock at the town of Zortman and further downstream at Goslin Flats, show the alluvium to be unsaturated and the limestone bedrock to have vertical downward gradients. These downward gradients increase the potential for surface water and alluvial groundwater to recharge the Madison limestone. The decrease in the volume of water observed in the streams and alluvium at these downstream locations, suggests a significant proportion of the flow is currently intercepted by the limestone units.

Many springs occur along the flanks of the Little Rocky Mountains. Most of the springs are fed through precipitation and infiltration into exposed limestones as evidenced by the quick reaction of spring flow to the precipitation events in the mountains (Feltis 1983). Data from oil well drill stem tests on the Fort Belknap Reservation and monitoring wells installed as part of U.S.G.S. Water Resources Investigation 93-4193 show the potentiometric surface of water in the Madison Group limestones and overlying formations to be near ground level and artesian in many cases. These artesian conditions reduce the potential for infiltration of any impacted surface water on a regional scale, i.e., once outside the Little Rocky Mountains limits.

In summary, key points concerning groundwater flow in the Zortman and Landusky study areas are:

- Downward hydraulic gradients exist in the upper levels of the Little Rocky Mountains, allowing infiltration and recharge directly into the permeable metamorphic and volcanic rocks at higher altitudes in the Little Rocky Mountains.
- The Madison Group limestones exposed within the Little Rocky Mountains have received relatively minor amounts of recharge by waters impacted by mining activities. This recharge is facilitated by downward vertical gradients in the rocks exposed in the streambeds.
- The overlying low permeability shales and the upward hydraulic gradients within the Madison Group Limestone reduce the potential for direct recharge once outside the Little Rocky Mountains.
- Springs flanking the Little Rocky Mountains are recharged by infiltration at higher elevations, reflecting the upward hydraulic gradient in the vicinity of the springs.
- The Gold Bug and August Adits have a significant effect on groundwater flow directions in the upper elevations of the Landusky mining area, effectively draining the overlying groundwater to a level well below the present bottom of the Landusky Pits and discharging it to the Montana Gulch drainage in the Landusky pit complex. Elevated or perched water suggest that some Landusky pit water may drain to the north.

3.2.5 Water Quality

3.2.5.1 Surface Water Quality

Data Sources

Surface water flow and quality data have been collected periodically by Hydrometrics and Zortman Mining from monitoring sites in the mining area since 1979. This baseline monitoring effort has developed into a long-term sampling program at a number of sites with the objective of detecting long-term changes in the hydrological systems within and peripheral to the mining area. General surface water resources data are presented in the Zortman and Landusky Water Resources Annual Monitoring reports (AMR) prepared for ZMI by Hydrometrics (ZMI 1982 through 1994). Additional flow and surface water quality data has been gathered periodically by the BLM, Montana Department of State Lands (DSL), United States Geological Survey (USGS), data was also collected prior to Zortman Mining activity as part of the 1979 Zortman/Landusky EIS (Botz and Gartner 1978).

Surface water monitoring has developed into a network of approximately 63 stations, positioned throughout the length of drainages containing mining related activities and within several drainages currently not affected by mining. As of 1994, baseline monitoring is carried out on a quarterly basis with operational data being gathered from selected wells on a monthly and in some cases a daily basis. As part of this EIS, all available monitoring data has been compiled and reviewed in order to assess baseline (pre 1979) and existing groundwater and surface water quality and surface water flow conditions in both current mining areas and proposed extension areas.

The following water quality parameters are recognized indicators of ARD and releases of gold processing chemicals, and form the basis of the review of surface water quality.

- pH - A low pH (<6.0) acidic water may be an indicator of ARD, while a high alkaline pH value (>8.5) may signify a release of process liquids within the operation facilities

- Metals - A number of metals are commonly mobilized (go into solution) upon contact with acidic fluids. These include Arsenic (As) which is soluble at a wide range of pHs, Iron (Fe) common at relatively high concentrations, Lead (Pb), Nickel (Ni), Zinc (Zn), Cadmium (Cd), Copper (Cu), and Aluminum (Al).

- Total dissolved solids (TDS) - The concentration of dissolved constituents in the water can increase exponentially as the solution pH decreases, so an increase in TDS over time may indicate the development of ARD

- Sulfates - Sulfate is a product of the oxidation of pyrite and other metal sulfides. An increase in sulfate concentration in surface or groundwater can signify the existence of acid rock drainage contamination. The effect of metal sulfide oxidation on groundwater is sometimes more subtle than on surface waters, as the iron released may be precipitated or lost by cation exchange and the sulfate may be lost by reduction as water moves through the aquifer (Hem, 1992).

- Specific conductivity (SC) - As with TDS, an increase in SC signifies an increase in the proportion of dissolved constituents.

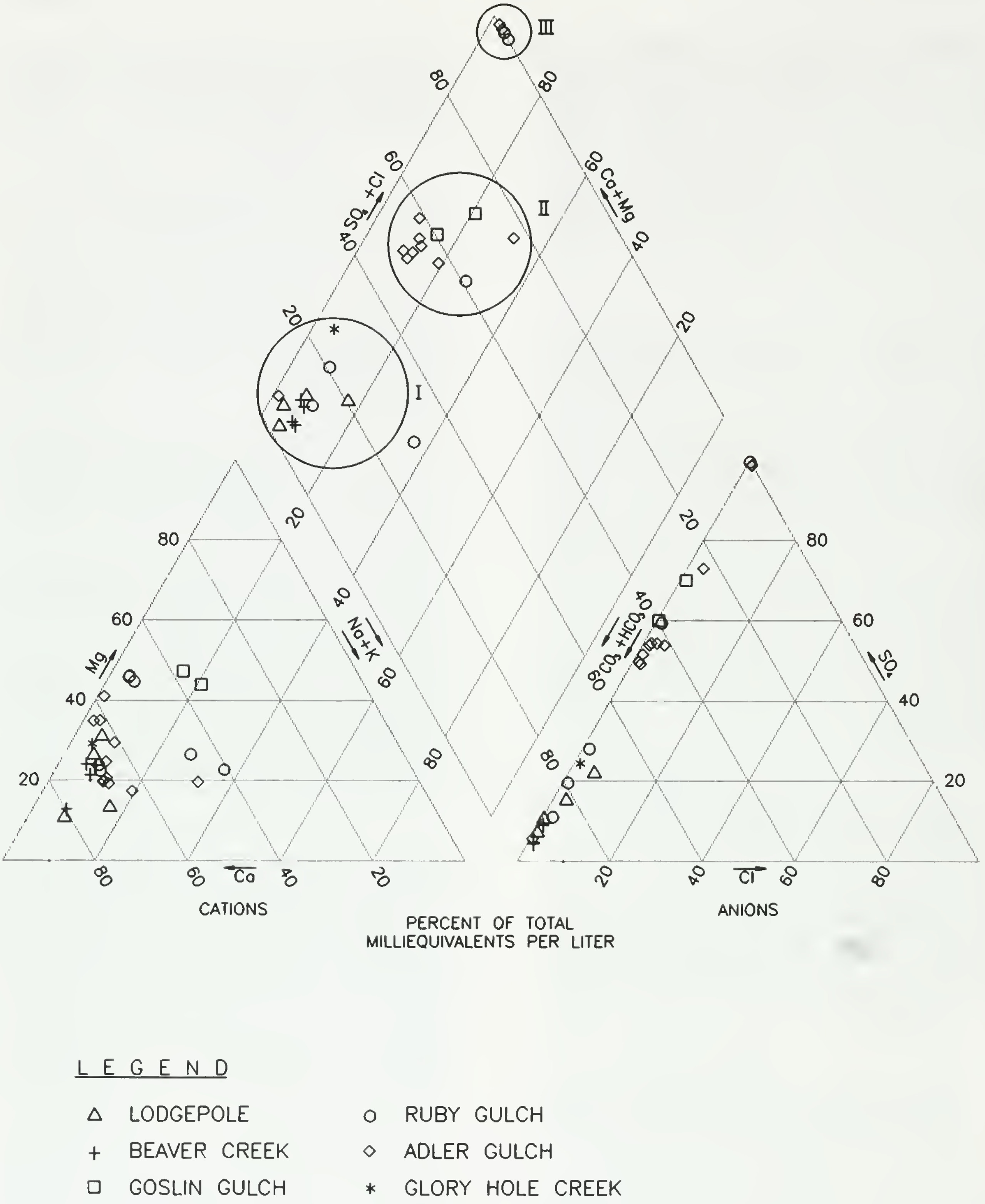
- Cyanide - Cyanide solutions are used in the heap leach gold recovery process. Detections of cyanide or its nitrogen breakdown forms (nitrate, nitrite, ammonia) in surface and groundwater downgradient of a facility indicates a problem with the cyanide containment system.

- Nitrates and Nitrites - As well as being a breakdown product of cyanide, nitrate is present in most mined material due to the use of ANFO as a blasting agent. Nitrate can also be derived from fertilizers used during reclamation.

- Total suspended solids (TSS) - An increase in TSS may represent erosion events or disturbances to land surfaces within the drainage.

Tables and graphics are used in this EIS to illustrate water quality changes over time and the variation in water quality within a particular drainage area. The major ion chemistry of surface waters from the Zortman and Landusky mining areas are summarized on Figures 3.2-9 and 3.2-10, respectively.

The surface waters from the Zortman Mining area fall within three general groups depending on their percentage sulfate (Figure 3.2-10). Elevated sulfate is discussed above as a product of ARD. Surface waters plotting in group one include Lodgepole, Beaver and Glory Hole Creeks, as well as some samples from Ruby and Alder Gulches. These waters are of a calcium carbonate and represent baseline surface water chemistry for the Little Rocky Mountains with little or no signs of impacts from ARD. Group two includes waters from Ruby and Alder Gulches and Goslin Flats. Waters from Ruby and Alder Gulches have higher levels of sulfate than those in group one due to the impact from ARD. Goslin Flats has a naturally high sulfate content due to interaction with the mineral rich shale bedrock; these waters are of a general magnesium sulfate type. Finally, group three consists of highly impacted waters from Ruby and Alder Gulches, their chemistry being dominated by sulfate.

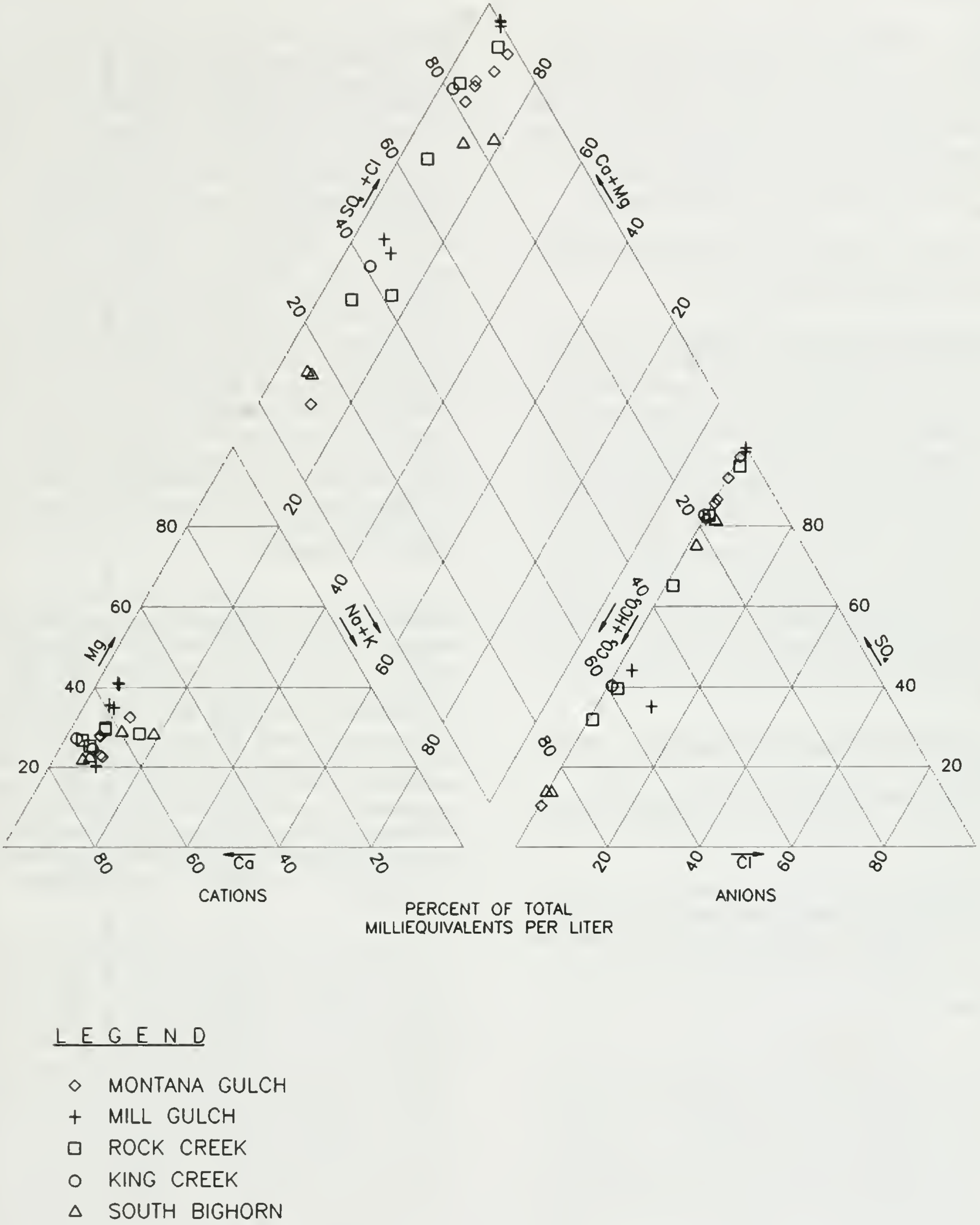


SOURCE: ZMI WATER QUALITY
MONITORING REPORTS

PIPER TRILINEAR PLOT FOR
ZORTMAN MINE SURFACE WATER
SAMPLED MAY 1994

ZORTSW

FIG. 3.2-9



SOURCE: ZMI WATER QUALITY
MONITORING REPORTS

PIPER TRILINEAR PLOT FOR
LANDUSKY MINE SURFACE WATER
SAMPLED MAY 1994

FIG. 3.2-10

The Landusky surface water data, plotted on Figure 3.2-10, shows the waters to also be of a calcium sulfate type. With the exception of King Creek, waters from Montana Gulch, Mill Gulch, Rock Creek and South Bighorn are spread along the sulfate axis depending on the degree of impact from ARD, the sulfate content decreasing with distance downstream due to dilution and attenuation of sulfate complexes.

The surface water quality of each drainage within the Little Rocky Mountains will be discussed in detail within the remainder of this chapter.

Baseline Surface Water Quality - Pre-1979

Table 3.2-10 summarizes all the available baseline "pre 1979" surface water data. Because mining activity has been ongoing since the early 1900's in the Little Rocky Mountains, water quality data gathered prior to Zortman Mining activity is defined as "baseline" rather than "background" as the water chemistry may have already been impacted by the effects of mining activity. The record shows Montana Gulch, Rock Creek and King Creek at Landusky to have had the highest SC, TDS and sulfate concentrations. Although few metal analyses are available from the pre-1979 samples, the baseline range of concentrations measured for selected water quality indicators is pH (6.9 to 8.4), SC (315 to 559 μmhos/cm), TDS (53 to 432 mg/l) and sulfate (8 to 134 mg/l).

Zortman Surface Water Quality - 1979 to 1994

Surface water monitoring stations found within the Zortman mine area are shown on Exhibit 1 (in EIS map pocket).

Ruby Gulch. Surface water quality data from Ruby Gulch has been reviewed from stations Z-1, Z-37, Z-10, Z-11, Z-15 (in the upper reaches), Z-1B (above the town of Zortman), Z-17 and Z-18 (below the town of Zortman) and Z-32, Z-33 and Z-34 (in the Ruby Flats area).

Representative surface water quality from throughout the length of Ruby Gulch is summarized in Table 3.2-11. Pre-1979 (baseline) data are available from monitoring station Z-1 only, in the upper reaches of Ruby Gulch. Data from Station Z-1 show the surface water to have had a pH of 7.4 and sulfate and TDS concentrations of 110 and 190 mg/l respectively in 1978, suggesting only minimal, if any, ARD effects from historical mining activity in the drainage. However it should be noted that Ruby Gulch has been choked with historic tailing since this time.

At sampling locations in the upper and middle reaches of Ruby Gulch (Z-1 and Z-15), impacts from ARD have been pronounced up until the fall of 1994, with depressed pHs and elevated concentrations of sulfate, TDS and metals. In the fall of 1993 stations Z-1 and Z-15 had pHs of 3.0 and 2.5, SC of 1170 and 2810 μmhos/cm and sulfate concentrations of 615 and 2080 mg/l, respectively. Figure 3.2-11 illustrates the changes in water quality at Z-1 since 1978. Although there is some variability in pH values, most pHs reported for the surface water samples from Ruby Gulch in 1992 and 1993 are below 5.0 and many are below 4.0. At station Z-1 total recoverable metal (trc) concentrations have exceeded Acute Chronic Aquatic Life Standards and/or Human Health criteria in the majority of samples for manganese, nickel, zinc and occasionally arsenic between 1979 and 1994. Cyanide has also been detected in the majority of the samples taken since 1978 at station Z-1. The deterioration of the surface water quality is clearly illustrated by the increase in sulfate and TDS concentrations shown on Figure 3.2-11 reaching maximums of 3,330 mg/l and 6,940 mg/l, respectively.

Monitoring station Z-1 is located downstream of the 89 leach pad, the 85/86 pad, the process plant and the mine pits. The poor surface water quality recorded at monitoring station Z-1 is closely related to the poor quality of the water seeping out of the 1985/1986 leach pad underdrain at the head of Ruby Gulch. There are several possible sources for this contaminated water. ARD seeping through from the Zortman pit walls and/or floor, ARD originating from rock used in the construction of the underdrains for 1985/86 leach pad, ARD originating from sulfide bearing rocks excavated to place the 1985/86 leach pad, or possibly acid generating material used in the construction of the 1985/1986 leach pad buttress.

The quality of the water at the head of Ruby Gulch decreased significantly during 1985 with the pH at monitoring station Z-1 falling from 6.0 to 2.8 and TDS rising from 198 to 1170 mg/l (Figure 3.2-11). This decrease in water quality correlates directly with the construction of the 1985/1986 leach pad suggesting that a significant proportion of the ARD is in fact derived from the underlying disturbed bedrock, the materials used in the construction of the underdrains and or the buttress. However, cyanide was first detected at station Z-1 during 1981, prior to construction of the leach pad and appears to have derived from spills and or leaks at the process plant. The correlation of the decreased water quality with construction of the 1985/86 leach pad indicates that this is the primary source of the ARD, although the recharge water itself likely infiltrates

TABLE 3.2-10

SURFACE WATER BASELINE WATER QUALITY (PRE-1979 DATA)

	Zortman												
	Ruby Gulch	Alder Gulch		Lodgepole Creek		Montana Gulch	Rock Creek		King Creek		Summary Statistics		
	Z-1 Upstream (1978)	Z-2 Upstream (1978)	Z-8 Midstream (1978)	Z-6 Below Developed Spring (1977)	Z-7 Above Reservation Boundary (1978)	L-2 Downstream (1977)	L-1 Downstream (1977-1978)		L-5 Upstream (1978)	L-6 Downstream (1978)			
No. of Samples	1	1	1	1	1	1	3		1	1	n	Minimum	Maximum
							Range	$\bar{\chi}$					
pH	7.4	7.8	7.6	7.5	8.0	8.4	7.9-8.2	8.0	6.9	7.5	11	6.9	8.4
SC μmhos/cm	325	315	370	360	375	330	395-559	501	490	525	11	315	559
TDS mg/L	190	183	206	NA	NA	NA	53-432	199	291	306	8	53	432
TSS mg/L	9.0	1.0	1.0	<1.0	<1.0	NA	11-11	11	NA	NA	6	1	11
SO$_4$ mg/L	110	74	70	12	8	61	53-112	82	134	95	10	8	134
CN mg/L	NA	NA	NA	NA	NA	ND	ND		NA	NA	0	0	0
NO$_2$/NO$_3$ mg/L	NA	NA	NA	NA	NA	NA	ND		NA	NA	1	0.03	0.03
NH$_3$ mg/L	NA	NA	NA	NA	NA	NA	NA		NA	NA	0	0	0
Hardness as CaCO$_3$ mg/L	139	139	168	178	183	NA	NA		231	245	7	139	245
Ca mg/L	41	44	50	46	52	NA	NA		70	77	7	41	77
Mg mg/L	9.0	7.0	10	15	13	NA	NA		14	13	7	7	15
K mg/L	2.0	2.0	2.0	1	2	NA	NA		2	2	7	1	2
Na mg/L	8.0	10	10	3	6	NA	NA		8	13	7	3	13
Cl mg/L	5.0	4.0	4.0	1	4	NA	NA		3	4	7	1	5
HCO$_3$ mg/L	31	85	122	207	220	NA	NA		122	207	7	31	220
Al mg/L	NA	NA	NA	NA	NA	NA	NA		NA	NA	0	0	0
As mg/L	NA	ND	(trc) 0.007	NA	(trc) <0.002	0.11	NA		NA	(trc) 0.01	3	0.002	0.01
Cd mg/L	NA	ND	NA	NA	NA	NA	NA		NA	NA	0	0	0
Fe mg/L	NA	NA	0.11	NA	0.03	NA	NA		NA	(trc) 0.17	3	0.011	0.17
Pb mg/L	NA	NA	NA	NA	NA	NA	NA		NA	NA	0	0	0
Mn mg/L	NA	NA	NA	NA	NA	NA	NA		NA	NA	0	0	0
Zn mg/L	NA	NA	NA	NA	(trc) <0.01	NA	NA		NA	NA	1	0.01	0.01

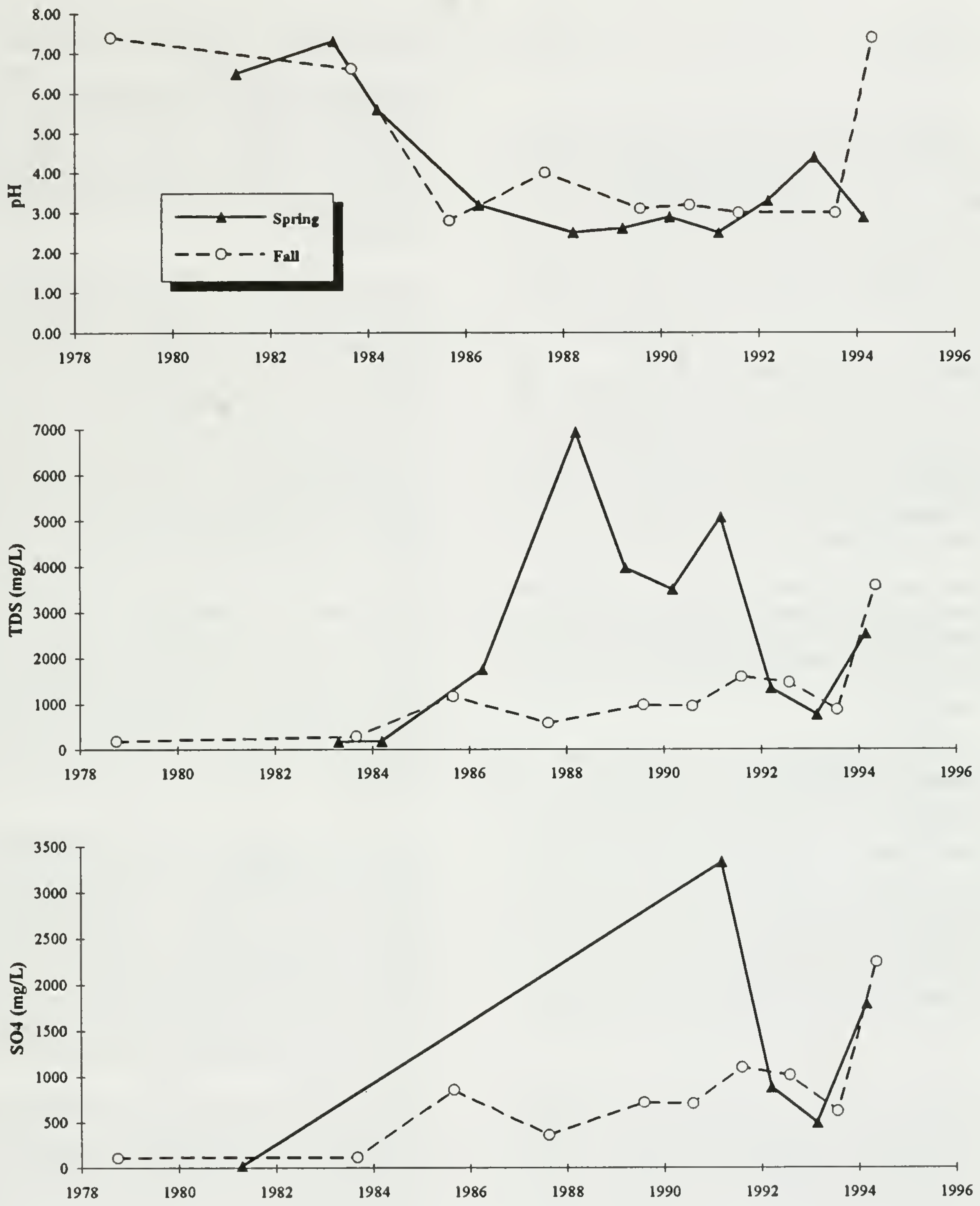
Data as dissolved concentrations unless otherwise stated.
TRC = Total Recoverable

TABLE 3.2-11

RUBY GULCH SURFACE WATER QUALITY SUMMARY

BASELINE (PRE 1979)		OPERATION (POST 1979)					
		Z-1 Upstream (1979-1994)		Z-1B Midstream (1990-1994)		Z-32 Downstream (1990-1994)	
	Z-1 Upstream (1978)	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	1	47		13		9	
pH S.U.	7.4	2.5-7.4	4.0	4.7-6.7	5.5	4.7-8.2	7.3
Sc μmhos/cm	325	175-4,990	1,912	197-2,340	1,351	791-1,310	983
TDS mg/L	190	176-6,940	2,132	131-2,450	1,338	518-1370	760
TSS mg/L	9.0	0.5-6,550	327	39-4,000	1,420	3-5810	1459
SO_4 mg/L	110	25-3,330	1,224	212-1,480	671	195-849	399
CN mg/L	NA	ND-1.38	0.11	ND-0.008	0.004	ND-0.01	0.0025
NO_2/NO_3 mg/L	NA	0.32-23.4	3.9	ND-3.01	1.04	0.025-1.22	0.62
NH3	NA	ND-0.7	0.12	ND		ND	
Hardness as $CaCO_3$ mg/L	139	102-2,220	602	95-1,419	793	408-794	523
Ca mg/L	41.0	26-817	162	28-430	192	104-237	151
Mg mg/L	9.0	7-107	53	6-79	34	34-49	39
K mg/L	2.0	0.5-3.0	1.5	2-7	3.5	3-5	4.0
Na mg/L	8.0	8-82	20	3-23	11.8	11-37	23
Cl mg/L	5.0	0.5-29	6.5	0.5-42	11.0	2-5	3.6
HCO_3 mg/L	31.0	0.5-107	26	0.5-108	16	2-374	246
Al mg/L	NA	(trc)5.2-288	106	(trc) 1.7-81	37	(trc) ND-64.1	21.4
As mg/L	NA	(trc)ND-0.24	0.05	(trc) 0.01-0.13	0.07	(trc) ND-0.18	0.06
Cd mg/L	NA	(trc)ND-0.35	0.11	(trc) ND-0.09	0.04	(trc) ND-0.12	0.04
Cu mg/L	NA	(trc)0.03-14.8	4.18	(trc)0.02-1.34	0.50	(trc)ND-2.76	0.92
Fe mg/L	NA	(trc)0.09-247	48	(trc) 2.4-43	15.3	(trc) 0.09-68	22.7
Pb mg/L	NA	(trc)ND-0.06	0.01	(trc) ND-0.17	0.07	(trc) ND-0.19	0.07
Mn mg/L	NA	(trc)0.01-27.6	11.1	(trc) 0.11-15.7	8.0	(trc) ND-16.4	5.6
Zn mg/L	NA	(trc)0.02-9.0	2.5	(trc) 0.08-13.5	5.6	(trc) 0.005-8.05	2.7

NA = Not Analyzed
ND - Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION Z-1
UPSTREAM RUBY GULCH

FIG. 3.2-11

through the pit floor and flows towards Ruby Gulch downgradient and along paths of preferential permeability.

Above and below the Zortman town site (surface water sampling locations Z-IB and Z-17), there are indications that ARD effects may be less severe, with some near-neutral pHs being reported for samples from sites Z-1B and Z-17. However, numerous pHs below 5.0 have been recorded at these stations along with elevated concentrations of sulfate, TDS, SC and metal concentrations. Cyanide was detected in all three samples taken from Z-17 during 1990 and 1991 with an average concentration of 0.022 mg/l total cyanide.

Data from the farthest downstream monitoring point for Ruby Creek (Z-32) has been gathered since 1990. The record shows moderate effects from mining activity with pHs ranging from 4.7 to 8.2, SC from 791 to 1,310 μmhos/cm, and sulfate from 195 to 849 mg/l (Figure 3.2-12). ARD impacts only appear to reach this far downstream after specific events, such as extreme rainfall or snowmelt.

Water quality monitoring throughout the length of Ruby Gulch records an event in the spring of 1991 which impacted the quality of the surface water for a period of several months causing elevated concentrations of sulfate, TDS, SC and detectable levels of cyanide (Figure 3.2-12).

In order to improve the water quality within the Zortman area tributaries, ZMI have constructed and brought on line a water capture and treatment system, capturing water from Ruby Gulch and Alder Spur and Carter Gulch. Ruby Gulch currently contributes approximately 80 percent of influent (on average 80 gpm) and receives all of the water after treatment. The plant provides treatment by the use of a simple hydroxide precipitation process and can operate at a rate of 200 to 2,000 gpm depending on precipitation and seasonal operating conditions. Details regarding the water treatment plant are provided in Section 2.6.11.6.

Figure 3.2-13 illustrates the change in pH and SC at Station Z-1 (upper Ruby Gulch) once the treatment process was initiated. An immediate increase in pH can be seen, although a reduction in the specific conductivity was not attained until August 1994. Table 3.2-12 shows the levels of metals at surface water monitoring stations Z-1 and Z-15 approximately 1,600 feet downstream, prior to and after initiation of water treatment. The significant concentrations of aluminum and iron are effectively removed from the water down to below detection limits; the more moderate levels of copper, zinc and manganese are also reduced significantly.

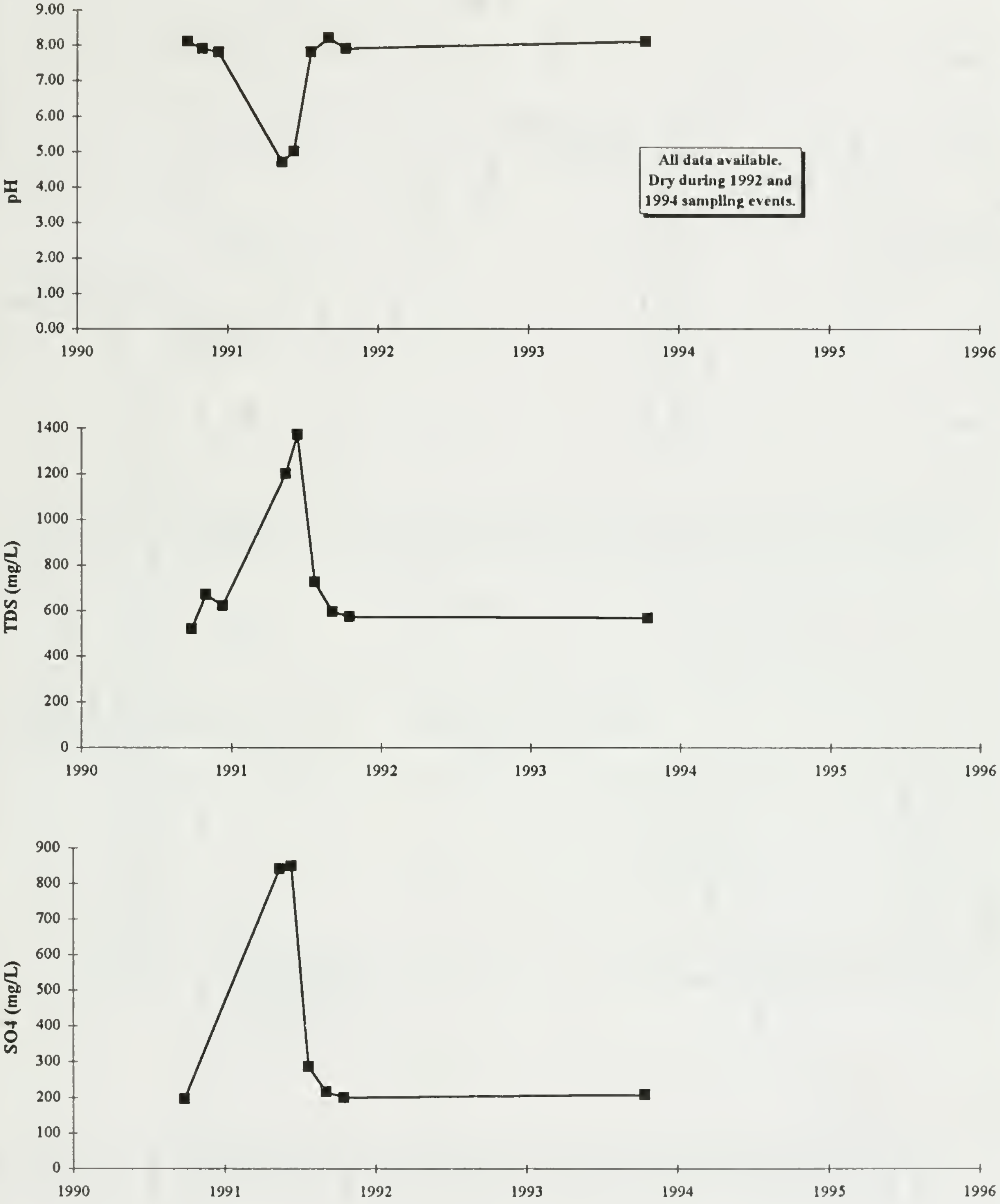
Alder Gulch, Carter Gulch and Alder Spur. Surface water quality data for the Alder Gulch drainage was reviewed from Stations Z-3 (toe of the Alder Gulch waste dump), Z-2 and Z-3A (above the Alder Spur/Alder Gulch confluence), Z-14 and Z-6A (within Alder Spur), and Z-8 and Z-16 (below the Alder Spur/Alder Gulch confluence).

Water quality from prior to Zortman Mining activity in 1979 is available from two monitoring stations Z-2 (in the upper reaches of Alder Gulch) and Z-8 (below the Alder Gulch/Alder Spur confluence), these "baseline" data and the following "operational" data are shown on Table 3.2-13. The pre-1979 data show pHs of 7.8 and 7.5, specific conductivity values of 315 and 370 μmhos/cm, sulfate concentrations of 74 and 70 mg/l, and total dissolved solids concentrations of 183 and 206 mg/l, suggesting little or no effect from historic mining activities. The initial analysis reported for the surface water monitoring station Z-3A, dated 5/29/87, shows minimal or no effects from current mining operations.

Initial analyses from other surface water sampling stations in the Alder Gulch/Spur area, such as Z-6A and Z-14, dated 5/29/87 and 5/1/84, respectively, show near-neutral pHs but higher specific conductivity values and higher concentrations of sulfate and TDS than the initial analyses for locations Z-2, Z-8, and Z-3A. The Z-6A and Z-14 sampling locations reflect drainage from Alder Spur.

Carter Gulch is the uppermost tributary to Alder Gulch. Results of chemical analyses for Carter Gulch surface water show decreasing pH values and increasing specific conductivity, sulfate and TDS. Available data from monitoring station Z-13 located at the toe of the Alder Gulch waste dump show the surface water to be impacted by ARD with pHs ranging from 3.4 to 4.0 TDS from 2,630 to 6,420 and sulfate from 1,790 to 4,520 mg/l. Samples from station Z-13 also regularly have elevated levels of manganese, nickel, lead and zinc.

During the period from 1978 to 1994, depending on the specific site in Alder Gulch, there are episodes of decreasing pH, with overall trends of increasing specific conductivity values and increasing concentrations of sulfate, TDS, and metals. The pH values recorded for sampling location Z-2 ranged from 4.2 to 7.9 (Figure 3.2-14). The capture system installed at the base of the Alder Gulch waste rock dump currently captures and pumps an average of 10 gpm to the Zortman treatment plant.

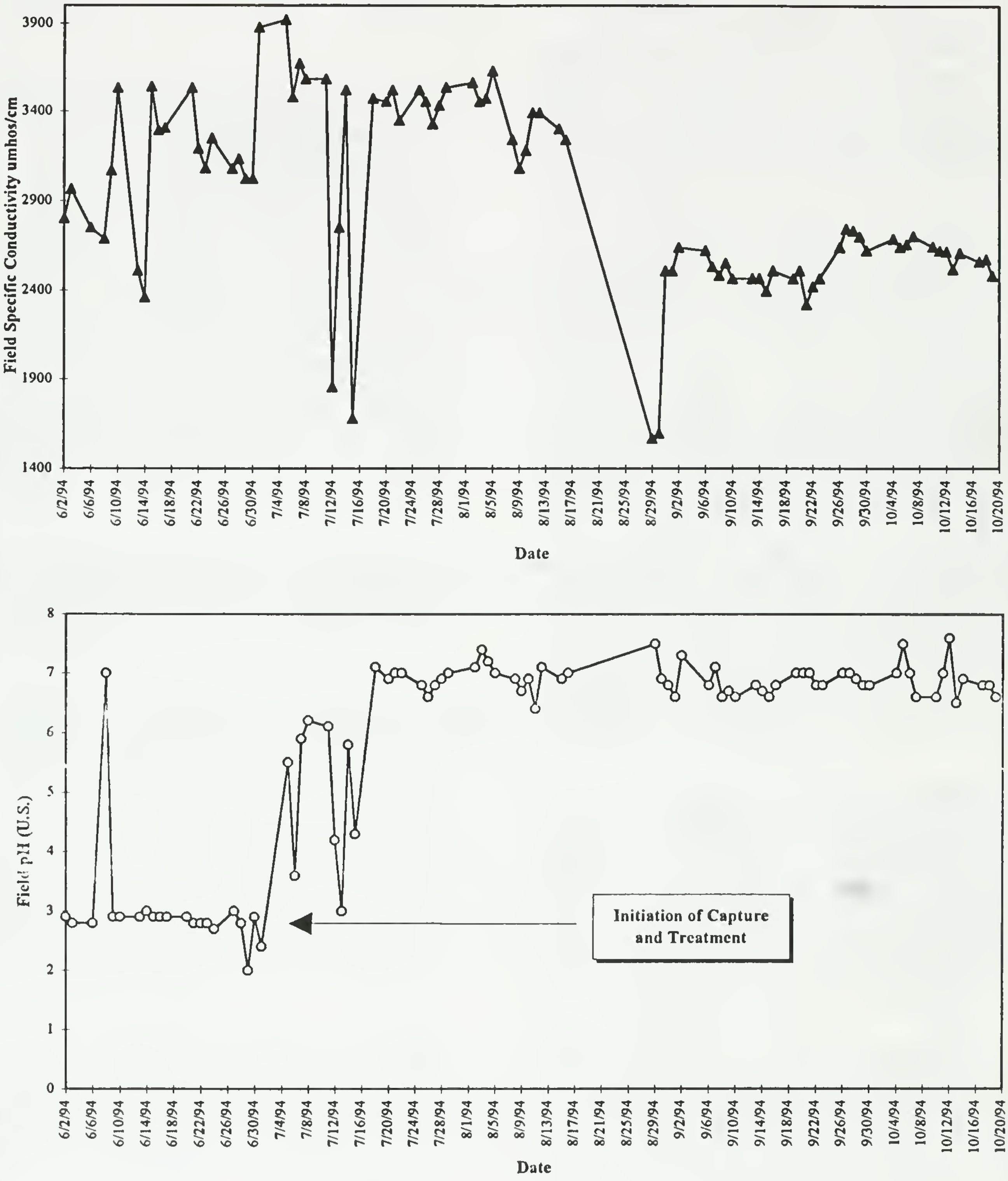


All data available.
Dry during 1992 and
1994 sampling events.

SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION Z-32
DOWNSTREAM RUBY GULCH

FIG. 3.2-12



SOURCE: ZMI OPERATIONAL MONITORING DATA

OPERATIONAL SURFACE WATER QUALITY
MONITORING STATION Z–1
RUBY GULCH

FIG. 3.2-13

TABLE 3.2-12

CAPTURE AND TREATMENT EFFECTS ON WATER QUALITY AT MONITORING STATIONS Z-1 AND Z-15 RUBY GULCH

Description	Sample Date	mg/L AL	mg/L Ag	mg/L Cu	mg/L Fe	mg/L Ca	mg/L Pb	mg/L Zn	mg/L Cr	mg/L Cd	mg/L Mg	mg/L Mn	mg/L SO_4
Z-1	19-May	160	0.00	5.38	53.80	162	0.00	5.06	0.11	0.160	90.00	19.30	1,790
Z-1	13-Jun	143	0.01	5.40	64.00	106	0.04	4.50	0.24	0.17	80.00	20.60	1,971
Z-1	06-Jul	33.67	0.00	1.47	13.80	514.0	0.10	1.10	0.08	0.04	70.00	9.70	NA
Z-1	01-Aug	4.10	0.00	0.03	2.18	786	0.00	0.05	0.00	0.00	44	2.14	2240
Z-1	10-Aug	0.00	0.01	0.31	0.25	3,400	0.00	0.03	0.08	0.03	1,000	5.00	2,093
Z-1	12-Sep	0.00	0.00	0.04	0.20	403	0.00	0.01	0.02	0.01	110	6.70	1,385
Z-1	11-Oct	0.00	0.01	0.06	0.23	430	0.04	0.04	0.00	0.01	50	2.59	1,407
Z-15	19-May	154	0.006	5.23	50.40	160	0.03	4.73	0.10	0.159	90	18.50	1800
Z-15	13-Jun	60.67	0.00	2.18	14.60	44.50	0.03	1.60	0.16	0.06	27.00	7.50	763
Z-15	06-Jul	33.33	0.00	1.39	25.90	503	0.09	1.00	0.06	0.06	70	10.40	NA
Z-15	09-Aug	0.00	0.01	0.06	0.43	4,500	0.00	0.02	0.10	0.01	1,000	3.90	1,557
Z-15	12-Sep	0.00	0.00	0.07	1.38	389	0.00	0.04	0.05	0.01	70	6.40	1,590
Z-15	11-Oct	0.00	0.00	0.05	0.47	425	0.07	0.05	0.01	0.02	70	2.7	1,654

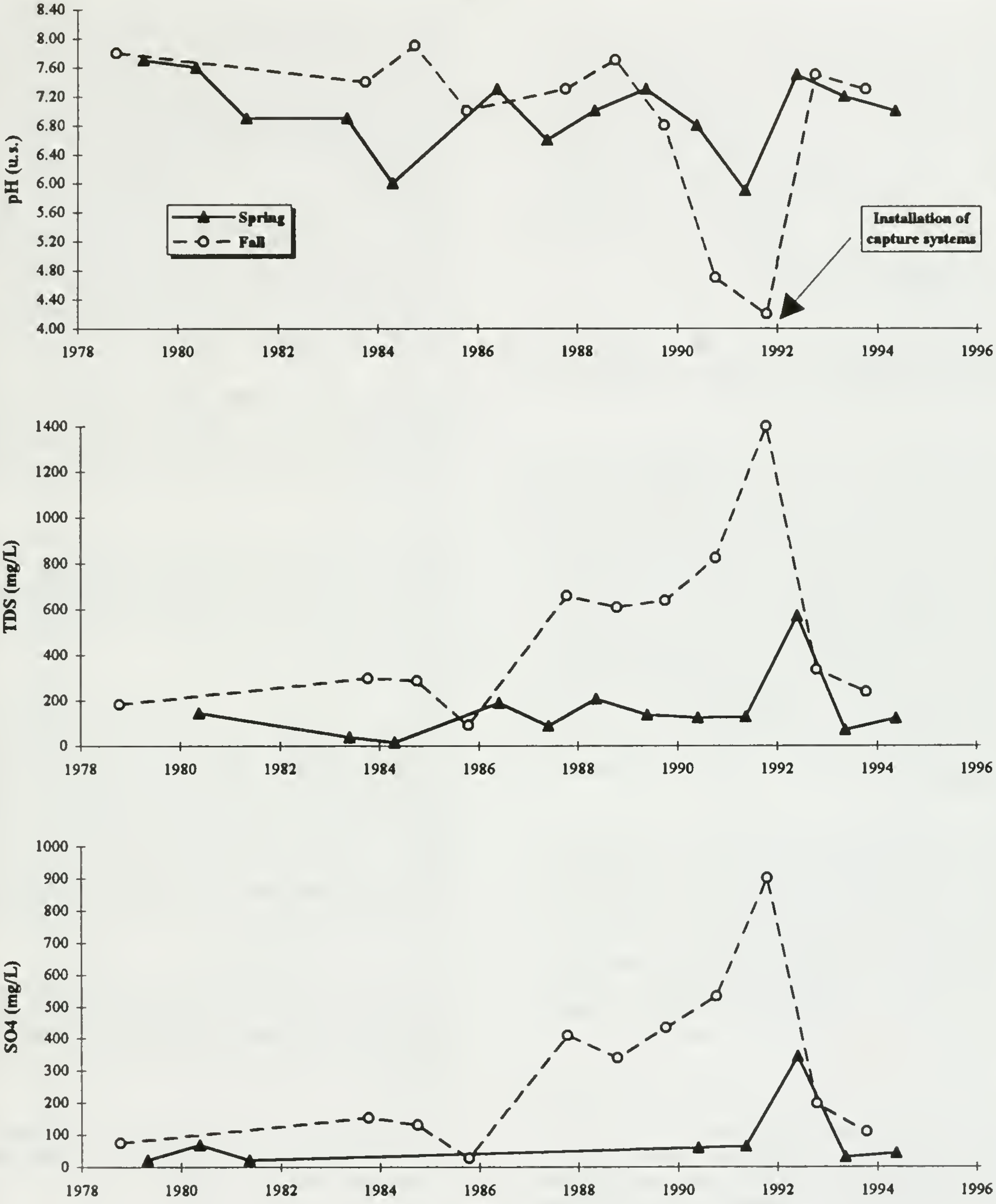
Note: 0.00 = below the detection limit
NA = Not analyzed

TABLE 3.2-13

ALDER GULCH SURFACE WATER QUALITY SUMMARY

	BASELINE (PRE 1979)		OPERATIONAL (1979 - 1993)			
			Upstream Z-2 (1979-1994)		Midstream Z-8 (1979-1994)	
	Upstream Z-2 (1978)	Midstream Z-8 (1978)	Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	1	1	43		44	
pH S.U.	7.8	7.6	3.8-7.9	6.4	4.3-8.3	6.7
SC μmhos/cm	315	370	53-1930	535	83-1,410	520
TDS mg/L	183	206	15-2160	458	22-1,370	404
TSS mg/L	1.0	1.0	ND-73	11.82	ND-460	44.8
SO_4 mg/L	74	70	14-1420	256	17-904	188
CN mg/L	NA	NA	ND	ND	ND-0.48	0.023
NO_2/NO_3 mg/L	NA	NA	0.01-2.96	0.66	ND-1.03	0.19
NH_3 mg/L	NA	NA	ND		ND-0.4	0.06
Hardness as CaCO3 mg/L	139	168	24-918	251	38-768	262
Ca mg/L	44	50	7-220	67.6	11-205	66
Mg mg/L	7.0	10	1-90	17.5	3-62	17
K mg/L	2.0	2.0	1-5	2.3	1-3	2.10
Na mg/L	10.0	10	1-47	9.0	1-17	8.5
Cl mg/L	4.0	4	ND-6	1.57	ND-8.0	3.13
HCO_3 mg/L	85	122	0.5-157.0	50	2-172	78
Al mg/L	NA	NA	(trc)0.30-57.06	9.7	(trc)ND-20.6	2.60
As mg/L	ND	(trc)0.007	(trc)ND-0.009	0.0031	(trc)ND-0.013	0.004
Cd mg/L	ND	NA	(trc)ND-0.172	0.026	(trc)ND-0.109	0.012
Cu mg/L	NA	ND	(trc)ND-2.01	0.23	(trc)ND-0.63	0.069
Fe mg/L	NA	0.11	(trc)ND-0.98	0.20	(trc)ND-5.5	0.57
Pb mg/L	NA	NA	(trc)ND-0.02	0.01	(trc)ND-0.03	0.01
Mn mg/L	NA	NA	(trc)ND-25.2	3.7	(trc)ND-13.5	1.19
Zn mg/L	NA	NA	(trc)ND-3.65	0.47	(trc)ND-3.14	0.22

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION Z–2
MIDSTREAM ALDER GULCH

FIG. 3.2-14

Monitoring station Z-14 in the upper reaches of Alder Spur has a history of decreasing water quality since 1984, and in the latest round of samples in the Fall of 1994 had a pH of 4.1, a SC of 2,310 μmhos/cm and a sulfate concentration of 1,460 mg/l. Monitoring station Z-6A in the lower reaches of Alder Spur also shows a history of poor water quality, with numerous detections of cyanide reaching a maximum of 0.07 mg/l total cyanide in 1990. Sulfate and dissolved solids concentration are also elevated at station Z-6A, but the pH of the water has remained near neutral.

Cyanide contamination in Alder Spur can be traced to a major spill (pipeline break) in 1984 and the 1986-87 LAD of 20 million gallons of cyanide process solution treated with calcium hypochlorite.

Due to impacts associated with drainage from the waste rock dump in Carter Gulch and leach pads and buttresses (built with waste rock) in Alder Spur, solution capture systems were installed during the fall off 1992 below the waste rock dump and the 83/84 pads. The capture system currently pumps an average of 10 gpm to the Zortman treatment plant. Figure 3.2-15 illustrates water quality at station Z-8 below the confluence of Alder Gulch and Alder Spur. The monitoring record at Z-8 shows generally good water quality, with only occasional events of reduced quality. An overall improvement in water quality is however apparent at Z-8 after construction of the capture ponds in 1992 (Figure 3.2-15); a similar improvement is recognizable at station Z-2.

The farthest downstream monitoring station in Alder Gulch receiving drainage from all its tributaries is station Z-16 (Exhibit 1). This station is often dry but between 1990 and 1994, has had an average pH, SC and sulfate of 6.8, 526 μmhos/cm, and 223 mg/l respectively, indicating that the impacted surface water either infiltrates prior to reaching this downstream monitoring station, or the water improves substantially in quality as it flows downstream due to neutralization and attenuation.

Goslin Flats. Surface water monitoring in Goslin Flats began in 1990. Water quality data are available from three stations down the length of the Gulch (Z-21, Z-35 and Z-22); the other two stations have been dry since their installation. Representative water quality data from these three stations are shown on Table 3.2-14.

Despite the lack of any mining operations in Goslin Flats, indicators often associated with ARD are moderately high at each of the stations. For example station Z-22 near the bottom of the gulch typically has SC levels of around 1800 μmhos/cm, TDS of 1,500 mg/l and sulfate of 700 mg/l. The pH of the water has however remained neutral since monitoring started in 1990 and no cyanide has been detected. Stations Z-21 and Z-35 have similar water chemistry with neutral pHs, moderately high sulfate and TDS. The neutral pH but high sulfate etc. are due to ongoing water rock interaction with sediments partially made up of the underlying mineral-rich shales which are reduced and have high sulfate concentrations. This high sulfate, high TDS water type is clearly illustrated on Figure 3.2-9 where it plots among surface waters with ARD impacts. Such high TDS, high sulfate, alkaline pH waters are commonly associated with continental and marine shales.

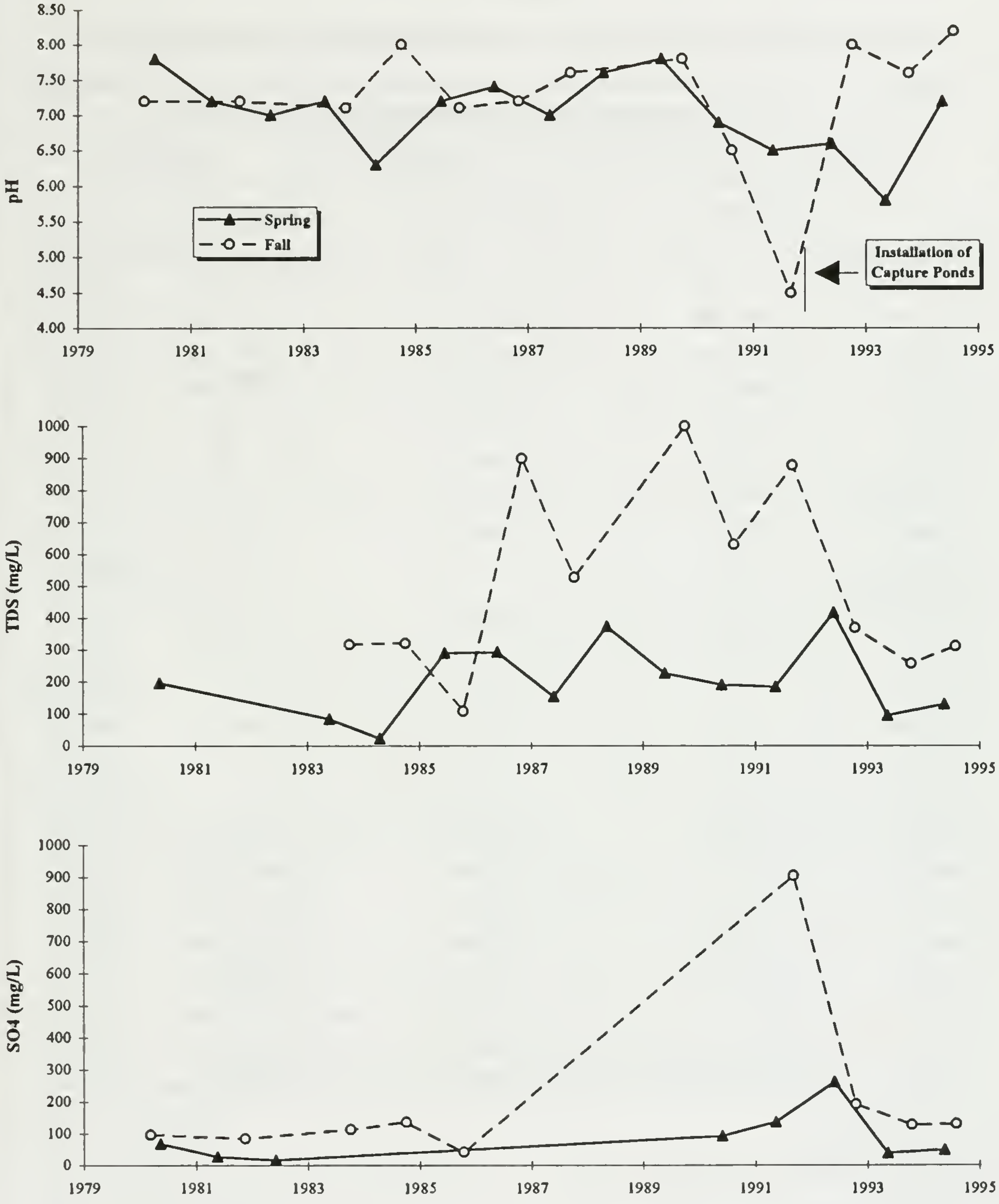
Lodgepole Creek. Lodgepole Creek drains approximately 15 square miles of the northern portion of the Little Rocky Mountains, its headwaters once included what is now part of the present day Zortman Mine workings.

Surface water quality data for the Lodgepole Creek drainage is available from stations Z-5, Z-30 and Z-28 (upstream Lodgepole Creek), Z-29 (at the confluence of Glory Hole Gulch and Lodgepole Creek) and Z-7 (downstream near the boundary of the Fort Belknap Indian Reservation).

Table 3.2-15 summarizes the water quality data from the Lodgepole Creek drainage between 1981 and 1994. Monitoring data from station Z-5 shows that nitrate concentrations in 1981 and 1982 were 0.09 mg/l for one sample and below detection (0.05 mg/l) for two samples. Nitrate concentrations from 1989 to 1993 range up to a maximum of 2.1 mg/l. This increase in nitrate in the headwaters of Lodgepole Creek may be due to blasting activities at the Zortman pits or due to fertilization of reclaimed areas.

Water quality from further downstream station does not show any discernable impacts from mining activities with maximum concentrations of nitrate, sulfate, SC and TDS of 0.68 mg/l, 40 mg/l, 450 μmhos/cm, and 268 mg/l, respectively.

Surface water quality at Lodgepole Creek overall appear to have had minimal and possibly short-lived impacts from mining activity.



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION Z–8
MIDSTREAM ALDER GULCH

FIG. 3.2-15

TABLE 3.2-14

GOSLIN GULCH REPRESENTATIVE SURFACE WATER QUALITY SUMMARY

	OPERATIONAL BUT REPRESENTATIVE OF BASELINE					
	Upstream Z-21 (1990-1994)		Upstream Z-35 (1990-1994)		Downstream Z-22 (1990-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	14		11		12	
pH S.U.	7.3-7.6	7.5	7.6-8.0	7.8	6.7-7.8	7.5
SC μmhos/cm	1,540-1,920	1,760	1,070-1,370	1,280	1,530-1,990	1,747
TDS mg/L	1350-1550	1,438	851-1,030	975	1,290-1,720	1,468
TSS mg/L	ND-393	35.3	0.50-10.00	2.43	27-1,370	433
SO_4 mg/L	709-1,020	812	414-506	477	709-1,020	813
CN mg/L	ND		ND		ND	
NO_2/NO_3 mg/L	2.35-4.90	3.60	0.36-1.61	0.60	ND-0.14	0.044
NH_3 mg/L	ND		ND		ND	
Hardness as CaCO3 mg/L	792-962	890	635-749	701	835-1070	924
Ca mg/L	136-172	156	112-128	121	199-256	221
Mg mg/L	110-134	122	86-104	97	88-106	91
K mg/L	5-10	7.4	6-9	6.7	4-9	6.36
Na mg/L	91-125	107	38-53	48.5	90-124	105.4
Cl mg/L	9-14	12.1	3-14	4.2	5-10	7.9
HCO_3 mg/L	317-394	371	332-382	365		336
Al mg/L	(trc) ND		(trc)ND-0.10	0.06	(trc)0.20-2.50	1.00
As mg/L	(trc)ND-0.04	0.0057	(trc) ND		(trc)ND-0.007	0.0033
Cd mg/L	(trc) ND		(trc) ND		(trc) ND	
Cu mg/L	(trc)ND		(trc)ND		(trc)ND-0.01	0.0056
Fe mg/L	(trc)ND-0.250	0.116	(trc) ND		(trc)0.40-4.55	2.28
Pb mg/L	(trc)ND-0.020	0.007	(trc)ND-0.01	0.006	(trc)ND-0.03	0.0089
Mn mg/L	(trc)0.020-0.060	0.04	(trc) ND		(trc)0.020-0.47	0.1167
Zn mg/L	(trc)ND-0.070	0.013	(trc)0.005-0.02	0.01	(trc)0.005-0.03	0.167

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable

TABLE 3.2-15

LODGEPOLE CREEK SURFACE WATER QUALITY SUMMARY

	Operational (But Representative of Baseline)					
	Upstream Z-28 (1990 - 1994)		Upstream Z-29 (1990 - 1994)		Downstream Z-7 (1990 - 1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	12		23		29	
pH S.U.	6.7-7.8	7.29	6.9-8.2	7.8	7.4-8.5	7.8
SC μmhos/cm	78-182	128	140-428	323	195-450	334
TDS mg/L	31-141	80	80-245	187	83-268	195
TSS mg/L	ND-35	9.0	ND-512	43	0.5-118.0	7
SO_4 mg/L	8.0-19.0	12	13-40	23.6	8-36	24
CN mg/L	ND		ND		ND	
NO_2/NO_3 mg/L	ND-0.35	0.17	ND-0.68	0.28	0.03-0.13	0.039
NH_3 mg/L	ND		ND		0.03-0.05	0.039
Hardness as CaCO3 mg/L			61-260	182	114-252	185
Ca mg/L	14-32	20	18-66	48.5	32-69	53
Mg mg/L	1.00-3.00	1.70	4-24	16.2	5-19	14
K mg/L	ND-1.0	0.70	ND-2.0	1.22	1-3	1-6
Na mg/L	1.0-2.0	1.70	1-3	2.4	3.8	5-3
Cl mg/L	ND-2.0	0.70	ND-3	0.81	ND-4.0	1-4
HCO_3 mg/L	32-102	60.9	66-276	194	105-274	203
Al mg/L	(trc)0.1-0.60	0.32	(trc)ND-7.1	0.69	0.05-0.20	0.07
As mg/L	(trc) ND		(trc)ND-0.005	0.0026	0.001-0.007	0.003
Cd mg/L	(trc) ND		(trc)ND-0.006	0.0006	ND	
Cu mg/L	(trc) ND		(trc)ND-0.02	0.0056	(trc) ND	
Fe mg/L	(trc)0.07-0.33	0.16	(trc)ND-11.4	1.06	0.002-0.20	0.05
Pb mg/L	(trc)ND-0.03	0.02	(trc)ND-0.03	0.009	ND	
Mn mg/L	(trc) ND		(trc)ND-0.93	0.08	ND	
Zn mg/L	(trc)ND-0.03	0.01	(trc)ND-0.06	0.02	ND	

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable

Beaver Creek. Surface water quality data is available from three monitoring stations throughout the upper length of the Beaver Creek drainage. Sampling locations include Z-27 (headwaters, draining a canyon with exposed limestone) and stations Z-31 and Z-39 (at downstream tributary confluences) (Exhibit 1). Table 3.2-16 summarizes the surface water quality data from these stations. Water quality from throughout the drainage as unimpacted by any mining related activity with maximum values for SC of 399 μmhos/cm, sulfate 20 mg/l and a minimum pH of 6.8. Metals concentrations in the water samples are either very low or below detection limits. Water quality data from the Beaver Creek drainage is also representative of "baseline conditions" for the Little Rocky Mountains.

Summary of Zortman Surface Water Quality - 1979 to 1994

In summary, the recent and historical surface water quality data reviewed for the Zortman Mining area indicate the following:

Ruby Gulch

- A water quality sample from pre-1979 is available from station Z-1 in the upper reaches of Ruby Gulch, showing a pH of 7.4, sulfate concentration of 110 mg/l, and TDS of 190 mg/l, suggesting minimal or no effects from ARD at that time.
- ARD-impacted surface water has reached well downstream of the town of Zortman. Impacts of mining operations include slight detections of cyanide, variable or decreasing pH values, increased specific conductivity and increased concentrations of sulfate, total dissolved solids (TDS), and metals.
- The monitoring record indicates that ARD impacts only reach the lower levels of the drainage after specific events, possibly periods of high precipitation or snowmelt.
- Ruby Gulch appears to be the most impacted drainage in the Zortman and Landusky mining areas, both by the physical impact of the historic mining activities (tailing deposition), and recent mining ARD effects.
- Construction of the Ruby Gulch capture and treat system has had significant beneficial effects on the surface water quality of the drainage.

Alder Gulch

- A pre-1979 water quality sample is available for stations Z-2 and Z-8 in Alder Gulch. These samples had neutral pHs of 7.8 and 7.6, sulfate concentrations 74 and 70 mg/l, and TDS of 183 and 206 mg/l, respectively. The data indicate minimal or no effects from ARD at that time.
- Water quality in Carter Gulch is presently impacted by ARD with monitoring station Z-13 having a pH of 4.4, SC of 2,490 μmhos/cm and sulfate of 3,480 mg/l in the Fall of 1993. This ARD drains from the Alder Gulch waste rock dump.
- Water Quality in Alder Spur is presently impacted by ARD with monitoring station Z-14 having pHs of 4.1, SC of 2,090 μmhos/cm, and sulfate of 1,460 mg/l, in the Fall of 1993. Cyanide detections and ARD contamination within Alder Spur, can be traced to several different sources. The 83/84 leach pad complex with a cyanide pipeline break in 1984, dike/foundation construction for the heap leach pads, and the 1986-87 LAD of 20 million gallons of process solution treated with calcium hypochlorite on the east side of Carter Butte.
- Water quality has improved at sampling location Z-8, below the confluence of Alder Spur with Alder Gulch, since 1992 due to installation of solution capture systems.

Goslin Flats

- Surface water quality in Goslin Flats is characterized by a near neutral pH but high levels of sulfate, SC and TDS. The relatively high levels of dissolved constituents but near neutral pH is the result of natural water-rock interaction with sediments derived from the underlying shales in Goslin Flats.

Lodgepole Creek

- The surface water quality within Lodgepole Creek shows that impacts to Lodgepole Creek have been short-lived.

Beaver Creek

- The surface water quality within Beaver Creek exhibits no impacts from existing mining operations, and may represent "baseline conditions" for this area of the Little Rocky Mountains.

TABLE 3.2-16

BEAVER CREEK
SURFACE WATER QUALITY SUMMARY

	OPERATIONAL (But Representative of Baseline)				
	BEAVER CREEK				
	Upstream Z-27 (1990-1994)		Downstream Z-31 (1990-1994)		Downstream Z-39 (1994)
	Range	$\bar{x}$	Range	$\bar{x}$	Range
No. of samples	14		12		2
pH S.U.	6.8-7.9	7.3	7.1-8.0	7.6	8.1-8.2
SC μmhos/cm	74.8-399.0	188	135-252	193	228-310
TDS mg/L	41-236	122	63-158	119	127-243
TSS mg/L	ND-44	12.9	0.5-8.0	3.3	2-8
SO_4 mg/L	4-18	8.3	5.0-8.0	6.43	10-20
CN mg/L	ND		ND		ND
NO_2/NO_3 mg/L	ND		ND		ND
NH_3 mg/L	ND		ND		ND
Hardness as CaCO3 mg/L	39-178	97	69-124	98	108-171
Ca mg/L	13-61	30.6	21-38	29.1	33-50
Mg mg/L	2-6	3.2	4-7	5.6	7-11
K mg/L	1-2	1.7	ND		0.5-1.0
Na mg/L	2-3	2.3	2-4	3.3	3-4
Cl mg/L	0.5-2.0	1.0	0.5-2.0	0.71	ND
HCO_3 mg/L	30-203	98.2	76-155	115	125-188
Al mg/L	(trc)0.05-2.10	0.78	(trc)0.05-.60	0.19	(trc) ND
As mg/L	(trc) ND		(trc) ND		(trc) ND
Cd mg/L	(trc)0.0001-0.0030	0.009	(trc)ND-0.003	0.0009	(trc) ND
Cu mg/L	(trc) ND		(trc) ND		(trc) ND
Fe mg/L	(trc)0.05-1.21	0.43	(trc)ND-0.32	0.01	(trc) ND
Pb mg/L	(trc)0.001-0.02	0.007	(trc)ND-0.02	0.006	(trc) ND
Mn mg/L	(trc)0.01-0.27	0.05	(trc) ND		(trc) ND
Zn mg/L	(trc)0.005-0.04	0.01	(trc)0.005-0.070	0.01	(trc) ND

Note: No pre-1979 (baseline data) available
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

Landusky Surface Water Quality

Surface water monitoring stations found within the Landusky mine area are shown on Exhibit 2 (EIS map pocket).

Rock Creek/Sullivan Creek. Surface water monitoring stations reviewed from Rock Creek included L-27 and L-28 (Sullivan Creek Tributary), L-23 and L-29 (main reach of Rock Creek), L-4 and L-10 (below the confluence with Mill Gulch) and L-1 (downstream of confluence with Montana Gulch).

Table 3.2-17 summarizes baseline and operational water data from within Rock Creek. Surface water quality data for Sullivan Creek is limited to after 1991 when the Sullivan Park Heap leach pad was constructed. Monitoring station L-28, located at the toe of the leach pad receives water directly from the leach pad underdrain and appears to have become intensely affected by ARD, as illustrated by increases in sulfate, TDS and SC concentrations. During 1991 and 1992 sulfate, TDS and SC reached maximum concentrations of 9,960 mg/l, 14,700 mg/l and 10,700 μmhos/cm, respectively. Since 1991 the pH at L-28 has been consistently low, between 2.7 and 3.9 (Table 3.2-17). This water from the underdrain flows at less than 1/2 gpm and is currently captured by a contingency pond and then pumped back into the process circuit. Captured and recirculated water at Sullivan Creek currently averages a flow of 20 gpm. Also of note are anomalously high concentrations of Cl at 85 mg/l and the detections of ammonia at 1.1 mg/l and Nitrate +Nitrite at 4.78 mg/l on 10/15/92. The elevated nitrates are likely due to fertilizers being used on the '91 dike for revegetation or blasting residues on the rocks used in the '91 dike.

Monitoring station L-27 located a few hundred feet further down Sullivan Creek has demonstrated a similar decline of water quality. The ARD effects seen in Sullivan Creek are thought to be derived from acid generating material used in the construction of the Sullivan Park leach pad dike or due to oxidation of acid-generating bedrock exposed during construction of the pad.

Surface water is also sampled at monitoring station L-29, above the confluence of Sullivan and Rock creeks. This tributary does not receive drainage from any mining-related activities. Although the record of analysis is limited to 1990 through 1994, no effects from mining activity are apparent, demonstrated by consistently neutral pH values and low sulfate and TDS (Table 3.2-17). Water quality data from station L-29 may be representative of baseline surface water conditions for the Rock Creek/Sullivan Creek area.

Located just upstream of the town of Landusky, monitoring station L-4 shows surface water with a near neutral pH and low TDS and sulfate concentrations. Monitoring station L-1 is located in Rock Creek down stream of the confluence of Mill and Montana Gulches, and thus represents the total surface water drainage from the southern side of the Landusky mining operation. Pre-1979 (baseline) data from station L-1 shows the pH to have ranged between 8.0 and 8.2, sulfate between 53 and 112 mg/l and SC from 395 to 609 μmhos/cm (Table 3.2-17). Figure 3.2-16 shows TDS, SC and sulfate data from station L-1 between 1977 and 1994. The slight increase since 1979 for each of these analytes shows the surface water to have been slightly impacted by the mining operation although water quality at the point is of generally good quality. Since 1977, no cyanide has been detected at station L-1 and the pH of the water has remained neutral.

Mill Gulch. Surface water monitoring stations reviewed for Mill Gulch included L-18 and L-24 (Upper Mill Gulch, covered during 1988 by the construction of Mill Gulch waste rock repository), L-8 (western tributary to Mill Gulch draining the Landusky process area), and L-26 and L-25 (in a downstream direction). Stations L-25 and L-26 were replaced in 1994 by stations L-35 and L-36. Also, monitoring stations L-22 (half way down the drainage) and L-7 (just above the confluence with Rock Creek). Table 3.2-18 summarizes the water quality record for the total length of the Gulch with data from monitoring stations L-18, L-8 and L-7.

The record shows that the construction of the 1987 (Mill Gulch) leach pad had an immediate impact on the surface water quality downstream, monitored at that time by stations L-18 and L-24. Between 1987 and 1988 surface water samples taken at L-18 showed a decrease in pH from 7.1 to 3.2 combined with increases in sulfate concentrations from 12 to 268 mg/l, SC from 45 to 855 μmhos/cm and TDS from 84 to 469 mg/l. These changes in water chemistry were also observed at L-24. No cyanide was detected at L-18 or L-24 between 1983 and 1988, after which time the stations were covered by construction of Mill Gulch waste rock repository.

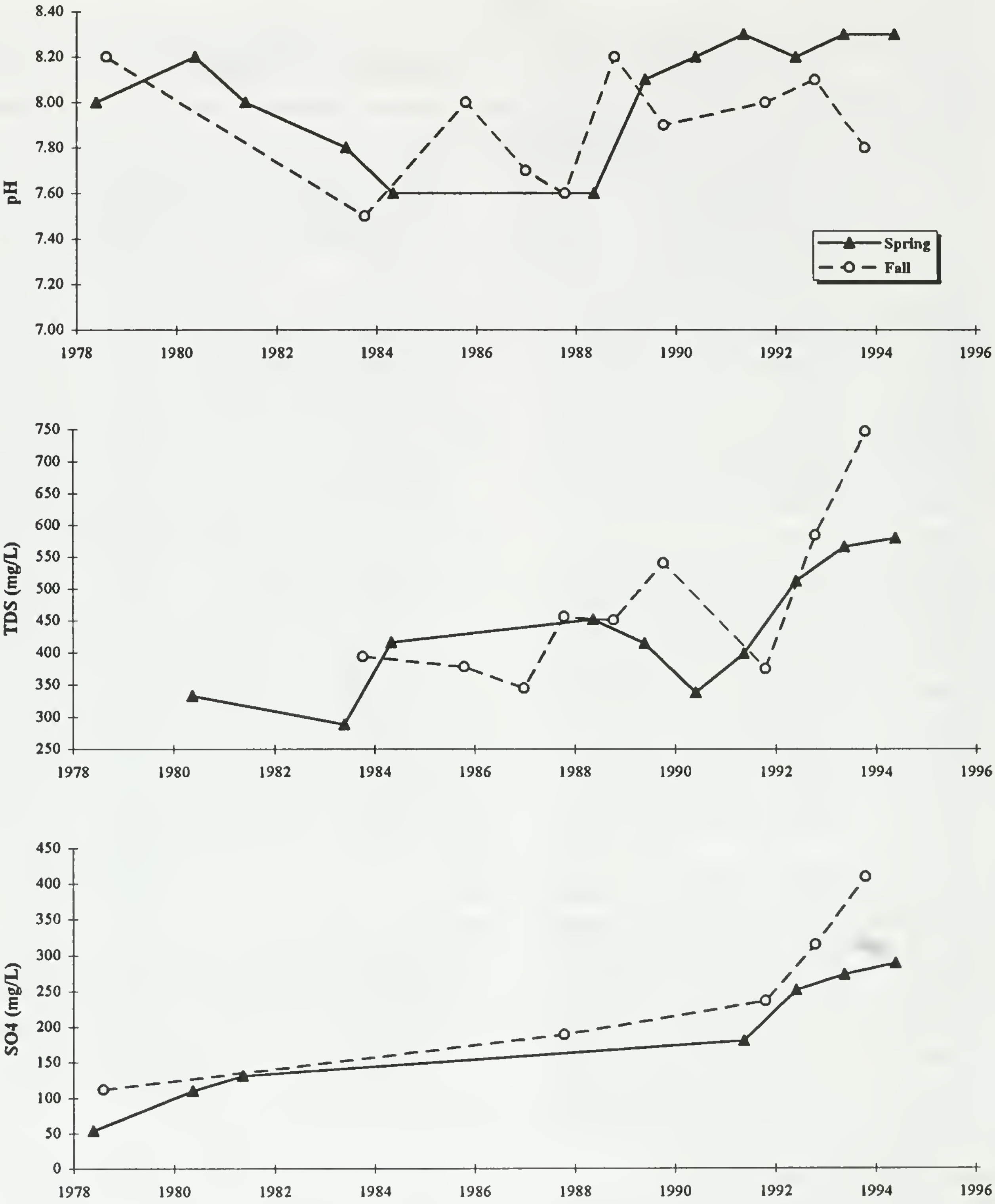
Monitoring station L-25 was located immediately downstream of the Mill Gulch rock dump, and has a record of only minimal ARD effects up until 1991 when the pH dropped to 4.3 and maximum concentrations of 926 mg/l sulfate, 540 mg/l TDS and 1420 μmhos/cm SC were reached. However, during 1991 and 1992 surface water quality below the rock dump improved

TABLE 3.2-17

ROCK CREEK SURFACE WATER QUALITY SUMMARY

	BASELINE		OPERATIONAL (BUT REPRESENTATIVE OF BASELINE)		OPERATIONAL (POST 1979)			
	Downstream L-1 (1977-1978)		Upstream L-29 (1990-1994)		Upstream L-28 (1991-1992)		Downstream L-1 (1979-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	3		15		6		34	
pH S.U.	8.00-8.20	8	7.0-7.7	7.2	2.7-3.9	3.0	7.4-8.4	7.9
SC μmhos/cm	395-609	521	60-384	250	724-10700	3095	367-970	638
TDS mg/L	NA		48-272	174	621-14700	3720	310-751	454
TSS mg/L	11-11	11	0.5-60	16.9	0.5-135	63	ND-380	36
SO_4 mg/L	53-112	82	14-129	69	340-9960	2412	71-410	223
CN mg/L	ND		ND		0.003-0.009	0.005	ND-0.013	0.005
NO_2/NO_3 mg/L	ND		ND-0.1	0.04	0.87-4.80	2.3	0.025-0.910	0.34
NH_3 mg/L	NA		ND		0.05-1.10	0.4	ND	
Hardness as CaCO3 mg/L	NA		29-185	116	205-1650	583	198-526	348
Ca mg/L	NA		7-51	31	53-306	125	56-145	102
Mg mg/L	NA		3-14	8.5	18-216	66	14-40	25
K mg/L	NA		1-3	2.5	2-20	5.7	2-4	3
Na mg/L	NA		2-8	5.2	8-1650	283	8-16	12.5
Cl mg/L	NA		ND-3.0	0.73	1-85	16	0.5-6.0	2.2
HCO_3 mg/L	NA		17-129	61	ND		121-228	174
Al mg/L	NA		(trc) ND-1.2	0.42	(trc) 38-679	261	(trc) ND-0.80	0.30
As mg/L	NA		(trc) ND-0.007	0.003	(trc) 0.03-5.51	2.3	(trc) 0.0025-0.8200	0.13
Cd mg/L	NA		(trc) ND-0.001	0.006	(trc) 0.07-0.60	0.3	(trc) ND	0.0026
Cu mg/L	NA		(trc) ND		(trc)0.18-2.34	0.92	(trc)ND-0.2	0.0088
Fe mg/L	NA		(trc) ND-1.06	0.38	(trc) 28-536	223	(trc) 0.01-0.55	0.28
Pb mg/L	NA		(trc) ND		(trc) ND-0.06	0.02	(trc) ND-0.02	0.01
Mn mg/L	NA		(trc) ND		(trc) 4.5-110.0	47	(trc) 0.03-0.35	0.5
Zn mg/L	NA		(trc) 0.01-0.1	0.05	(trc) 2.5-25.4	10.7	(trc) 0.02-0.73	0.28

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION L-1
DOWNSTREAM ROCK CREEK

FIG. 3.2-16

TABLE 3.2-18

MILL GULCH SURFACE WATER QUALITY SUMMARY

	OPERATIONAL					
	Upstream L-18 (1983-1988)		Midstream Tributary L-8 (1983-1994)		Downstream L-7 (1982-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	5		9		30	
pH S.U.	3.2-7.1	5.8	7.6-8.5	7-9	7.1-8.6	7.9
SC µmhos/cm	45-855	329	580-1,260	999	113-1130	635
TDS mg/L	84-469	224	376-855	657	100-921	478
TSS mg/L	0.5-14.0	6.9	0.5-184.0	45	0.5-1370.0	88.5
SO$_4$ mg/L	8-268	100	165-253	208	16-515	258
CN mg/L	ND		0.01-0.12	0.05	ND	
NO$_2$/NO$_3$ mg/L	0.025-17.200	4.2	ND-5.73	2.43	0.025-4.400	0.83
NH$_3$ mg/L	NA		ND		ND	
Hardness as CaCO3 mg/L	17-208	109	112-769	491	63-666	359
Ca mg/L	4-58	23	140-176	155	15-170	103
Mg mg/L	2-15	7.8	23-37	30	6-59	37
K mg/L	2-3	2.3	3.0-5.0	3.5	2-7	3.7
Na mg/L	2-10	6.3	20-34	24.2	4-15	10.7
Cl mg/L	1-4	2	15-71	46	0.5-10.0	4.1
HCO$_3$ mg/L	24-24	24	296-374	328	55-292	178
Al mg/L	NA		(trc)ND-0.3	0.15	(trc)0.05-0.60	0.11
As mg/L	NA		(trc) ND		(trc)ND-0.0140	0.004
Cd mg/L	NA		(trc)ND-0.002	0.001	(trc) ND	
Cu mg/L	NA		(trc) ND		(trc)ND-0.01	0.0062
Fe mg/L	1.28-1.28	1.28	(trc)0.05-0.55	0.27	(trc)ND-2.0	0.33
Pb mg/L	NA		(trc)0.005-0.010	0.006	(trc)0.001-0.010	0.006
Mn mg/L	NA		(trc)0.06-0.65	0.22	(trc)0.005-0.160	0.025
Zn mg/L	NA		(trc)0.005-0.020	0.01	(trc)ND-0.08	0.03

Note: No pre-1979 (baseline data) available
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable

substantially. Replacement station Z-35 is now located at the base of the Mill Gulch rock dump and in the sample taken during the spring of 1994 had a pH of 4, SC of 2,330 μmhos/cm, sulfate concentration of 1,620 mg/l and elevated levels of metals. The water draining from the waste rock pile is currently being captured in a contingency pond and recirculated onto the 1987 leach pad. Recirculated flows from Mill Gulch average 40 gpm.

Monitoring station L-8 is located in a western tributary to Mill Gulch draining the Landusky processing plant and ponds. Station L-8 has reported detectable total and WAD cyanide in nearly every sample taken between 1983 and 1994, with a maximum of 0.12 mg/l (tot) in the spring of 1993. Concentrations of other analytes have been erratic over this time, although the pH of the surface water has remained near neutral in all samples (Table 3.2-18). The consistent cyanide detections and neutral pH indicate that the contamination is coming from either several spill events or a process pond leak in the Landusky process plant area.

Effects of mining activity are seen throughout the length of the gulch. Figure 3.2-17 shows a slight decline in water quality between 1982 and 1992 at monitoring station L-7 at the bottom of the Mill Gulch near its confluence with Rock Creek. This decline is illustrated by increasing TDS and sulfate, but relatively stable near-neutral pH. Also, metal concentrations at station L-7 are almost entirely below detection limits, indicating that the ARD-impacted waters originating in the headwaters of the drainage are being effectively neutralized by the time they get to the lower reaches of Mill Gulch.

Montana Gulch. Surface water monitoring locations reviewed in Montana Gulch included L-17 (immediately downstream of the 1985/1986 pad), L-16 (approximately 400 feet downstream), L-3 (the Gold Bug Adit [GBA] discharge), L-11 and L-12 (tributary to Montana Gulch, below 1983 Pad) and L-2 (just upstream of the Montana Gulch, Rock Creek confluence).

Table 3.2-19 summarizes pre-1979 (baseline) and operational water data from station L-3 and L-2 downstream.

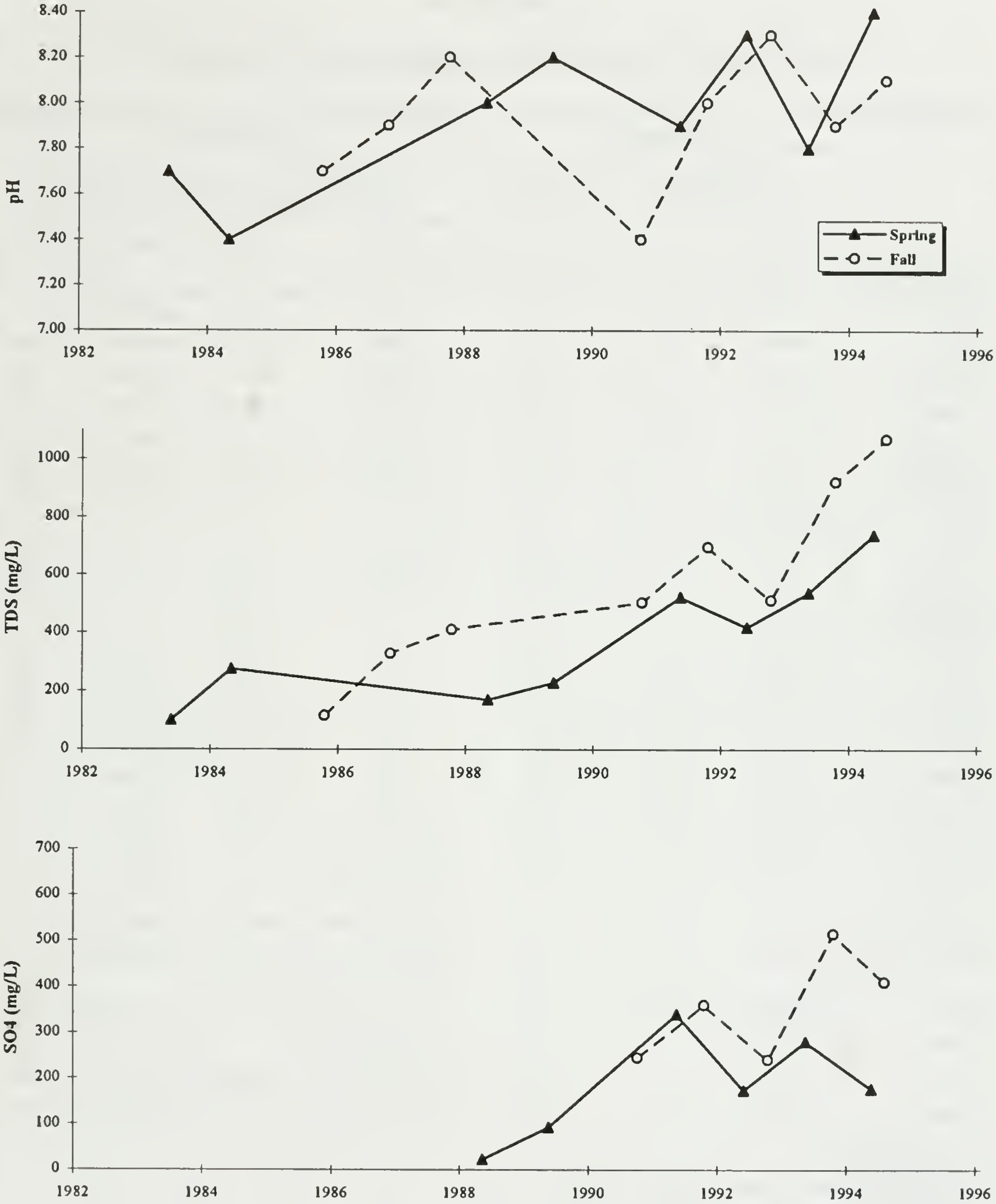
Although L-3 is actually groundwater, it contributes the majority of the surface water flow in Montana Gulch and has a significant impact on the surface water quality downstream. Therefore, for this discussion it is treated as surface water. Prior to 1979, L-3 had an average pH of 6.57, sulfate of 162 mg/l and SC of 503 μmhos/cm. Since 1979, water quality deriving from the GBA has remained similar to baseline conditions, although in the spring of 1994, L-3 had a pH of 5 to 6, a SC of 754 μmhos/cm and a sulfate concentration of 373 mg/l. Water quality changes between 1979 and 1994 are shown on Figure 3.2-18. Water discharging from the adit has elevated iron concentration on average 13.3 mg/l since 1977. The iron rich water is currently being captured at the base of the 1985/1986 pad, and oxygenated causing the iron to precipitate out of solution.

Prior to 1979, the GBA discharged approximately 300 gpm. The majority of the discharge from the GBA is presently captured and used for road wetting.

Monitoring station L-17, located immediately below the 1983 leach pad, has detected trace WAD cyanide in samples taken during 1986, 87, 88, 89, 91 and 92. The post 1986 detections are the result of a rupture in the 1986 leach pad, identified and repaired during 1986. The 1992 detections are likely to be associated with a pipeline rupture directly below the 1983 pad during 1992. Station L-17 also shows moderate impacts from ARD since monitoring began in 1983 reaching maximums of 1,180 μmhos/cm SC, and 630 mg/l sulfate although the pH has remained neutral throughout this time.

During 1985, an orange colored precipitate was observed in the streambed of a perennial section of Montana Gulch next to the Montana Gulch campground. This discoloration of sediments and plants was due to overtopping of a capture system below the 1983 heap leach pad allowing acidic and metalliferous waters to flow down the drainage. The released water had a pH of 4 to 5 and appears to have been derived from underdrainage of the 1983 heap leach facility.

Stations L-12 and L-13 are at the heads of two minor tributaries together draining the 1983 leach pad. Surface water quality in both the tributaries appears to have been adversely affected by construction of the leach pads, with pHs falling to less than 3.0. TDS and sulfate levels recorded at station L-12 reached maximums of 84,800 mg/l and 64,100 mg/l, respectively during 1984. A significant improvement in water quality occurred between 1984 and 1990, restoring the pH to 7.6 and reducing the SC to 4,220 μmhos/cm. No data are available since 1990 because the stations have been dry. A similar trend is seen at L-11, although the maximum concentrations reached were considerably lower.



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION L-7
DOWNSTREAM MILL CREEK

FIG. 3.2-17

TABLE 3.2-19

MONTANA GULCH SURFACE WATER QUALITY SUMMARY

	BASELINE			OPERATIONAL			
	L-3 Upstream (Gold Bug Adit) (1977-1978)		L-2 Downstream (1978)	Gold Bug Adit L-3 Upstream (1979-1994)		L-2 Downstream (1979-1992)	
	Range	$\bar{x}$		Range	$\bar{x}$	Range	$\bar{x}$
No. of samples	6		1	27		35	
pH S.U.	6.50-6.70	6.57	8.40	4-7.50	6.4	6.50-8.40	7.75
SC μmhos/cm	485-520	503	330	430-901	591	242-1,090	664
TDS mg/L	302-302	302	NA	340-699	450	285-894	530
TSS mg/L			NA	27-287	75.6	2-3,550	199
SO_4 mg/L	150-186	161.80	61	140-435	227	45-572	265
CN mg/L	ND		ND	ND-0.14	0.012	ND-0.13	0.01
NO_2/NO_3 mg/L	NA		NA	ND-0.17	0.05	ND-3.03	0.70
NH_3 mg/L	NA		NA	ND		ND	
Hardness as CaCO3 mg/L	NA		NA	217-413	294	127-596	370
Ca mg/L	62-63	62.50	NA	63-119	82.7	34-161	102
Mg mg/L	16-18	17	NA	11-28	18.14	10-47	26
K mg/L	3-3	3	NA	3-5	3.3	2-4	3.08
Na mg/L	13-16	14.50	NA	12-17	13.91	6-18	14.5
Cl mg/L	3.20-4	3.60	NA	ND-6	1.30	0.50-10.00	1.82
HCO_3 mg/L	98-104	101	NA	ND-120	78.5	50-192	119
Al mg/L	NA		NA	(trc) 1.2-2.2	1.7	NA	
As mg/L	0.179-0.19	0.18	0.11	(trc) 0.025-0.32	0.19	(trc) 0.009-0.300	0.08
Cd mg/L	NA		NA	(trc) ND-0.006	0.003	(trc) ND-0.01	0.003
Cu mg/L	0.05	0.05	NA	(trc)ND-0.05	0.0219	(trc)ND-0.05	0.0140
Fe mg/L	11-11	11	NA	(trc) 3.26-28.5	13.6	(trc) 0.69-17.90	5.3
Pb mg/L	NA		NA	(trc) ND		(trc) ND-0.03	0.008
Mn mg/L	NA		NA	(trc) 0.78-4.29	1.85	(trc) 0.02-1.12	0.33
Zn mg/L	0.83-0.88	0.85	NA	0.61-3.51	1.52	(trc) 0.17-1.76	0.87

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable

SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION L-3
(GOLD BUG ADIT DISCHARGE)
MONTANA GULCH

FIG. 3.2-18

Limited pre-1979 (baseline) data exist from station L-2, (upstream of the Montana Gulch/Rock Creek confluence). Since 1979 no cyanide has been detected and pH values have remained near neutral. Figure 3.2-19 illustrates the slight increase that has been recorded in TDS and SC reaching maximums of 894 mg/l and 1090 μmhos/cm, respectively. Baseline sulfate concentration at L-2 was 146 mg/l; since 1979 sulfate concentrations have slowly increased to a maximum of 572 mg/l in the Fall of 1993.

Swift Gulch/South Bighorn Creek. Two surface water monitoring stations exist within Swift Gulch (L-20 and L-21) and one in South Bighorn Creek (L-19); monitoring has been carried out at all three of these stations since 1985. Table 3.2-20 summarizes representative water quality data collected from station L-19 at South Bighorn Creek. Rising concentrations of sulfate and hardness and fluctuations in nitrate concentration at surface sites L-19 and L-20 show that drainage from the Landusky Mine site may have affected water quality in Swift Gulch, which is a tributary to South Bighorn Creek.

King Creek. Studies of the historic tailing contained within the King Creek drainage and their potential impact on the water quality of the King Creek and lower drainages have been conducted in 1978 by the BLM, in 1979 by the US Department of the Interior, Bureau of Indian Affairs (BIA), in 1982 and 1987 by the Council of Energy Resource Tribes (CERT), and in 1989 by the USGS. More recent investigations have been carried out by the Agency for Toxic Substances and Disease Registry (ATSDR) in January and July of 1993, and a Preliminary Assessment and Site Investigation report was also prepared during 1993 on behalf of the EPA Region VIII. The health consultations carried out by the ATSDR were in response to a request by the Indian Health Service (IHS) to determine if there was a health threat from the historic mine tailing to the people at Fort Belknap. Morrison Knudsen Corporation under contract to the EPA undertook investigations to assess the threat to human health and the environment and to determine the need for additional CERCLA/SARA or other action.

The ATSDR study concluded that concentrations of inorganic chemicals in the surface water and sediment from King Creek and Little Peoples Creek, do not represent a health risk to the people of the Fort Belknap Indian Reservation.

The surface water quality monitoring record is limited to two monitoring stations, L-5 and L-6 in the headwaters of King Creek. Data gathered at both stations are available from prior to and since 1979 are summarized on Table 3.2-20. Baseline or pre-Zortman Mining activity data illustrate that the surface water was only slightly effected by mining activities if at all prior to 1979. Sulfate concentrations ranging from 95 to 135 mg/l and SC from 490 to 525 μmhos/cm may have been due to drainage from adits at the head of King Creek and/or the mine tailing lining the creek bottom. Prior to 1979, the pH of the surface water ranged between 6.9 and 7.5.

Figure 3.2-20 illustrates water quality trends at monitoring station L-5 between 1979 and 1994 with sulfate concentrations increasing from approximately 100 to 1,070 mg/l, TDS from 351 to 1,930, although a constant near neutral pH has been maintained throughout this period. Monitoring station L-5 has detected significant concentrations of nitrate in water samples since 1982 ranging between 7.37 and 36.9 mg/l. These nitrates are possibly derived from the fertilizers being used in the reclamation of the waste rock at the head of the drainage or ANFO used in blasting of waste rock and ore. Figure 3.2-21 illustrates water quality trends at station L-6 located approximately 4,000 feet downstream from L-5, showing significantly lower TDS and sulfate concentrations than observed at L-5, but higher levels of suspended solids. The high total suspended solids recorded in this stream represent the large amount of erosion that has occurred during major precipitation events. Of note is the reduction in TSS at this location after 1993, correlating with ZMI's efforts to remove the historic tailing from the drainage. Sulfate at this location reached a maximum concentration of 260 mg/l, TDS of 627 mg/l, and SC 838 μmhos/cm in 1993 and nitrates are generally below detection limits. The pH at this location has remained near neutral since monitoring began in 1987.

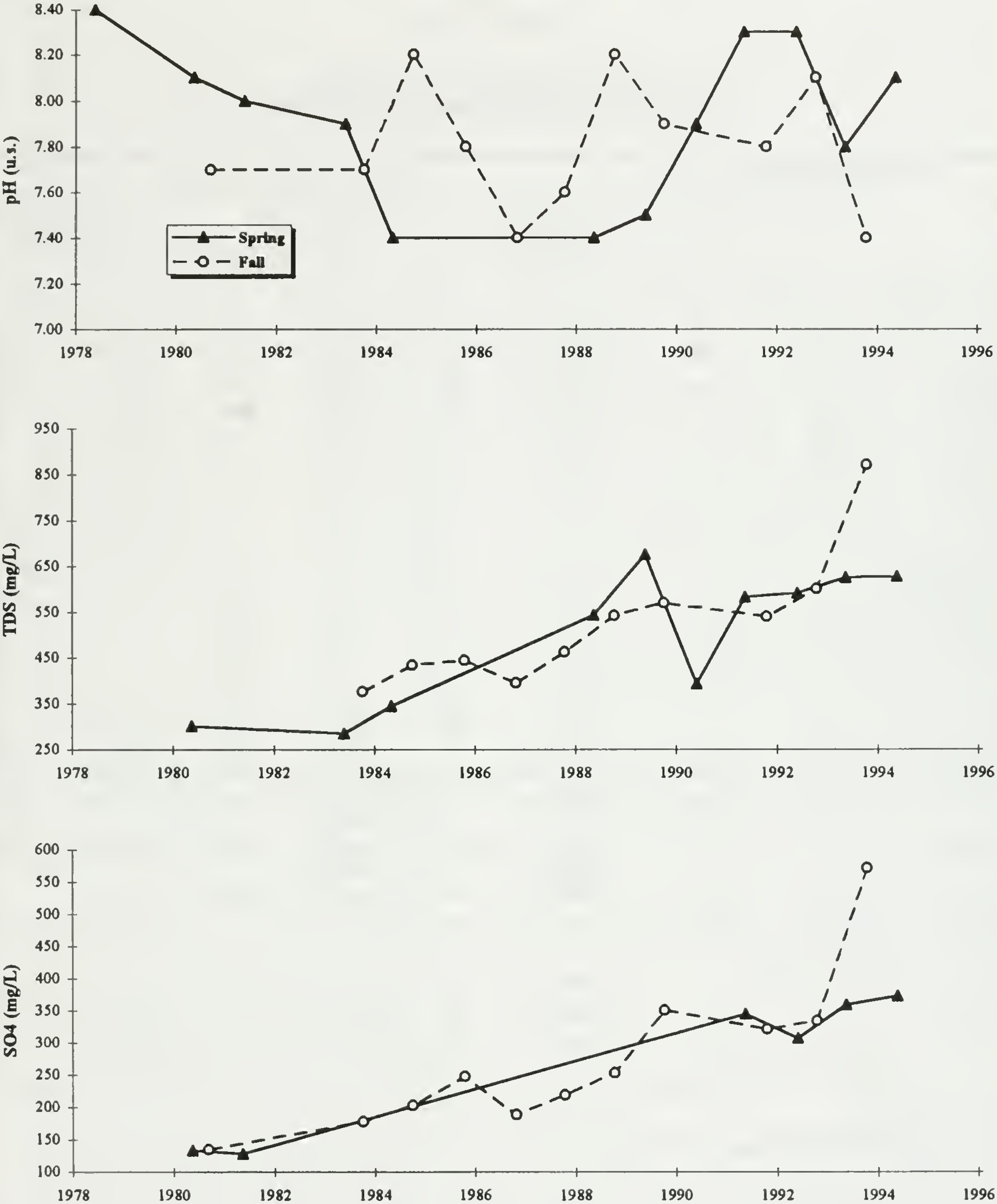
Summary of Landusky Surface Water Quality

In summary, the recent and historical surface water quality data reviewed for the Landusky mining area indicate the following:

Rock Creek/Sullivan Creek

- The 1991 heap leach pad buttress and/or the underlying disturbed bedrock is contributing ARD to the surface water in Sullivan Creek drainage. However, what is not captured appears to be significantly diluted once reaching the confluence with Rock Creek.

- The upper reaches of Rock Creek above the confluence with Sullivan Creek may be



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION L-2
DOWNSTREAM MONTANA GULCH

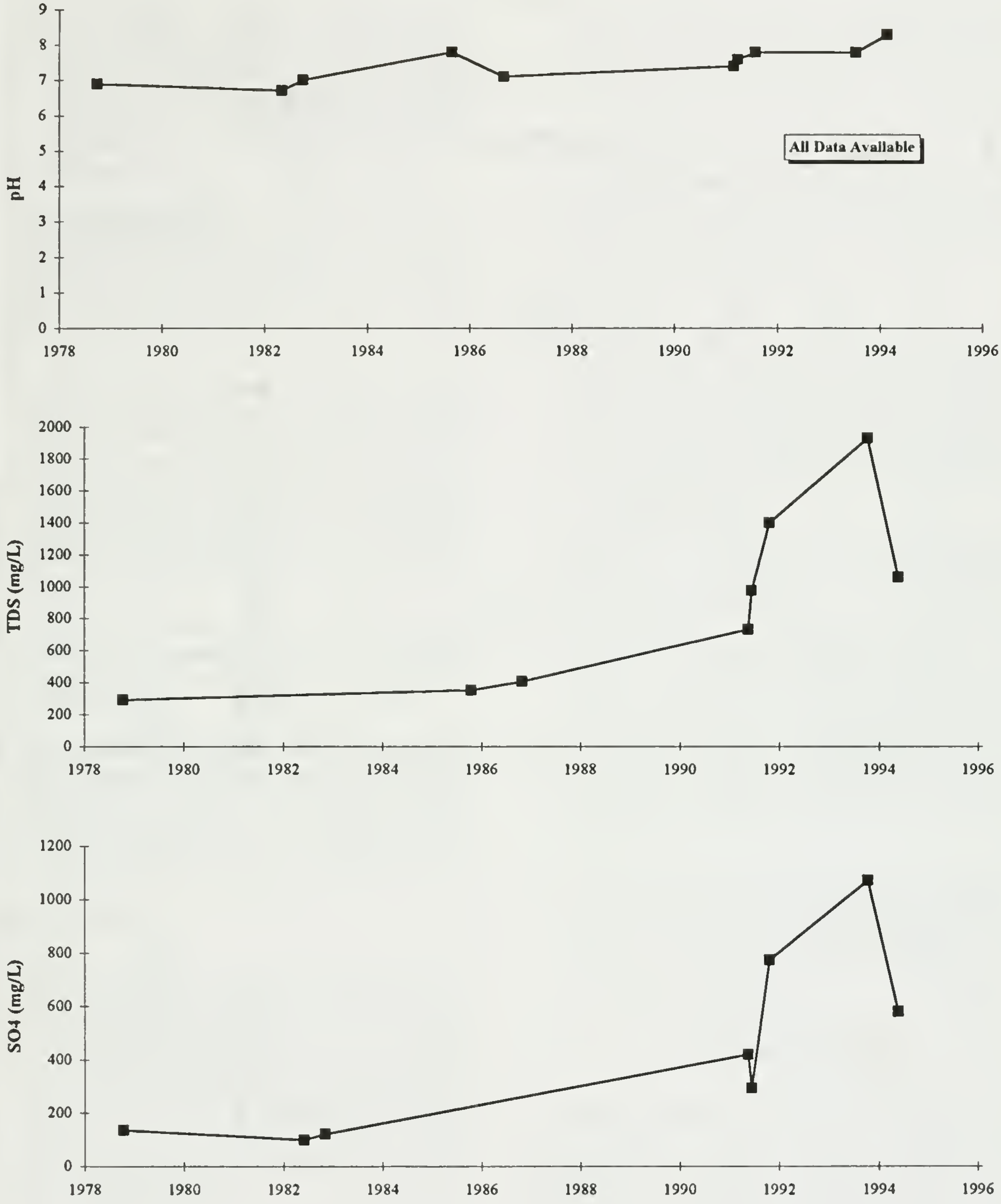
FIG. 3.2-19

TABLE 3.2-20

KING CREEK/SWIFT GULCH SURFACE WATER QUALITY SUMMARY

	BASELINE (Pre 1979)		OPERATIONAL (Post 1979)					
	L5	L6	L5 Upstream (1979-1994)		L6 Midstream (1979-1994)		Swift Gulch, L-19 (1985-1994)	
	Upstream	Downstream	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	1	1	10		20		24	
pH S.U.	6.9	7.5	6.7-8.3	7.4	7.2-8.1	7.6	6.4-8.0	7.4
SC μmhos/cm	490	525	340-2,010	1,094	293-838	593	48-523	314
TDS mg/L	291	306	351-1,930	978	236-735	520	53-355	221
TSS mg/L	NA	NA	ND-486	87	0.5-191.0	44.7	0.5-33.0	5.5
SO$_4$ mg/L	134	95	98-1,070	507	69-260	116	12-183	94
CN mg/L	NA	NA	ND		ND		ND	
NO$_2$/NO$_3$ mg/L	NA	NA	7.3-36.9	18.2	ND-1.29	0.14	ND-1.49	0.32
NH$_3$ mg/L	NA	NA	ND		ND		ND-0.10	0.054
Hardness as CaCO3 mg/L	231	245	168-1,330	577	153-486	334	18-251	148
Ca mg/L	70	77	53-368	190	49-136	88.6	4-72	41.0
Mg mg/L	14	13	9-99	40	8-40	28	2-19	9.8
K mg/L	2	2	2-6	3.9	2-5	3	1-4	2.3
Na	8	13	5-13	9.0	6-19	11.3	1-16	8.7
Cl mg/L	3	4	2-86	14.5	ND-3	1.13	0.5-9.0	1.2
HCO$_3$ mg/L	122	207	80-204	160	100-408	276	(trc)13-113	64
Al mg/L	NA	NA	(trc)ND-0.02	0.008	(trc)ND-0.7	0.23	(trc)ND-1.0	0.26
As mg/L	NA	(trc) 0.01	(trc)ND-0.02	0.008	(trc)ND-0.0170	0.0081	(trc)ND-0.018	0.012
Cd mg/L	NA	NA	(trc)ND-0.0010	0.0007	(trc)ND-0.0020	0.0006	(trc)ND-0.001	0.0006
Cu mg/L	NA	(trc)0.02	(trc)ND-0.011	0.0068	(trc)ND-0.01	0.0062	(trc)ND	
Fe mg/L	NA	(trc) 0.17	(trc)ND-1.47	0.51	(trc)0.01-1.47	0.5	(trc)ND-2.11	0.44
Pb mg/L	NA	NA	(trc)ND-0.05	0.02	(trc)ND-0.02	0.006	(trc)ND-0.02	0.007
Mn mg/L	NA	NA	(trc)ND-0.15	0.05	(trc)ND-1.19	0.53	(trc)ND-0.08	0.026
Zn mg/L	NA	NA	0.02-0.25	0.07	(trc)ND-0.06	0.016	(trc)ND-0.16	0.09

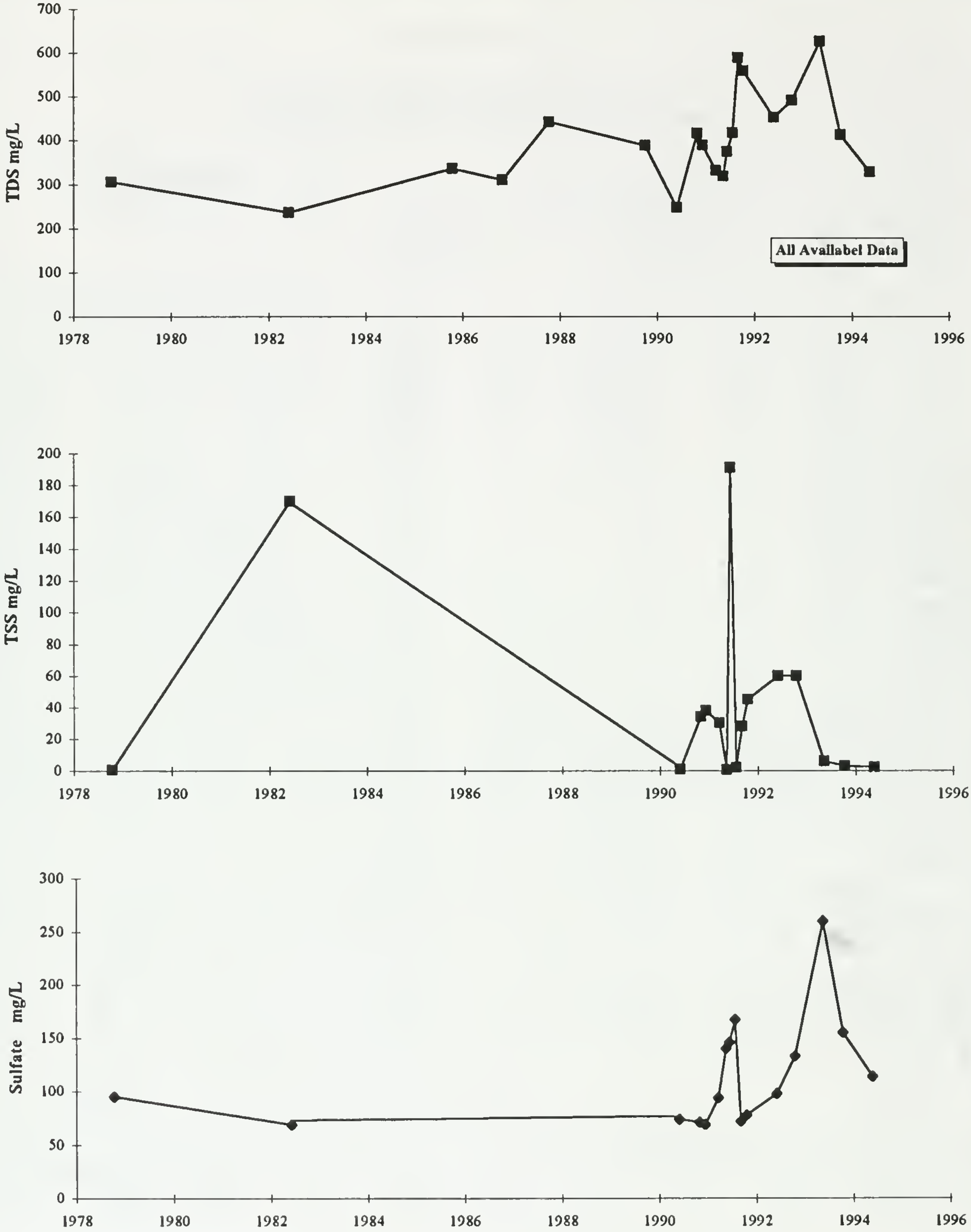
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated
(tot) = Total
(trc) = Total Recoverable



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION L-5
UPSTREAM KING CREEK

FIG. 3.2-20



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

SURFACE WATER QUALITY
MONITORING STATION L-6
DOWNSTREAM KING CREEK

FIG. 3.2-21

representative of pre-Zortman Mining activity baseline conditions. Pre-1979 (baseline data) are available from monitoring station L-1, the furthest downstream monitoring station. Between 1977 and 1978, station L-1 had an average pH of 8, sulfate concentration of 82 mg/l and SC of 521 μmhos/cm, indicating little or no adverse impact from historical mining operations.

- Effects from mining activity since 1979 are recognizable in the monitoring record of downstream monitoring station L-1, with minor increases in TDS and sulfate levels.

Mill Gulch

- Effects of mining activity are seen in surface water samples throughout the length of Mill Gulch, in the form of cyanide detections, lowered pH and increased concentrations of dissolved solids. Two specific events can be recognized in the sampling record having impacted surface water quality in Mill Gulch: (1) the initiation of the 1987 Mill Gulch Heap leach pad and (2) an event in early 1991 affecting the total length of the drainage.

- A western tributary to Mill Gulch draining the processing area and portions of the 83 leach pad complex contains traces of cyanide from past spills in the plant area.

- No pre-Zortman Mining operation (baseline) data are available for Mill Gulch, but the earliest data gathered at L-7 in 1982 is representative of baseline surface water conditions for the drainage as the earliest disturbances were in 1985/1986 during preconstruction testing of the leach pad site.

Montana Gulch

- Surface water quality data from prior to Zortman Mining activity are available from monitoring station L-2 (downstream) and suggest that the upper reaches of the drainage were impacted by ARD prior to Zortman Mining activities commencing in 1979. This impact was most likely derived from discharge from the August and Gold Bug adits. Station L-2 had an average pH of 6.57, sulfate concentration of 162 mg/l, TDS of 302 mg/l, and SC of 503 μmhos/cm.

- Water draining from the 1983 Pad area is of poor quality although it appears to have improved substantially since 1984.

- The Gold Bug Adit has been contributing the bulk of flow in Montana Gulch since 1960. The iron rich, near neutral waters discharging from the adit are currently captured and oxygenated to precipitate the excessive iron out of solution.

South Bighorn Creek

- South Bighorn Creek surface water quality data, fall within the ranges derived for pre-1979 "baseline" water quality data, and are currently not adversely impacted by mining activity.

King Creek

- Baseline data from station L-5 and L-6 indicate that King Creek surface water may have been slightly impacted by historic mining activities prior to 1979. Stations L-5 and L-6 had pHs of 6.9 and 7.5, sulfate concentrations of 134 and 95 mg/l, TDS of 291 and 306 mg/l, and SC of 490 and 525 μmhos/cm respectively in 1978.

- King Creek surface water quality has been progressively effected by mining activities at Landusky since 1979.

- Occasionally elevated levels of TSS reported in the King Creek monitoring record indicate that there has been significant erosion and or disturbances in the drainage. Action was taken by ZMI during 1993 to remove the historic tailing from the upper reaches of King Creek, has noticeably reduced the amount of suspended solids being transported downstream.

- The ATSDR study performed in January and July of 1993 concluded that concentrations of inorganic chemicals in the surface water and sediment from King Creek and Little Peoples Creek do not represent a health risk to the people of the Fort Belknap Indian Reservation.

3.2.5.2 Groundwater Quality

Water quality data have been collected from a network of groundwater monitoring sites in the Zortman and Landusky mining areas on at least a bi-annual basis since 1977. This baseline monitoring effort has developed into a long-term sampling program at some sites, with the objective of detecting long-term changes in the water quality within and near the mining areas. Groundwater monitoring wells have been progressively completed in the representative alluvial and bedrock units since 1977 as the operations have developed and expanded into new drainages. The water resources monitoring program under existing operations is detailed in Section 2.6.5.1.

As with surface waters, groundwater samples are analyzed by Energy Laboratories in Billings, Montana. For QA/QC, duplicate samples are often sent to other laboratories. Groundwater quality monitoring in the area has also been carried out by BLM, DHES and USGS. Data are also available from a few wells installed in 1978 prior to Zortman Mining activity as part of the 1979 EIS program.

Figures 3.2-22 and 3.2-23 are piper trilinear plots of the major anion and cation concentrations in groundwater samples from Zortman and Landusky during the spring 1994 sampling event. Similar to the distribution seen for surface waters at Zortman and Landusky, the groundwaters are of a general calcium sulfate type. A wide distribution of alluvial, metamorphic, volcanic, and limestone groundwaters is seen along the sulfate axis of the trilinear, depending on presence and degree of impact from ARD.

One discernable group is the Goslin Flats shale groundwater samples (Figure 3.2-22). Their moderately high sulfate content combined with a lack of calcium and excess of sodium and potassium plots them away from the other waters lower in sodium and potassium.

Baseline Groundwater Quality

Table 3.2-21 summarizes all the available pre-1979 "baseline" groundwater quality data and summary statistics. For comparison purposes only, alluvial groundwater, bedrock groundwater, spring and adit discharges data have been pulled together to form a data set of baseline groundwater quality. The differences in chemistry between groundwater sources are recognized. In general the baseline groundwater quality data show the water to be of calcium bicarbonate type. Figures 3.2-22 and 3.2-23 illustrate that in many drainages the groundwater is now of calcium sulfate type. The higher proportion of sulfate coming from the ongoing oxidation of metal sulfides at the mine sites.

Zortman Area Groundwater Monitoring Results

The following summarizes these data in terms of impacts to groundwater quality due to past or current mining operations and baseline groundwater quality conditions in presently disturbed areas and that of proposed extension areas. Water quality and groundwater level data from monitoring wells known to be constructed with screen in both alluvium and bedrock and those wells suspected of having an unsatisfactory seal between the alluvium and the underlying bedrock have been excluded from the groundwater quality review. The locations of groundwater monitoring wells at Zortman are shown on Exhibit 1 (EIS map pocket).

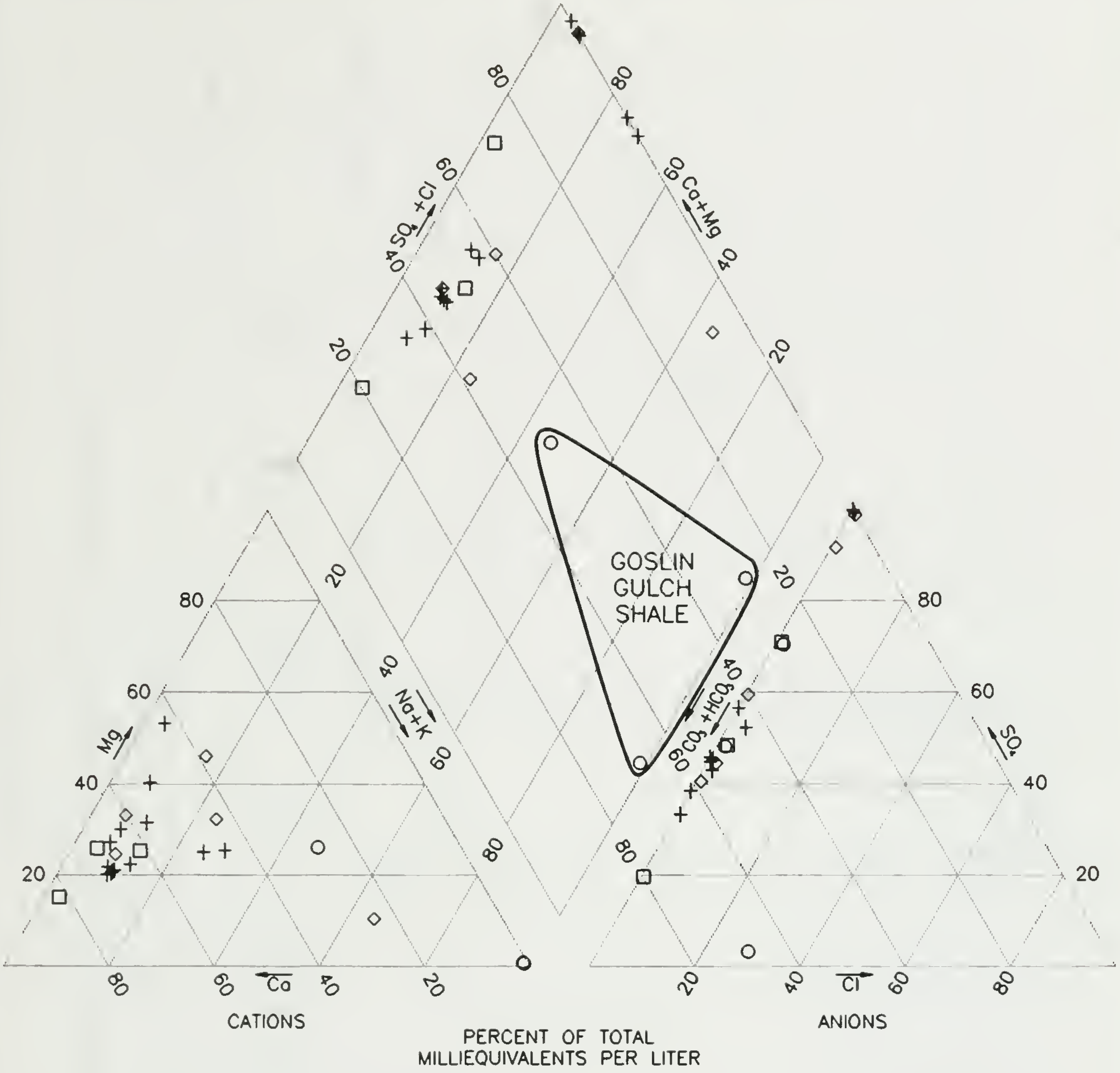
Ruby Gulch. Wells used to evaluate groundwater conditions in Ruby Gulch included ZL-200, ZL-201, 203 and ZL-207R (completed in syenite rock within the open pits), RG-99 (fractured metamorphics in the upper reaches of the drainage), ZL-102 and ZL-101A (within fractured metamorphics and alluvium, respectively next to the process plant), RG-108 and ZL-134 (syenite and metamorphics below the process plant area), RG-109 and ZL-143 (alluvium below the process plant area and above the town of Zortman, ZL-142 (limestone above the town of Zortman, and Z-8A (Zortman community well completed in limestone).

Table 3.2-22 summarizes the groundwater quality throughout the length of Ruby Gulch. Monitoring wells completed within the pits at Zortman (Zl-200, ZL-201, ZL-202, ZL-207R) show the effects of ARD with pHs generally below 4. The two samples taken from ZL-200 during 1993 had pH's of 2.5 and 2.7, SC of 10,100 and 5,130 μmhos/cm and sulfate concentrations of 15,800 and 5,300 mg/l.

Review of groundwater quality data from RG-99 (metamorphic rocks at head of Ruby Gulch) shows a trend of increasing TDS, SC, hardness and decreasing pH. Figure 3.2-24 illustrates that after 1989, the pH in well RG-99 ranged from 2.6 to 3.5 units; TDS values from 3,950 to 20,200 mg/l; and sulfate from 2,680 to 6,590 μmhos/cm. RG-99 also consistently detects elevated levels of iron, manganese, nickel and zinc. The elevated concentration of TDS, elevated sulfate and metals, and low pH indicate that the bedrock in the upper reaches of Ruby Gulch is impacted by ARD.

The pod of groundwater monitoring wells located just downstream of RG-99 show a variety of groundwater quality conditions. Wells RG-108 (63 feet deep within porphyry volcanics) and ZL-134 (150 feet deep within porphyry volcanics) show no effects from mining activity. These wells have pH values which are generally near-neutral, with specific conductivities ranging from 367 to 587 μmhos/cm. Sulfate concentrations at RG-108 and ZL-134 average 104 and 127 mg/l, respectively, while TDS concentrations average 306 mg/l for RG-108 and 285 mg/l for ZL-134 (Table 3.2-22). Dissolved metal concentrations at these wells are consistently low.

Groundwater samples from ZL-102 (225 feet deep within metamorphics) also appear to be relatively unaffected by mining activities with the exception of



L E G E N D

◇ ALLUVIUM

\+ METAMORPHIC & VOLCANIC ROCK

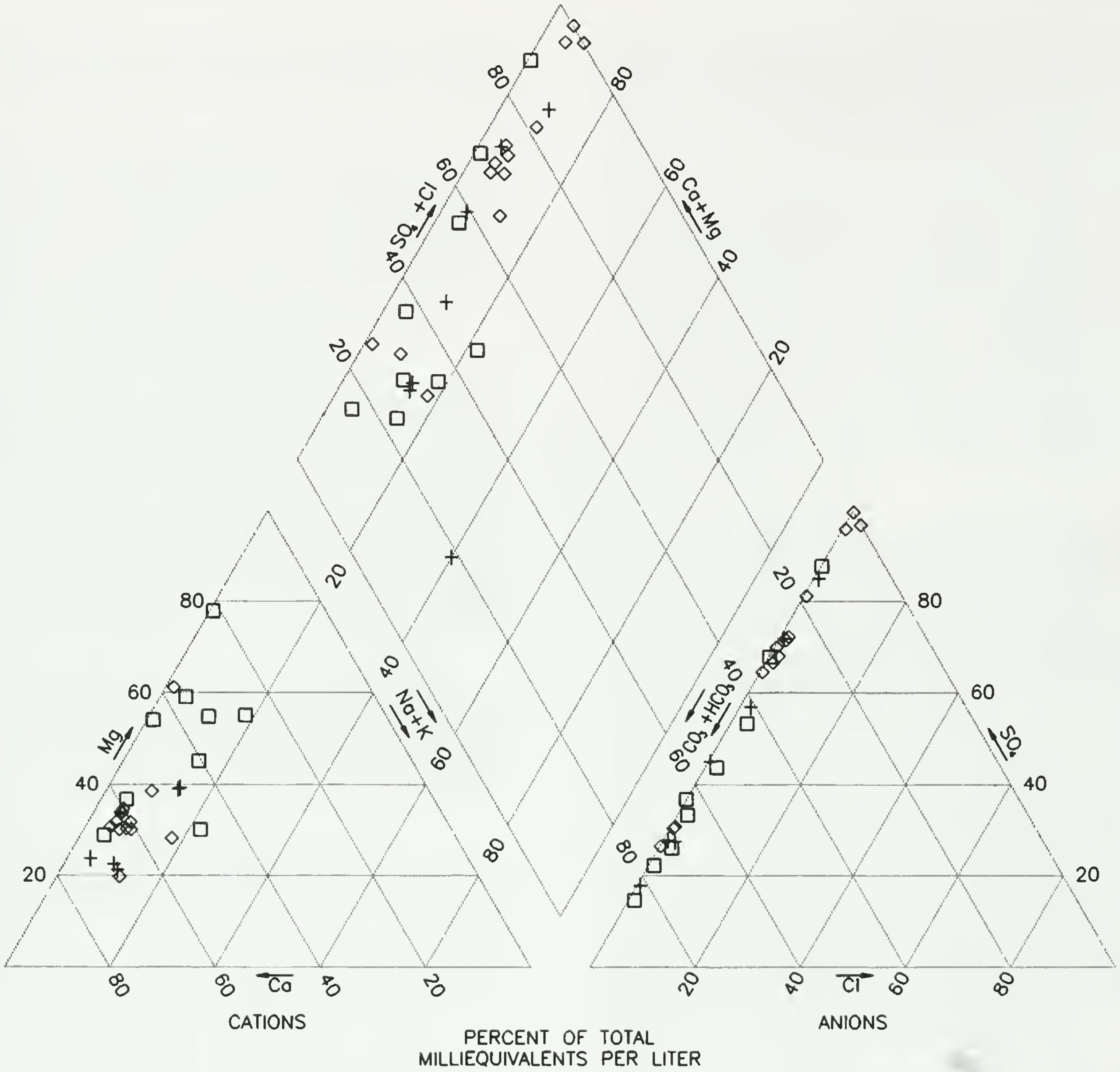
☐ LIMESTONE

○ SHALE

SOURCE: ZMI WATER QUALITY MONITORING REPORTS

PIPER TRILINEAR PLOT FOR ZORTMAN MINE GROUNDWATER

FIG. 3.2-22



LEGEND

◇ ALLUVIUM

\+ BEDROCK

□ LIMESTONE

SOURCE: ZMI WATER QUALITY
MONITORING REPORTS

PIPER TRILINEAR PLOT FOR LANDUSKY MINE GROUNDWATER

LANDGW

FIG. 3.2-23

TABLE 3.2-21

GROUNDWATER BASELINE (PRE-1979) WATER QUALITY

	Zortman			Landusky										
	Ruby Gulch	Alder Gulch	Lodge Pole	Mill Gulch					Montana Gulch		King Creek	Summary Statistics		
	Spring @ Campground (1978)	Mine Adit Discharge (1978)	Developed Spring (1978)	Shallow Well No. 6 (1978)	Int Well No. B (1978)		Deep Well No. 1 (1978)		L-3 (Gold Bug Adit) Upstream (1977-1978)		Spring @ Tailings (1978)	Alluvial & Bedrock Groundwater		
No. of Samples	1	1	1	1	2		3		7		1			
					Range	$\bar{X}$	Range	$\bar{X}$	Range	$\bar{X}$		n	Minimum	Maximum
pH	7.8	7.2	8.0	7.4	7.8-8.0	7.9	7.4-7.6	7.5	6.5-6.7	6.6	6.9	13	6.5	8
Sc μmhos/cm	285	530	445	940	480-510	495	560-610	585	485-520	503	490	13	285	520
TDS mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
TSS mg/L	<1.0	5	1	NA	5390		NA		22-32	27	<1.0	6	1	5390
SO$_4$ mg/L	8	100	5	10	2-12	7	15-44	29.5	150-186	161.8	134	11	2	186
Cn (tot) mg/L	NA	NA	NA	ND	ND		ND		0.00		NA	8	0	0.005
NO$_2$/NO$_3$ mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
NH$_3$ mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
Hardness as CaCO$_3$ mg/L	135	240	221	NA	NA		NA		NA		231	3	135	240
Ca mg/L	41	77	56	129	46		56		62-63	62.5	70	8	41	129
Mg mg/L	8	12	20	50	35		39		16-18	17	14	8	8	50
K mg/L	2	3	1	2	1		2		3-3	3	2	7	1	3
Na mg/L	5	16	2	5	2		2		13-16	14.5	8	8	2	16
Cl mg/L	4	5	3	6	4		4		3.2-4.0	3.6	3	7	3	6
HCO$_3$ mg/L	159	195	268	647	305		329		98-104	101	122	8	98	647
Al mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
As mg/L	NA	0.108	NA	0.005	0.030		0.021		0.179-0.310	0.27	<0.003	7	0.005	0.31
Cd mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
Fe mg/L	NA	2.3	NA	0.021	3.0		8.2		10.9-11	11	0.03	6	0.021	11
Pb mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
Mn mg/L	NA	NA	NA	NA	NA		NA		NA		NA	0		
Zn mg/L	NA	0.8	NA	0.17	0.005		0.11-0.43	0.27	0.83-0.88	0.82	0.05	9	0.005	0.88

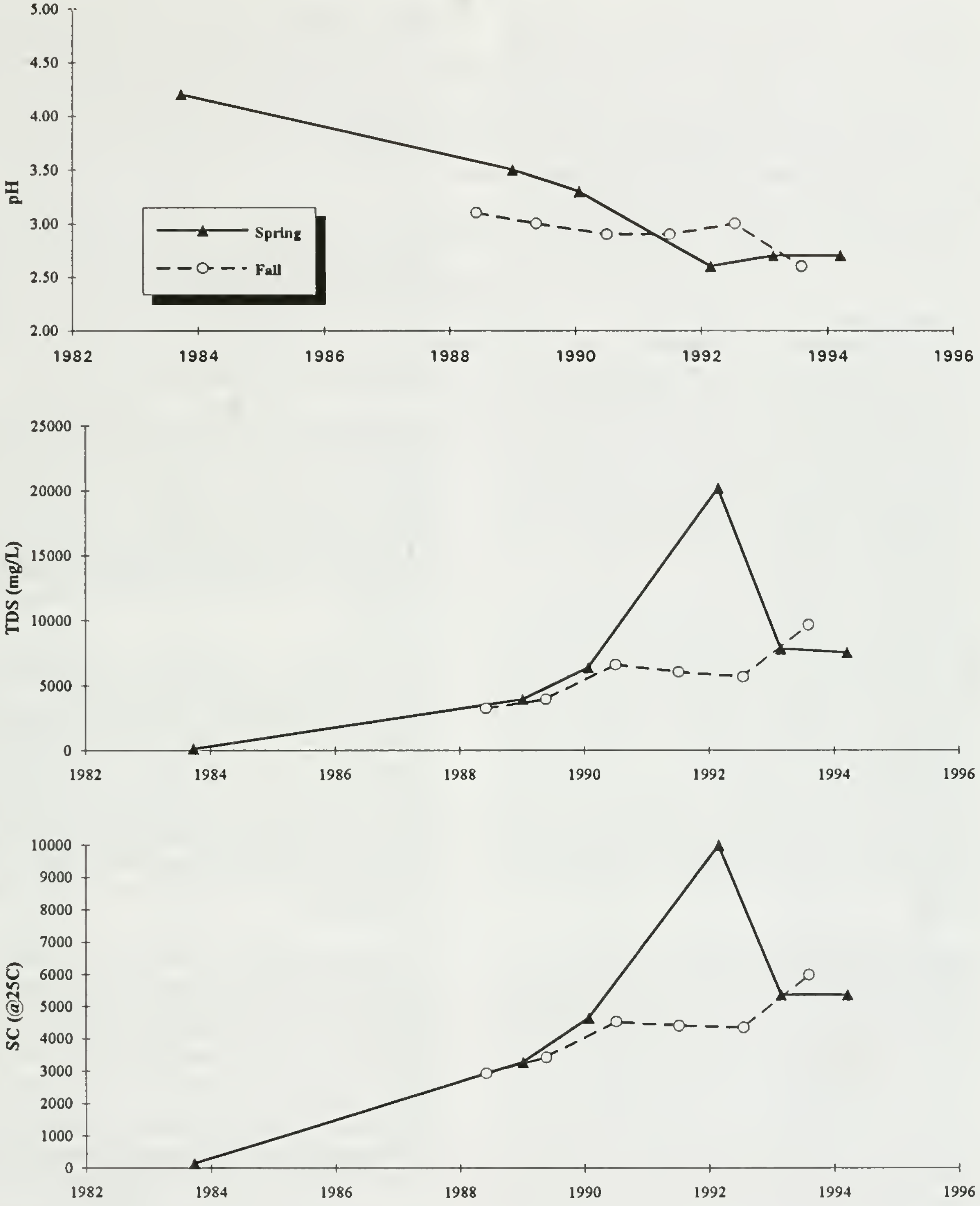
TABLE 3.2-22

RUBY GULCH GROUNDWATER QUALITY SUMMARY

	Representative Baseline				Operational				Operational			
	Bedrock				Bedrock				Alluvium			
	Metamorphics Upgradient RG-108 (1986-1994)		Metamorphics Downgradient ZL-134 (1989-1994)		Metamorphics Upgradient RG-99 (1984-1994)		Limestone Downgradient ZL-142 (1990-1994)		Tailings Upgradient RG-109 (1986-1994)		Gravels Downgradient ZL-143 (1990-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	22		11		13		14		22		3	
pH S.U.	7.00-7.90	7.60	7.20-7.80	7.60	2.60-4.20	3.10	6.50-7.60	7.20	2.70-4.70	3.50	7.50-7.90	7.66
SC μmhos/cm	367-587	450	389-425	405	141-9,990	4,379	1,080-1,990	1,430	755-4,480	1,895	1,120-1,300	1,196
TDS mg/L	244-421	306	225-285	254	106-20,200	6,566	862-1,800	1,275	569-5,587	2,014	954-1,150	1,084
SO_4 mg/L	85-192	104	68-80	75.6	2,680-4,060	4,367	457-1,070	703	384-3,100	1,286	569-658	621
CN mg/L	ND		ND		0.005-0.009	0.009	ND-006	.0047	ND-0.24	0.04	ND-.005	.003
NO_2/NO_3 mg/L	ND-0.41	0.64	ND		2.70-3.60	3.75	0.81-2.68	1.50	0.27-4.40	1.46	0.92-0.92	0.92
NH_3 mg/L	ND		ND		NA	0.57	ND		0.10-0.40	0.19	ND	
Hardness $CaCO_3$ mg/L	186-295	228	181-213	196	44-2,870	1,653	646-1,320	923	296-1,225	652	719-882	799
Ca mg/L	57-89	68	56-65	60.3	262-342	310	223-434	298	79-236	155	238-289	266
Mg mg/L	10-18	12.4	10-12	11.0	178-323	225	22-57	36.6	24-92	57.8	29-39	33
K mg/L	0.5-3.0	1.70	1-2	1.9	2-13	6.7	3-6	4.3	1-8	2.3	4-5	4.30
Na mg/L	7.0-12	9.0	8-10	8.9	7-29	13.5	7-12	9.20	11-22	15.8	7-9	8
Cl mg/L	ND-8	1.50	0.50-7.00	2.28	0.50-45.00	11.3	2-12	4.80	2-18	8.0	2-4	3
HCO_3 mg/L	125-155	144	141-163	155	NA		129-228	177	ND		153-192	168
Al mg/L			ND		543-556	549	ND-3.40	0.68	15.20-261	76.9	ND	
As mg/L			0.06-0.14	0.12	0.50-0.92	0.71	ND		ND-0.049	0.009	ND	
Cd mg/L	ND-0.003	0.002	0.0001-0.0020	0.008	0.40-0.45	0.41	ND-0.003	0.0015	0.034-0.390	0.12	0.0003-.0003	.0003
Cu mg/L	ND		ND		29.5-31.7	30.6	ND		0.94-18.7	4.2622	0.06	0.06
Fe mg/L	0.20-1.22	0.60	0.36-0.88	0.55	3.10-225.00	4.60	ND		0.55-140.00	17.1	0.07-0.07	0.07
Pb mg/L	ND-0.01	0.005	ND-0.10	0.005	ND		ND		ND-0.03	0.01	ND	
Mn mg/L	0.27-0.71	0.48	0.23-0.37	0.27	53.8-63.2	58.5	ND-0.43	0.08	4.40-34.60	16.2	ND	
Zn mg/L	0.03-0.06	0.043	0.01-0.04	0.030	5.60-15.60	10.1	0.12-0.90	0.31	1.09-11.30	4.0	0.03-0.03	0.03

NA = Not Analyzed; ND = Not Detected; All concentrations dissolved unless otherwise stated
Note: No pre-1979 (baseline data) available

Sheet 1 of 1



SOURCE: ZMI WATER QUALITY MONITORING REPORTS

BEDROCK WATER QUALITY
MONITORING WELL RG-99
PORPHYRY METAMORPHIC ROCK
RUBY GULCH

FIG. 3.2-24

occasional total WAD cyanide detections. Monitoring well ZL-101A (78 feet deep in alluvium) had total cyanide concentrations detected in every sample between 1985 and 1988, with a maximum concentration of 0.10 mg/l. The effects of mining activity are also indicated by SC values between 1100 and 1800 µmhos/cm and TDS concentrations of 895 to 1480 mg/l. The pH of the samples was slightly below neutral with an arithmetic mean of 6.8. Monitoring wells ZL-102 and ZL-101a are installed in the Zortman Mine processing plant area, the cyanide detections in the underlying groundwater resulting from process solution leaks and spills.

Monitoring well RG-109 is completed at a depth of 30 feet in mineralized tailing in Ruby Gulch downstream of the 1985-1986 leach pad. Groundwater flowing within the tailing is impacted by ARD, illustrated by low pH values (ranging from 2.6 to 4.70), elevated concentrations of TDS (from 569 to 20,200 mg/l), and sulfate from 2,680 to 6,590 mg/l. Water within the tailing also consistently has elevated concentrations of iron, manganese, nickel and zinc. It is not clear if this contamination is due to the tailing themselves or upstream ARD contamination.

Monitoring well ZL-142 is completed in limestone bedrock (total depth 64 feet) at the town of Zortman. From 1990 through 1994, groundwater at this location had TDS concentrations averaging 1,275 and sulfate from 457 to 1,070 mg/l (Table 3.2-21). Metal concentrations within samples from ZL-142 are low or below detection limits, suggesting that the moderately elevated TDS and sulfate could be due to either neutralized ARD or possible naturally high sulfate conditions within the limestone. Water levels at this location indicate a downward vertical gradient, suggesting this water is currently recharging the limestone.

The Zortman community well Z-8A is located within an eastern tributary to Ruby Gulch and is completed with perforations between 395 and 738 feet in limestone bedrock. The well has been monitored since 1982 and has shown no indications of ARD contamination, with maximum concentrations of 432 µmhos/cm SC, 272 mg/l TDS and 209 mg/l sulfate. This tributary has no mining-related facilities within its drainage and is separated from the impacted limestone at ZL-142 by considerable distance and depth, thus ARD contamination or other mining related effects at Z-8A are extremely unlikely.

Alder Gulch and Alder Spur. Groundwater quality data from the Alder Gulch drainage area was reviewed from monitoring well ZL-107R (limestone, Carter Spur), ZL-110 (metamorphics in Alder Spur), AG-200 (syenite volcanics), AG-201 (limestone), AG-202 (alluvium) and AG-203 (limestone) from Alder Gulch in a downstream direction.

Table 3.2-23 summarizes alluvial and bedrock water quality data for the Alder Gulch drainage. Data are available for ZL-107R from 1982 to 1989. During this time the groundwater quality appears to have improved with TDS concentrations dropping from 747 to 306 mg/l. This improvement may be due to the neutralizing capacity of the limestone, neutralizing the ARD and causing the metals to precipitate out of solution.

AG-200 is located just above the confluence of Alder Gulch and Alder Spur. The monitoring record from this bedrock well shows the groundwater to be of good general quality with an average TDS of 415 mg/l. However, samples taken during 1991 show a period of degradation, with the pH dropping to 6.5, TDS reached a maximum of 1,080 mg/l and sulfate a maximum of 664 mg/l. Since 1991, the water quality has continued to improve.

Data from well ZL-110 appears to be representative of bedrock groundwater quality for Alder Spur. At well ZL-110 (200 feet deep in metamorphics and screened between 70 and 200 feet), specific conductivity has ranged from 545 to 664 µmhos/cm; pH from 7.2 to 8.1 units; and TDS from 336 to 471 mg/l (from 1983 to 1994). Sample analyses from this deep well show minimal or no effects from mining activities in contrast to surface water samples in the vicinity, and may be representative of baseline water quality in the bedrock of Alder Gulch.

Groundwater samples from the shallow alluvial well (AG-202) below the confluence of Alder Gulch and Alder Spur have a record of near-neutral pHs, many cyanide detections and variable SC, TDS and sulfate (Table 3.2-23). The cyanide detections may have resulted from emergency land application of processing solution during 1987, which was carried out in cooperation with DSL and the BLM in response to extremely large precipitation events (Stephen 1993). No cyanide has been detected at AG-202 since 1992.

Monitoring wells AG-201 and AG-203 are constructed in limestone downstream of the main Alder Gulch/Alder Spur confluence. The monitoring record shows water from these wells to be of good quality with the exception of a period of degradation at AG-201

TABLE 3.2-23

ALDER GULCH GROUNDWATER QUALITY SUMMARY

	Operational							
	Bedrock						Alluvium	
	Upgradient Metamorphics (Alder Spur) (ZL-110) (1983-1994)		Metamorphics Carter Gulch Upgradient (ZL-107R) (1982-1989)		Upgradient AG-200 (1990-1994)		Downgradient AG-202 (1987-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	24		16		13		11	
pH S.U.	6.81-8.04	7.1	6.8-8.0	7.4	6.5-7.6	6.8	6.90-7.80	7.39
SC μmhos/cm	545-664	611	488-1030	654	256-1,170	544	199-1,450	559
TDS mg/L	504-550	518	306-747	423	147-1,080	414	132-1,300	442
SO_4 mg/L	75-127	105	258-318	288	63-664	240	40-793	253
CN mg/L	ND		ND		ND		ND-0.03	0.008
NO_2/NO_3 mg/L	ND-0.05	0.03	0.005-0.025	0.015	ND-0.57	0.13	ND-1.19	0.36
NH_3 mg/L	ND		NA		ND		ND	
Hardness as CaCO3 mg/L	298-374	330	230-604	353	123-682	2.84	95-932	305
Ca mg/L	68-80	73.3	145-167	156	41-198	87.3	30-273	93
Mg mg/L	33-38	35	31-45	38	8-46	19.25	5-61	21.4
K mg/L	3-7	3.6	6-6	6	1-4	2.25	1-5	2.3
Na mg/L	10-14	11	11.00-17.00	14.00	4-15	8.3	4-16	7.9
Cl mg/L	ND-12	4.3	3.00-3.00	3.00	0.50-3.00	2.2	2-9	4.8
HCO_3 mg/L	266-297	285	302-373	338	27-104	71.6	17-123	73.2
Al mg/L	ND		NA		ND-0.3	0.10	ND-0.10	0.06
As/L	ND		0.01-0.01	0.01	ND		ND-0.009	0.004
Cd mg/L	ND		NA		ND-0.01	0.002	ND-0.002	0.0008
Cu mg/L	ND		ND-0.01	0.0075	ND		ND-0.006	0.0051
Fe mg/L	0.03-0.10	0.06	0.55-1.37	0.96	ND-1.02	0.15	ND-0.04	0.02
Pb mg/L	ND-0.01	0.0075	ND-0.01	0.008	ND-0.01	0.005	ND-0.02	0.01
Mn mg/L	ND		0.05-0.07	0.06	ND-2.02	0.30	ND-0.28	0.05
Zn mg/L	0.01-0.48	0.17	0.04-0.61	0.33	0.03-1.03	0.15	ND-0.03	0.02

Note: No pre-1979 (baseline data) available
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

during 1991, when the pH dropped to 6.8, TDS reached 1,270 mg/l and sulfate 783 mg/l.

All monitoring wells within Alder Gulch, with the exception of the deep well ZL-110, had specific conductivity, sulfate, nitrate, and TDS values that were generally higher during July, September, and October of 1991 than in the remaining samples collected from these wells.

Goslin Flats. Groundwater quality data in Goslin Flats was reviewed from wells ZL-147 (alluvium, tributary to Goslin Flats), ZL-148 (undifferentiated shale, Goslin Flats), ZL-149 and ZL-154 (alluvium, Goslin Flats) and ZL-152 (undifferentiated shale, Goslin Flats).

Table 3.2-24 summarizes the alluvial and bedrock water quality for the Goslin Flats area. Wells in Goslin Flats that have elevated TDS and sulfate include ZL-147 and ZL-148 (completed in the shale). ZL-147 showed detectable levels of total and WAD cyanide during November 1991, but this detection is likely the result of a quality control error, as there is no source of cyanide in this area and no other detections of cyanide are recorded in nearby wells or surface water monitoring sites. The pH in this well has been constant and near neutral, but specific conductance and total dissolved solids analysis are relatively high, with average values of 1279 μmhos/cm and 959 mg/l, respectively. Sulfate concentrations are also elevated, reaching a maximum of 480 mg/l.

The other alluvial groundwater monitoring well reviewed (ZL-149) is located downgradient at Goslin Flats. Water quality data from this well shows a near neutral pH, moderate SC ranging from 792 to 991 μmhos/cm, and TDS concentrations ranging from 570 to 663 mg/l. Sulfate concentrations are also lower than in the upgradient alluvium, ranging from 196 to 246 mg/l.

Bedrock monitoring well ZL-152 has no detections of cyanide and a pH with an arithmetic mean of 8.1; however, since installation in 1990, the SC and TDS in the well have fluctuated significantly, reaching maximums of 2,210 μmhos/cm and 1,260 mg/l, respectively. Sulfate in this deeper well has remained low with an average concentration of 41 mg/l. Monitoring well ZL-148 also has a slightly alkaline pH with an arithmetic mean of 8.3 and SC and TDS levels with mean values of 2,801 μmhos/cm and 1,885 mg/l, respectively. Sulfate concentrations at ZL-148 have fluctuated reaching a maximum concentration of 1,050 mg/l in the Fall of 1993.

The consistently neutral pH's and varying sulfate concentrations suggest that the elevated dissolved constituents in the samples is due to continuing water rock interaction within the mineral-rich shales.

Lodgepole Creek.. Lodgepole Creek drains approximately 15 square miles of the northern portion of the Little Rocky Mountains, its headwaters starting just north of the present day Zortman Mine workings. Groundwater quality data in the Lodgepole drainage is limited to two newly completed wells in Glory Hole Gulch (ZL-209 and ZL-210) and a spring Z-6, located on the hillside above Lodgepole Creek north of the confluence with Glory Hole Gulch. Lodgepole groundwater data are summarized on Table 3.2-25. Monitoring wells ZL-209 and ZL-210 are completed at 260 feet and 445 feet respectively, within igneous and metamorphic bedrock. Water samples from the wells are of a general calcium bicarbonate to calcium sulfate type and show no evidence of impacts from mining activity with pHs of 7.4, 7.9, sulfate concentrations of 158 and 80 mg/l and TDS of 243 and 389 μmhos/cm, respectively. The Z-6 monitoring record spans from 1979 to 1994 and shows the shallow groundwater to be unimpacted by the neighboring mining activity with a consistently neutral pH, and TDS and sulfate concentrations of 229 mg/l and 14 mg/l, respectively.

Beaver Creek. Beaver Creek drains approximately 7.5 square miles of the eastern portion of the Little Rocky Mountains. No mining extensions are proposed to enter the Beaver Creek drainage and no groundwater quality data are presently available.

Summary of Zortman Area Groundwater Monitoring Results

In summary, the recent and historical groundwater quality data reviewed for the Zortman Mining area indicate the following:

Ruby Gulch

- With the exception of RG-108 and possibly ZL-143, groundwater monitoring wells constructed in the metamorphics at the head of Ruby Gulch show effects of mining operations, including cyanide detections, depressed pHs, increased specific conductivity values, and increased concentrations of sulfate, TDS, and metals.

- Water quality data from wells RG-108 may represent baseline conditions for mineralized rocks in this area, as they appear to be isolated from any recognizable effects of ARD.

TABLE 3.2-24

GOSLIN GULCH GROUNDWATER QUALITY SUMMARY

	Representation of Baseline							
	Alluvium Upgradient ZL-147 (1990-1994)		Alluvium Downgradient ZL-149 (1990-1994)		Bedrock Upgradient ZL-152 (1990-1994)		Bedrock Downgradient ZL-148 (1990-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	16		16		16		16	
pH S.U.	7.00-7.90	7.60	7.40-8.10	7.78	7.5-8.4	8.1	7.5-8.7	8.28
SC μmhos/cm	1,080-1,340	1,278	792-991	917	621-2,130	1,184	2,270-3,080	2,801
TDS mg/L	831-999	959	545-663	603	426-1,380	740	1,660-2,050	1,884
SO_4 mg/L	429-480	455	196-246	221	27-51	40	86-1,050	983
CN mg/L	ND-0.031	0.005	ND		ND		ND	
NO_2/NO_3 mg/L	0.17-0.69	0.36	ND		ND-0.21	0.05	ND-1.68	0.18
NH_3 mg/L	ND		ND		0.40-0.70	0.53	1.30-3.30	2.04
Hardness as CaCO3 mg/L	623-710	677	363-454	414	10-53	19.7	15-178	45
Ca mg/L	116-128	121	81-104	94	2-7	3.9	4-17	8.5
Mg mg/L	80-96	91	39-47	43	0.50-8.00	2.44	2-8	4.2
K mg/L	6-8	6.8	3-7	5.3	2-17	5.1	3-6	4.4
Na mg/L	50-61	53	55-63	57.9	165-515	288	574-764	675
Cl mg/L	2-5	3.4	3-5	4.2	18-267	99	10-53	27
HCO_3 mg/L	346-402	387	322-424	364	376-986	574	486-666	559
Al mg/L	ND-0.1	0.06	ND		ND-16.2	1.5	ND-0.3	0.14
As mg/L	ND		ND		ND-0.006	0.0028	ND-0.01	0.004
Cd mg/L	ND		ND		ND-0.001	0.0005	ND	
Cu mg/L	ND		ND		ND		ND-0.01	0.0056
Fe mg/L	ND-0.10	0.04	ND-0.06	0.024	ND-3.34	0.58	ND-0.37	0.12
Pb mg/L	ND		ND-0.01	0.005	ND		ND-0.02	0.006
Mn mg/L	ND-0.22	0.03	ND-0.01	0.009	ND-0.04	0.2	ND	
Zn mg/L	ND-0.02	0.01	ND-0.09	0.04	ND-0.13	0.04	ND-0.08	0.03

Note: No pre-1979 (baseline data) available
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

TABLE 3.2-25

LODGEPOLE CREEK GROUNDWATER DATA

Operational				
Spring Water Upstream Z-6 (1979-1994)	Range	$\bar{x}$	Bedrock Upgradient (ZL-210) 1995 Range	Bedrock Upgradient (ZL-209) 1995
No. of Samples	37		2	1
pH S.U.	7.7-8.7	8.3	7.4-7.8	7.8
SC μmhos/cm	310-445	406	367-523	330
TDS mg/L	200-292	229	252-389	259
SO_4 mg/L	11-26	14	82-158	80
CN (tot) mg/L	ND		<0.005	<0.005
NO_2/NO_3 mg/L	ND-0.17	0.08	<0.05	<0.05
NH_3 mg/L	ND		<0.01	<0.01
Hardness as CaCO3 mg/L	213-278	245	187-271	163
Ca mg/L	46-61	56	55-81	42
Mg mg/L	21-27	25	12-17	14
K mg/L	0.5-2.0	0.7	3-4	1.0
Na mg/L	0.5-5.0	1.2	8-16	9.0
Cl mg/L	0.5-8.0	1.0	<1	<1.0
HCO_3 mg/L	252-288	270	132-154	124
Al mg/L	(trc) ND-0.40	0.06	<0.1	<0.1
As mg/L	(trc) ND-0.005	0.0025	0.016-0.042	0.018
Cd mg/L	(trc) ND		<0.001	<0.001
Cu mg/L	(trc) ND		<0.01	<0.01
Fe mg/L	(trc)/tot ND-0.99	0.11	<0.03	<0.03
Pb mg/L	(trc) ND-0.020	0.006	<0.01	<0.01
Mn mg/L	(trc) ND-0.13	0.02	0.31-0.54	0.10
Zn mg/L	(trc) ND-0.300	0.028	0.02-0.25	0.01

Note: Spring discharges from limestone bedrock.

- Results from groundwater monitoring near the bottom of Ruby Gulch (ZL-142 in Madison Formation limestone near the Zortman townsite) show that by this point, much of the potential ARD has been neutralized, in the subsurface, although cyanide has been detected a number of times at trace concentrations in ZL-142 samples. Despite neutral pHs, specific conductivity and TDS values in these monitoring wells have remained high, suggesting that the water recharging the limestone is impacted by neutralized ARD.

Alder Gulch/Alder Spur

- There are no pre-1979 "baseline" data reported from groundwater wells in the area, but data from ZL-110 may be representative of baseline water quality for metamorphic bedrock in Alder Gulch.

- The shallow wells AG-200, AG-201, and AG-202 were first sampled in 1986 or 1987 and showed effects of mining activities at that time. These include cyanide detections, decreased or variable pH values, increased specific conductance values, and increased sulfate, TDS, and metals concentrations.

- Land application of processing liquids in 1987 adversely affected the groundwater quality in all the shallow wells within Alder Gulch; however, groundwater quality appears to have recovered to pre-1987 conditions within 12 months.

- Limestone bedrock well ZL-107R, located at the head of Alder Gulch shows a linear improvement in groundwater quality from 1982 until the last sampling event at ZL-107R in 1989 (indicated by decreasing levels of SC, TDS and Hardness).

- With the exception of ZL-107R (not sampled) and ZL-110 (deep well), all other alluvial and bedrock wells within the Alder Gulch drainage suffered a period of degraded water quality during 1991.

Goslin Flats

- Shallow alluvial and deeper wells completed in the underlying shale have relatively high TDS and sulfate concentrations which appear to be due to water/rock interaction with the mineral-rich shales.

- All Goslin Flats groundwater wells are unaffected by present mining operations and can be considered as baseline groundwater conditions for alluvium and shale bedrock in the Goslin Flats area.

Landusky Area Groundwater Monitoring Results

The locations of groundwater monitoring wells at Landusky are shown on Exhibit 2 (EIS map pocket).

Rock Creek/Sullivan Creek. Sullivan Creek, the upper tributary to Rock Creek, drains the 1991 Heap leach pad area (Sullivan Park). Groundwater quality data were reviewed from ZL-132 (alluvial well, Sullivan Creek), ZL-131 (volcanic bedrock well, Sullivan Creek), ZL-133 (limestone bedrock well, near the bottom of the Rock Creek Gulch), TP-1, TP-2 and TP-3 (alluvial wells at Landusky town) and TP-4 (a bedrock well at Landusky).

Groundwater quality data for Rock Creek are summarized on Table 3.2-26. Sampling of the alluvial monitoring well (ZL-132) downstream of the Sullivan Park dike shows sulfate and SC concentrations to have increased to 2,360 mg/l and 3,180 μmhos/cm respectively in the Fall of 1993, and the pH of the water to have dropped to 3.3 in 1994. Water samples from ZL-132 are also characterized by elevated levels of aluminum, manganese and zinc. These data indicate substantial effects on the alluvial groundwater from ARD most likely derived from the Sullivan Park leach pad dike or underlying acid-generating bedrock. Monitoring of well (ZL-131 bedrock well) suggests that the impacts have also reached the bedrock aquifer illustrated by a slight decrease in pH and increasing sulfate concentrations since 1992 reaching a minimum of 6.6 and a maximum of 335 mg/l, respectively (Table 3.2-26).

Water quality in the bedrock at the base of Rock Creek and within the town of Landusky has been monitored by wells ZL-133 and TP-4 (Table 3.2-26). Well ZL-133 is completed in alluvium and limestone, but TP-4 may be representative of baseline conditions for bedrock groundwater in the Landusky township area.

The quality of the alluvial groundwater in the vicinity of the Landusky township is monitored by wells TP-1 and TP-2, below the confluence with Mill Gulch and TP-3 upstream of the confluence. Monitoring data suggest the quality of the alluvial groundwater has been slightly impacted by mining activity. This is demonstrated by erratic but moderate changes in SC, TDS and sulfate concentration since 1983, although the pH of the water has remained neutral (Table 3.2-26). Monitoring well TP-1 reached maximums of 1,180 μmhos/cm SC, 921 mg/l TDS and 508 mg/l sulfate in the sample collected in the Fall of 1993, although the pH has remained near neutral since installation of the well in 1983.

TABLE 3.2-26

ROCK CREEK GROUNDWATER QUALITY SUMMARY

	REPRESENTATIVE OF BASELINE				OPERATIONAL					
	Bedrock				Bedrock		Alluvium			
	Limestone Downstream ZL-133 (1989-1994)		Downstream TP-4 (1990-1994)		Metamorphic Upgradient ZL-131 (1989-1994)		Upgradient ZL-132 (1990-1994)		Downgradient TP-1 (1983-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	15		9		14		11		22	
pH S.U.	7.3-8.1	7.76	7.4-7.9	7.5	6.0-7.6	6.94	3.3-6.0	4.5	6.8-11.8	7.6
SC μmhos/cm	286-587	425	669-748	700	259-1,140	451	190-3,180	1,483	354-3,390	755
TDS mg/L	190-392	273	370-435	400	188-603	294	140-3,550	136	193-921	446
SO$_4$ mg/L	57-144	93	64-73	70.4	65-335	136	71-2,360	924	190-508	315
CN mg/L	ND		ND		ND-0.006	0.003	ND-0.01	0.0032	ND-0.006	0.004
NO$_2$/NO$_3$ mg/L	0.025-0.110	0.049	ND-0.06	0.03	ND-0.080	0.02	0.22-2.95	1.5	0.39-1.76	1.1
NH$_3$ mg/L	ND-0.10	0.056	ND-0.3	0.18	ND		ND-0.10	0.06	ND	
Hardness as CaCO3 mg/L	148-337	230	198-255	232	128-381	186	66-1,550	685	183-652	364
Ca mg/L	41-84	62	49-64	58	38-114	58	18-377	168	89-169	131
Mg mg/L	11-24	18	19-23	21	8-23	12.3	5-152	64	27-56	40.6
K mg/L	2-4	3	4-5	4.2	2-4	3.2	3-8	5.6	2-4	3
Na mg/L	4-7	5.2	63-84	75	10-16	12.7	8-73	33.3	9-13	11.1
Cl mg/L	0.5-1.0	0.55	2-2	2	ND-3.0	0.75	1-10	4	2-11	6.6
HCO$_3$ mg/L	124-198	164	364-431	388	70-135	91.3	3-10	6.2	163-261	202
Al mg/L	ND		ND		0.2-113	32.4	0.2-113.0	32	ND	
As mg/L	ND		ND		ND		ND		ND	
Cd mg/L	ND-0.001	0.0005	ND		ND-0.08	0.06	ND-0.08	0.04	ND	
Cu mg/L	ND		ND		ND		ND-0.28	0.0683	ND	
Fe mg/L	ND-0.1	0.03	ND-0.51	0.35	0.35-8.63	2.73	ND-1.21	0.23	ND-0.1	0.05
Pb mg/L	ND-0.02	0.008	ND		ND-0.005	0.004	ND-0.06	0.02	ND-0.02	0.008
Mn mg/L	ND-0.15	0.08	ND		0.76-6.68	2.77	1.37-46.70	22.9	ND	
Zn mg/L	ND-0.12	0.02	ND-0.05	0.02	0.13-0.75	0.34	0.25-9.21	4.3	0.01-0.05	0.03

Note: No pre-1979 (baseline data) available

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

Domestic water for the town of Landusky is currently attained from the TP series of wells, a contingency well constructed in the shales exists to the south of Landusky, although yields are limited and it is not presently on line (personal communication C. Russell, June 1995).

Mill Gulch. Groundwater quality data for Mill Gulch was reviewed from the following wells: ZL-126 (alluvium) and ZL-121, ZL-122, ZL-128, ZL-129, and ZL-130 (fractured metamorphics, upper Mill Gulch now covered by the waste rock dump); ZL-155, ZL-156 (replacement alluvial wells at base of waste rock dump); ZL-157 (replacement bedrock well, completed in syenite porphyry volcanics); ZL-105 (limestone well, downgradient of 1984 leach pad); ZL-108, ZL-118 and ZL-112A (limestone next to the process area), ZL-109 (limestone downgradient of the process area) and ZL-136, ZL-137 and ZL-138 (alluvial wells above the confluence of Mill Gulch and Rock Creek).

Table 3.2-27 summarizes alluvial and bedrock groundwater quality data in the Mill Gulch drainage. Monitoring well ZL-126, completed in alluvium near the head of Mill Gulch, has monitoring data for 1987 and 1988 only; however, the effects on groundwater quality at this time are clear. During these two years, pH values dropped from 6.2 to 3.7, SC increased from 232 to 745 μmhos/cm, and TDS increased from 179 to 458 mg/l. No cyanide was detected within this two-year period. A few hundred feet downstream ZL-122 completed in bedrock at 45 feet was also affected by mining activities. During the period 1986 to 1991, the pH dropped from 7.0 to 6.6 and SC, TDS and sulfate concentrations all increased but to a lesser degree than ZL-126. Monitoring well ZL-121 is positioned next to ZL-122, but reaches a total depth of 100 feet. The static water level in the well is at 11 feet below ground level, indicating that the bedrock is fully saturated and that little vertical potential exists between the alluvium and the underlying bedrock. Water quality data at ZL-121 show the water to possibly be effected by mining activities further upstream. Although the pH, SC, sulfate and TDS concentrations have remained neutral. Iron concentrations have increased from 0.07 to 5.2 mg/l.

Shallow bedrock groundwater in upper Mill Gulch, below the waste rock dump, was monitored by wells ZL-128, ZL-129, and ZL-130 between 1988 and 1992. All three wells were completed in fractured metamorphics at depths varying from 22 to 66 feet. These monitoring sites have been replaced by three new wells, ZL-155, ZL-156 and ZL-157. Monitoring wells ZL-129 and ZL-130 showed improving groundwater quality trends between 1988 and 1992. However, ZL-128 shows significant effects from mining activity. Only a slight drop in pH has occurred from 7.2 to 6.2; however, water quality indicators such as SC, TDS and sulfate have increased substantially reaching maximum concentrations of 1,260 μmhos/cm and 1,303 mg/l, respectively (Table 3.2-27). The disparity in water quality between these wells may be due to preferential flow in weathered bedrock.

Water quality data from replacement wells ZL-155 and ZL-157 completed in alluvium and bedrock respectively show no impact from ARD or process chemicals. However, ZL-156 an alluvial well, had a pH of 6.5, SC concentration of 1,350 μmhos/cm, TDS of 1,130 mg/l, and a sulfate concentration of 699 mg/l in the sample collected in the Spring of 1994, indicating ARD is impacting the alluvial groundwater quality.

Monitoring wells placed downgradient of the Landusky processing plant area to the west of Mill Gulch (ZL-108, ZL-118 and ZL-112A) are completed in limestones. Well ZL-108 has been monitored since 1982, ZL-118 since 1983, but ZL-112A was not installed until 1989. Cyanide concentrations were detected in ZL-118 in every sample up until 1987 and again during 1990 - 1991, reaching maximum levels of 0.110 mg/l (tot) and 0.011 mg/l (WAD). Well ZL-112A has detected cyanide in every sample since its installation, reaching maximum concentrations of 0.054 mg/l (tot) and 0.039 mg/l (WAD). SC and TDS have been constant and relatively low throughout, and pHs have remained near neutral. Monitoring well ZL-108 has recorded significant cyanide concentrations since 1982, with a maximum concentration of 125 mg/l reached in the fall of that year (Table 3.2-27). After 1983, concentrations dropped dramatically, although a high of 23.1 mg/l was recorded during 1988. The above periods of cyanide contamination are all attributable to specific spill and liner failure events at the process plant and ponds.

Monitoring well ZL-109 is completed in limestone within the drainage containing the process plant area and the 1980/82 pad complex. The well, located approximately 1,400 feet downgradient of the plant area detected total cyanide in 1982 and 1983, but concentrations have been below detection limits since.

The pH of the groundwater at this location has remained neutral since sampling began in 1982. However, TDS and sulfate concentrations have been moderately high, averaging 1,113 mg/l and 514 mg/l, respectively. Metals within these samples are generally below detection limits. The moderately high TDS but neutral pH may represent neutralized ARD within the limestone.

At the bottom of Mill Gulch, above the confluence with Rock Creek, a pod of wells was installed in 1990 to monitor the water quality in the sandstone bedrock and the overlying alluvium. Water levels measured in the

TABLE 3.2-27

MILL GULCH GROUNDWATER QUALITY SUMMARY

	OPERATIONAL							
			Bedrock				Alluvium	
	Metamorphics Upgrade ZL-121 (1986-1991)		Metamorphics Upgradient ZL-128 (1988-1992)		Limestone Upgradient ZL-108 (1982-1994)		Downgradient ZL-137 (1990-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	11		13		26		4	
pH S.U.	6.5-7.4	6.9	6.2-7.5	6.95	6.8-8.0	7.4	7.4-7.8	7.62
SC μmhos/cm	342-460	398	233-1260	686	630-3,150	915	564-1,000	734
TDS mg/L	226-353	269	154-1030	530	335-2,720	599	395-735	550
SO_4 mg/L	107-137	120	83-517	303	61-116	88	180-359	254
CN mg/L	ND		ND		0.08-125.00	19	ND	
NO_2/NO_3 mg/L	ND		ND-4.3	2.3	5.6-9.7	6.1	0.61-1.25	0.93
NH_3 mg/L	ND		ND		ND-0.5	0.3	ND	
Hardness as CaCO3 mg/L	152-239	192	87-738	363	250-1,001	450	315-565	429
Ca mg/L	46-68	5.5	23-145	100	57-81	64	83-146	118
Mg mg/L	12-18	14	7-46	26.2	55-71	64	26-49	37
K mg/L	1-5	3	3-4	3.33	2-2	2	3-5	3.8
Na mg/L	8-14	11	6-18	14	15-35	22	9-12	11
Cl mg/L	0.5-1.0	0.73	0.5-2.0	[0.23]	1-69	13	2-6	3.75
HCO_3 mg/L	86-147	10.6	17-123	73.11	382-436	407	164-231	198
Al mg/L	ND		0.05-0.40	0.18	ND		ND	
As mg/L	ND		0.03-0.50	0.10	ND-0.14	0.05	ND	
Cd mg/L	ND		ND-0.002	0.001	ND-0.03	0.13	ND	
Cu mg/L	ND		ND		ND-0.24	0.0883	ND	
Fe mg/L	0.07-5.22	3.0	0.15-2.31	1.2	ND		ND	
Pb mg/L	ND		ND-0.005	0.0014	ND		ND-0.0010	0.0010
Mn mg/L	0.88-0.88	0.88	0.65-6.43	2.9	0.06-0.11	0.08	ND-0.0010	0.0010
Zn mg/L	0.05-0.12	0.08	0.04-4.02	1.1	0.07-0.37	0.18	0.010-0.040	0.03

Note: No pre-1979 (baseline data) available
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

sandstone well are above the alluvium/sandstone contact and at a similar level to those measured in the alluvium. This indicates that the sandstone is fully saturated in this area. All three wells have shown constant, neutral pH values and no detections of cyanide. Monitoring well ZL-138, constructed in alluvium has undergone a gradual increase in sulfate and TDS reaching maximums of 425 mg/l and 816 mg/l, respectively, in the Fall of 1993. Monitoring well ZL-136 constructed in the sandstone bedrock had reached maximums of 315 mg/l sulfate, 713 mg/l TDS, and 1,000 μmhos/cm SC in the spring sampling round of 1994. These increases suggest that neutralized ARD-affected water is reaching the bottom of Mill Gulch within the alluvium with the sulfate concentration remaining elevated after the pH has been neutralized and metals precipitated. This neutralizing potential may come from limestone outcrop in the stream bed, calcareous material in the sandstone itself, or limestone alluvium.

Montana Gulch. Groundwater quality data for Montana Gulch was reviewed from: monitoring wells ZL-119 (completed in porphyry volcanic bedrock, immediately downgradient of the 1983 and 1985/1986 leach pad), ZL-123, ZL-124, ZL-125 (a pod of alluvial wells, downstream of the 1985/1986 pad contingency pond), ZL-115 and ZL-116 (limestone bedrock wells, within eastern tributaries to Montana Gulch pad) and ZL-112A, ZL-113 and ZL-114 (limestone bedrock wells, located in the minor tributaries draining the southern portion of the 1983 pad).

Table 3.2-28 summarizes alluvial and bedrock groundwater data within the Montana Gulch drainage. Groundwater samples have been gathered at ZL-119 since 1985, and cyanide has been detected in every sample collected between 1992 and 1994, having a maximum concentration of 0.125 mg/l (tot) cyanide during the fall 1992 sampling event. Water quality indicators such as sulfate, SC and TDS have been erratic at this location, with maximum values of 186 mg/l, 940 μmhos/cm and 577 mg/l, respectively, indicating only minor ARD impacts. The cyanide contamination at this location is associated with a pipeline rupture below the 1983 pad in 1992.

The pod of alluvial monitoring wells (ZL-123, ZL-124 and ZL-125) were installed in 1986 in response to the failure of the 1986 leach pad liner (Hydrometrics, 1986). Cyanide was detected during 1986 and 1987 at ZL-123 and ZL-124 but not until 1987 at ZL-125. The maximum cyanide concentration at ZL-123 monitored in relation to the liner failure in 1986 was 0.032 mg/l total cyanide. Cyanide is detected in the alluvium again after 1992 as a result of a process fluid pipe break associated with the 1983 leach pad.

The increase in SC, TDS and sulfate concentrations observed at ZL-123 is typical of the three wells, reaching maximum concentrations of 1,220 μmhos/cm, 981 mg/l and 603 mg/l respectively in the fall of 1993. This pattern illustrates some moderate levels of ARD impact derived from the Montana Gulch waste rock dump, the 1985/1986 leach pad buttress and/or underdrain, and/or the August Adit.

The monitoring record from ZL-115 and ZL-116 constructed in limestone within eastern tributaries to Montana Gulch is characterized by neutral pHs, moderate SC, TDS and sulfate concentrations. These two monitoring wells are representative of baseline conditions in limestone within the Little Rocky Mountains.

Monitoring wells ZL-113 and ZL-114R are also constructed in limestone but are positioned in tributaries draining the 1983 leach pad. The monitoring records show almost continuous detections of total cyanide since 1983 at each location, with a maximum of 0.2 mg/l at ZL-114R during 1990. Indicators of ARD such as TDS and sulfate have also been high at ZL-113 and ZL-114R. Since installation, ZL-113 has had average TDS and sulfate concentrations of 1,419 mg/l and 797 mg/l, respectively (Table 3.2-27); ZL-114 has average sulfate concentrations of 4,290 mg/l TDS and 2,603 mg/l sulfate. Of note is the neutral pH maintained at both these wells due to the buffering capacity of the limestone.

During the late seventies, an alluvial well was drilled in the Montana Gulch campground area, approximately 50 feet south of the creek (see Exhibit 2, EIS map pocket). However, because of elevated arsenic concentrations the well was never completed as a public water source. The well was capped soon after drilling and was finally plugged and abandoned in 1991 (written communication, J. Frazier, BLM Jan. 1995). It is unclear if the elevated arsenic levels were measured prior to, or after the initiation of ZMI mining activity in 1979.

King Creek. Groundwater monitoring data in King Creek have been limited to two wells ZL-139 and ZL-140. The wells are constructed side by side approximately 1/4 of a mile downstream of the August Pit. Monitoring well ZL-139 was installed in 1990 to a total depth of 39 feet below ground level and screened granitic bedrock between 29 and 39 feet below ground level. In 1993 the upper 12 feet of tailing was removed

TABLE 3.2-28

MONTANA GULCH GROUNDWATER QUALITY SUMMARY

	OPERATIONAL					
	Bedrock		Alluvium			
	Porphyry Igneous Upstream ZL-119 (1985-1993)		Downstream ZL-113 (1983-1994)		ZL-125 (1986-1994)	
	Range	$\bar{x}$	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	20		23		17	
pH S.U.	7-8	7.4	6.5-7.9	7.2	7.0-9.5	7.5
SC μmhos/cm	488-940	661	541-2,440	1,638	602-1,250	952
TDS mg/L	293-577	405	497-2,250	1,419	390-986	701
SO_4 mg/L	23-503	131	27-1,180	798	131-562	330
CN mg/L	ND-0.125	0.0025	ND-0.04	0.013	ND-0.02	0.004
NO_2/NO_3 mg/L	3.35-5.67	4.5	0.27-6.23	4.6	0.87-2.90	1.7
NH_3 mg/L	ND		ND		ND	
Hardness as CaCO3 mg/L	73-394	305	308-1,760	1,118	290-703	528
Ca mg/L	20-101	66	51-303	218	77-191	135
Mg mg/L	6-116	48	44-234	171	24-55	40
K mg/L	1-11	3	2-3	2.5	2-3	2.6
Na mg/L	2-178	44	2-8	6	15-27	18.3
Cl mg/L	1-27	7.4	3-4	3.2	1-6	2.4
HCO_3 mg/L	271-517	370	339-587	511	163-353	234
Al mg/L	ND		ND		ND	
As mg/L	ND		ND		ND	
Cd mg/L	ND		ND-0.002	0.001	ND	
Cu mg/L	ND		ND		ND-0.02	0.0063
Fe mg/L	ND		ND-0.08	0.04	0.015-0.140	0.07
Pb mg/L	ND		ND-0.03	0.02	ND-0.01	0.008
Mn mg/L	ND		ND-0.02	0.01	ND-0.03	0.02
Zn mg/L	0.01-0.25	0.11	0.03-0.39	0.15	ND-0.05	0.03

Note: No pre-1979 (baseline data) available
NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

from around the well so it now reaches a depth of 27 feet below ground level. Monitoring well ZL-140 was completed at approximately 12 feet below ground level in alluvium and was excavated in 1993 during the removal of historic tailing within which it was constructed.

Groundwater quality monitoring at King Creek has been undertaken since 1990 and is summarized on Table 3.2-29. No cyanide has been detected in the groundwater from either well during this time and pH values have remained relatively constant and near neutral. During 1992 SC, TDS and sulfate reached maximums of 1,450 μmhos/cm, 1,240 mg/l, and 640 mg/l respectively at the bedrock well ZL-139 (Table 3.2-29). Total nitrate concentrations at ZL-139 have been consistently elevated since its installation in 1990. These concentrations are likely derived from fertilizers used in rehabilitation in the headwaters of the drainage, or from ANFO used as a blasting agent. In either case, the elevated nitrates indicate that the water quality at monitoring well ZL-139 is receiving recharge from surface waters. Few data are available for ZL-140 as it was often dry. However, data gathered during 1992 show the alluvial water to have been neutral in pH and to have had low levels of TDS and sulfate, averaging 505 mg/l and 223 mg/l, respectively (Table 3.2-29).

Water quality data from bedrock well ZL-139 has had moderately high TDS, SC and sulfate levels but neutral pH since monitoring began in 1990. Despite the neutral pHs at this well, the presence of elevated nitrate concentrations suggest that ZL-139 is impacted by mining activity through fractured bedrock flow or a poor well completion. No groundwater data are currently available from South Bighorn Creek.

Summary of Landusky Area Groundwater Monitoring Results

In summary, the recent and historical groundwater quality data reviewed for the Landusky mining area indicate the following:

Rock Creek/Sullivan Creek

- Alluvial and syenite bedrock groundwater in upper Sullivan Creek appear to be affected by ARD conditions originating from the 1991 (Sullivan Park) leach pad dike and/or underlying acid generating bedrock.

- Downstream limestone bedrock water quality appears to be unaffected by mining activities.

- Alluvial groundwater within and below the town of Landusky has had erratic changes in SC, TDS and sulfate, suggesting it may receive flushes of affected groundwater from its drainage area. Traces of cyanide 1983 and 1984 were detected in the two wells below the confluence with Mill Gulch.

- No cyanide has been detected in alluvial or sandstone bedrock groundwater above Rock Creek's confluence with Mill Creek.

Mill Gulch

- Construction of the 1987 (Mill Gulch) heap leach pad caused an immediate impact on the alluvial and syenite bedrock groundwater directly downgradient of the pad in the form of reduced pH and increased sulfate, TDS and SC concentrations. These ARD impacts likely derive from acid generating material underlying the 1987 pad.

- The Landusky process plant area on the western side of the Mill Gulch drainage has impacted the underlying limestone bedrock, in the form of cyanide contamination.

- Groundwater samples from the alluvium and the sandstone bedrock at the bottom of Mill Gulch have illustrated the effect of neutralized ARD conditions over the last three years.

Montana Gulch

- Montana Gulch alluvial groundwater downgradient of the 1985-1986 leach pad has been degraded by ARD and cyanide contamination. These impacts are likely derived from the upgradient Montana Gulch waste dump, a breach in the 1986 pad liner, discharges from the Gold Bug and August Adits, and a leak in a process fluid line in 1992.

- Elevated arsenic concentrations from an alluvial well at the Montana Gulch campground indicate that alluvial groundwater has been affected by pre-ZMI mining activity at least as far downstream as the campground since the 1970's.

- Monitoring wells (ZL-113 and ZL-114R) downgradient of the 1983 leach pad, show the limestone bedrock to have impacted by cyanide releases and ARD probably from the pad buttress. The pH within these wells is neutral and metal concentrations are low due to the neutralizing capacity of the limestone.

TABLE 3.2-29

KING CREEK GROUNDWATER QUALITY SUMMARY

	OPERATIONAL			
	Bedrock Upper Reaches ZL-139 (1990-1994)		Alluvium Upper Reaches ZL-140 (1990-1992)	
	Range	$\bar{x}$	Range	$\bar{x}$
No. of Samples	16		3	
pH S.U.	6.5-7.7	7.2	7.1-7.7	7.3
SC μmhos/cm	783-1450	1,078	567-799	658
TDS mg/L	574-1,240	852	438-592	505
SO_4 mg/L	292-640	460	190-283	223
CN mg/L	ND		ND	
NO_2/NO_3 mg/L	4.4-19.3	10.5	2.83-3.26	3.04
NH_3 mg/L	ND		ND-0.20	0.10
Hardness as CaCO3 mg/L	446-923	627	325-437	366
Ca mg/L	139-294	198	108-141	120
Mg mg/L	22-48	33	14-20	16.3
K mg/L	2.0-5.0	3.3	3-3	3
Na mg/L	9-14	11.7	8-11	9.3
Cl mg/L	2-11	3.5	1-2	1.6
HCO_3 mg/L	132-184	165	148-181	163
Al mg/L	ND-0.1	0.54	ND-0.10	0.054
As mg/L	ND		ND	
Cd mg/L	ND-0.03	0.0009	ND-0.0005	0.009
Cu mg/L	ND		ND	
Fe mg/L	ND-0.090	0.028	ND-0.03	0.01
Pb mg/L	ND-0.030	0.008	ND	
Mn mg/L	ND-0.010	0.008	ND-0.01	0.007
Zn mg/L	ND-0.01	0.01	0.03-0.04	0.035

Note: No pre-1979 (baseline data) available

NA = Not Analyzed
ND = Not Detected
All concentrations dissolved unless otherwise stated

- Monitoring wells ZL-115 and ZL-116 may be representative of baseline groundwater chemistry for limestones within the Little Rocky Mountains.

King Creek

- Syenite bedrock groundwater monitored from ZL-139 has elevated TDS, SC, sulfate and nitrate levels, but a consistently neutral pH. Despite the neutral pH, the presence of elevated nitrates within this well indicates it is presently impacted by mining related activities.

- Available alluvial groundwater data indicate ZL-140 has not been noticeably impacted by mining related activities at the time of sampling.

3.2.6 Groundwater/Surface Water Interaction

The intermittent nature of flow within drainages and the high level of similarity between surface water and alluvial groundwater chemistry (Section 3.2.5), illustrates the high degree of surface water/alluvial groundwater interaction along most drainages within the Little Rocky Mountains. Figure 3.2-25 schematically illustrates the surface water/ groundwater flow patterns throughout the length of a typical drainage within the Little Rocky Mountains and, the regional relationship once outside the confines of the mountains.

In the upper parts of the Little Rocky Mountains, groundwater infiltrates directly into the unsaturated syenite porphyry rocks. Construction of the open pits, heap leach and waste rock piles has increased the land surface area available for direct infiltration and proportionally reduced the amount of direct runoff to surface water drainages. The enhanced infiltration increases the volume of water available to interact with the rock (bedrock and waste rock, spent ore etc.) and thus increases the potential for generation of ARD. A percentage of the groundwater infiltrating into the pits flows towards, and then discharges to the streams and valley alluvium through springs and seeps located in the upper reaches of the drainages (Figure 3.2-25). Groundwater flow from the pits towards the valleys is possibly facilitated by enhanced permeability along faulted zones. The remainder of the recharge infiltrates vertically into the syenite porphyry bedrock, this recharge path is illustrated schematically on Figure 3.2-25. This near vertical flow path will eventually contribute to the recharge of the Madison Group limestones or its overlying sedimentary formations. However, the long distance and resulting long duration of time (possibly thousands of years) will result in the recharge chemistry equilibrating with the regional groundwater.

Surface water flow in the drainages is intermingled with alluvial groundwater flow, available recharge to the drainages flows in and out of the alluvium depending on the gradient of the stream and permeability of the alluvial sediments.

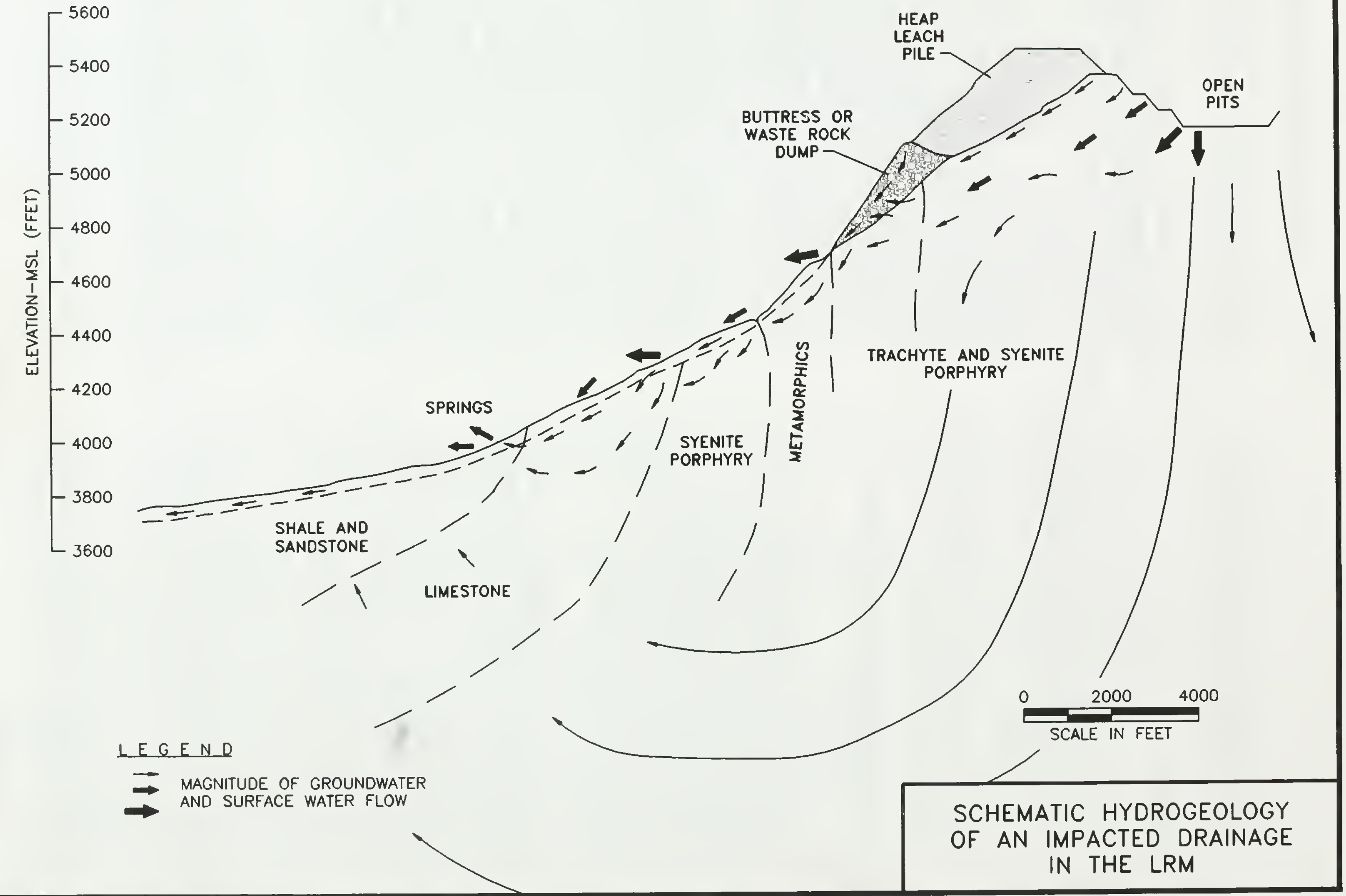
Some recharge to the Madison Group limestones appears to occur in the Little Rocky Mountains by infiltration of precipitation from streams where the limestones are close to, or at the surface. Recharge to the limestones is likely enhanced by their near vertical dip angle around the periphery of Little Rocky Mountains and the numerous solution cavities and karst features found within the upper levels of the Mission Canyon Limestone. Recharge is also facilitated by the downward vertical potential within the limestone at these locations. Streamflow is reported to decrease or disappear as water moves from the interior of the mountains across the limestone (Feltis, 1983).

Karstic limestones have both primary porosity (intergranular voids) and secondary porosity such as caves, cavities and joints. These secondary features developed along pre-existing joints, bedding planes or other openings. As a result of the high dip angle of the limestone within the Little Rocky Mountains, groundwater flow in these limestones will be primarily downward rather than lateral or down-slope.

ARD contaminated water that enters the limestone bedrock will undergo two geochemical processes. Firstly, the acidic water will be diluted by the high alkalinity formation water. Secondly, the pH of the contaminated water will rise due to the high level of bicarbonate in the limestone water. As the pH rises, precipitation reactions will occur, dropping the iron oxyhydroxides out of the solution. Other metals will also precipitate out due to sorption onto the Fe oxyhydroxides.

Any downgradient monitoring of these neutralized waters will be characterized by increased sulfate and chloride concentrations and metals able to remain in solution at higher pHs such as arsenic and zinc. If cyanide contaminated waters enter the limestone, downstream groundwater samples may detect and increase in nitrate (a breakdown product of the cyanide).

At least ten springs have been identified around the flanks of the Little Rocky Mountains. Six or seven of



SCHEMATIC HYDROGEOLOGY OF AN IMPACTED DRAINAGE IN THE LRM

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FIG. 3.2-25

these springs discharge from either the Mission Canyon or Lodgepole limestone units. The remainder discharge from syenite porphyry or the Cretaceous Thermopolis shale. Many of the springs are located in valley bottoms. Although they are not obviously related to any geological structures, they may be located at contacts between different geological units.

Available flow and groundwater quality data from these springs shows the discharge to be directly related to recharge in the Little Rocky Mountains. At the Big Warm Spring discharge volumes are recorded to have increased from approximately 6 ft^3/s to 9 ft^3/s, following a heavy snowstorm of May 20-21, 1974 (Feltis, 1983). A change in chemical quality of the water was also observed at the Big Warm Spring. Comparison of the dissolved constituents shows a decrease in concentration during June caused by the recharge of water from the May 1974 storm. Subsequently more normal concentrations returned as water from the regional aquifer became dominant.

Observations from monitoring wells installed by the USGS and potentiometric heads measured in existing exploratory oil wells shows an upward vertical potential within the limestones and a potentiometric surface close to or above the ground surface.

ARD impacted groundwater sampled from the limestone units within the Little Rocky Mountains is generally neutral in pH, but still contains elevated TDS and sulfate levels. No indications of ARD or mining process chemicals have been observed in any springs sampled around the periphery of the Little Rocky Mountains. A recent sampling by the USGS in cooperation with the Bureau of Indian Affairs collected samples from 9 surface water stations, 3 springs and 2 groundwater wells on the Fort Belknap Indian Reservation (USGS, 1995). Analytical results show the springs and groundwater to be of a general calcium bicarbonate type with no indications of ARD. The continued good quality of the spring discharges is likely due to the high neutralizing capacity and dilution within the limestones upgradient.

Discharge from springs surrounding the Little Rocky Mountains does not preclude recharge from the Little Rocky Mountains to the Madison Group Limestones but suggests it is limited.

The key points regarding groundwater/surface water interaction in the Little Rocky Mountains are as follows:

- By excavating the open pits and constructing leach pads and waste rock piles, the mining process has significantly increased the area available for infiltration and will have proportionally decreased the volume of direct surface water runoff.
- The increased surface area for infiltration has also increased the amount of groundwater flow and potential for acid generation.
- A portion of the water that infiltrates in the upper Little Rocky Mountains discharges to surface water streams from springs, seeps, and adits throughout the length of drainages of the Little Rocky Mountains. This suggests that water contaminated by ARD may be transmitted from the groundwater system to surface water at some lower elevation. The remainder of the recharge infiltrates vertically following a long, slow recharge route to the sedimentary formation surrounding the Little Rocky Mountains.
- A major regional aquifer (Madison Limestone) is found near land surface or exposed in several drainages around the flanks of the Little Rocky Mountains. Its near surface exposure and high permeability result in the potential for impacted surface or alluvial waters to directly recharge the limestone units.
- The springs surrounding the Little Rocky Mountains and artesian pressures observed within the limestone regionally, suggests that much of the direct recharge to the limestone will be returned to the surface downgradient through springs and seeps. Due to the hydrogeologic conditions mentioned above and the significant attenuation capacity of the limestone, it is un likely that the Madison Limestone groundwaters would become contaminated beyond the margins of the Little Rocky Mountains. The water quality of the peripheral springs is unimpacted by mining related processes.

3.2.7 Beneficial Uses

3.2.7.1 Surface Water Use

As discussed above, numerous springs are found around the entire base of the Little Rocky Mountains. Springs and adits supply relatively constant flow to sustain a base flow in a number of drainages. These flows are used by a variety of wildlife.

In the Zortman and Landusky areas, there are numerous surface water rights on record for industrial and agricultural areas. Zortman Mining, Inc. owns a total of seven industrial appropriations in Ruby Gulch and Alder Gulch. Square Butte Grazing Association holds 14 appropriations of surface water within the Zortman study area as well as others below the study area. These rights are for agricultural use and typically are appropriated for the entire channel flow of the ephemeral drainages in the area. Square Butte Grazing owns rights in Goslin Flats, Camp Creek, and Ruby Creek within the study area. Also, the Winters Doctrine (1908), states that the tribe has reserved water rights that are superior to any rights under Montana or any state law (see Section 1.5.3). Surface water rights within the Zortman and Landusky mine extension areas are summarized in Table 3-2.30. The Little Peoples Creek Basin which receives water from King Creek is used as a recreational area by residents of the Fort Belknap Indian Reservation.

Little useful information is available on any impact mining operations may have had on surface water flows of the Little Rocky Mountains. Flow gauging data in the majority of the drainages has in the past been irregular and often estimated. However, permanent monitoring stations have been established in selected drainages on the northern side of the Little Rocky Mountains by the USGS, yielding continuous monitoring data as far back as 1987. Unfortunately no earlier data are available. Figure 3.2-26 shows annual total and maximum flows for Little Peoples Creek, Lodgepole Creek and Little Warm Creek. Since 1987 no long-term changes in surface flow are apparent, although an initial decrease in flow between 1978 and 1980 occurred in Little Peoples Creek near the town of Hays. Although monitoring data is not available it is expected that surface water flow and spring discharge to the north of the Landusky mining operation would have decreased when the August and Gold Bug Adits were completed in the 1960's, effectively diverting a large percentage of the catchment to the south.

3.2.7.2 Groundwater Use

Domestic water supplies in the Towns of Zortman and Landusky depend entirely upon groundwater. Most of the recorded wells near the towns are constructed in alluvial deposits or shallow sandstones at depths of less than 200 feet. As a result of the impacts to the alluvial groundwater the town of Zortman now has community well, Z-8A, installed by ZMI. The well is completed into the Madison Group and screened from 395 to 738 feet in depth. Landusky has shallow domestic wells constructed in both bedrock and alluvium. Groundwater rights within the Zortman and Landusky mine extension areas are summarized in Table 3.2-31. Shallow alluvial deposits within drainages such as Little Peoples Creek provide domestic water supplies for numerous homes (Feltis 1983). During historic and recent mining operations, groundwater from wells constructed in the fractured porphyry rock has been used for milling, cyanide processing of gold ores and heap leaching.

3.2.8 Regulatory Criteria

The water-use criteria for all the drainage in the Little Rocky Mountains is contained ARM 16.2 - 0.607. All surface water which drain to the Missouri River (i.e. Ruby and Rock Creek) are currently classified as C3 by the Montana Department of Health and Environmental Science. Waters classified as C-3 are suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agricultural and industrial water supply. The water quality standards for C-3 streams are located in ARM 16-20-624. The northern creeks (Beaver, Lodgepole and South Bighorn) are classified as B-1. Water classified as B-1 should be suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply (ARM 16-20-618). The water quality standards for streams are located in ARM 16-20-618.

Any waste discharge to state water must obtain a discharge permit and comply with the terms of that permit. Effluent limits are established in permits which are based on nondegradation, water quality standards, natural conditions, treatment standards among other factors.

Regulatory standards such as aquatic life standards and human health criteria for surface water have been consistently exceeded in the headwaters of many drainages in the Little Rocky Mountains. Parameters exceeding the available criteria are generally restricted to metals, leached out of the rock by ARD.

Once reaching the perimeter of the Little Rocky Mountains, water quality criteria have in the past generally been exceeded only after specific events such as extreme precipitation. These exceedances should now be avoided due to the construction and expansion of capture systems in the headwaters of the drainages.

Available pre-1979 "baseline" data for the Little Rocky Mountains illustrates that aquatic life standards were

TABLE 3.2-30

DEPARTMENT OF NATURAL RESOURCES & CONSERVATION (DNRC)
SURFACE WATER RIGHT LISTING BY LAND DESCRIPTION

Water Right	Use	Rate		Volume	QTR SCTN	SC	TWP	RGE	CN	UT	Source Name	Owner Name
G40EJ W184806-00	DM			.80	NESENW	17	25N	25E	PH		RUBY GULCH	FEDERAL LAND BANK OF SPOKANE
G40EJ W113794-00	DM	15.00	G	1.50	NENWSW	17	25N	25E	PH			KALAL DICK KALAL LUCILLE M
G40EJ W113795-00	CM	60.00	G	48.00	NENWSW	17	25N	25E	PH			KALAL LUCILLE M KALAL DICK
S40EJ T033479-00	MN				SENWSW	17	25N	25E	PH		ALDER GULCH	TENNARD RESOURCES INC
S40EJ W167789-00	MN	200.00	G	322.00	SENWSW	17	25N	25E	PH		ALDER GULCH	GOLD RESERVE INC
S40EJ W206598-00	MN	100.00	G	2.00	SENWSW	17	25N	25E	PH		ALDER GULCH	KALAL PERRY E
S40EJ W167785-00	MN	4.00	C	2,890.00	SWNWSW	17	25N	25E	PH		ALDER GULCH	GOLD RESERVE INC
S40EJ W167786-00	MN	1.00	C	723.00	SWNWSW	17	25N	25E	PH		ALDER GULCH	GOLD RESERVE INC
S40EJ W167787-00	MN	1.50	C	1,884.00	SWNWSW	17	25N	25E	PH		ALDER GULCH	GOLD RESERVE INC
S40EJ W167788-00	MN	3.75	C	1,351.35	SWNWSW	17	25N	25E	PH		ALDER GULCH	GOLD RESERVE INC
S40EJ W167790-00	MN	2.50	C	1,807.00	SWNWSW	17	25N	25E	PH		ALDER GULCH	GOLD RESERVE INC
S40EJ W166078-00	DM	3.00	G	1.50	NWSWSW	17	25N	25E	PH			CUMMINGS NEWTON E HOLZEY RAY
G40EJ W166077-00	MN	3.00	C			18	25N	25E	PH		ALDER CREEK	HOLMAN DONOVAN W SUNDIN ARVID N
G40EJ W037512-00	ST	5.00	G	1.60	SESESW	20	25N	25E	PH		GOSLIN	SQUARE BUTTE GRAZING ASSN
S40EJ W037487-00	ST	16.00	G	2.52	N2NW	25	25N	25E	PH&		CAMP CREEK	SQUARE BUTTE GRAZING ASSN
G40EJ W152917-00	ST	3.00	G	1.70	SESESE	25	25N	25E	PH			LAZY J D CATTLE CO
S40EJ W037501-00	ST	5.00	C	3.36	NWSWSW	26	25N	25E	PH&		CAMP CREEK	SQUARE BUTTE GRAZING ASSN
G40EJ W065372-00	WI	3.95	G	36.64	SENE	29	25N	25E	PH			USA (DEPT OF INTERIOR BUREAU OF

TABLE 3.2-30
DNRC SURFACE WATER RIGHT LISTING
(Continued)

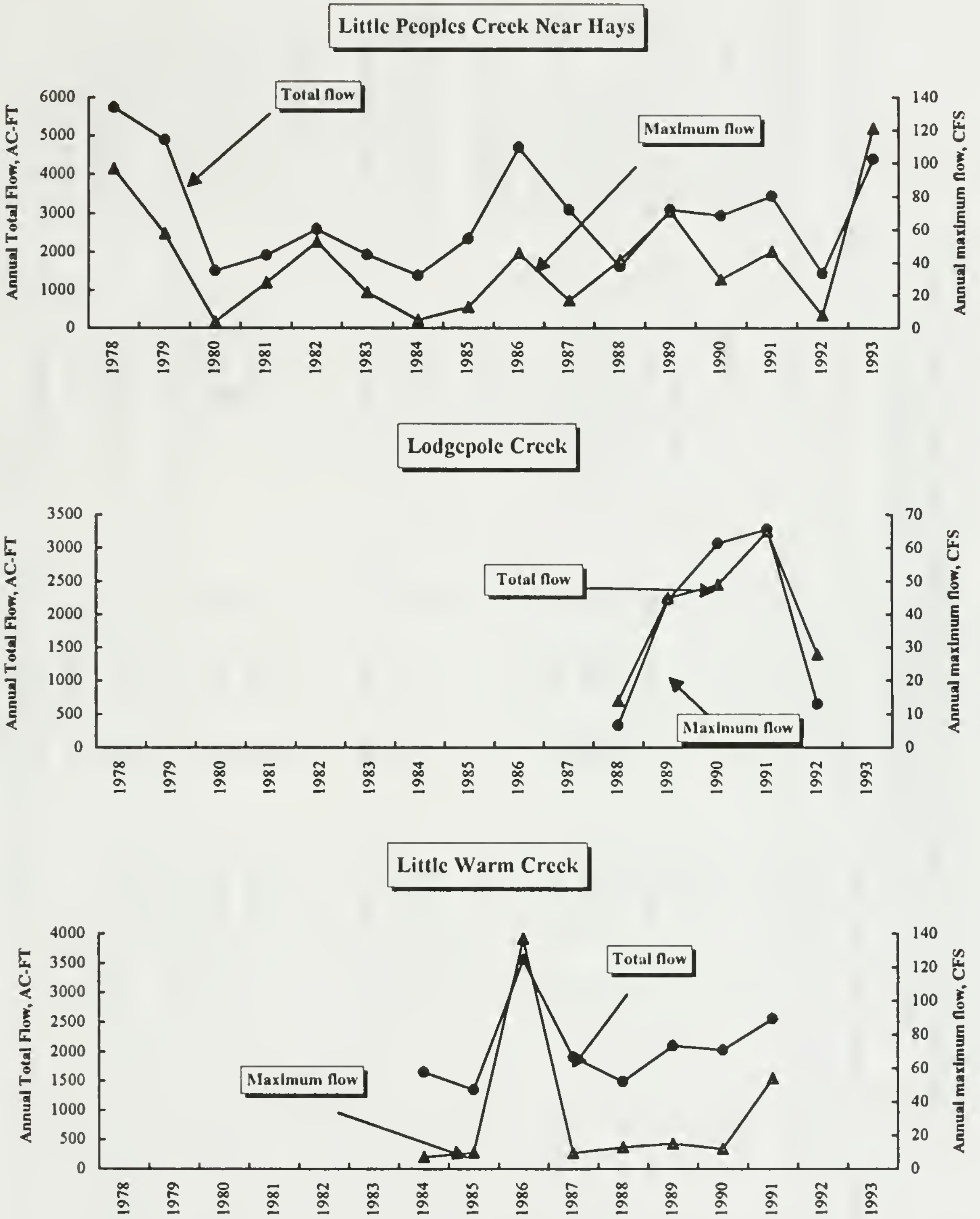
Water Right	Use	Rate		Volume	QTR SCTN	SC	TWP	RGE	CN	UT	Source Name	Owner Name
G40EJ W065373-00	ST	3.95	G	.34	SENE	29	25N	25E	PH			USA (DEPT OF INTERIOR BUREAU OF
S40EJ T061826-00	MN				NENWNW	30	25N	25E	PH		GROUSE GULCH	CUMMINGS THOMAS HASLER FLOYD
G40EJ W065374-00	WI	2.96	G	2.84	SESE	30	25N	25E	PH			USA (DEPT OF INTERIOR BUREAU OF
G40EJ W065375-00	ST	2.96	G	.35	SESE	30	25N	25E	PH			USA (DEPT OF INTERIOR BUREAU OF
G40EJ W037506-00	ST	1.50	G	1.30	NENENE	33	25N	25E	PH			SQUARE BUTTE GRAZING ASSN
S40EJ W037502-00	ST	450.00	G	19.20	NESWNE	33	25N	25E	PH&		ALDER CREEK	SQUARE BUTTE GRAZING ASSN
G40EJ W037508-00	ST	15.00	G	2.50	SWSWNW	33	25N	25E	PH		ALDER CREEK 2	SQUARE BUTTE GRAZING ASSN
S40EJ W037486-00	ST	30.00	G	4.20		35	25N	25E	PH&		CAMP CREEK	SQUARE BUTTE GRAZING ASSN
S40M W112488-00	ST	.52	C	15.21	SENWNW	1	25N	26E	PH	X	MISSOURI RIVER	MONTANA, STAT OF BOARD OF LAND
S40M W112487-00	ST	.61	C	40.05	SESWSE	2	25N	26E	PH	X	MISSOURI RIVER	MONTANA, STATE OF BOARD OF LAND
G40M W169688-00	ST	1.50	G		NENESW	2	25N	26E	PH	X	COBURN CREEK	MATADOR RANCH INC
S40M W040428-00	ST	14.08	C	16.00	NESWSE	7	25N	26E	PH	X	GHAST COULEE	CRASCO ORVILLE W
S40M W040429-00	IR	100.00	C	150.00	E2	8	25N	26E	PH		BEAVER CREEK	CRASCO ORVILLE W
S40M W40430-00	IR	100.00	C	150.00	SW	8	25N	26E	PH		BAKER CREEK	CRASCO ORVILLE W
S40EJ W152937-00	ST	4.00	C	26.00	N2NWSW	28	25N	23E	PH	X	BULL CREEK	MONTANA CATHOLIC MISSION S J
S40EJ W152932-00	ST	8.00	G	10.00	S2NWSW	28	25N	23E	PH	X	BULL CREEK	MONTANA CATHOLIC MISSION S J
S40EJ P004845-00	ST			5.00	SENWNE	29	25N	23E	PH	X	CABIN CREEK	MONTGOMERY C JOHN
S40EJ W184796-00	ST	20.00	G	10.92	E2NESE	29	25N	23E	PH	X	BULL CREEK	MONTANA CATHOLIC MISSION S J
S40EJ W152944-00	ST	10.00	C	20.00	E2SESE	29	25N	23E	PH	X	BULL CREEK	WILLIAMS RAYMOND S

TABLE 3.2-30
DNRC SURFACE WATER RIGHT LISTING
(Continued)

Water Right	Use	Rate		Volume	QTR SCTN	SC	TWP	RGE	CN	UT	Source Name	Owner Name
S40EJ P004847-00	ST			4.00	NWNWNW	30	25N	23E	PH	X	CABIN CREEK	MONTGOMERY C JOHN
S40EJ W184797-00	ST			12.00	E2NESE	30	25N	23E	PH	X	BULL CREEK	MONTANA CATHOLIC MISSION S J
S40EJ W152928-00	ST			8.60	NESWNW	33	25N	23E	PH	X	CABIN CREEK	MITCHELL WINSTON N
S40EJ W152929-00	ST			33.50	NWNENW	34	25N	23E	PH	X	CABIN COULEE	MITCHELL WINSTON N
S40I W017296-00	MN	1,122.00	G	95.50	NENE	14	25N	24E	PH		LITTLE PEOPLES CREEK	LAFOND LLOYD J LAFOND MILDRED S
G40EJ W152945-00	ST	25.00	G	10.82	NESWSW	20	25N	24E	PH			MONTANA CATHOLIC MISSION S J
G40EJ P023219-00	MN	250.00	G	100.00	SENENW	22	25N	24E	PH			LANDUSKY MINING INC
G40EJ W019674-00	DM	5.00	G	1.50	SENESE	22	25N	24E	PH			ZORTMAN MINING CO
G40EJ C037323-00	DM	5.00	G	1.50	SWNESE	22	25N	24E	PH			EREAUX ROY G EREAUX MARIAN S
G40EJ W184801-00	DM	15.00	G	3.25	NWNWSW	27	25N	24E	PH	X	ROCK CREEK	HEPPNER HAROLD H
G40EJ W184800-00	DM	15.00	G	3.25	NESWSW	27	25N	24E	PH	X	ROCK CREEK	HEPPNER HAROLD H
G40EJ W184802-00	DM	7.50	G	1.62	SWSWSW	27	25N	24E	PH	X	ROCK CREEK	HEPPNER HAROLD H
G40EJ W184799-00	ST	7.50	G	1.62	E2E2E2	28	25N	24E	PH		MONTANA GULCH	HEPPNER HAROLD H
G40EJ W184803-00	DM	7.50	G	1.62	NWSWNE	28	25N	24E	PH			HEPPNER HAROLD H
S40EJ W152946-00	IR	200.00	C	949.60	E2NENE	30	25N	24E	PH&		BULL CREEK	WILLIAMS RAYMOND S
S40EJ W152938-00	ST	12.00	C	23.00	E2NESW	31	25N	24E	PH&	X	SLIPPERY ANN HUD CREEK	WILLIAMS RAYMOND S
S40EJ W037511-00	ST	30.00	G	2.50	NW	32	25N	24E	PH		MUD CREEK	SQUARE BUTTE GRAZING ASSN
G40EJ W018250-00	ST	3.00	G	1.00	NWSESE	36	25N	24E	PH			MONTANA, STATE OF BOARD OF LAND
S40EJ W166074-00	MN	3.75	C	2,710.00	SWNWSE	7	25N	25E	PH		RUBY GULCH	GOLD RESERVE INC

TABLE 3.2-30
DNRC SURFACE WATER RIGHT LISTING
(Concluded)

Water Right	Use	Rate		Volume	QTR SCTN	SC	TWP	RGE	CN	UT	Source Name	Owner Name
G40I W166075-00	MN	6.25	C	4,517.00	NESESE	7	25N	25E	PH			GOLD RESERVE INC
S40EJ W166073-00	MN	30.00	G	48.00	NWSWSE	7	25N	25E	PH		RUBY GULCH	GOLD RESERVE INC



SOURCE: USGS MONITORING DATA

CHANGE IN FLOW
OF NORTHERN DRAINAGES
LITTLE ROCK MOUNTAINS

FIG. 3.2-26

TABLE 3.2-31

DEPARTMENT OF NATURAL RESOURCES & CONSERVATION (DNRC)
GROUND WATER RIGHT LISTING BY LAND DESCRIPTION

Water Right	Use	Rate		Volume	QTR SCTN	SC	TWP	RGE	CN	UT	Source Name	Owner Name
G40EJ W065370-00	WI	.72	G	.79	NENE	16	25N	25E	PH		WELL	USA (DEPT OF INTERIOR BUREAU OF
G40EJ W065371-00	ST	.72	G	.34	NENE	16	25N	25E	PH		WELL	USA (DEPT OF INTERIOR BUREAU OF
G40EJ C053271-00	MC	90.00	G	135.00	SWSESE	16	25N	25E	PH		WELL (DEPTH - 738 FT)	ZORTMAN WATER USERS ASSN
G40EJ G053271-00	MC	90.00	G	135.00	SWSESE	16	25N	25E	PH		WELL (DEPTH - 738 FT)	ZORTMAN WATER USERS ASSN
G40EJ G053271-01	MC	90.00	G	135.00	SWSESE	16	25N	25E	PH		WELL	ZORTMAN WATER USERS ASSN
G40EJ C031281-00	CN	24.00	G	38.71	SESWSE	16	25N	25E	PH		WELL (DEPTH - 738 FT)	NESBIT HENRY
G40EJ W011159-00	DM	10.00	G	25.00	SWNWSW	16	25N	25E	PH		WELL	MONTANA, STATE OF BOARD OF LAND
G40EJ W006432-00	DM	3.00	G	1.50		17	25N	25E	PH		WELL	SOUTHWICK MARDA R SOUTHWICK JAY W
G4OEJ W013060-00	ST	15.00	G	1.25	NENWSW	32	25N	25E	PH		WELL	SQUARE BUTTE GRAZING ASSN
G40EJ C004613-00	ST	4.00	G		SENW	33	25N	23E	PH		WELL	MITCHELL WINSTON
G401 C016704-00	MN	55.00	G	3.50	SW	12	25N	24E	PH		WELL	WELCH PAULINE C
G40EJ W167791-00	MN	2.00	C	1,445.00	SWNWNE	22	25N	24E	PH		GOLD BUG ADIT	LANDUSKY MINING INC
G40EJ C069239-00	MN	90.00	G	120.51	NWNENW	22	25N	24E	PH		WELL	ZORTMAN MINING CO
G40EJ T055440-00	IN				NWNENW	22	25N	24E	PH		WELL	LANDUSKY MINING INC
G40EJ C005963-00	FW	.25	G		NENWSE	22	25N	24E	PH		WELL	DOUCETTE RANCH
G40EJ W043875-00	DM	30.00	G	1.20		27	25N	24E	PH		WELL	WILLIAMS WILLIAM E
G40EJ W047136-00	DM	70.00	G	5.00		27	25N	24E	PH		WELL	TURNER DAVID H
G40EJ C031157-00	DM	20.00	G	4.50	NE	27	25N	24E	PH		WELL (DEPTH - 60 FT)	HOULD BARBARA J

TABLE 3.2-31
DNRC GROUNDWATER RIGHT LISTING
(Concluded)

Water Right	Use	Rate		Volume	QTR SCTN	SC	TWP	RGE	CN	UT	Source Name	Owner Name
G40EJ C064020-00	DM	5.00	G	3.00	NENENE	27	25N	24E	PH		WELL (DEPTH - 187 FT)	LANDUSKY MINING INC
G40EJ W017297-00	DM	50.00	G	4.50	N2NWNE	27	25N	24E	PH		WELL	FRENCH WINNIE R
G40EJ T045103-00	ST				NWNWSW	31	25N	24E	PH		WELL	WILLIAMS RAYMOND S
G40EJ C075853-00	DM	15.00	G	1.50	SWNWNW	34	25N	24E	PH		WELL (DEPTH - 400 FT)	KOLCZAK FRANCIS
G40EJ C077139-00	IN	95.00	G	145.61	SWSE	7	25N	25E	PH		WELL (DEPTH - 450 FT)	PEGASUS GOLD CORP
G40EJ C041510-00	IN	30.00	G	48.00	NESWSE	7	25N	25E	PH		WELL	ZORTMAN MINING CO
G40EJ P042324-00	IN	500.00	G	530.00	NESWSE	7	25N	25E	PH		WELL	ZORTMAN MINING CO
G40EJ W037498-00	ST	8.00	G	2.10	SWSESW	21	25N	25E	PH		ALDER SPRINGS 1	SQUARE BUTTE GRAZING ASSN
G40EJ W037497-00	ST	3.00	G	2.10	SESENW	35	25N	25E	PH		LOWER CAMP SPRING	SQUARE BUTTE GRAZING ASSN
G40I W005563-00	MN			200.00		13	25N	24E	PH		CASCADE SPRINGS	TAYLOR J H

also exceeded prior to Zortman Mining activity although exceedances were restricted to a few specific locations, namely historical adit discharges. Baseline surface water data that exceeded current aquatic life criteria came from the following facilities. The Gold Bug adit discharge at Montana Gulch, with up to 0.310 mg/l As, up to 11 mg/l Fe and up to 0.88 mg/l zinc, exceeding the chronic aquatic life criteria for As and Fe of 0.19 mg/l and 1 mg/l respectively, and the acute aquatic life standard for Zn of 0.12 mg/l at 100 mg/l hardness. Exceedances in surface water was also recorded at the mine adit drainage in Alder Gulch, with 2.3 mg/l Fe and 0.8 mg/l Zn.

3.2.9 Summary of Findings

A summary of the present water quality status and related mining facilities, where present, is provided on Table 3.2-32.

In addition to the information summarized in Table 3.2-32, the following major conclusions are pertinent:

- Streams flowing from the Little Rocky Mountains are ephemeral in their upper most reaches and then become intermittent in their mid reaches. They have defined bed and banks and support aquatic communities. Due to the presence of springs and shallow bedrock they are perennial to intermittent in their mid reaches, becoming ephemeral again as they leave the Little Rocky Mountains and enter the plains.

- The shales underlying the Goslin Flats area are of low permeability and have naturally high TDS and sulfate concentrations.

- Pre-1979 (baseline) data shows little or no degradation to water quality due to historical mining activity in most drainages.

- Post-1979 surface water and alluvial groundwaters have exhibited elevated chemical constituent concentrations on specific occasions, downstream as far as the Towns of Zortman and Landusky.

- Madison limestone exposed at or near the surface in the Little Rocky Mountains has received ARD contaminated recharge due to upstream mining activity.

- No monitoring evidence is available to document a change in surface water flow due to mining activity. However, the excavation of the pits and diversion of surface water flow into these pits is expected to have decreased flows in the northern streams to some degree.

- Due to the ephemeral nature of surface water drainages of the Little Rocky Mountains, beneficial uses are relatively limited in streams upper to mid reaches. Selected downstream reaches are used for livestock watering, recreation (campgrounds), wildlife drinking water, macroinvertebrate populations, and possible fisheries and agricultural uses.

- Beneficial uses of groundwater include domestic and commercial water supplies, livestock and wildlife water.

- Capture and treatment or recirculation systems are currently operating in all impacted drainages at Zortman and Landusky and have demonstrated significant improvements in downstream water quality.

TABLE 3.2-32

EXISTING WATER QUALITY CONDITIONS - SUMMARY

		Groundwater	
Facility	Surface Water	Alluvium	Bedrock
		ZORTMAN	
Ruby Gulch			
Zortman Pits Zortman Process Plant 1985-1986 Pads 1979-1982 Pads	Numerous cyanide detections likely from spills at the Zortman process area and ARD effects illustrated by elevated SO_4, TDS, SC and low pH, e.g. Z-1	Alluvium in upper reach of the Gulch consists of mineralized tailings, containing groundwater with occasional cyanide detections elevated SO_4, TDS, SC and low pH, e.g., RG-109	Some bedrock wells completed in metamorphic rock show the effects of mining with low pH, elevated SO_4, TDS and SC, e.g., RG-99
	Effects from mining activity on surface water are recognized throughout the length of Ruby Gulch down to Station Z-32, approximately 8,000 feet downstream of the Zortman township. Alluvial groundwater also shows effects of mining activity throughout the length of the Gulch, but only on occasions in the lower reaches. A dramatic improvement in the quality of the surface water has been observed since the initiation of capture and treatment at Ruby Gulch.		

TABLE 3.2-32
EXISTING WATER QUALITY CONDITIONS - SUMMARY
(Continued)

Facility	Surface Water	Groundwater	
		Alluvium	Bedrock
		ZORTMAN	
Alder Gulch			
Waste Rock Dump	Deteriorating water quality is illustrated by decreasing pH and occasional elevated SO_4, TDS, and SC, e.g. Z-13	Alluvial groundwater has been adversely impacted by the mining process illustrated by numerous cyanide detections and occasional elevated SO_4, SC and TDS, e.g., AG-202	Apparently unaffected by the rock dump
1979-1982 Pads 1984 Leach Pad 1983/1989 Pads	Deteriorating water quality illustrated by occasional cyanide detections, elevated SO_4, TDS, SC and low pHs, e.g., Z-8		Shallow bedrock appears to be effected by the mining facilities illustrated by cyanide detections and elevated SO_4, TDS and SC, e.g., AG-202
	Effects from the waste rock dump are recognized in the surface water of Alder Creek by the decreasing pH and elevated SO_4, TDS, and SC. Surface water quality is also effected by spills and land application of process chemicals, with cyanide detections below the Alder Spur confluence. Effects to alluvial and bedrock groundwater are illustrated by cyanide and occasional elevated SO_4, SC, and TDS. An improvement in surface water quality from Carter Spur and Alder Spur has been recognized since the installation of capture systems in 1992. It is unclear how far downstream the groundwater is effected and/or if it contributes to the decreased groundwater quality seen in lower Ruby Gulch.		

TABLE 3.2-32
EXISTING WATER QUALITY CONDITIONS - SUMMARY
(Continued)

Facility	Surface Water	Groundwater	
		Alluvium	Bedrock
	ZORTMAN		
Goslin Gulch			
No existing facilities	Naturally high levels of TDS and sulfate and a neutral pH	Similar to surface water, showing elevated TDS, sulfate and a neutral pH	Bedrock wells show increasing levels of sulfate and TDS with time.
	The neutral pHs but high sulfate, TDS, etc., are due to ongoing water/rock interaction with sediments and bedrock consisting of mineral-rich shales which are reduced and have high sulfate concentrations.		
Lodgepole Creek			
Zortman Pit Complex	Neutral pHs, low TDS and sulfate, no cyanide detections, e.g. Z-27	(Spring water) Neutral, low TDS and sulfate, good quality water, e.g. Z-6	
Beaver Creek			
No existing facilities	Neutral pHs, low TDS and sulfate e.g. Z-31	No groundwater data available.	
	The neutral pH, low TDS, sulfate, no cyanide detection and neutral concentration at or below detection limits, indicate that impacts to Lodgepole Creek have only been short-term and Beaver Creek has not been impacted by ZMI mining activity.		

TABLE 3.2-32
EXISTING WATER QUALITY CONDITIONS - SUMMARY
(Continued)

Facility	Surface Water	Groundwater	
		Alluvium	Bedrock
		LANDUSKY	
Rock Creek			
1991 (Sullivan Park) Pad	Surface water has been effected by construction of the pad with pHs reduced to 2.7 after 1991 and increases in SO_4, TDS and SC.	Substantial effects are seen in alluvial groundwater at the base of the pad. Illustrated by reduced pH and increases in SO_4, TDS and SC. No cyanide has been detected, e.g., ZL-132	Bedrock groundwater immediately below the 1991 Pad appears to be effected illustrated by a subtle trend of decreasing pH and increasing SO_4, TDS and SC, e.g., ZL-113
	Water effected by the Sullivan Park Heap Pad buttress or underdrains appears to be captured or significantly diluted by nonimpacted water from the upper reaches of Rock Creek. Below the confluence of these creeks, effects from mining activity are only occasionally recognized down to the confluence with Mill Creek.		
Mill Gulch			
1987 Pad	Mod. increases in SO_4, TDS and SC during 1987-1988. Monitoring station was covered by the 1988 Mill Gulch Waste Dump, e.g. L-18	Moderate increase in TDS, SO_4 and SC recorded during 1977-1978 period. Decreasing pH, e.g. ZL-126	Slight effect on bedrock groundwater, slightly reduced pH and minor increases in TDS, SO_4 and SC, e.g., ZL-122

TABLE 3.2-32
EXISTING WATER QUALITY CONDITIONS - SUMMARY
(Continued)

Facility	Surface Water	Groundwater	
		Alluvium	Bedrock
		LANDUSKY	
Mill Gulch Waste Dump	Moderate effects illustrated by elevated SC, TDS, SO_4 and low pH during 1991, e.g., L-25	Occasional effect on alluvial groundwater only. Occasional elevated SO_4, TDS, and SC, e.g., ZL-128	No effect is recognized in the bedrock groundwater, e.g., ZL-130
Landusky Process Plant Area	Effect on surface water illustrated by constant detections of cyanide, e.g., L-8	No data available	Effect of leaks/spills on limestone bedrock illustrated by near constant detections of cyanide, e.g., ZL-118
Mill Gulch	The 1987 Pad underdrain effected surface water, alluvial and bedrock groundwater illustrated by moderate increases in SO_4, TDS and SC. Cumulative effects from the waste rock dump and the 1987 Pad are restricted to surface water and the alluvium. The process plant area has spilled/leaked cyanide to surface water and bedrock groundwater on the western side of drainage. ARD effects in the surface water and alluvial groundwater have reached the Mill Gulch Rock Creek Confluence.		
Montana Gulch			
Montana Gulch Waste Rock Dump Gold Bugs Pit 1984 Pad 1985/1986 Pad	Effects from these facilities are seen cumulatively as occasional cyanide detections and increases in SO_4, TDS, and SC, e.g., L-16	Effects are illustrated in the form of occasional increases in SO_4, TDS and SC ,e.g., ZL-124	Cyanide has been detected in a bedrock well in 1992, otherwise bedrock groundwater appears to be unaffected, e.g., ZL-119

TABLE 3.2-32
EXISTING WATER QUALITY CONDITIONS - SUMMARY
(Continued)

		Groundwater	
Facility	Surface Water	Alluvium	Bedrock
		LANDUSKY	
1983 Pad	Effects on surface water illustrated by cyanide detections and extremely high SO_4, TDS and SC although these have improved since 1984, e.g., L-12	No Data Available	Cyanide has been detected in two bedrock wells below the 1983 leach pad buttress. Limestones also have elevated TDS and sulfate although pH is neutral e.g., ZL-114R
	Effects from the waste rock dump and 1984-1985/1986 Pads appear to be restricted to the surface and alluvial water, this water then meets with surface water draining the 1983 pad which also has been impacted by cyanide detection and possible ARD, but has improved substantially since 1988. The surface water sampled as L-2 just above the confluence with Rock Creek appears to be of good quality.		
King Creek			
Montana Gulch Waste Rock Dump August Pit	Neutral pH but mod levels of TDS and sulfate. Elevated nitrate concentrations, e.g. L-6	Little data available, but neutral pH and moderate levels of TDS and sulfate, e.g. ZL-140	Elevated TDS, sulfate and nitrates but neutral pH, e.g. ZL-139.
	Monitoring record shows surface water to have been only slightly impacted if at all, prior to ZMI activity. Nitrate levels are thought to be derived from reclamation efforts in the headwaters or the use of ANFO. Removal of historic tailings during 1993 has reduced the TSS concentration of surface waters.		

TABLE 3.2-32
EXISTING WATER QUALITY CONDITIONS - SUMMARY
(Concluded)

Facility	Surface Water	Groundwater	
		Alluvium	Bedrock
		LANDUSKY	
Swift Gulch			
Queen Rose Pit	Neutral pH and low levels of TDS, sulfate and metals. No cyanide detections	No groundwater data is available.	
	Monitoring record shows the surface waters of South Bighorn Creek to be of good quality and not impacted by present or historic mining activity.		

3.3 SOIL AND RECLAMATION

3.3.1 Study Area

Soil of the Zortman and Landusky mining area are developing in two distinct sets of landforms (Figure 2.2-1). The first set consists of mountain tops, ridges, sideslopes, and V-shaped valley bottoms within the portion of the study area occupied by the Little Rocky Mountains. Elevations proximate to the study area range from high points of about 5,700 feet above mean sea level (msl) atop Old Scraggy Peak, Antoine Butte, and Shell Butte, to a low point of approximately 4,000 feet above msl at the mouths of Ruby Creek (Zortman), Rock Creek, Mill Gulch, and Montana Gulch (Landusky), where these drainages leave the mountains. Dominant slopes range from approximately 10 percent to over 80 percent (USGS Quads). Slopes greater than 50 percent are common. The presence of V-shaped valleys and the absence of glacial deposits within the mountains indicates that much of the Little Rocky Mountains were not glaciated.

The second set (the remainder of the study area on the Zortman side) occurs on the nearly level to gently sloping high plains which extend out from the base of the Little Rocky Mountains (Figure 2.2-1). The plains portion of the study area is known as Goslin Flats and the Ruby Flats. Goslin Flats and the Ruby Flats are adjacent broad, nearly level drainage bottoms which contains both Goslin Gulch and Ruby Creek. Elevations range from about 4,000 feet at the base of Whitcomb Butte to approximately 3,600 feet at the southern end of the study area. Dominant slopes are less than 8 percent for this portion of the study area. Minor areas with slopes of 8 to 30 percent occur within potential areas of disturbance on the slopes of Whitcomb Butte and side-slopes of higher terraces.

3.3.2 General Soil Description

Soil of the Zortman and Landusky Mines area have been mapped and described during a series of soil surveys. Noel and Houlton (1991, in ZMI Amendment Plan of Operations 1993, Appendix 3) compiled all soil mapping and descriptions information for the two mine areas into a summary soil survey document. Previous soil mapping and descriptions addressed in the most recent Noel and Houlton (1991) report include reports by Olsen (1978) and Noel (1983, 1985, 1986, 1988, and 1989). All soil mapping and descriptions developed and presented in the 1991 summary soil survey were conducted in accordance with the National Cooperative Soil Survey using procedures outlined in USDA Handbooks 18, 430, and 436, and unpublished soil survey guidelines provided by the Montana Department of State Lands (DSL 1985).

Bodies of soil (soil mapping units) were initially identified and verified in the field using topographic maps and both color and black-and-white aerial photography of the study areas. As part of the field verification of soil units (soil with similar characteristics), profiles of delineated soil units were exposed by excavation at representative sites from the surface to bedrock, to unsuitable salvage material, or to a 60-inch profile depth, whichever was reached first at a sample site. Based on field observations of soil profiles and interpretation of soil and landform relationships, adjoining soil that differed markedly in physical and/or chemical characteristics were delineated into separate units with a minimum size of two acres. Soil that differed slightly in physical and/or chemical characteristics from adjoining soil were delineated to a minimum of five acres in size of discreet soil mapping unit. All horizons of soil profiles determined by field observation to be suitable for salvage and use in reclamation were sampled for subsequent laboratory analyses for soil properties important to the assessment of a soil as a suitable plant growth medium. The assessment of soil characteristics also included the evaluation of soil materials for uses other than cover soil, growth medium; evaluations for suitability of use as a capillary break, drain layer, liner shield, and clay layer were also completed.

3.3.2.1 Mountain Soil

Soil in the mountainous portions of the study area are predominantly young soil in the early stages of development due to the relatively continuous loss of soil material from rapid runoff on steep slopes (ZMI 1993, Appendix 3). Soil material (less than 2 mm-sized fraction) is weathering from exposed rock surfaces and masses of broken rock deposited by erosion and gravity in rock falls (screen slopes or colluvium). Because of soil loss due to erosion and associated natural sorting, soil textures are gravelly and cobbly sandy loams on the steeper, more unstable slopes; loams on less steep, more stable slopes; and less frequently, clay loams in upland swale bottoms. Parent materials are intrusive igneous rocks, metamorphic rocks, and limestone which are the dominant lithologies of the mountainous features. Drainage bottoms and any low terraces consist of water deposited materials (alluvium) derived from these parent materials. Detailed soil-type mapping, map unit descriptions, site-specific soil profile descriptions, and soil sample analytical results for the mountain and Goslin Flats soil are presented in Appendix 3 of the Zortman Mine Amendment Plan of Operations (ZMI 1993). Soil survey information presented in Appendix 3 also fully addresses the soil resource for the Landusky Mine area.

3.3.2.2 Goslin Flats and Ruby Flats Soil

Soil of the Goslin Flats portion of the study area are of similar age as the mountain soil. However, they are moderately to well developed, due to reduced slopes (hence, more stable areas) and increased influence from other soil forming factors such as infiltration of water. Predominant soil textures of surface horizons (topsoil) for soil to be salvaged within the footprints of proposed facilities in the Goslin Flats and Ruby Flats areas are loams, silt loams, and clay loams (Noel and Houlton 1991). For those soil mostly occupying slopes of 8 percent or less, coarse fragment content (soil particles greater than 2 mm in size including gravel, cobbles, and boulders or rocks) of surface horizons ranges from a trace to 40 percent gravel; however, much of the area and volumes of material have coarse fragment contents of less than 25 percent and soil erodibility factors of approximately 0.40. A soil erodibility factor (K factor) of 0.40 represents a higher inherent erodibility or susceptibility to water erosion.

For soil occupying slopes mostly greater than 8 percent, coarse fragment content ranges from a trace to over 80 percent gravel and cobbles. Soil of much of these steeper areas have coarse fragment contents of 20 to 50 percent and soil erodibility factors of approximately 0.21. A soil K factor of 0.21 represents a lower inherent erodibility (water erosion).

Predominant subsoil horizons textures in the Goslin Flats and Ruby Flats areas are clay loams to clays (Noel and Houlton 1991). Coarse fragment contents of soil on 8 percent or less slopes range from a trace to approximately 60 percent. For soil occupying slopes greater than 8 percent, coarse fragment content of subsoil horizons ranges from a trace to over 85 percent.

Greater infiltration of water in the flats and on terraces (even though textures are more clayey) is due not only to (a) more level surfaces, but also to (b) more soil structure within the surface and subsoil horizons, which yields spaces between soil aggregates where water can flow down by gravity. The presence of more clayey soil in comparison to the mountain soil is due likely to past transport of weathered fines in streams and deposition in floodplains and terraces. As the streams left the steeper mountains and entered the more level plains, the waters slowed and allowed the fines to settle out in deposits of clayey alluvium. Other possible sources of clay in soil is physical weathering of in-place materials in the surface horizon, air deposition of clay sized particles on the soil surface, and eluviation (i.e., transport by water and gravity from the surface horizon) into subsurface horizons as part of the normal soil formation process.

Coarse fragment content varies among and within soil types, but is more prevalent in colluvium along the edge of the mountains and in the alluvial stream deposits. Parent materials include erosional deposits of alluvium, colluvium and residium (underlying rocks which are weathering in place to produce soil sized particles), sandstones and shales (Noel and Houlton 1991).

3.3.3 Soil Reclamation Potential

Issues and concerns raised by agencies and the public during scoping have focused on identifying the availability and capability of the soil resources (a) to withstand impacts from mine development and (b) to provide adequate quantities of appropriate materials for effective, long-term reclamation of affected lands, particularly the waste rock and heap leach materials. The soil is an essential resource, which when properly salvaged, protected, and redistributed, would hasten reclamation and new soil formation.

Soil of the Little Rocky Mountain area are likely a minimum of 10,000 years old and have developed since the last major climatic change and major soil disturbance associated with the retreat of the ice sheets and glaciers. These soil have developed to varying degrees distinct layers or horizons in response to climate, weathering of parent materials, erosion and deposition of soil materials, and biological activity including introduction of organic matter from the decay of vegetative litter and plant roots.

Salvaged topsoil (surface horizon) usually have higher organic matter contents, which typically increases productivity. Salvaged subsoil, due to natural sorting and soil development, can have characteristics that can lend themselves to various uses operationally and post-operationally in a selected reclamation cover. The preservation of many of the characteristics of different surface and subsurface horizons by salvage and separate stockpiling lessens the adverse effects of soil disturbance and associated loss of soil development. Salvage of distinct soil layers, storage, and replacement in kind as part of a reclamation program greatly restores the soil resources' abilities to support protective and productive vegetation for wildlife habitat and visual enhancement. The reestablishment of a stabile soil system and vegetative cover on affected landforms can occur in a matter of a few years, depending on environmental conditions and effectiveness of the implemented reclamation plan. The absence of a reclamation program involving soil salvage, storage, and replacement would waste the previous 10,000 years of soil development. Salvage, storage, and the ordered replacement of soil materials "short-circuits" the time required to reach a higher level of soil development, soil stability, and vegetative productivity comparable to existing, predisturbance conditions.

Based on the qualitative characterization of the soil resource and quantitative analytical data derived from the analysis of on-site soil samples, impact susceptibility and reclamation suitability can be assessed. The following sections describe reclamation potential of various soil in this context.

3.3.3.1 Mountain Soil

Soil occupying steep slopes are frequently susceptible to accelerated water erosion, particularly when disturbed; however, most of the mountain soil situated on steep slopes within the Zortman and Landusky Mines area have low to moderate erosion potentials. These soil have a high coarse fragment content, which serves to stabilize the soil-sized fraction and, in some cases, armor the surface; both factors increase resistance to water erosion and soil loss. Over time, the mountain soil have become armored at the surface through the loss of susceptible soil fines to erosion. In addition, soil are covered with vegetation to reduce erosive rainfall impact velocities. Roots and organic matter accumulation increase infiltration characteristics into the soil. The development of soil structure, effects of freezing and thawing, plants root growth, and the activity by soil animals reduce soil bulk density. The high coarse fragment content, in combination with (1) mostly coarser soil textures, (2) erosion-resistant vegetation community root patterns, (3) soil structure, and (4) inherent soil water and permeability conditions, results in most of the mountain soil having very low soil erodibility factors (Noel and Houlton, Table 3-3).

3.3.3.2 Goslin Flats and Ruby Flats Soil

The reduced slopes (mostly 0-8 percent) of the Goslin Flats and Ruby Flats portions of the study area would result in mostly low to moderate potentials for accelerated erosion. However, much of the soil material comprising the floodplains and terraces of the flats is highly erodible when disturbed. Should these soil materials be exposed to channelized flows such as new drainage diversions or be placed on over-steepened, accelerated, erosion rates and soil loss from mill and/or gully development could occur.

3.3.4 Soil Suitability and Availability

The suitability and availability of soil material for use in reclamation (particularly for use in the development of cover systems for reclaiming waste materials) is addressed for proposed and alternative facilities in the following subsections. The Zortman Mine extension (ZMI 1993, as amended) proposes a total of approximately 1,275 acres to be disturbed, including approximately 178 acres for waste rock storage (based on 54 to 60 million tons of rock storage), and 298 acres for the heap leach pad and adjacent facilities processing area, ore crushing/handling, and topsoil/cover soil stockpiles. The Landusky Mine extension (ZMI 1994) proposes an additional 73 acres of disturbance, in addition to the existing 814 acres of disturbance (DSL and BLM 1993), for a total of 887 acres.

The amounts of soil available for salvage or redistribution, if already stockpiled, are presented in Table 3.3-1 (Zortman Mine area) and Table 3.3-2 (Landusky Mine area). These tables show the volumes of available cover soil and subsoil for existing stockpiles, reclaimed areas, proposed facilities, and alternative facilities. In addition, Table 3.3-1 provides salvage volumes for three possible combinations of proposed facilities and alternative facilities at the Zortman Mine. Approximately 2,057,000 cubic yards would be required to reclaim 1,275 acres at the Zortman Mine with 12 inches of cover soil. Approximately 1,431,000 cubic yards would be required to reclaim 887 acres at the Landusky Mine with 12 inches of cover soil.

Volumes of suitable cover soil and subsoil materials were based on the determination of suitability by depth for each of the soil types using a combination of guidance from the DSL (1985), BLM (1992b), soil suitability evaluations in ZMI (1993, Section 3.0, Reclamation Plan [revised], Noel and Houlton, 1991) and professional judgement. Table 3.3-3 presents a summary of suitability information by soil type for the

Reclamation Covers

Reclamation covers, or caps, will serve two critical functions at the Zortman/Landusky mines during mine reclamation. ***First***, and most visibly, the covers will be used over regraded heap leaches, waste repositories and dumps, pit bottoms and ledges, and other facilities to provide a ***growth zone for plants***. Replacement of suitable soil (from native soil salvaged and stockpiled ahead of mining activities, or obtained nearby) promotes the rapid re-establishment of native plants by helping restore soil conditions similar to those present prior to mining. Native seeds and plants are increasingly favored by the regulatory agencies to re-establish wildlife habitat and the forest and range resources that are often disturbed by mining.

Second, and most importantly from an environmental protection standpoint, the cover is a ***protective barrier*** to prevent air and water from reaching zones of covered spent ore or waste rock that can produce acid rock drainage (see the Acid Rock Drainage sidebar on this matter), and other contamination. The various layers and their functions in a multi-layered, extremely protective cap are described below. Any or all of these layers could also contain net neutralizing materials to aid in passive water treatment by raising alkalinity of potential ARD.

Approximate Range (inches)	Cap Layers	Function
	Vegetative	Provides a protective, stabilizing cover which controls erosive effects of raindrop impact, overland flow, and wind erosion, and holds the soil with roots.
8-24	Soil Layer	Provides a suitable growth medium for desired vegetation; soil physiochemical attributes should support a sustained cover of vegetation, and adequate water-holding capacity, and be of sufficient depth to allow for expected, long-term erosion losses.
18-36	Capillary Break	Provides a mostly rocky layer which serves to hold the overlying soil layer, to conduct excess water from the soil layer away as a drainage layer, to retain moisture (when sufficient fines are present) for use by plants which have rooted into this layer, and to prevent or limit any rise of contaminated moisture from any underlying acid-producing materials.
3-6 (sand or gravel) 5 ounce geotextile	Liner Shield	Provides layer of protective padding between the rocky materials of the capillary break layer above and the low hydraulic conductivity or moisture barrier layer below. The shield can be a layer of coarse sand or gravel, or a thick fabric or geotextile which prevents puncture or damage to the underlying moisture barrier or liner. This layer can also provide drainage of excess moisture.
6-24 (clay) 15-20 mil PVC (geomembrane)	Liner	Provides a barrier to the movement of moisture and air down into the underlying waste or previously exposed rock materials, and to the movement of potentially acidic or contaminated moisture up into overlying layers from the underlying waste and rock materials. This layer can consist of a synthetic (hydrocarbon), geomembrane, a layer of compacted clay, or a combination of both.
	Waste	

At the Zortman and Landusky mines, various covers are being tested in a Reclamation Surface Performance Study (RSPS), which is reported elsewhere in the EIS. Different covers, depths, and layer types and thicknesses may be used on different facilities, based primarily on environmental protection needs, and anticipated effectiveness of a cover system in response to specific site conditions.

Sources: See *Suggested Reading* in the References regarding reclamation covers, their variations, and functions.

TABLE 3.3-1

SOURCES OF SUITABLE COVER SOIL AND SUBSOIL MATERIALS FOR THE ZORTMAN MINE AREA

	Volumes (yd^3)	
	Cover Soil	Subsoil
Existing Stockpiles[1]		
North Ruby Saddle	136,000	NS
South Ruby Saddle	32,000	NS
1982 Leach Pad	15,000	NS
Reclaimed Area[2]		
67-acres with a minimum of 8 inches of redistributed cover soil	80,000	NTBS
Proposed Facilities		
Goslin Flats Heap Leach Pad, Processing Area, and Crushing/Handling	589,000	1,448,000
Carter Gulch Waste Rock Depository	NTBS	NTBS
Mine Pits Expansion	NTBS	NTBS
Limestone Quarry	20,000	40,000
Alternative Facilities		
Ruby Flats Waste Rock Depository	271,000	1,637,000
Alder Gulch Heap Leach Pad, Plant and Ore Handling	NTBS	NTBS
Totals		
Existing Stockpiles, Reclaimed Area, and Proposed Facilities	872,000	1,488,000
Existing Stockpiles, Reclaimed Area, and Modified Proposed Facilities (Ruby Flats Waste Rock Depository)	1,143,000	3,125,000
Existing Stockpiles, Reclaimed Area, and Modified Proposed Facilities (Alder Gulch Heap Leach Pad, Plant and Ore Handling)	326,000	40,000

NS = none salvaged
NTBS = none to be salvaged due to steep slopes (>2:1), excessive coarse fragment content (>50%), and/or absence of soil material (scree and rock outcrop)

[1] See Figure 2.6-1 for locations of existing cover soil stockpiles.

[2] Specific reclaimed areas and associated acreages are presented in ZMI's 1993 Annual Reclamation Summary Report, Table II (ZMI 1994a).

Source: Zortman Mining, Inc., Application for Amendment to Operating Permit #00096, 1993.

TABLE 3.3-2

SOURCES OF SUITABLE COVER SOIL AND SUBSOIL MATERIALS FOR THE LANDUSKY MINE AREA[1]

	Volume (yd^3)	
	Cover Soil	Subsoil
Existing Stockpiles[1]		
Montana Gulch	181,000	NS
Gold Bug	75,000	NS
August Pit	437,000	NS
Mill Gulch	1,479,000	NS
Reclaimed Areas[2]		
147 acres with a minimum of 8 inches of redistributed cover soil	176,000	
Proposed Facilities		
King Creek Quarry[*]	8,000	16,000

[*] Assume 6 inches cover soil and 12 inches of subsoil for 9.7 acre area.

[1] See Figure 2.6-1 for locations of existing cover soil stockpiles.

[2] Specific reclaimed areas and associated acreages are presented in ZMI's 1993 Annual Reclamation Summary Report, Table II (ZMI 1994a).

Source: Zortman Mining, Inc., Revisions to plans for the Landusky Mining Area Permit #00095, 1995.

TABLE 3.3-3

VOLUMES OF SOIL MATERIALS BY TYPE OF USE, ZORTMAN MINE

	Goslin Flats Heap Leach Pad and Ancillary Facilities (yd³)	Ruby Flats Waste Rock Depository (yd³)
Cover Soil		
Steeper Slopes[1]	280,000	271,000
Lesser Slopes[2]	309,000	
Subsoil[3]		
Capillary Break[4]	1,335,000	1,637,000
Liner Shield[4]	69,000	
Clay Layer[5]	44,000	

[1] Slopes generally greater than 3:1; higher coarse fragment content and lower (0.21) K factor soils.

[2] Slopes generally less than 3:1; lower coarse fragment content and higher (0.40) K factor soils.

[3] Most subsoil materials are also acid neutralizing.

[4] Subsoil material potentially suitable for use as a capillary break layer and for moisture retention in support of deeper rooted vegetation and erosion resistance due to higher content of stabilizing coarse fragments.

[5] Coarse sands to gravelly subsoil materials used as liner shield would also act as a drainage layer above a geomembrane or clay liner.

[6] Clay loam to clay subsoils could provide a degree of impermeability almost equivalent to mined clay and not have some of the undesirable features such as desiccation upon drying.

proposed Goslin Flats heap leach pad, plant facilities, and ore handling area and the alternative Ruby Flats waste rock depository, respectively. Soil beneath these two sets of facilities are the best potential sources of suitable cover soil and subsoil for the reclamation of all disturbances (including the construction of cover systems at final reclamation and closure of the mine facilities), beyond that which is already stockpiled at the Zortman and Landusky mines.

Soil to be disturbed in both Zortman and Landusky mine areas by construction of the linear access/haul roads, conveyor, power line, LAD support areas, drainages, and reclamation access are located principally in the mountainous portion of the study area. Preceding construction of facilities, suitable cover soil material, where encountered, would be salvaged and windrowed or stockpiled adjacent to the facility for subsequent use in reclamation. The salvaged cover soil materials would be protected from contamination and stabilized through the use of interim revegetation and/or erosion control measures for the life of operations.

Primary physical and chemical properties of soil that define its suitability for use as cover soil or subsoil by MDSL are slope (less than 2:1), coarse fragment content (less than 50 percent), and organic matter content (greater than 0.5 percent). Regardless of organic matter content, MDSL recommends soil salvage to a depth of 60 inches unless slope or coarse fragment content exceed criteria or bedrock is encountered. The BLM (1992a) provides additional suitability criteria for soil pH (greater than 5 and less than 8.5), sodium adsorption ratio (SAR - less than 8), and electrical conductivity (EC, mmhos/cm - less than 7). The preceding MDSL and BLM criteria apply mostly to the evaluation of growth-media cover soil. Additional criteria for the design and construction of cover systems involving potential use of subsoil materials are addressed in BLM (1992a) and in EPA's seminar publication Design and Construction of RCRA/CERCLA Final Covers (EPA 1991).

In Table 3.3-3, potential volumes of suitable cover soil and subsoil materials have been estimated based on criteria for suitability and calculations of volume. Subsoil materials potentially suitable for use in the capillary break layer, the liner shield layer, and the clay (low hydraulic conductivity) layer have been identified. Estimated volumes of these materials are also presented in Table 3.3-3. Subsoil materials for use in capillary break or liner shield layers have been identified as "potentially" suitable for use in cover layers because of the variability in percent coarse fragment content and because of the presence of soil fines (silt- and clay-sized particles) in the subsoil layers. Use of these materials would likely require processing (screening and removal of fines) prior to use in the cover systems. Processing would likely reduce the volumes of available subsoil material by 5 to 40 percent depending on actual field conditions. Subsoil materials used as the capillary break layer would likely also meet BLM criteria for a moisture retention and erosion resistance layer (BLM 1992a). Subsoil materials used for the liner shield layer would also meet BLM criteria for a drainage layer.

In the study area, excessive coarse fragments, shallow depth to bedrock, clayey textures, low organic matter content, SAR, EC, slope, and shallow water table are the main factors which may limit availability of suitable cover soil and subsoil (Table 3.3-3).

3.3.4.1 Zortman Mine - Pits and Limestone Quarry

Soil of the proposed mine pits in the mountainous region of the Little Rocky Mountains are relatively young, shallow soil on steep slopes, often over 50 percent. Soil types mapped in areas of proposed mine pit extension are characterized by gravelly, very cobbly loam textures, steep slopes, high coarse fragment contents, and shallow soil which preclude soil salvage from the mine pits extension area. Resource value for use as cover soil (growth medium) is limited. In addition, acid neutralization potential is low. The use of overburden and waste rock cover layers to isolate acid generating mine wastes is addressed in Section 3.1 of this EIS.

The soil type present at the proposed limestone quarry (Section 6) is a gravelly loam on 25 - 50 percent slopes. Estimated cover soil and subsoil volumes to be salvaged from the proposed quarry are presented in Table 3.3-1. Where slopes permit, soil would be salvaged ahead of limestone mining operations for future reclamation of the quarry. Quarried limestone would be crushed for use in reclamation efforts to control acid rock drainage. Any remaining overburden or waste rock from quarry operations could be used in cover systems at the quarry or at the Zortman Mine to reduce net acid production and to increase rooting depth.

3.3.4.2 Zortman Mine - Alder Gulch

The soil types in the Carter and Alder Gulch and Landusky Mine areas are dominated by gravelly and cobbly loams (Noel and Houlton 1991). Most of these are characterized by slopes over 50 percent, and parent rocks which consist of syenite and syenite porphyry. These soil generally have a low soil erodibility characteristics, low water holding capacity, and a high potential for severe runoff and erosion, if disturbed. Steep slopes, high coarse fragment content, and the lack of soil for plant growth (shallow soil) preclude soil salvage from either facility. Subsoil may have use as capillary break material, but lack net neutralization potential.

3.3.4.3 Goslin Flats and Ruby Flats

The major source of salvageable cover soil and subsoil are the presently undisturbed Goslin Flats and Ruby Flats, with the other primary sources of cover soil being existing topsoil/cover soil stockpiles located within the Zortman and Landusky Mines area (Figure 2.6-1, Tables 3.3-1 and 3.3-2).

The dominant soil present at Goslin Flats consist of loams, gravelly loams, and cobbly loams and have predominantly net neutralizing characteristics. Clay loam to clay subsoil could provide a degree of impermeability almost equivalent to mined clay and not have some of the undesirable features such as desiccation upon drying. The parent materials for these soil are alluvium and sedimentary rocks, and slopes are mostly nearly level to gently sloping (less than 8 percent). Coarse fragment content is higher in glacial tills and colluvium, and their associated soil along Ruby Creek.

The soil of Goslin Flats have higher soil erodibility factors, resulting from higher percent contents of silt and fine sand generally, and less coarse fragment content than in the mountain soil. However, soil erosion potential is still low to moderate due to the greatly reduced slopes of the Goslin Flats area. Table 3.3-1 presents the estimated cover soil and subsoil volumes available for salvage beneath the proposed Goslin Flats heap leach plant, plant facilities, and ore handling area and waste rock depository.

3.4 VEGETATION AND WETLANDS

The Little Rocky Mountains are an isolated range in the northern Great Plains of Montana. A wide array of plant communities[1] are found, some of which are unique to the area. This wide array of plant communities can be attributed to the physical diversity of the area (e.g., a wide range of elevational change and the associated climatic variations in temperature, wind and precipitation regimes; parent material diversity leading to different soil types, depths and fertility; and high geologic diversity) and the response to, and time since, past disturbances such as fire, grazing, and drought.

When a change (disturbance) in the physical environment occurs, changes in the types, numbers, and groupings of plant communities and other organisms occupying an area take place, with accompanying changes in certain features of the physical microenvironment. For example, following a forest fire, lodgepole pine is often the first species to occupy the burned area, generally in dense stands. The dense stands create a shaded understory (i.e., a change in the physical micro-environment). Because lodgepole pine is a shade-intolerant species, its own seedlings either cannot survive or grow poorly, while shade-tolerant seedlings of invading species flourish. Over time, the lodgepole pine forest is replaced by another forest community. This process, known as plant succession, is important in the reclamation of mined areas.

When planning for reclamation, it is necessary to understand the vegetation potential and patterns of vegetation development over time. By replacing topsoil and seeding, reclamation can set the stage for and accelerate the plant succession process, thus providing early and increased protection against wind and water erosion, and reduce the time needed to reclaim the site for proposed post-mine land uses.

Numerous vegetation inventories have been conducted in the project area. A general reconnaissance of the area was made by Culwell (1977). Culwell and Ramsden (1978) conducted site-specific baseline inventories. Additional site specific inventories were conducted by Scow (1983) and Scow and Culwell (1986). Culwell et al. (1989) summarized these vegetative inventories. Larsen et al. (1989) reported on revegetation monitoring of mined sites.

Culwell et al. (1990) collected additional site-specific data and synthesized these previous reports to prepare a comprehensive account of the vegetation in the project area. This information included detailed vegetation baseline maps.

The BLM has summarized region-wide vegetation data in the Judith Valley Phillips Resource Management Plan EIS (BLM 1992b). A listing of rare or endangered plant species and plant communities which might occur in the project area was obtained from the U.S. Fish and Wildlife Service (USFWS), MDFWP, and the Montana Natural Heritage Program (MNHP) (see Section 3.4.5.1). Figure 3.4-1 shows the general vegetation patterns of the Zortman and Landusky mine areas and proposed extension areas, including forested areas, grassland areas, rock outcrops/screen, and disturbed areas (see Figures in Section 2.0 for the location of existing facilities and proposed expansion areas). These patterns are described in the subsections below.

3.4.1 General Vegetative Patterns

Vegetation is typically described in terms of plant communities. A total of some 25 community types have been identified in the project and surrounding area. This seemingly large number reflects the environmental diversity encountered. The community types are listed in Table 3.4-1. The acres of vegetation by community type in the Little Rocky Mountains are as follows:

Community	Acres
Grasslands	2,700
Shrubland	800
Lodgepole Pine Forest	7,300
Ponderosa Pine Forest	300
Douglas Fir Forest	300
Deciduous Forest	1,300
Rock/Scree/Disturbed	1,700
Total Acres	14,400

A detailed description of each community type is included in the vegetation resources report by Culwell et al. (1990), along with data on production, density, cover, and environmental characteristics for each community type. The report also includes a species list for the Little Rocky Mountains area and a community type/habitat type correlation.

The Little Rocky Mountains are isolated in a sea of northern great plains grasslands. Gentle slopes with variable aspect support a foothills/mixed-prairie community type dominated by various dryland grasses. Various shrubland types dominate the lower drainage bottoms and occur on steep sidehills leading into the mountains. Several dry south-facing sidehill slopes and draws radiating from the mountains contain ponderosa

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[1] Communities are groups of associated plants typically occurring in repeating patterns.

TABLE 3.4-1

VEGETATION COMMUNITY TYPES
LITTLE ROCKY MOUNTAIN AREA

- Grassland Types
    - Foothills Mixed Prairie
    - Montane Grassland
    - Seral Grass/Shrub
    - Mesic Grassland

- Shrubland Types
    - Skunkbush Sumac/Grassland
    - Big Sagebrush/Grassland
    - Silver Sagebrush/Grassland
    - Western Snowberry Drainage Bottom
    - Chokecherry Sidehill/Bottom
    - Columbia Hawthorne Thicket

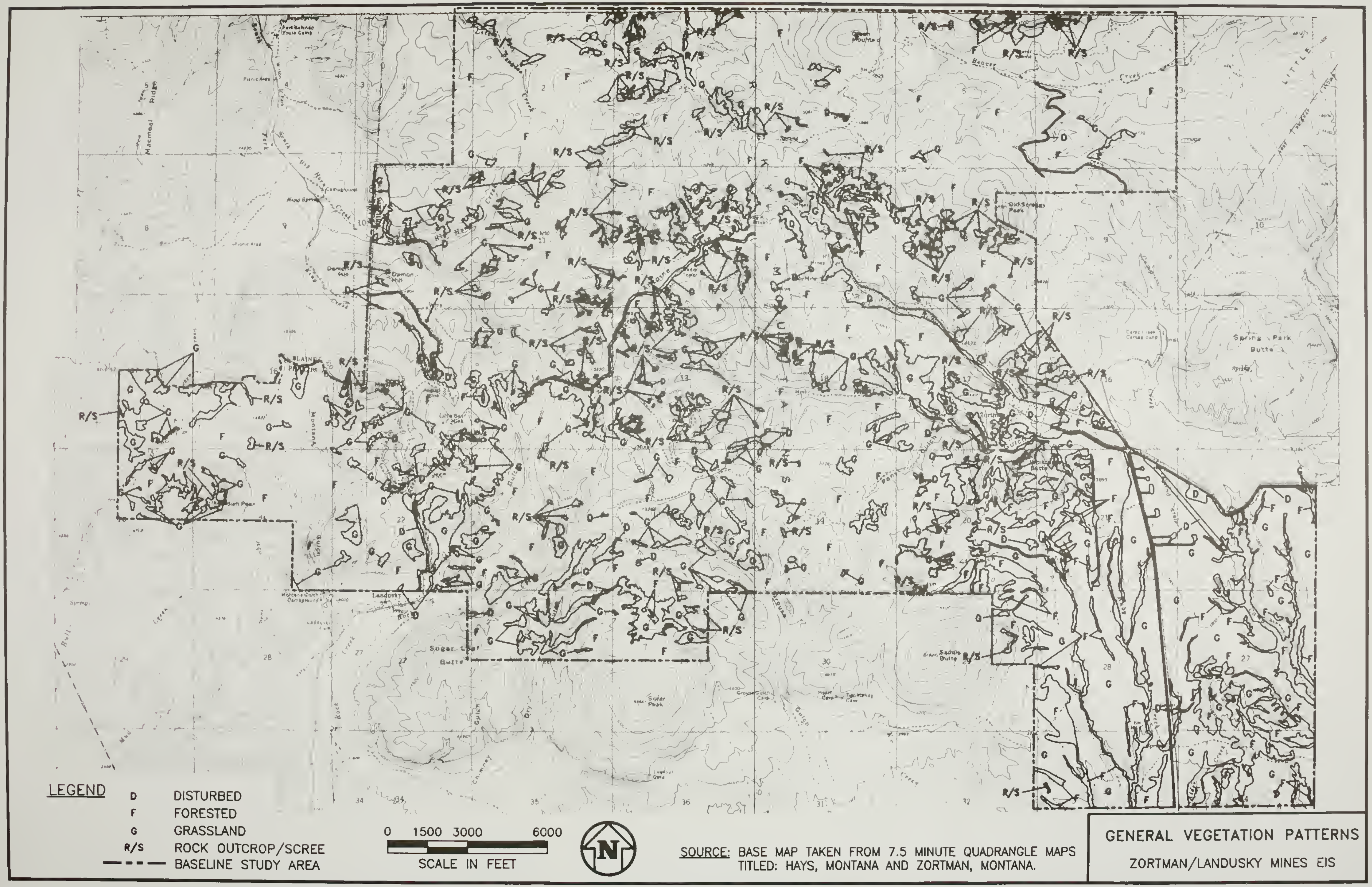
- Lodgepole Pine Forest Types
    - Lodgepole Pine Scree
    - Lodgepole Pine/Common Juniper
    - Lodgepole Pine/Bearberry (aka kinnikinnick)
    - Lodgepole Pine/Mixed Shrub
    - Lodgepole Pine/Twinflower
    - Recently burned Lodgepole Pine

- Ponderosa Pine Forest Types
    - Ponderosa Pine/Grass
    - Ponderosa Pine/Creeping Juniper
    - Ponderosa Pine/Western Snowberry
    - Ponderosa Pine/Common Juiper
    - Ponderosa Pine/Bearberry (aka kinnikinnick)
    - Ponderosa Pine/Oregon Grape

- Douglas-Fir Forest Types
    - Douglas-fir/Western Snowberry
    - Douglas-fir/Bearberry (aka kinnikinnick)
    - Douglas-fir/Twinflower
    - Douglas-fir/Oregon Grape

- Deciduous Tree Woodland
    - Quaking Aspen/Paper Birch

Source: Culwell et al. 1990



SOURCE: BASE MAP TAKEN FROM 7.5 MINUTE QUADRANGLE MAPS TITLED: HAYS, MONTANA AND ZORTMAN, MONTANA.

GENERAL VEGETATION PATTERNS

ZORTMAN/LANDUSKY MINES EIS

FIG. 3.4–1

TABLE 3.4-1

VEGETATION COMMUNITY TYPES
LITTLE ROCKY MOUNTAIN AREA

Grassland Types
- Foothills Mixed Prairie
- Montane Grassland
- Seral Grass/Shrub
- Mesic Grassland

Shrubland Types
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- Big Sagebrush/Grassland
- Silver Sagebrush/Grassland
- Western Snowberry Drainage Bottom
- Chokecherry Sidehill/Bottom
- Columbia Hawthorne Thicket

Lodgepole Pine Forest Types
- Lodgepole Pine Scree
- Lodgepole Pine/Common Juniper
- Lodgepole Pine/Bearberry (aka kinnikinnick)
- Lodgepole Pine/Mixed Shrub
- Lodgepole Pine/Twinflower
- Recently burned Lodgepole Pine

Ponderosa Pine Forest Types
- Ponderosa Pine/Grass
- Ponderosa Pine/Creeping Juniper
- Ponderosa Pine/Western Snowberry
- Ponderosa Pine/Common Juiper
- Ponderosa Pine/Bearberry (aka kinnikinnick)
- Ponderosa Pine/Oregon Grape

Douglas-Fir Forest Types
- Douglas-fir/Western Snowberry
- Douglas-fir/Bearberry (aka kinnikinnick)
- Douglas-fir/Twinflower
- Douglas-fir/Oregon Grape

Deciduous Tree Woodland
- Quaking Aspen/Paper Birch

Source: Culwell et al. 1990

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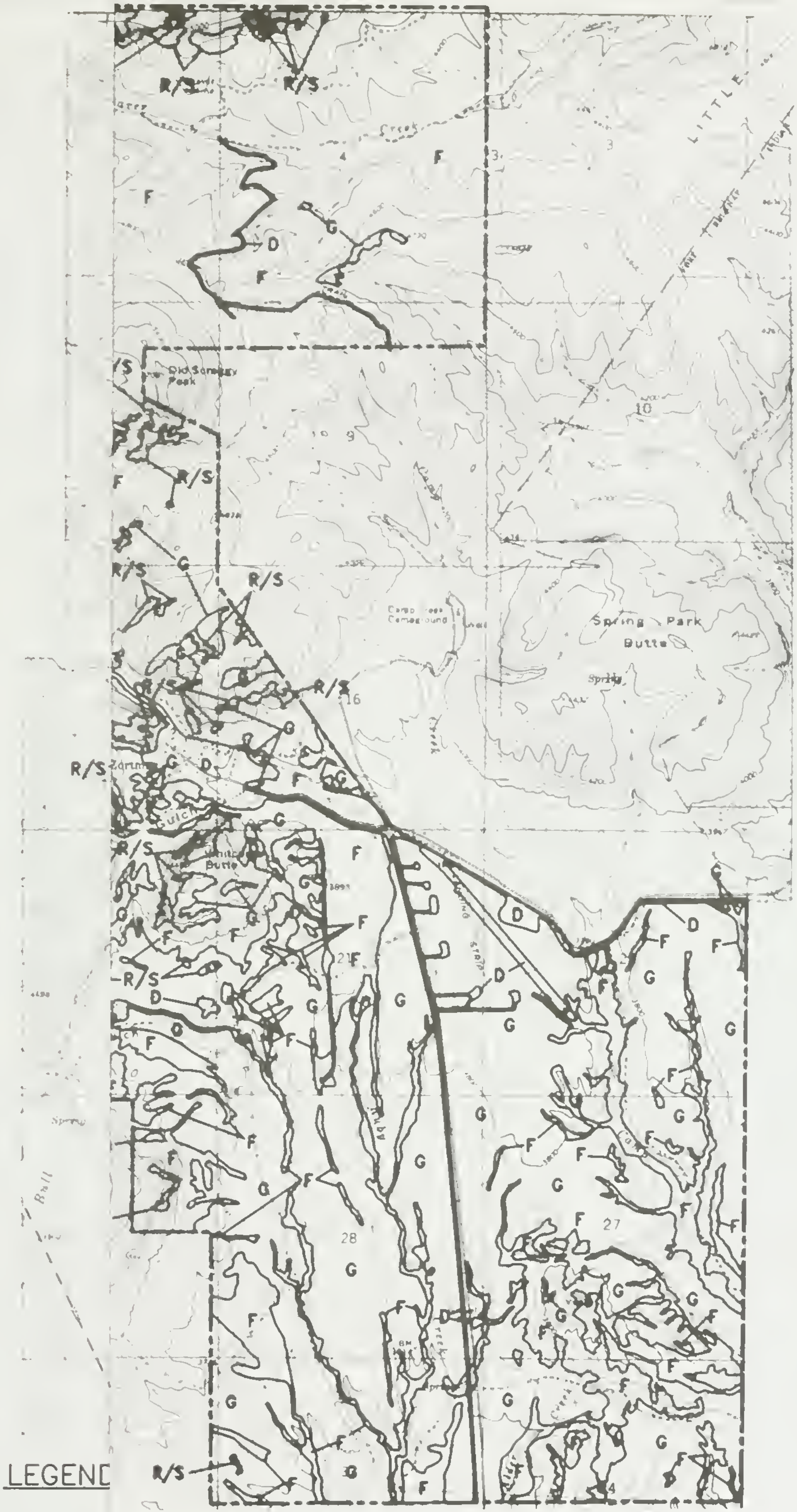


LEGEND

ADRANGLE MAPS
MONTANA.

GENERAL VEGETATION PATTERNS

ZORTMAN/LANDUSKY MINES EIS

FIG. 3.4–1

pine forest types. Broad moist draws contain substantial stands of quaking aspen/paper birch. Low elevation, north-facing slopes contain stands of Douglas-fir. Lodgepole pine types dominate the majority of the area. Most stands are dense as a result of past wild fires.

Vegetation in the immediate area of the Zortman mine ranges from a western snowberry shrubland community at 3,500 feet in elevation in Ruby Gulch to a lodgepole pine/screen community at 5,700 feet on Shell Butte and Scraggy Peak. Community types found at the Goslin Flats area consist primarily of foothills mixed prairie grasslands and Columbia hawthorn shrublands intermixed with smaller plots of big sagebrush and silver sagebrush communities. Alder Gulch consists of several community types. At the mouth of the Alder Gulch drainage, quaking aspen/paper birch and Douglas-fir/twinflower communities dominate the surroundings. Ponderosa pine communities are found on south-facing sidehill slopes and draws radiating from the drainage floor. Recently burned lodgepole pine and lodgepole pine/screen communities are found in the upper elevations at the head of Alder Gulch.

Vegetation in the immediate area of the Landusky mine consists mainly of forested community types. Ponderosa pine/bearberry (also known as kinnikinnick) and ponderosa pine/Oregon grape community types are common on the south side of Landusky mine, intermixed with montane grasslands. Douglas-fir/twinberry and quaking aspen/paper birch community types are found in the drainages. On the north side of the mine, lodgepole pine community types are more common, including lodgepole pine/mixed-shrub and lodgepole pine/twinflower.

A substantial area in the Little Rocky Mountains was burned by a forest fire in 1936. Smaller fires burned additional areas in 1984 and 1988. Lodgepole pine, a pioneer species, was quick to invade burned sites. Douglas-fir and ponderosa pine are invading many of the lodgepole stands and, without further disturbance, most of the area would likely support climax stands of Douglas-fir and ponderosa pine. Fire would likely continue to be a major ecological factor shaping this environment, resulting in early to mid-seral community types as the dominants. ("Seral" refers to the series of stages that follow one another in ecological succession.)

Historic and current mining-related disturbances occur in the Little Rocky Mountains. Approximately 401 acres have been disturbed by the existing Zortman operations, and approximately 814 acres by the Landusky operations. Past and ongoing reclamation efforts have included both interim and final reclamation measures. Interim revegetation (i.e., the stabilization of an area vegetatively prior to final reclamation) has been performed to meet short-term objectives to control erosion, sedimentation, and noxious weeds on stockpiles and cut-and-fill slopes. Final reclamation is performed at the completion of operations or concurrently with operations.

3.4.2 Forestry

Approximately 15,000 productive forested acres of BLM land exist in the Little Rocky Mountains, in addition to 29,360 acres of public and private merchantable timber on tribal lands (Spencer 1994), and an indeterminate number of acres of private productive forested land. Past and present demand for forest products from the Little Rocky Mountains has been locally significant. Forest products include house logs, corral poles, fence posts, Christmas trees, fuelwood, and limited sawtimber. Native American uses for timber resources include tipi poles (lodgepole pine), Sundance lodges (cottonwood), as well as ceremonial and medicinal uses (see "Spiritual and Physical Characteristics of the Little Rocky Mountains" in Section 3.12.4.3).

The commercial timber species from the area are lodgepole pine, ponderosa pine, and Douglas-fir. Based on information collected during the 1978, 1983, and 1985 inventories, most lodgepole pine were found to be even-aged stands ranging from 40 to 55 years old, 3 to 10 inches in diameter and 20 to 40 feet high. Yield capability for lodgepole pine, as determined by Roberts and Sibbernsen (1978), ranged from 20 - 41 ft^3/acre/year. The ponderosa pine stands were generally found to be older than the lodgepole pine stands, ranging from 120 to 150 years old with a few recorded over 200 years old. Other ponderosa pine stands are less than 80 years old. Diameters and heights of ponderosa pine were quite variable, reflecting an uneven-aged stand structure. Yield capability for ponderosa pine and Douglas-fir ranged from 19 to 68 ft^3/acre/year and 22 to 52 ft^3/acre/year, respectively (Roberts and Sibbernsen 1978).

The volume of lodgepole pine and ponderosa pine in the Little Rocky Mountains is estimated to be approximately 2.9 thousand board feet (MBF) per acre. This estimate, however, is based on a small sample area from a recent timber sale, and actual volumes will vary from stand to stand. Many areas may contain volumes much higher or much lower (Reid 1994). There are no recent volume estimates for other wood products such as posts, poles and firewood.

A forest analysis is provided in the vegetation resources report (Culwell et al. 1990), which includes data on tree density, diameter, height, age, site index, and yield capability by community type, and information on fire history.

3.4.3 Riparian Areas and Wetlands

3.4.3.1 Riparian Vegetation

Numerous streams and ephemeral creeks occur throughout the project area in moist drainage bottoms and several springs are present in the alluvium. These riparian areas do not qualify as wetlands based on the criteria in Section 3.4.3.2. Generally, these "non-wetland" areas lack the hydric soil component necessary to qualify as a jurisdictional wetland (Culwell et al. 1992).

A formal riparian study detailing vegetation species found along streams and other water bodies has not been conducted for the project area. However, a review of the vegetation maps accompanying the 1990 vegetation resource survey (Culwell et al. 1992) show the following community types are most commonly found in riparian areas:

- Quaking Aspen/Paper Birch
- Western Snowberry Drainage Bottom
- Columbia Hawthorne Thicket
- Chokecherry Sidehill/Bottom
- Mesic Grassland

3.4.3.2 Jurisdictional Wetlands

The value of wetlands and the need for their protection has recently risen to the forefront in vegetation management. Wetlands play a major role in water quantity and quality, serving as buffers for floods and as natural filters for sediments and pollutants. Wetlands are highly productive natural biological systems that provide abundant and diverse habitat for plants and animals. Recent legislation for wetlands has focused on minimizing or mitigating human impacts on these areas.

Wetlands within the project study area were inventoried in 1991 and 1992 (Culwell et al. 1992). Investigations to evaluate wetland criteria were performed in consideration of both the 1987 and 1989 COE wetland delineation manuals. Most of the onsite survey work was conducted using the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands (FICWD 1989) since field work predated the 1992 Energy and Water Development Appropriation Act amendment of 1992 prohibiting its use. Data and mapping were adapted to criteria set forth in the 1987 COE Manual (Environmental Laboratory 1987). The report is summarized below.

To be defined as a jurisdictional wetland a site must meet positive criteria in three areas including: (1) prevalence of hydrophytic vegetation, (2) hydric soil, and (3) wetland hydrology. Non-wetland waters of the U.S. are defined as incised drainages with defined beds and banks which do not meet all these criteria.

Hydrophytic Vegetation

Hydrophytic vegetation is plant life growing in water or on a substrate that is periodically saturated and deficient in oxygen as a result of excessive water content. Hydrophytic vegetation has the ability to grow, compete, reproduce, and persist in anaerobic soil conditions. A USFWS (Reed 1988) list of plant species that occur in wetlands, specific to Montana, was utilized for the wetlands survey.

Nebraska sedge, common spikebrush, cattail or beaked sedge dominated stands in the study area meet COE criteria for hydrophytic vegetation. These types are narrowly restricted to drainages, generally at lower elevations in the study area. In addition, one aspen stand and one small stand of Bebb willow in Camp Creek met COE criteria for hydrophytic vegetation.

Hydric Soil

Hydric soil are soil that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions, usually for one week or more during the growing season. Typically, the soil are poorly to very poorly drained. Site-specific hydric soil investigations were conducted using soil surveys, aerial photographs, USGS maps, and vegetation and hydrological data. These data were compiled and then verified in the field by digging shallow pits and noting hydric indicators.

Wetland Hydrology

An area is considered to have wetland hydrology when saturated to the surface or inundated, either permanently or periodically, during the growing season for one week or more. The wetland hydrology of a site is influenced by precipitation, stratigraphy, topography, soil permeability, and plant cover. Due to the variability of these influences, wetland hydrology can be difficult to determine. Water resource baseline data for the project area and field investigations were used to delineate areas meeting wetland hydrology criteria.

A minimum of one positive wetland indicator from each parameter (vegetation, soil, and hydrology) must be found in order to make a positive wetland determination.

3.4.3.3 Waters of the United States

Waters of the United States are regulated by the COE with program oversight by EPA and are subject to Section 404 of the Clean Water Act. "Waters of the U.S." has a broad meaning that includes, but is not limited to, lakes, streams, and rivers, including their adjacent wetlands and tributaries which are or have been used for interstate commerce; navigable waters; interstate waters; intermittent drainages; and any other waters, the degradation of which could effect interstate commerce.

Jurisdictional waters of the U.S. within the study area include vegetated wetlands, and drainages or waterways. Wetlands in the study area include palustrine and riverine habitat systems as defined by the National Wetland Inventory classification (Cowardin et al. 1979). Palustrine wetlands are the most abundant habitat type in the study area. The classification includes wet meadows, marshes and willow shrublands dominated by persistent emergents and shrubs. The most common wetland plant community identified in the study area is dominated by herbaceous species, including Nebraska sedge, Baltic rush, common spikerush, beaked sedge, common horsetail and cattail. A small shrub-dominated wetland (Bebb willow) occurs in Camp Creek. These wetland areas are generally restricted to drainage bottoms, alluvial deposits where stream currents are reduced and spring/seep areas. Refer to Table 3.4-2 for a summary of the wetland type by drainage. These wetland areas are considered subject to the jurisdiction of the COE under Section 404 of the Clean Water Act (Culwell et al. 1992). Riverine wetlands are those contained within a channel that is not dominated by vegetation. This wetland type is associated with perennial and intermittent streams in the study area. Many portions of the drainages may exhibit wetland hydrology as defined by the COE, however the wetland criteria for hydric soil and/or hydrophytic vegetation may not be present due to the steep stream gradients, incised channels, rapid runoff and coarse textured alluvial materials. These drainages are considered jurisdictional non-wetland waters of the U.S., and include all the major perennial, intermittent and ephemeral drainages and tributaries in the study area. The total linear feet or acreage of non-wetland waters of the U.S. within the study area has not been calculated.

There are approximately 21.8 acres of wetland identified in the study area. Approximately 12.8 acres are associated with the following drainages in the Zortman project area: Ruby Gulch, Alder Gulch, Goslin Gulch, Lodgepole Creek, Beaver Creek and Camp Creek. Approximately 9.0 acres of wetlands are associated with the following drainages in the Landusky project area: Rock Creek, Mill Gulch, Montana Gulch, King Creek, South Bighorn Creek, and Bull Creek. Table 3.4-2 summarizes the wetland acreage associated with each drainage. Figure 3.4-2 identifies the approximate location of the jurisdictional areas.

The wetlands and waters of the U.S. within the project area are recognized as providing several important functions and values. The assessment of the functions and values was based primarily on a modified approach of the Wetland Evaluation Technique (WET II) adapted for another mine site in Montana (EA Engineering, Science & Technology 1992). The social significance values (uniqueness, heritage and recreation) were evaluated using WET II (Adams et al. 1991). In addition, best professional judgement based on site visits and available literature were also used in this assessment. Hydrologic support (groundwater discharge), flood flow alteration, sediment stabilization, and aquatic and wildlife diversity/abundance are considered to be the most important functions of the wetlands and waters of the U.S. in the project site. Table 3.4-2 provides a summary of the existing wetland functions and values for each drainage area.

No wetlands or drainages will be disturbed by proposed activities at the Landusky Mine. The existing facilities and reclamation efforts at the Zortman Mine are effecting approximately 1.24 acres of non-wetland waters. No vegetated wetlands are currently being disturbed (Gallagher 1995). The proposed activities at the Zortman Mine associated with each alternative which may disturb waters of the U.S. are described in Section 4.4 for each of the affected drainages.

In addition, project impacts that may affect waters of the U.S. are addressed in the Preliminary Clean Water Act Section 404(b)(1) showing in accordance with the COE regulations (refer to Appendix B.) The 404(b)(1) analysis evaluates the potential adverse impacts in human use characteristics (i.e., water supplies, recreation, aesthetics) and physical, chemical and biological characteristics. Practical and appropriate steps to minimize potential impacts are also evaluated.

TABLE 3.4-2

SUMMARY OF EXISTING WETLAND FUNCTIONS AND VALUES* FOR ZORTMAN/LANDUSKY PROJECT AREA

Drainage	Dominant (D)/ subdominant (S) Wetland System Acres (# of sites)***	Overall Rating*** Effectiveness/ Opportunity	Functions and Values Provided at moderate (M) to high (H) level for Effectiveness or Opportunity; Impaired F/V indicated by I	Rationale
ZORTMAN				
Ruby Gulch below Zortman	Palustrine (D) 0.64 ac (2)	Very Low	Hydrologic Support (H)	Extent of wetlands is negligible; upstream channel system has been altered; Springs/seeps create one perennial wetland (in side trib); stockwaters a beneficial use
Ruby Gulch above Zortman	Palustrine (D) Riverine (S) 0.44ac (2)	Low	Hydrologic Support (H)	Wetlands occur only in side tributaries to Ruby
			Floodflow Alteration (M)	Extent of wetlands is small but occur in 100 year floodplain; dominated by forest/shrub cover; high gradient system
			Aquatic Diversity/Abundance (M)	No fishery but macroinvertebrate community intact in side tributaries
Alder Gulch below Zortman	--	--	none	No wetlands delineated; system has been altered
Alder Gulch above Zortman	Palustrine (D) Riverine (S) 0.26 ac (2)	Low	Floodflow Alteration (M)	Two small wetlands with large receiving area; man-made dam/old pond provides some flow reduction
			Sediment Stabilization (M)	Receives periodic sediment flushes from naturally eroding slopes in headwaters
			Water Purification (M)	Receives ARD from Hawkeye; assume some attenuation
			Wildlife Diversity/Abundance (M)	Provides habitat diversity and interspersion
Goslin Gulch	Palustrine (D) 1.8 ac (7)	Moderate (low end)	Hydrologic Support (H)	Springs/seeps create perennial wetlands; stockwatering is a beneficial use.
			Floodflow Alteration (M)	Extent of wetlands is small and channel connections discontinuous but stockponds create constricted outlets
			Sediment Stabilization (M)	Vegetative cover is intact with exceptions of overgrazed/trampled areas around ponds
			Water Purification (M)	Ponds receive and filter some sediment and nutrient enrichment but wetland community potential is not achieved
			Wildlife Diversity/Abundance (M)	Two sites provide limited waterfowl breeding/migration requirements but habitat diversity/interspersion is limited for other wildlife/waterfowl.
			TES Species Habitat (M)	Open water provides probable source for Azure Cave bats

Sheet 1 of 5

TABLE 3.4-2

SUMMARY OF EXISTING WETLAND FUNCTIONS AND VALUES* FOR ZORTMAN/LANDUSKY PROJECT AREA

Drainage	Dominant (D)/ subdominant (S) Wetland System Acres (# of sites)***	Overall Rating*** Effectiveness/ Opportunity	Functions and Values Provided at moderate (M) to high (H) level for Effectiveness or Opportunity; Impaired F/V indicated by I	Rationale
Lodgepole Creek	Palustrine (D) Riverine (S) 1.0 ac (1)	Moderate (high end)	Hydrologic Support (H)	Springs/seeps create perennial wetlands
			Floodflow Alteration (M)	Wetland area within the 100-year floodplain; forested/shrub wetland communities comprise >30% of wetland area
			Wildlife Diversity/Abundance (M)	Habitat diversity is moderately high
			Aquatic Diversity/Abundance (H)	Habitat dispersion and plant richness is high; good fish cover; intact macroinvertebrate community; brook trout present
			Uniqueness/Heritage (M)	Intact wetland/stream system with few perturbations
			Water Purification (M)	Wetlands are extensive in comparison to other drainages; often have organic soil and emergent communities to buffer/attenuate inputs; pollutant input low (primarily sediments)
Beaver Creek	Palustrine (D) Riverine (S) 1.1 ac (3)	High	Hydrologic Support (H)	Springs/seeps create perennial wetlands
			Floodflow Alteration (H)	Wetlands area within the 100-year floodplain; forested/shrub wetland communities comprise >30% of wetland area; series of active beaver ponds create outlet constriction
			Sediment Stabilization (M)	Wetlands can buffer erosive forces and sediment inputs
			Wildlife Diversity/Abundance (M)	Habitat diversity is moderately high
			Aquatic Diversity/Abundance (H)	Habitat dispersion and plant richness is high; good fish cover; intact macroinvertebrate community; brook trout present
			Uniqueness/Heritage (M)	Intact wetland/stream system with few perturbations
Camp Creek	Palustrine (D) 7.5 ac (5)	Moderate	Hydrologic Support (H)	Springs/seeps create perennial wetlands
			Floodflow Alteration (M)	Wetlands area within the 100-year floodplain; wetland areas wide
			Sediment Stabilization (M)	Wetlands can buffer erosive forces and sediment inputs; receives some sediment
			Wildlife Diversity/Abundance (M)	Habitat diversity is moderate

TABLE 3.4-2

SUMMARY OF EXISTING WETLAND FUNCTIONS AND VALUES* FOR ZORTMAN/LANDUSKY PROJECT AREA

Drainage	Dominant (D)/ subdominant (S) Wetland System Acres (# of sites)***	Overall Rating*** Effectiveness/ Opportunity	Functions and Values Provided at moderate (M) to high (H) level for Effectiveness or Opportunity; Impaired F/V indicated by I	Rationale
LANDUSKY				
Rock Creek/ Sullivan Gulch	Palustrine (D)	Low	Hydrologic Support (H)	Springs/seeps create perennial wetlands
	Riverine (S)		Floodflow Alteration (M)	Wetlands area within the 100-year floodplain; wetland areas wide
	0.24 ac (4)		Sediment Stabilization (M)	Wetlands can buffer erosive forces and sediment inputs; receives some sediment
			Wildlife Diversity/Abundance (M)	Habitat diversity is moderate
			Aquatic Diversity/Abundance, (I)	Aquatic habitat impaired upper end by ARD and nitrates/Sullivan Park leach pad
Mill Gulch	Palustrine (D) Riverine (S) 0.1 ac (2)	Very Low	Aquatic Diversity/Abundance, (I)	Aquatic habitat impaired by ARD and cyanide/'87 leach pad or process ponds
Rock Creek below Montana Gulch	Palustrine (D) Riverine (S) 2.8 ac (1)	Low	Sediment Stabilization (M)	Wetlands can buffer erosive forces and sediment inputs; receives some sediment
			Water Purification (M)	Wetlands have some organic soils and emergent communities to buffer/attenuate inputs; pollutant input from sediments low but ARD from Montana Gulch waste rock dump
			Aquatic Diversity/Abundance, (I)	Fishery and aquatic habitat impaired by ARD and cyanide/'85, '86 leach pad
Montana Gulch	Palustrine (D)	Moderate (low end)	Hydrologic Support (H)	Springs/seeps create perennial wetlands
	Riverine (S)		Floodflow Alteration (M)	Wetlands area within the 100-year floodplain; wetland areas wide
	0.89 ac (6)		Sediment Stabilization (M)	Wetlands can buffer erosive forces and sediment inputs; receives some sediment
			Wildlife Diversity/Abundance (M)	Habitat diversity is moderate; somewhat reduced by development

TABLE 3.4-2

SUMMARY OF EXISTING WETLAND FUNCTIONS AND VALUES* FOR ZORTMAN/LANDUSKY PROJECT AREA

Drainage	Dominant (D)/ subdominant (S) Wetland System Acres (# of sites)***	Overall Rating*** Effectiveness/ Opportunity	Functions and Values Provided at moderate (M) to high (H) level for Effectiveness or Opportunity; Impaired F/V indicated by 1	Rationale
King Creek	Palustrine (D)	Moderate (high end)	Hydrologic Support (H)	Springs/seeps create perennial wetlands
	Riverine (S)		Floodflow Alteration (M)	Wetlands area within the 100-year floodplain; wetland areas wide
	1.2 ac (5)		Sediment Stabilization (H)	Wetlands can buffer erosive forces and sediment inputs; receives sediment; active beaver
			Wildlife Diversity/Abundance (H)	Habitat diversity is moderate; somewhat reduced by development
			Uniqueness/Heritage/Recreation (H)	Used for recreational and traditional cultural practices
S. Bighorn/ Swift Gulch	Palustrine (D)	Moderate	Hydrologic Support (H)	Springs/seeps create perennial wetlands; continuous along channel
	Riverine (S)		Floodflow Alteration (M)	Wetlands area within the 100-year floodplain; wetland areas wide
	2.1 ac (4)		Sediment Stabilization (M)	Wetlands can buffer erosive forces and sediment inputs
			Aquatic Diversity/Abundance (M)	Habitat dispersion and plant richness is high; good fish cover; intact macroinvertebrate
			Wildlife Diversity/Abundance (M)	Habitat diversity is moderate
Bull Creek	Palustrine (D)	Moderate	Hydrologic Support (H)	Springs/seeps create perennial wetlands
	Riverine (S)		Floodflow Alteration (M)	Wetlands area within the 100-year floodplain; wetland areas wide
	1.7 ac (5)		Sediment Stabilization (H)	Wetlands can buffer erosive forces and sediment inputs; receives sediment; active beaver
			Wildlife Diversity/Abundance (H)	Habitat diversity is moderate; somewhat reduced by development
			Aquatic Diversity/Abundance (M)	Habitat dispersion and plant richness is high; good fish cover; intact macroinvertebrate

TABLE 3.4-2

SUMMARY OF EXISTING WETLAND FUNCTIONS AND VALUES* FOR ZORTMAN/LANDUSKY PROJECT AREA

Drainage	Dominant (D)/ subdominant (S) Wetland System Acres (# of sites)***	Overall Rating*** Effectiveness/ Opportunity	Functions and Values Provided at moderate (M) to high (H) level for Effectiveness or Opportunity; Impaired F/V indicated by l	Rationale

<u>Notes:</u>

* Functions and values evaluated

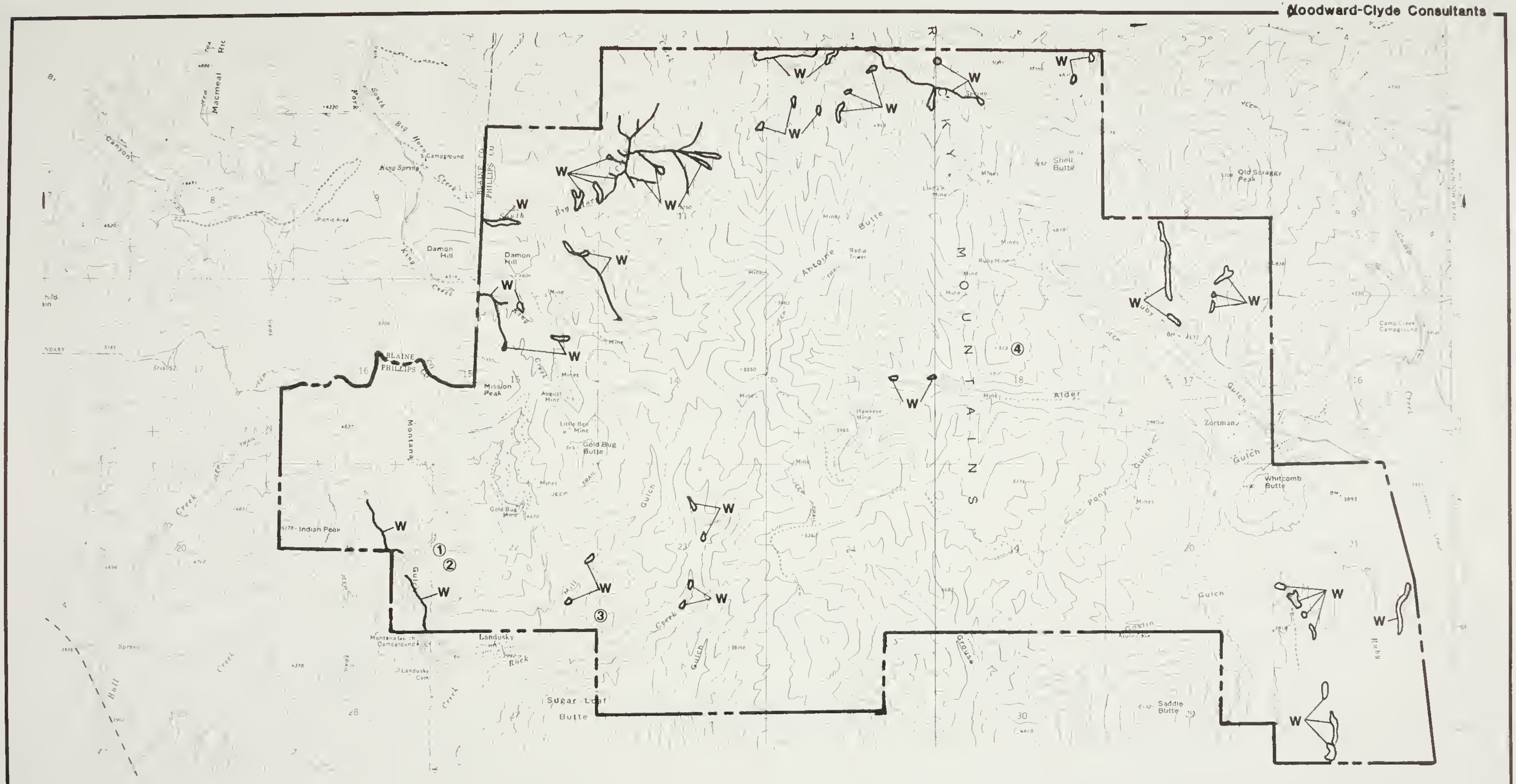
Hydrologic Support (Groundwater Discharge and/or Recharge)
Floodflow Alteration
Sediment Stabilization/Erosion Control
Water Purification (Sediment Transport/Toxicant Reduction; Nutrient Removal/Transformation)
Production Export/Food Chain Support
Aquatic Diversity/Abundance
Wildlife Diversity/Abundance (Breeding, Migration, and/or wintering)
Threatened, Endangered, or Sensitive (TES) Species Habitat
Uniqueness/Heritage/Recreation

** This summary is preliminary; further analysis is being conducted

*** Acreages were estimated unless noted on PDN Draft 1995 maps; study area boundary is the same as that used wetlands inventory

**** The overall rating addresses all the wetlands that may occur (not site specific) in the drainage; each site was evaluated using a modified Adamus (1987) probability analysis (ARCO 1992); known conditions gathered from site visits in June 1995, PDEIS, and ZMI baseline reports were used to "fine-tune" the rating; combines all functions and values rated; site detail is provided in the Wetland Functions and Values Report

Source: OEA Research, Inc., Helena, MT, July 15, 1995



SOURCE:

BASE MAP TAKEN FROM 7.5 MINUTE QUADRANGLE MAPS TITLED: HAYS, MONTANA AND ZORTMAN, MONTANA. WETLAND LOCATIONS TAKEN FROM CULWELL et al. 1992.

JURISDICTIONAL WETLANDS AND SPECIES OF SPECIAL CONCERN

ZORTMAN/LANDUSKY MINES EIS

FIG. 3.4–2

TABLE 3.4-2

SUMMARY OF EXISTING WETLAND FUNCTIONS AND VALUES* FOR ZORTMAN/LANDUSKY PROJECT AREA

Drainage	Dominant (D)/ subdominant (S) Wetland System Acres (# of sites)***	Overall Rating*** Effectiveness/ Opportunity	Functions and Values Provided at moderate (M) to high (H) level for Effectiveness or Opportunity; Impaired F/V indicated by I	Rationale

Notes:

* Functions and values evaluated
Hydrologic Support (Groundwater Discharge and/or Recharge)
Floodflow Alteration
Sediment Stabilization/Erosion Control
Water Purification (Sediment Transport/Toxicant Reduction; Nutrient Removal/Transformation)
Production Export/Food Chain Support
Aquatic Diversity/Abundance
Wildlife Diversity/Abundance (Breeding, Migration, and/or wintering)
Threatened, Endangered, or Sensitive (TES) Species Habitat
Uniqueness/Heritage/Recreation

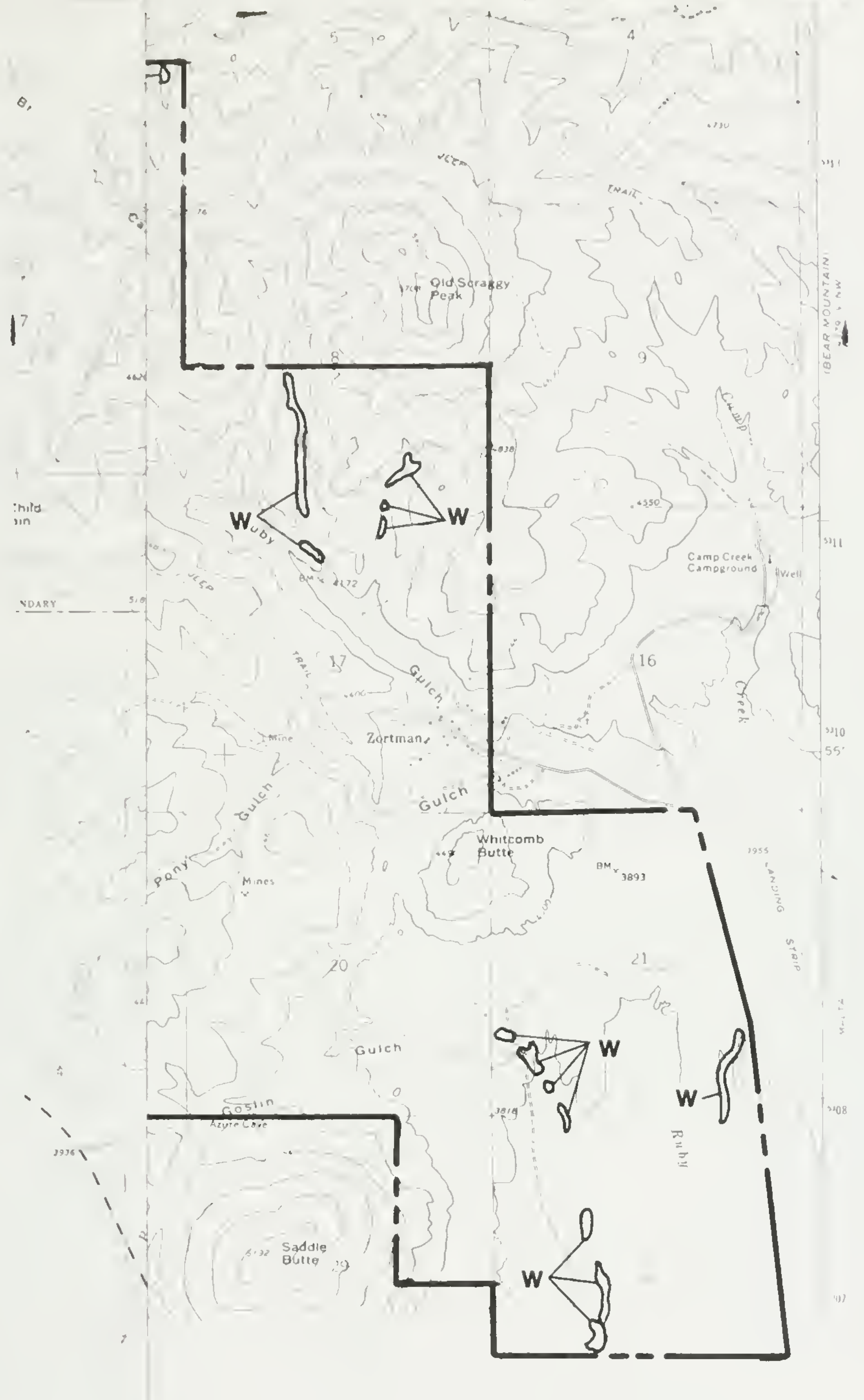
** This summary is preliminary; further analysis is being conducted

*** Acreages were estimated unless noted on PDN Draft 1995 maps; study area boundary is the same as that used wetlands inventory

**** The overall rating addresses all the wetlands that may occur (not site specific) in the drainage; each site was evaluated using a modified Adamus (1987) probability analysis (ARCO 1992); known conditions gathered from site visits in June 1995, PDEIS, and ZMI baseline reports were used to "fine-tune" the rating; combines all functions and values rated; site detail is provided in the Wetland Functions and Values Report

Source: OEA Research, Inc., Helena, MT, July 15, 1995

Woodward-Clyde Consultants



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W TLED: HAYS, MONTANA AND ZORTMAN, MONTANA.

ETLAND LOCATIONS TAKEN FROM CULWELL et al. 1992.

JURISDICTIONAL WETLANDS AND SPECIES OF SPECIAL CONCERN

ZORTMAN/LANDUSKY MINES EIS

FIG. 3.4–2

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TABLE 3.4-2

3.4.4 Noxious Weeds

Noxious weeds are an important local concern due to their impacts on agriculture production and native plant communities. Phillips County has an active weed control program to prevent the spread of and to eradicate all noxious weeds.

The Montana Noxious Weed Control Act identifies ten Category 1, two Category 2, and three Category 3 noxious weed species (see Table 3.4-3). Category 1 noxious weeds are weeds that are currently established and widespread in many counties of the state. These weeds are capable of rapid spread and render land unfit or greatly limit beneficial uses.

Currently, six of the ten Category 1 weeds are listed on the noxious weed list for Phillips County (Williams 1995). They are:

1. Canada thistle (*Cirsium arvense)*
2. Leafy spurge (*Euphorbia esula)*
3. Russian knapweed (*Centaurea repens)*
4. Whitetop (*Cardaria draba)*
5. Field bindweed (*Convolvulus arvensis)*
6. Spotted knapweed (*Centaurea maculosa)*

All of these weeds could potentially occur within the project area; however, Canada thistle and spotted knapweed are the only species observed during vegetation surveys conducted in the project vicinity. Trace values were recorded for Canada thistle and spotted knapweed was observed along roadsides and upland sites in the vicinity of the mine (name of the mine not specified) (Culwell et al. 1990).

Other weed species, though not officially designated as noxious, are of local concern. These "weedy" species are houndstongue (*Cynoglossum officinale*), leafy spurge (*Euphorbia esula*), Russian knapweed (*Centaurea repens*), Japanese brome (*Bromus japonicus*), burdock (*Arctium sp.*), musk thistle (*Carduus nutans*), whitetop, cheatgrass brome (*Bromus tectorum*), and dalmation toadflax (*Linaria dalmatica*). Disturbed sites throughout the area can provide suitable habitat for the invasion of noxious weeds. Noxious weed invasion is inevitable and cannot be entirely prevented.

To prevent the spread of noxious weeds, ZMI developed a weed control plan that has been reviewed by the Phillips County Weed Management Program which outlines specific procedures for control of noxious weeds on mine property. ZMI would control noxious weeds by mechanical methods or chemical application by licensed personnel. ZMI would control and monitor noxious weed populations throughout the life of the mine and post-closure until the reclamation bond is released.

3.4.5 Species of Special Concern

Species of special concern include those species listed as endangered or threatened by the USFWS, those under review (Category 1 and 2) for endangered or threatened status, those species of special interest or concern as listed by the MDFWP, those species considered critically imperiled or imperiled by the MNHP, and any species receiving substantial public comment during the scoping period.

3.4.5.1 Threatened, Endangered, or Sensitive Species and Communities

No plants listed as threatened or endangered under the Endangered Species Act or as of special interest or concern by the MDFWP are known to occur within the project area (BLM 1992b, USFWS 1993, MDFWP 1993). Additionally, the MNHP lists no rare plant communities in the project area (Cooper 1995).

Groundsel (*Senecio eremophilus*) is the only plant species listed as a species of special concern by the MNHP that may potentially occur in the project area. This plant was collected during the 1978 inventory on a rocky, historic mining road near the saddle at the head of Ruby Gulch. Additional specimens have not been noted during subsequent vegetation inventories (Culwell et al. 1990).

The MNHP status of *Senecio eremophilus* is "G4S1," which is defined as follows:

G4	Apparently secure globally, though it might be quite rare in parts of its range, especially at its periphery.
S1	Critically imperiled in Montana because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extirpation from the state.

The MNHP identified four occurrences of the ponderosa pine/bearberry (aka kinnikinnick) (*Pinus ponderosa/Actostaphylos uva-ursi)* plant association in the Zortman/Landusky area (see Figure 3.4-2). The status of this association is "G5S3," which is defined as

TABLE 3.4-3

MONTANA NOXIOUS WEED LIST

Category 1

Category 1 noxious weeds are weeds that are currently established and generally widespread in many counties of the state. These weeds are capable of rapid spread and render land unfit or greatly limit beneficial uses.

	Common Name	Scientific Name
1	Canada Thistle	*Cirsium arvense*
2	Field Bindweed	*Convolvulus arvensis*
3	Whitetop or Hoary Cress	*Cardaria draba*
4	Leafy Spurge	*Euphorbia esula*
5	Russian Knapweed	*Centaurea repens*
6	Spotted Knapweed	*Centaurea maculosa*
7	Diffuse Knapweed	*Centaurea diffusa*
8	Dalmatian Toadflax	*Linaria dalmatica*
9	St. Johnswort	*Hypemicum perforatum*
10	Sulfur (erect) cinquefoil	*Potentilla recta*

Category 2

Category 2 noxious weeds have recently been introduced into the state or are rapidly spreading from their current infestation sites. These weeds are capable of rapid spread and invasion of lands, rendering lands unfit for beneficial uses.

	Common Name	Scientific Name
1	Dyers Woad	*Isatis tinctoria*
2	Purple Loosestrife or Lythrum	*Lythrum salicaria, L. virgatum,* and any hybrid crosses thereof

Category 3

Category 3 noxious weeds have not been detected in the state or may be found only in small, scattered, localized infestations. These weeds are known pests in nearby states and are capable of rapid spread and render land unfit for beneficial uses.

	Common Name	Scientific Name
1	Yellow Starthistle	*Centaurea solstitialis*
2	Common Crupina	*Crupina vulgaris*
3	Rush Skeletonweed	*Chondrilla juncea*

Source: County Noxious Weed Control Act 1991 follows:

G5 Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery.

S3 Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factors; in the range of 21 to 100 occurrences.

Previously, the MNHP had identified two rare communities on Saddle Butte, a ponderosa pine/bluebunch wheatgrass (*Pinus ponderosa/Agropyron spicatum*) association and a Douglas-fir/little bluestem (*Pseudotsuga menziesii/Andropogon scoparius*) association. Upon further evaluation, the MNHP determined the ponderosa pine/bluebunch wheatgrass association to be a relatively common plant community and removed it from their list. Also, the Douglas-fir/little bluestem association has been re-defined as a minor seral association and will be removed from the next MNHP State Classification list, as well as the Western Region Classification list (Cooper 1995).

3.4.5.2 Ethnobotany

The Little Rocky Mountains have historically been and continue to be a source of plant materials for ethnobotanical uses. The term ethnobotany refers to the study of the uses of plants by different races of man. Numerous public comments were received concerning plants that occur near the project area and may be used by Native Americans for religious, medicinal, food, and shelter purposes. Deaver and Kooistra (1992) identified 29 species that are used in local traditional culture. Culwell et al. (1990) lists 200 species which are documented for ethnobotanical use.

Of the 29 plant species identified by Deaver and Kooistra (1992) as being utilized by the Native Americans at Fort Belknap, 23 species were documented by Lutwel (1990) as being present within the study area (see Table 3.12-2). Many of the plants, such as snowberry, chokecherry, juniper, bearberry, Oregon grape, wild rose, sage, and all of the tree species, are abundant throughout the study area. Approximately 50 percent of the species identified by Deaver and Kooistra (1992) were reported to occur in the project area; however, relative abundance was not recorded. Documentation is not available regarding the location of any preferred sites for the collection of plant material used by the Native Americans. Six of the plants identified in Deaver and Kooistra (1992) were not reported to occur in the study area. In particular, sweetgrass, used for ceremonies, medicine, and tea, has never been reported in the study area.

Section 3.12.4 and Table 3-12.2 Cultural Resources, present additional discussion on the use and significance of local plants by Native Americans.

3.4.6 Metals Levels in Plant Tissues

Land application of waste water is the most likely scenario at the Zortman and Landusky mines where plants could uptake metals from soil or absorb metals through deposition on the foliage. Although no specific criteria are established for the land application of mining process solutions, the EPA has developed standards for the application of municipal wastewater and sewage sludge. The criteria established are conservative and are intended to protect croplands against the accumulation of trace elements in soil and crops, and thus protect human health. Standards exist specifically for cadmium (Cd), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn), as these metals have been determined to pose the greatest environmental threat (Schafer and Associates 1993b).

Total metal accumulation by plants from soil or nutrient solutions depends on many factors including: (1) the nature of plants, such as species, growth rate, root size and depth, transpiration rate, and nutritional requirements; (2) soil factors such as pH, organic matter content and nature, nutrient status, and amount of metal ions and certain anions like phosphate, sulfate, and sulfides, and clay content and type; (3) environmental and management variables such as temperature, moisture, sunlight, and amendments and fertilization; and (4) the modes of metal toxicity and plant tolerance (Overcash and Pal 1979).

Pendias and Pendias (1992) also state that the fate of metals in soil and the potential uptake of the metals by plants is dependent on a number of environmental factors and the physical and chemical characteristics of the soil and the individual plant species. Numerous studies have shown a general relationship between concentrations of metals in soil and concentrations of metals in plants, and several researchers have developed proposals for maximum acceptable concentrations of trace elements in agricultural soil; however, there is not enough data to set up definite values for criteria needed to protect soil against the long-term effects of trace element pollution. Mullen (1994) and Lipton et al. (1993) in studies conducted on Superfund Mining Sites also show a strong relationship between metals in soil and metal concentrations in plants, noting that most contamination is found in the top two inches of soil.

In September 1986, an above normal level of precipitation resulted in approximately 30 million gallons of excess solution inventory. The mine facility lacked the storage capacity necessary to accommodate further precipitation, and the regulatory agencies and ZMI determined treatment of the solution and an emergency land application was the best option. Approximately 20 million gallons of leachate was treated and disposed of over 17 acres. Haight et al. (1990) presented a paper on the environmental effects of the land application in which sampling of the application area soil and downgradient water quality showed impacts below those anticipated. Soil samples showed that metals in solution and residual cyanide were attenuated by the duff layer and uppermost soil horizons. The most noticeable affects to vegetation was some surficial "burning" of pine trees in the land application area due to excess chlorine in solution left from cyanide neutralization. (Note: chlorine is no longer being used in the neutralization process.) Understory vegetation showed little damage due to land application. After four years of monitoring, no negative affects to vegetation are attributed to the increased metal concentrations in the soil. All post-application metal levels are below levels considered toxic to plants and levels are expected to decrease over time.

In a report on "Selection and Evaluation of a Land Application Area for the Zortman Mine, Zortman, Montana" (Schafer and Associates 1993a), it was determined that it is unlikely that metals would concentrate in levels that pose a threat to vegetation, human health, or any state waters. These conclusions were based on the soil characteristics of the proposed land application area and the EPA standards for the land application of municipal wastewater. In this study, 4.5 million gallons of solution was discharged onto 25 acres of land at a rate of 75 gallons per minute, 8 to 12 hours a day from July to September. The study concluded that soil exhibit considerable variability in their adsorption tendencies and, although metal concentrations were typically low, no one soil offers the potential to attenuate all metals. The study went on to show that using normal irrigation practice criteria, the treated solution could be applied to soil without compromising metal adsorption capacity of the soil for 9-20 years. Considering the short duration of land application and the very low loading rates, it appears unlikely that soil or vegetation will be impacted by the proposed land application in Goslin Flats.

Generally, effects of metal accumulations in plants are stunted growth of roots and tops, browning of leaves, interveinal chlorosis, wilting of the leaves, and red or brown spots on the leaves. However, each case of plant phytotoxicity is different, and, in fact, many plants may show no visible signs of injury. Therefore, it would be prudent to monitor soil in the land application area to ensure no impacts to soil and vegetation.

3.5 WILDLIFE AND AQUATICS

3.5.1 Wildlife

Numerous wildlife species have traditionally used the Little Rocky Mountains for all or part of their existence. Wildlife habitats in and around the Little Rocky Mountains have been greatly changed by settlement, irrigation, cultivation, and mineral extraction. Nineteen species of mammals have been documented in the Little Rocky Mountains, including mule and white-tailed deer, bighorn sheep, coyote, badger and numerous small mammals (DSL 1979a). Some animals (white-tailed deer, raccoon, fox) have likely become more numerous with recent changes in wildlife habitats.

A diversity of wildlife habitats occur in the Little Rocky Mountains and adjacent prairies. High elevation peaks have scree slopes and wind-blown ridges, providing feeding and wintering areas for marmots and bighorn sheep. Deeply eroded steep canyons offer cliffs for raptor nesting and escape cover for bighorn sheep and mule deer. Numerous caves provide habitat for bats and woodrats. Lodgepole pine stands provide nesting requirements for numerous birds such as American robin, black-capped chickadee, downy woodpecker, yellow-rumped warbler, and ruby-crowned kinglet; and provide escape cover for deer and elk (WESTECH 1991). Large forest fires have created a mosaic of dense forest interspersed with open meadows, providing preferred feeding areas for big game and woodpeckers. Low elevation, south-facing slopes support a diversity of shrub species, providing browse and snow-free areas for wintering wildlife. Lower elevation riparian zones support aspen and willow communities, providing habitat requirements for turkeys, passerine birds and small mammals. Adjoining shortgrass prairies provide habitat for pronghorn antelope and foraging areas for raptors.

Numerous wildlife studies have been conducted within the Zortman mining area, including a general reconnaissance of the area (Farmer 1977) and a series of baseline and supplemental studies (Scow 1978, 1979, 1983; WESTECH 1985, 1986, 1989). An environmental analysis of the impacts of the proposed Zortman mine was conducted in 1978 (WESTECH 1978). A supplemental study conducted in 1990 summarized the above reports into one document (WESTECH 1991). Reports on the wildlife found in Azure Cave have been prepared by Chester et al. (1979), and Butts (1993). The BLM has summarized region-wide wildlife data in the Judith Valley Phillips Resource Management Plan EIS (BLM 1992b).

The responsibility for managing Montana wildlife rests with the MDFWP; local MDFWP staff were consulted to verify and supplement available data. Wildlife habitat within the project area is managed by the BLM. Wildlife residing within the borders of the Fort Belknap Indian Reservation are managed by a wildlife biologist recently hired by the tribal government. The USFWS is mandated to provide assistance to the tribe concerning reservation wildlife management plans and strategies. Wildlife protected under the Endangered Species Act (ESA) and Migratory Bird Treaty Act are managed by land management agencies (specifically the BLM within the Little Rocky Mountains) in consultation with the USFWS.

3.5.1.1 Special Status Species

Special status species include species listed as threatened and endangered (T/E) by the USFWS, those under review (Category 1 and 2) for endangered and threatened status, and species of special interest or concern listed by MDFWP (Flath 1993). A listing of federal threatened and endangered species which could occur in the project area was provided by the USFWS (1994).

A review of available data revealed 18 wildlife species of special concern which may potentially occur in the project area (Table 3.5-1). Four of these species (bald eagle, peregrine falcon, piping plover, and black-footed ferret) are listed as endangered. Ten other species (ferruginous hawk, mountain plover, northern goshawk, burrowing owl, loggerhead shrike, Baird's sparrow, Townsend's big-eared bat, northern long-eared myotis, fringed myotis, long-legged myotis, and western small footed myotis) are considered candidate species which may be suitable for listing, but sufficient data are lacking on a national level to do so at this time. Additional species of special concern, listed by MDFWP, include black-tailed prairie dog, sharp-tailed grouse, and long-billed curlew.

Threatened and Endangered Species

An endangered species is one that faces extinction throughout all or a significant portion of its range. Threatened species are those likely to become endangered in the future.

Four species of wildlife that are federally classified as endangered do potentially occur in South Phillips County; however, no endangered species occur within the proposed mine area. No species listed as threatened

TABLE 3.5-1

WILDLIFE SPECIES OF CONCERN POTENTIALLY OCCURRING ON OR NEAR THE PROJECT SITE

Common Name	Scientific Name	Federal Status*	State Status*
Peregrine Falcon	*Falco peregrinus*	E	E
Bald Eagle	*Haliaeetus leucocephalus*	E	S
Piping Plover	*Charadrius melodus*	E	S
Black-footed Ferret	*Mustela nigripes*	E	S
Ferruginous Hawk	*Buteo regalis*	C2	S
Mountain Plover	*Charadrius montanus*	C2	S
Long-billed Curlew	*Numenius Americanus*	--	S
Black-tailed Prairie Dog	*Cynomys ludovicianus*	--	S
Northern Goshawk	*Accipiter gentilis*	C-2	S
Sharp-tailed Grouse	*Tympanuchus phasianellus*	--	UB
Burrowing Owl	*Athene cunicularia*	C-2	S
Loggerhead Shrike	*Lanius ludovicianus*	C-2	S
Baird's Sparrow	*Ammodramus bairdii*	C-2	--
Townsend's Big-eared Bat	*Plecotus townsendii*	C-2	S
Northern Long-eared Myotis	*Myotis evotis*	C-2	S
Fringed Myotis	*Myotis thysanades*	C-2	S
Long-legged Myotis	*Myotis volans*	C-2	--
Western Small Footed Myotis	*Myotis ciliolabrum*	C-2	--

*Definitions:

E = Federally listed as endangered
S = State listed as Species of Special Interest or Concern
UB = Upland Game Bird
SH = Historically known; may be rediscovered
C2 = Federally listed as Category 2 - current information indicates that species might qualify for protection under the Endangered Species Act, but further biological information is needed.

Sources: USFWS 1992, 1993
MDFWP 1992

potentially occur in the project area. Brief descriptions of endangered species and their habitat are provided below.

Bald Eagle - The bald eagle is a federally listed endangered species. Montana state law does not list the bald eagle as either endangered or threatened, but as a "Species of Special Interest or Concern" (Flath 1984); however, federal law supersedes state law. Bald eagles are very rare in the Little Rocky Mountains and have not been observed on the project site. Bald eagles have been recorded in the Little Rocky Mountains on one occasion during Audubon Society Christmas Bird counts (American Birds 1982). However, bald eagles are winter residents within Phillips County, particularly along the Missouri and Milk Rivers, concentrating in areas of open water where fish and waterfowl are available as food sources (BLM 1992b).

There are no known bald eagle nests or essential habitat in the Little Rocky Mountains, and open water bodies that could provide nesting or foraging habitat do not exist (WESTECH 1991). The Phillips Resource Area is used during spring and fall migration, with peak use occurring in March, April, and November. Bald eagles appear to migrate through Phillips County somewhat concurrent with the waterfowl spring and fall migrations (BLM 1992b).

Peregrine Falcon - The peregrine falcon is a federally and state listed endangered species. Peregrine falcons generally nest on high steep cliffs that provide commanding views, in open country or mountain parkland. They usually occupy the same territory and often the same ledge or eyrie from year to year (Ratcliffe 1980). Peregrine falcons have been sighted during migration seasons in southern Phillips County (BLM 1985). DeLap (1962) reported breeding peregrine falcons in the Little Rocky Mountains in 1961, but did not report the location of the nest.

Potentially suitable habitat exists in the Little Rocky Mountains. Two separate studies conducted during the late 1970s thoroughly searched the non-reservation portion of the mountains during the nesting season, and no peregrines were observed (Farmer 1977, Scow 1978). Seven peregrine falcon sightings were recorded during spring of 1986 within the Phillips Resource Area (BLM 1986). An area of the Little Rocky Mountains containing potential cliff nesting sites for peregrines was searched in July 1985 and April 1986. Prairie falcons were actively defending territories at this site, prohibiting the establishment of a peregrine falcon nesting territory (BLM 1985, 1986). Currently, a peregrine falcon working group is investigating sites within the Phillips Resource Area, including the Little Rocky Mountains, for potential reintroduction of peregrine falcons. Additionally, potential nesting sites within 1/2 mile of the proposed mine development were searched in 1990 and no evidence of peregrine falcons was found (WESTECH 1991).

Black-footed Ferret - The black-footed ferret is federally listed as an endangered species and listed by the State of Montana as a Species of Special Interest or Concern. Black-footed ferrets depend on prairie dog colonies as a source of food and shelter (BLM 1984). Changes in land-use practices and poisoning programs over the last century have substantially reduced prairie dog distribution in the western United States. As a result, all active prairie dog towns (or a complex of towns) large enough to support ferrets are considered potential black-footed ferret habitat. Current USFWS criteria for defining potential black-footed ferret habitat specifies that any black-tailed prairie dog town or complex larger than 80 acres, and any white-tailed prairie dog colony or complex larger than 200 acres, should be considered (USFWS 1989).

There are historical records of black-footed ferrets in the prairie habitat within Phillips Resource Area, but none within the Little Rocky Mountains. Flath and Clark (1986) list two ferret specimens from Phillips County in 1923 and 1924. Recent unconfirmed sightings have been made in adjoining areas, and skeletal remains were found on the Fort Belknap Indian Reservation in 1983.

The historic range of the ferrets corresponds to the range of black-tailed prairie dogs. The black-footed ferret recovery plan suggests that at least one population of ferrets should be reintroduced into states that make up its historic range, which includes Montana. A group of biologists known as the Montana Black-Footed Ferret Working Group, studying prairie dogs since 1984, has selected four top sites for potential reintroduction within Montana. All four sites are within or associated with the Phillips Resource Area. Further evaluation selected a prairie dog complex (7km Complex) within the Phillips Resource Area. Ferrets were reintroduced into the area in 1994. There are no prairie dog towns or black-footed ferret habitat in or adjacent to the project area.

The BLM has designated prairie dog towns on BLM land within the 7km complex as an Area of Critical Environmental Concern (ACEC), to be managed for black-footed ferret reintroduction (BLM 1992b). This ACEC is located south and east of the proposed project, approximately 8 miles from the southern boundary.

Piping Plover - The piping plover is a federally listed endangered species and a Montana Species of Special Interest or Concern. Nesting piping plovers have been documented on the Bowdoin National Wildlife Refuge and Nelson Reservoir, approximately 50 miles northeast of the proposed project. This species is known to migrate from Saskatchewan during early August. Throughout its range, the piping plover nests on wide beaches with minimal vegetative cover (Gaines and Ryan 1988). Piping plovers in Montana nest on sand/pebble beaches of large permanent reservoirs and natural lakes. Plovers in North Dakota use saline wetlands. Both of these habitats are severely restricted within the project area, and no piping plovers have been reported to occur on the project site in wildlife reports (WESTECH 1991).

Federal Candidate Species

The project area supports or contains potential habitat for ten federal candidate species (ferruginous hawk, mountain plover, northern goshawk, burrowing owl, loggerhead shrike, Baird's sparrow, small footed myotis, northern long-eared myotis, fringed myotis, long-legged myotis, and Townsend's big-eared bat (CFR 59 (219):58952-59028). These species are Category 2 species, which means current information indicates that species might qualify for protection under the Endangered Species Act, but further biological information is needed.

Burrowing Owl - The burrowing owl is a small owl of open plains and prairies. Primarily diurnal, this owl uses abandoned mammal burrows for nesting and raising young. The owl is often associated with prairie dog towns, but also uses ground squirrel burrows that have been enlarged by badgers. No burrowing owls have been observed on the project area (WESTECH 1991), and the closest prairie dog town occurs 7 to 10 miles south of the Little Rocky Mountains.

Ferruginous Hawk - The ferruginous hawk is the largest and most powerful of North American buteos, and is endemic to prairie and grassland habitats in Western North America (Brown and Amadon 1968). They were historically found in most states west of the Mississippi River, but populations have declined as cultivation has converted grassland into cropland (Olendorff 1973). Ferruginous hawks typically nest on the ground or on small outcrops in prairie habitats. Small and medium sized mammals are the primary prey species of ferruginous hawks, including cottontail rabbits, jackrabbits, prairie dogs and ground squirrels. Ferruginous hawks migrate into the project area in late March and leave in late October (BLM 1992b). A study of ferruginous hawk reproduction in Phillips County (Black 1992) revealed ferruginous hawks scattered widely across the county, occupying areas of open ground with moderate relief. Thirty-eight nests were located. Seventy-six percent of these nests were found on the ground, and all nests were found in areas with some topographic relief (Black 1992). Ferruginous hawks have been observed within the study area (WESTECH 1991); however, no nest sites occur within 10 miles of the project area (Black 1992).

Mountain Plover - The mountain plover is found on the open shortgrass (blue grama/clubmoss) prairies (Finch 1992). They migrate into the area in late April and are gone by early September (BLM 1992b). The plover nests on open ground and relies on insects and seeds for food. No mountain plover have been observed in the project area. Most of the known plovers in the area surrounding the project site are associated with level shortgrass prairie and often occur in black-tailed prairie dog towns.

Northern Goshawk - The northern goshawk is the largest North American member of the genus *Accipiter* and inhabits coniferous, deciduous, or mixed forests. This species requires large coniferous or deciduous trees in older stands for nesting. Nesting stands typically have a high degree of canopy closure and are often located on northern aspects (Reynolds 1989). Suitable nesting habitat is critical to the reproductive biology of goshawks. Nest areas are frequently reused for years and many goshawks have between two and four alternate nest areas within their home range. Nest areas are occupied by breeding goshawks from early March until late September (Reynolds et al. 1992). Goshawks prey on small to mid-sized birds and mammals, which it captures on the ground, in trees, or in the air (Reynolds et al. 1992). In Montana, the goshawk occurs primarily in coniferous forests and is common in many areas, but definitive data is lacking (Flath 1993). The Montana Natural Heritage Program has no recorded occurrences of goshawks in the Little Rocky Mountains (Hinshaw 1994); however, an adult goshawk (probably a migrant) was observed in Mill Gulch in October 1985 (Farmer 1994) and the BLM has a single record of a nest in the Little Rocky Mountains approximately 1.5 miles north of the project site (Grensten 1994).

Loggerhead Shrike - The loggerhead shrike is a perching bird of pasture, savannah and open brushland and is territorial in winter as well as summer (Fraser and Luukkonen 1986). Shrike nest earlier than most other passerine, laying eggs as early as April and May. Shrikes typically nest in open country in a variety of trees shrubs or vines and require trees or shrubs for nesting, roosting and hunting (Fraser and Luukkonen 1986). Loggerhead shrike occur primarily in the eastern part of Montana and have been observed on the project area (WESTECH 1991).

Baird's Sparrow - The baird's sparrow breeds from southeastern Alberta to southern Manitoba south to central and eastern Montana to central North Dakota. It winters from southeastern Arizona to north-central Texas into Mexico. This species favors large areas of prairie grassland with patchy shrubs. It also inhabits areas of ungrazed or lightly grazed mixed grass prairies, moist meadows, tall-grass prairies associated with wetlands, dry rangelands, fallow and stubble fields and hayfields. This species is sensitive to disturbance and requires relatively undisturbed or reclaimed prairie grasslands with scattered shrubs for breeding. Baird's sparrows nest on the ground in tall dense grass or dense herbaceous vegetation (Degraaf et al. 1991). There is no habitat or records of the Baird's sparrow in the Little Rocky Mountains.

Townsend's Big-eared Bat - The Townsend's big-eared bat ranges throughout western North America from southern British Columbia to southern Mexico inhabiting a variety of habitats including desert scrub, pinyon-juniper and pine forests (Barbour and Davis 1969). This bat is usually solitary or occurs in small groups and can be found in mines caves and man-made structures to 9,500 feet. The Townsend's big-eared bat is relatively sedentary and does not make major migrations. Winter hibernation areas (hibernacula) are selected that supply stable low temperatures and possibly a moderate airflow. This bat is sensitive to changes in temperature and humidity while hibernating (Freeman 1984). Townsend's big-eared bat has been recorded at Azure Cave.

Fringed Myotis - The fringed myotis is a species of western North America, ranging from British Columbia south to Veracruz and Chiapas, Mexico. This myotis is a species of wooded areas in foothills, mountains and high plateaus at elevations from 4,000 to 11,000 feet (Armstrong 1984a, Barbour and Davis 1969). Typical habitat is montane or subalpine forest, with oak and pinyon woodlands apparently the most commonly used habitat (Armstrong 1984a, O'Farrel and Studier 1980). Fringed myotis roost singly or in small groups. This species is known to migrate short distances to hibernate in mines or caves. The fringed myotis is easily disturbed by human activity, particularly during breeding (O'Farrel and Studier 1980). This bat has not been recorded on or near the project site.

Northern Long-eared Myotis - The northern long-eared myotis ranges widely in western North America from central Mexico to British Columbia. This is a species of high mountain coniferous forests where they roost in trees, buildings, caves and abandoned mines (Armstrong 1984b). The long-eared myotis emerges after dark to forage near trees or over water. This species is a gleaner, taking insect prey from the surface of leaves (Armstrong 1984b). Long-eared myotis have been recorded to occur at Azure Cave.

Western Small-footed Myotis - The western small-footed bat occurs throughout western North America. Little is known about this species' habitat, although it is known to inhabit rocky areas. This species is generally solitary and roosts in summer in buildings, mines and under tree bark. In winter the small footed myotis is found in caves and mines, either alone or in small groups. One small-footed myotis has been recorded at Azure Cave.

Long-legged Myotis - The long-legged myotis is a species of western North America from central Mexico to extreme northwestern British Columbia and from the Pacific coast to the western edge of the Great Plains. This species occurs in wooded areas of foothills and mountains. Typical habitat is montane or subalpine forest, pine woodland and montane shrub. This bat roosts by day singly or in small groups in buildings, fissures of rocks and beneath loose bark. The long-legged myotis hibernates singly or in small groups in cave or mines (Armstrong 1984c). The long-legged myotis has been recorded at Azure Cave.

State Species of Special Interest or Concern

Black-tailed Prairie Dog - The prairie dog occupies relatively level ground in short and mid-prairie habitats. Prairie dogs were originally recorded by Lewis and Clark in Phillips County in 1805 and were considered very much a part of the prairie ecosystem by Phillips County Extension Agents in 1917. Poisoning of prairie dog colonies began in 1931, and strychnine oats were spread over 170,000 acres of Phillips County between 1931 and 1933. Poisoning continued until 1939, when it was felt that prairie dogs had been eliminated from Phillips County. Prairie dogs began to expand in the 1950s, and in 1982 the BLM prepared the Programmatic Environment Assessment for Black-tailed Prairie Dog Control/Management in the Phillips Resource Area. In 1983, the BLM began a shooting program to manage and limit prairie dog expansion within Phillips Resource Area. No prairie dogs occur within the study area, and the closest prairie dog towns are 7 to 10 miles south of the project area.

Sharp-tailed Grouse - Sharp-tailed grouse is a state game species that occurs in intermountain grasslands, and on prairie bottoms and draws south of the Little Rocky Mountains. Important habitats for the sharp-tailed grouse include grassland, grassland shrub, riparian, woodland and agricultural areas (BLM 1992b). During winter, woody draws and woodlands are used for thermal cover. If snow is not available for burrowing into during severe winter weather, grouse would move to shrubby vegetation for thermal cover (BLM 1992b). Grouse have been observed in the project area in the lower creek drainages and historical "leks" are present in or near the southeastern boundary of the project area (WESTECH 1991, Grensten 1994).

Long-billed Curlew - The long-billed curlew typically nests in remnants of original prairie habitat, including damp meadowland and drier short-grass areas, particularly on gravelly soil (Hayman et al. 1986). Breeding curlews typically feed on grassland insects and seeds. After breeding, curlews move to estuaries and some winter on inland cultivated areas. Long-billed curlews are found in prairie habitats in South Phillips County. They migrate into the area in late March and leave in late September (BLM 1992b). No long-billed curlews have been observed on the project area (WESTECH 1991).

3.5.1.2 Important Wildlife Species

Important classes of wildlife which generated substantial EIS public scoping comments include big game animals, upland game birds, raptors and bats. Numerous other wildlife species are present and have been documented in the project area. A listing of all study area wildlife species, including common and scientific names for species recorded in the wildlife studies, is available in the Zortman permit application, Appendix 5 (ZMI 1993).

Big Game Animals

Big game species that may occur on the permit area include, bighorn sheep, mule deer, white-tailed deer, elk, pronghorn, black bear, and mountain lion. Abundance and distribution of big game in the Little Rocky Mountains are limited to a large extent by hunting mortality. Game animals that use lands within the Fort Belknap Indian Reservation are hunted year round. Road development within the southern portion of the mountains make animals easily accessible during Montana hunting seasons. Only the bighorn sheep and mule deer are capable of supporting substantial populations under these conditions. Elk, mountain lion, white-tailed deer, and black bear populations are depressed below habitat carrying capacities due to both legal and illegal hunting mortality (BLM 1992a).

Bighorn Sheep - Forty-one bighorn sheep were introduced into the Little Rocky Mountains between 1972 and 1974 (Scow 1978). This herd has remained fairly stable and currently consists of approximately 60 animals, primarily located in the southern portion of the Little Rocky Mountains (WESTECH 1991). The herd appears to have reached the carrying capacity of its current range. The herd does not appear to have distinct summer and winter ranges, and thus is not considered migratory (WESTECH 1991). A majority of animals winter along the southern fringes of the mountain range and disperse to higher elevations north in the summer. Several bighorn sheep (including some of the larger rams) may also summer on the Fort Belknap Indian Reservation. Bighorn sheep population size, composition and winter population characteristics is provided in the "Wildlife Resources of the Little Rocky Mountains Environmental Study Area" (WESTECH 1991).

Mule Deer - Mule deer are the most common big game animal in the Little Rocky Mountains. They range throughout the mountains from spring through fall. However, mule deer are generally confined to the winter range on southern exposures at lower elevations, in the southern portion of the mountains (WESTECH 1991).

White-tailed Deer - White-tailed deer have been recorded throughout the Little Rocky Mountains and the BLM (1972) reported that the mountain range has high value white-tailed deer habitat along major creek bottoms, including Camp Creek, Alder Gulch, Lodgepole Creek and Beaver Creek. White-tailed deer habitat typically involves low elevation riparian zones, where dense vegetation provides escape cover from predators and hunting pressure. Disturbance to this habitat in the southern portion of the range and an open hunting season to the north has prevented the expansion of this species.

Elk - Elk were traditional inhabitants of the Little Rocky Mountains. Elk were reintroduced into the nearby Missouri River Breaks in 1951 and flourished; elk were occasionally sighted in the Little Rocky Mountains in Grouse Gulch, Alder Gulch, Ruby Gulch, and C-K Creek (Scow 1978). The BLM (1972) concluded that the Little Rocky Mountains contain some moderate to high-value elk habitat, but the overall value is limited by the small size of the mountain range. Overharvest and disturbance to their native habitat has severely limited elk abundance and distribution in this mountain range. Current elk use of the Little Rocky Mountains appears to involve dispersal from the more secluded Missouri River Breaks. MDFWP objectives call for management of elk habitat in its most productive condition and to provide maximum recreation opportunity. Specific management objectives for the Missouri River Breaks Elk Management Unit include maintaining the population at current levels, maintaining current annual harvest, and developing cooperative programs that encourage public and private land managers to maintain productive elk habitat (MDFWP 1992).

Pronghorn - Pronghorn antelope use of the Little Rocky Mountains is confined to the sagebrush/grassland foothills. Some animals may occasionally use areas near Goslin Flats.

Black Bear - Studies conducted in the 1970s found no evidence of black bears in the Little Rocky Mountains (Scow 1978, 1979). However, in recent years black bears have been harvested and reported in very limited numbers in the Little Rocky Mountains. Dispersal from the Missouri River Breaks probably accounts for these observations.

Mountain Lion - Mountain lion occur in the Little Rocky Mountains in very limited numbers. MDFWP estimated the 1985-1986 population at 3 to 6 lions (Harvey Nyberg, MDFWP, in WESTECH 1991). Most of the lions in the Little Rocky Mountains are probably yearlings that have migrated from the Missouri River Breaks, but there are reports that at least one lion litter was produced in the area in 1986 (Harvey Nyberg, MDFWP, in WESTECH 1991). Observation of what appeared to be a mountain lion deer kill, indicated by a deer carcass and lion tracks, was recorded in the Azure Cave area by an EIS team biologist in winter of 1993.

Upland Game Birds

Six species of upland game birds (ring-necked pheasant, grey partridge, sharp-tailed grouse, blue grouse, wild turkey, and sage grouse) may occur near the proposed project area. Pheasant, grey partridge, and sharp-tailed and sage grouse inhabit the foothills surrounding the Zortman operation. Blue grouse use of the permit area occurs regularly. Wild turkeys were released in the Little Rocky Mountains in the early 1970s. The birds never appeared to multiply, possibly due to drought conditions, poor winter range, and overharvest. Some wild turkeys may remain in the Little Rocky Mountains and on adjacent private land.

Raptors

Numerous birds of prey (or raptors) use the Little Rocky Mountains. Raptor surveys were conducted in the project area prior to mining activity (DSL 1979a), and several reconnaissance-level surveys for nesting raptors have been conducted between 1979 and mid-March 1991 (WESTECH 1985, 1986, 1989). The most recent survey for nesting raptors was conducted in spring 1990 (WESTECH 1991) included areas such as proposed disturbance areas under the CPA and forest and riparian habitat along Alder, Ruby, Pony, Goslin, Mill, Montana, and Beaver Gulches and Bull and Lodgepole Creeks (WESTECH 1991, Farmer 1994). An element occurrence search conducted by the MNHP on December 19, 1994 found no northern goshawks reported within Phillips County (Hinshaw 1994). Golden eagles; red-tailed, ferruginous, and rough-legged hawks; American kestrel; and great-horned owls are common at various times of the year (WESTECH 1991). Other raptors such as Cooper's hawk, northern goshawk, and prairie falcon are occasionally observed. No raptor nests have been documented within the proposed project area; however, fledgling raptors have been observed near the mine site, suggesting nearby nesting. Suitable raptor nest sites are apparent in surrounding drainages.

Bats

Six species of bats have been documented to use Azure Cave. It is one of several hibernaculums in the Pacific Northwest, and may be the northernmost in the United States (Chester et al. 1979). An initial resource inventory and evaluation of the cave, performed in 1978, documented use of the cave by about 530 bats of several species, including little brown bat (*Myotis lucifugus*) and long-legged myotis (*M. volans*) (Chester et al. 1979). A survey conducted in August 1991 by a U.S. Forest Service biologist identified big brown bat (*Eptesicus fuscus*), western small-footed myotis (*M. ciliolabrum*), and little brown bat at the cave (Butts 1993). Surveys of Azure Cave in September 1992 documented the presence of big brown bat, northern long-eared myotis (*M. evotis*), little brown bat, and Townsend's big-eared bat (*Plecotus townsendii*) (Butts 1993).

Winter surveys conducted in March 1993 documented the presence of 250-300 little brown bat, 11 Townsend's big-eared bat, and one long-legged myotis (Butts 1993). This survey was aborted before the entire cave could be surveyed to avoid undue disturbance to hibernating bats; however, most portions of the cave likely to contain bats were surveyed. Azure Cave supports a bat hibernaculum of both local and national significance (Chester et al. 1979). The cave provides temperature and humidity ranges essential to the survival of at least 3 and likely 5 species of hibernating bats (Butts 1993).

Hibernating bats must not deplete their fat reserves prior to the end of winter. Disturbance resulting in movement requires heavy expenditure of energy and fat reserves (Yalden and Morris 1975); thus, mid-winter disturbance can pose a severe threat to bats in Azure Cave.

3.5.2 Fisheries

Fisheries habitat in the Little Rocky Mountains is very limited (WESTECH 1991; BLM 1972). Brook trout inhabit Beaver, Lodgepole, and Little Peoples Creeks, and can be found in ponds along lower Rock Creek; rainbow trout occur in Little Peoples Creek (WESTECH 1991). All other drainages in the project area, including Alder Gulch and Montana Gulch, have intermittent flows and thus do not support a fishery. The MDFWP conducted inventories on fish populations in reservoirs and perennial flowing portions of Rock Creek south of Landusky (DSL/BLM 1993c). Non-salmonid fish populations found include flat-headed minnows, long-nose dace, white sucker, northern redbelly dace, brook stickleback, northern pike, and perch. These studies concentrated on the lower reaches of Rock Creek, due to the fact that the stream often runs dry near Landusky and is not a perennial flowing stream until it is fed by springs which occur in drainages south of the mountains (DSL/BLM 1993b).

Ten perennial streams in the vicinity of proposed and existing mining operations were sampled for macroinvertebrates in June 1990 and seasonally in 1991 (WESTECH 1991). The nine streams surveyed included:

- Beaver Creek
- Upper Lodgepole Creek
- Lower Lodgepole Creek
- Alder Gulch
- Mill Gulch
- Rock Creek
- Montana Gulch
- Bull Gulch
- Big Horn Creek
- King Creek

Based on these two years of sampling, macroinvertebrate populations in the project area are relatively insubstantial. Fifty-one taxa of aquatic macroinvertebrates were identified during this study with mayflies and stoneflies accounting for more than half the organisms collected. The most common taxa identified included mayflies (*Baetis* sp. and *Epeorus* sp.), stoneflies (Nemouridae), fly larvae (Chironomidae and Simuliidae), flatworm (Turbellaria), the stonefly *Sweltsa/Suwallia* sp., and the mayfly (*Cinygmula* sp.). Overall low total macroinvertebrate numbers, low diversity of taxa and an abundance of pollution tolerant organisms are reflective of natural perturbations and previous mining activities still affecting streams in the area. Extreme annual fluctuations in runoff and discharge maintenance contribute to erratic population numbers annually and seasonally. The "cleanest", "healthiest" streams in the project area, in terms of being able to maintain a relatively abundant, diverse population of macroinvertebrates annually, are beaver and lodgepole creeks. Although subject to fluctuating water levels, these two streams maintain sufficient water to support benthic populations throughout the year, and appear less affected by historical mining operations.

3.6 AIR QUALITY AND METEOROLOGY

3.6.1 Air Quality

3.6.1.1 General Conditions

Air resources in the project area are generally of good quality. Baseline data concerning respirable particulates (PM_{10}) were collected from March 1990 to September 1991 at six locations within the project area. These data are summarized in Table 3.6-1. Zortman and Landusky air quality monitoring station locations are shown in Figure 3-6.1. The maximum 24-hour PM_{10} concentrations in the area ranged from 32 $\mu g/m^3$ at Site 1, near Landusky (located generally upwind of the Zortman and Landusky Mines); to 70 $\mu g/m^3$ recorded at Site 3, located downwind of the Landusky Mine pits at Sullivan Park.

Note that the Montana and federal *24-hour* ambient air quality standard for PM_{10} is 150 $\mu g/m^3$, and is not to be exceeded more than once per year. Baseline data show that the annual average PM_{10} concentration in the project area ranged from 10 $\mu g/m^3$ at Site 1 and Site 6 (Seven Mile Road) to 16 $\mu g/m^3$ at Site 3. These concentrations are below the Montana and federal *annual* ambient air quality standard of 50 $\mu g/m^3$.

PM_{10} data collection in the project area was continued in 1992 and 1993. The data are summarized in Tables 3.6-2 and 3.6-3, respectively. Three additional monitoring stations were operated in 1992 and 1993. They are Site 7, located east of Zortman at Beaver Creek; Site 8, located at the town of Lodgepole; and Site 9, located at the town of Hays. Site 3 was relocated from Sullivan Park to Upper Alder Gulch on April 1, 1993. During 1992, maximum 24-hour PM_{10} concentrations ranged from 19 $\mu g/m^3$ at the town of Lodgepole (Site 8); to 102 $\mu g/m^3$ at the town of Zortman (Site 4). The annual average PM_{10} concentration in the project area ranged from 6 $\mu g/m^3$ at Beaver Creek (Site 7); to 14 $\mu g/m^3$ at Sullivan Park (Site 3). During 1993, maximum 24-hour PM_{10} concentrations ranged from 22 $\mu g/m^3$ at the town of Lodgepole (Site 8) to 30 $\mu g/m^3$ measured at three locations. The annual average PM_{10} concentration in the project area ranged from 9 $\mu g/m^3$ at 6 sampling stations to 12 $\mu g/m^3$ at Upper Alder Gulch (Site 3). These concentrations are below the Montana and federal 24-hour and annual ambient air quality standards of 150 $\mu g/m^3$ and 50 $\mu g/m^3$, respectively.

3.6.1.2 Existing Air Emission Point Sources

Other air quality sources involve (1) lead emissions from the assay lab located in the town of Zortman; (2) emissions from the refinery at the Zortman Mine process plant; and (3) hydrogen cyanide gas emissions from the various Zortman and Landusky leach pads. Each of these sources and their nature are discussed below.

Lead air emissions from the assay lab have been estimated by the Montana Air Quality Division (AQD 1994a) at approximately 504 pounds per year (0.25 tons per year) based on the current lab operating schedule of 8 hours per day. An air quality permit is not required until lead emissions are greater than 5 tons per year. Ambient air lead concentrations in the town of Zortman were analyzed from the PM_{10} samples taken at the town of Zortman air quality monitoring location (Figure 3.6-1). This monitoring station is located within a few hundred yards of the assay lab. The maximum lead concentration measured at this monitoring location was 0.03 $\mu g/m^3$. This concentration is below the Montana and federal ambient air quality standard for lead of 1.5 $\mu g/m^3$.

Stack testing of emissions from the refinery indicate a total particulate emission of 2.42 tons per year (AQD 1994a). An EPA-approved model called SCREEN was used to estimate the ambient air concentrations at the town of Zortman resulting from the refinery emissions. Modeling results estimate a 24-hour and annual PM_{10} concentration of 1.4 $\mu g/m^3$ and 0.3 $\mu g/m^3$, respectively. These concentrations are below applicable Montana and federal ambient PM_{10} standards.

Emissions of hydrogen cyanide from the leach pads at the Landusky mine were measured by ZMI personnel in early 1990 (DSL/BLM 1991b). Hydrogen cyanide concentrations did not exceed 1 ppm. Industry-wide measurements of hydrogen cyanide in ambient air near working leach pads show average concentrations of 2 to 3 ppm (NPS 1986). The Threshold Limit Value for hydrogen cyanide is 10 ppm (ACGIH 1993). Hydrogen cyanide at 110 ppm is fatal after one hour. At 270 ppm, it is immediately fatal.

3.6.2 Climate and Meteorology

The climate of the Little Rocky Mountains in north-central Montana is classified as semi-arid continental. Features of this climate include cold winters, warm summers, wide temperature extremes, annual

TABLE 3.6-1

MAXIMUM AND AVERAGE PM_{10} CONCENTRATIONS ($\mu g/m^3$) FOR THE PROJECT AREA

(March 1990 - September 1991)

Site	Maximum	Second Highest	Arithmetic Average
1	32	28	10
2	35	32	12
3	70	41	16
4	42	35	13
5	48	39	12
6	33	26	10

TABLE 3.6-2

MAXIMUM AND AVERAGE PM_{10} CONCENTRATIONS ($\mu g/m^3$) FOR THE PROJECT AREA

(January 1992 - December 1992)

Site	Maximum	Second Highest	Arithmetic Average
1	90	25	9
2	96	37	10
3	101	58	14
4	102	29	9
5	95	24	9
6	29	24	8
7	23	14	6
8	19	18	7
9	29	22	9

Site 1:	Upwind of the Zortman and Landusky Mines
Site 2:	Town of Landusky
Site 3:	Downwind of Landusky Mine at Sullivan Park
Site 4:	Town of Zortman
Site 5:	Downwind of the Zortman Mine, SE of the Zortman School
Site 6:	Seven Mile Road
Site 7:	Beaver Creek
Site 8:	Town of Lodgepole
Site 9:	Town of Hays

Source (both tables): Gelhaus 1993.

TABLE 3.6-3

MAXIMUM AND AVERAGE PM_{10} CONCENTRATIONS ($\mu g/m^3$) FOR THE PROJECT AREA

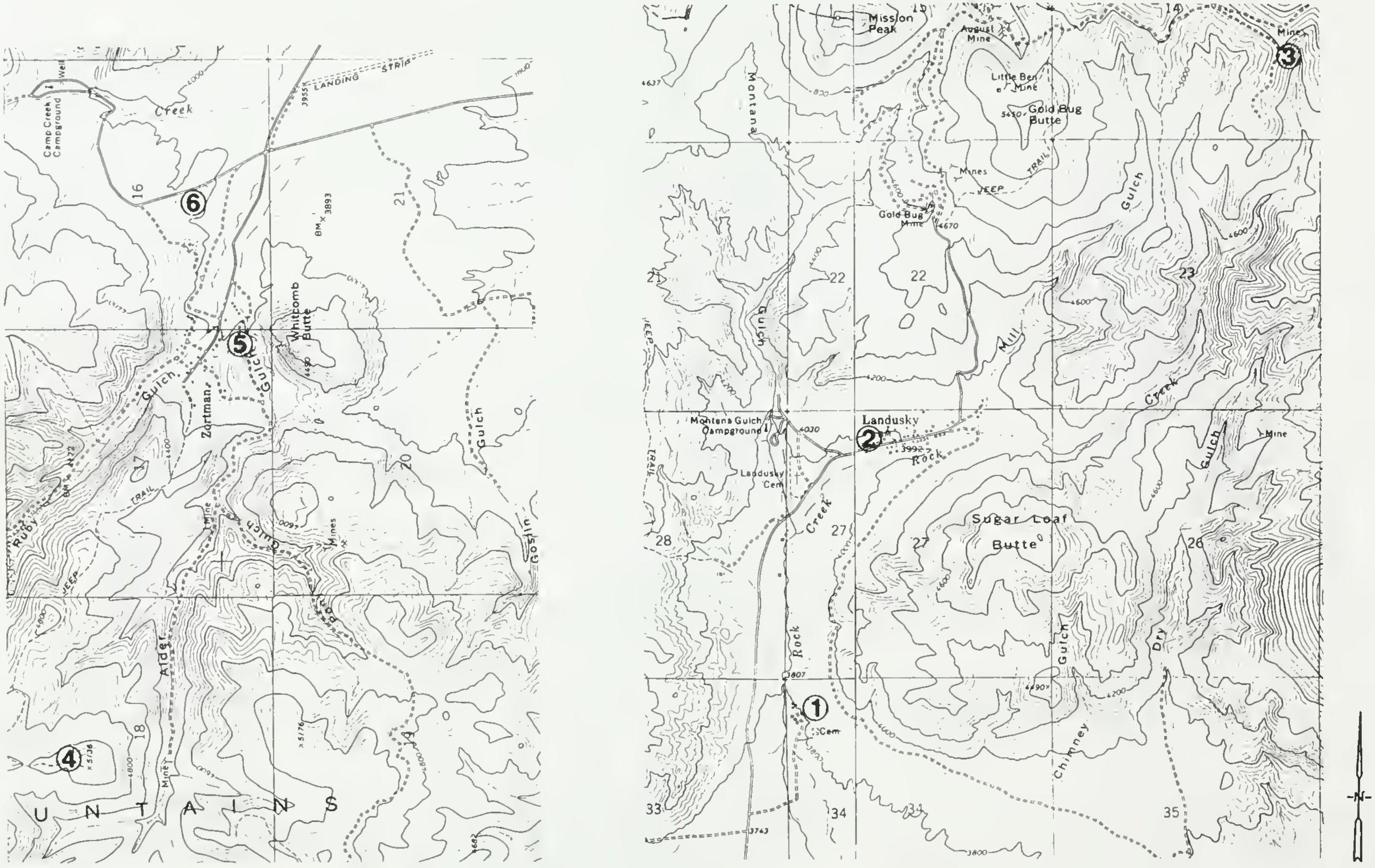
(January 1993 - December 1993)

Site	Maximum	Second Highest	Arithmetic Average
1	25	21	9
2	30	27	10
3	30	29	12
4	28	21	9
5	24	24	9
6	24	23	9
7	30	23	9
8	22	21	9
9	26	24	10

Site 1:	Upwind of the Zortman and Landusky Mines
Site 2:	Town of Landusky
Site 3:	Downwind of Landusky Mine at Sullivan Park
Site 4:	Town of Zortman
Site 5:	Downwind of the Zortman Mine, SE of the Zortman School
Site 6:	Seven Mile Road
Site 7:	Beaver Creek
Site 8:	Town of Lodgepole
Site 9:	Town of Hays

* Site 3 was relocated to Upper Older Gulch on April 1, 1993.

Source: Gelhaus 1994.



ZORTMAN MINE

LANDUSKY MINE

ZORTMAN AND LANDUSKY MINES
AIR QUALITY MONITORING SITES

FIG. 3.6-1

precipitation totals of 11 to 40 inches, and abundant sunshine.

Meteorological data were collected at three locations in the project area. Site-specific meteorological data from April 1990 to September 1991 are summarized in Tables 3.6-4, 3.6-5, and 3-6.6. For comparison, regional 25-year climatological averages of temperature and precipitation are presented in Tables 3.6-7 and 3.6-8, respectively. Figure 3.6-2 presents the wind rose for the Zortman Mine Boneyard meteorological station. The wind rose depicts the percentage of time that the wind blows from a particular direction in a certain wind speed class. The most common wind direction was from the west northwest, which occurred 25 percent of the time during the monitoring year. Table 3.6-4 summarizes average wind speed and most frequent wind direction by month at the Sullivan Park, the Zortman Mine Boneyard, and the Seven Mile Road meteorological stations. The Seven Mile Road station exhibited a more northerly wind flow than the other stations, especially in the summer. Average wind speeds at all three stations were fairly strong, averaging approximately 11 mph for the monitoring period. The monthly average wind speed at the Zortman Mine Station ranged from 5.5 mph in May to 17.2 mph in December. At the Sullivan Park Station, monthly average wind speeds ranged from 9.7 mph in August to 14.1 mph in November. Monthly average wind speeds at the Seven Mile Road station ranged from 7.6 mph in September to 14.8 mph in November and December.

Monthly temperature means and extremes for the immediate project area for the monitoring period May 1990 to September 1991 are presented in Table 3.6-5. Monthly temperature means for the project location are somewhat lower than the climatological averages for the region, due to the higher elevation of the project area. The range of monthly mean temperatures in the project area was from 12.2° F in December to 68.0° F in August. The lowest temperature recorded in the project area was -31° F at Sullivan Park in December and the highest temperature was 88° F, recorded at both stations in August.

Regional monthly temperature means and extremes representing 25-year climatological averages are presented in Table 3.6-7. Monthly mean temperatures in the region range from 9.2° F in January to 70.5° F in July. Temperatures can get as cold as -50° F in the winter months and as high as 111° F in the summer months, although these extremes of temperature rarely last for long periods of time.

The 25-year climatological average annual precipitation range from 10.87 inches in Glasgow to 17.20 inches in Lewistown (see Table 3.6-8). Mountainous locations in the region receive as much as 40 inches per year. The majority of the rainfall occurs in late spring and summer. The wettest month is June, averaging from 2.55 inches in Havre to 3.47 inches in Lewistown. February is the driest month, averaging 0.32 inches in Glasgow to 0.60 inches in Lewistown. Snowfall amounts in the area vary with elevation, with the mountainous areas receiving higher amounts.

Monthly precipitation totals for the immediate project area are presented in Table 3.6-6 and cover the monitoring period of July 1990 through September 1991. The range of monthly total precipitation amounts in the project area was from 0.13 inches in September 1990 to 7.54 inches in June 1991. Most of the rainfall in the project area occurs from April through June.

Table 3.6-9 presents additional precipitation and storm event data for the project area. Table 3.6-9 summarizes 6 years of precipitation data collected at the Bureau of Land Management-operated RAWS weather station near the Zortman Mine. The maximum annual precipitation recorded at this station was 19.7 inches, occurring in 1989. The highest monthly precipitation total was 8.0 inches, occurring in June 1991, and the highest 24-hour precipitation total was 5.5 inches, recorded in May 1988. The 100-year, 24-hour design storm event for the Zortman, Montana area has been calculated by the Montana Department of State Lands at 6.0 inches, and may have been approached at the project site during June 1993 (DSL 1993b).

The area therefore is characterized by high precipitation in the early summer months, with storm flows capable of causing stresses to constructed waste piles, heap leaches, drainage ditches, and retention ponds, as confirmed by field visits following the June 1993 event.

TABLE 3.6-4

SUMMARY OF WIND SPEED AND DIRECTION FOR THE PROJECT AREA

	Sullivan Park		Zortman Mine Boneyard		Seven Mile Road	
Month	Average Speed (mph)	Most Frequent Direction	Zortman Average Speed (mph)	Most Frequent Direction	Average Speed (mph)	Most Frequent Direction
April 1990	11.2	WNW	9.8	W	--	--
May	11.0	WNW	5.5	W	--	--
June	11.6	W	5.7	W	--	--
July	10.4	ESE	8.8	SE	--	--
August	9.7	W	9.7	W	--	--
September	10.0	WNW	9.7	W	7.6[*]	N[*]
October	12.5	W	13.8	W	14.6	W
November	14.1	W	16.4	W	14.8	W
December	13.0	W	17.2	WNW	14.8	W
January 1991	13.0	WNW	15.2	WNW	12.9	WNW
February	12.8	WNW	15.3	WNW	12.7	W
March	11.0	W	10.4	WNW	10.1	W
April	11.5	WNW	12.7	WNW	11.7	NW
May	10.7	ESE	11.2	SE	8.7	NNW
June	11.8	SW	11.5	WNW	10.1	W
July	11.3	WNW	9.7	WNW	8.3	N
August	11.2	WNW	9.3	WNW	8.2	N
September	11.3	WNW	10.7	WNW	8.7	NW

[*] Partial Month

Source: Gelhaus 1991a.

TABLE 3.6-5

MONTHLY TEMPERATURE MEANS AND EXTREMES (°F) FOR THE PROJECT AREA

	Sullivan Park			Zortman Boneyard		
Month	Monthly Mean	Maximum	Minimum	Monthly Mean	Maximum	Minimum
May 1990	44.6	68	23	44.6	70	25
June	55.4	84	34	50.0*	75*	34*
July	60.8	86	37	60.8*	79*	46*
August	64.4	88	46	64.4	88	46
September	60.8	82	37	60.8	81	37
October	41.0	68	21	41.0	68	23
November	32.0	63	1	33.8	63	5
December	12.2	50	-31	14.0	52	-29
January 1991	17.6	43	-13	17.6	43	-11
February	32.0	50	0	33.8	52	-4
March	30.2	52	-11	30.2	54	-9
April	37.4	59	21	37.4	61	23
May	50.0	66	18	46.4	68	19
June	55.4	75	39	55.4	77	39
July	64.4	81	43	64.4	82	43
August	68.0	84	45	68.0	88	45
September	53.6	79	25	53.6	79	27

* Partial month of data

Source: Gelhaus 1991a.

TABLE 3.6-6

MONTHLY PRECIPITATION TOTAL (inches) FOR THE PROJECT AREA

Month	Sullivan Park	Seven Mile Road
July 1990	1.00*	--
August	1.44	--
September	0.13	--
October	0.79	--
November	0.18	--
December	0.94	0.05*
January 1991	0.49	0.35
February	0.32	0.31
March	0.74	0.70
April	3.08*	2.18
May	2.97	2.80
June	7.54	5.69
July	0.53	0.35
August	0.82	0.72
September	1.23	0.96

* Partial month
Source: Gelhaus 1991a.

TABLE 3.6-7

REGIONAL TEMPERATURE MEANS AND EXTREMES (°F)
25-Year Climatological Averages

	Glasgow, MT			Havre, MT			Lewistown, MT		
Month	Monthly Mean	Maximum	Minimum	Monthly Mean	Maximum	Minimum	Monthly Mean	Maximum	Minimum
January	9.2	55	-47	11.3	63	-52	18.9	65	-38
February	15.2	59	-37	17.6	67	-30	24.8	63	-31
March	25.2	75	-27	26.5	75	-24	28.3	73	-28
April	42.8	88	-3	43.6	87	-14	39.5	83	-2
May	54.2	95	20	54.9	94	24	49.7	89	14
June	62.0	98	33	62.1	100	32	57.7	93	23
July	70.5	104	41	69.9	106	39	65.5	100	33
August	69.0	106	37	68.0	111	36	65.1	103	33
September	57.2	99	21	57.1	101	20	54.1	96	19
October	46.4	88	5	46.6	88	0	45.4	89	-8
November	29.0	75	-21	30.0	78	-23	32.4	72	-29
December	17.1	56	-37	18.2	65	-46	24.5	65	-41
Annual	41.5	106	-47	42.2	111	-52	42.2	103	-41

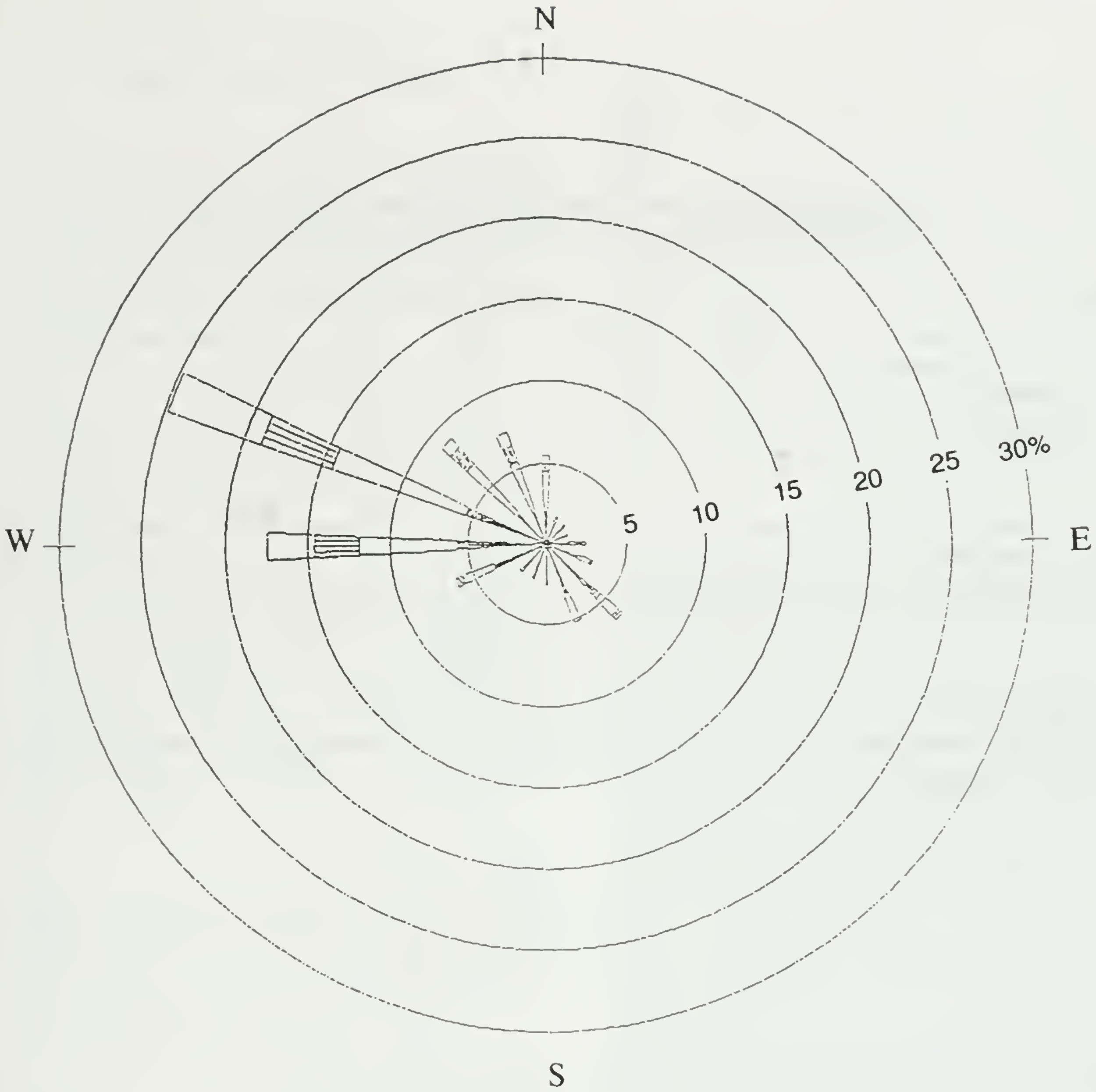
Source: NOAA 1982.

TABLE 3.6-8

REGIONAL MEAN PRECIPITATION (inches)
25-year Climatological Averages

	Glasgow	Havre	Lewistown
January	0.39	0.52	0.81
February	0.32	0.40	0.60
March	0.37	0.49	0.72
April	0.71	1.02	1.21
May	1.31	1.48	3.26
June	2.72	2.55	3.47
July	1.43	1.38	1.45
August	1.51	1.05	1.94
September	0.85	1.11	1.39
October	0.56	0.67	1.00
November	0.39	0.46	0.65
December	0.31	0.42	0.70
Annual	10.87	11.55	17.20

Source: NOAA 1982.



WIND SPEED CLASS BOUNDARIES

(MILES/HOUR)

NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE - WIND IS BLOWING FROM THE NORTH 5.5 PERCENT OF THE TIME.

WINDROSE

ZORTMAN MINE
BONEYARD METEOROLOGY STATION
PERIOD: 1990-91

FIGURE 3.6-2

TABLE 3.6-9

PRECIPITATION AND STORM EVENT DATA COLLECTED AT THE ZORTMAN MINE METEOROLOGICAL (RAWS) STATION

	1987	1988	1989	1990	1991	1992
Total Precipitation (inches)	10.9	15.2	19.7	11.3	17.2	16.4
Monthly Max. (inches)	3.6	6.5	5.9	4.3	8.0	5.0
Month	May	May	May	May	June	June
24-hour Max. (inches)	1.9	5.5	1.1	0.9	1.9	1.6
Date	May 27	May 7	Jun 11 Nov 4	May 24	Jun 29	Jun 16
Data Recovery (percent)	57	96	95	97	96	94

Source: BLM 1995a.

3.7 RECREATION AND LAND USE

This section will identify recreation and land use resources in the study area which could be affected, either directly or indirectly, by the proposed expansion and reclamation plans for the Zortman and Landusky mines. Information was compiled from maps and literature supplied by public and private agencies and telephone communications with federal, state, and Native American agencies.

Public lands in the vicinity of the Zortman and Landusky mines provide both developed and dispersed recreational opportunities. Prior to 1979, recreation use included the Montana Gulch campground near Landusky and the Camp Creek campground near Zortman. Both campgrounds were well used, especially on weekends during the summer and fall seasons. In 1976 a well was drilled at the Montana Gulch campground. Water samples from that well showed the groundwater to contain elevated concentrations of arsenic. The well was capped and not available for public use. Historic mining was the most likely cause of the groundwater contamination. Dispersed recreation activities included camping, picnicking, hiking, sightseeing, off-road vehicles use and hunting. Recreationists could access the Zortman to Landusky county road over Antoine Butte which is currently off limits to non-mine vehicles.

Currently, the Camp Creek Campground and associated Buffington day use area, and the Montana Gulch campground are still developed sites managed by the BLM. In 1992 there were approximately 500 visits at the Montana Gulch campground and 2,400 visits at the Camp Creek facilities (900 visits to the campground and 1,500 visits at the day use area).

The Camp Creek Campground, and the area surrounding the campground, is a designated watchable wildlife area. This is a program, participated in by many federal and state agencies, that identifies areas which may provide the public with opportunities for viewing wildlife. The area surrounding the Camp Creek campground provides good habitat for songbirds. Currently there are minimum facilities associated with the wildlife area but the BLM has future plans for an interpretive display describing the wildlife that can be observed in the area.

The Phillips Resource Area contains three Recreation Management Areas (RMAs). BLM land within the Phillips Resource Area provided an estimated 29,600 recreation visits in 1992 (Whitehead 1995). The Little Rocky Mountain RMA, which encompasses approximately 25,800 acres of public land, is in the area of the Zortman and Landusky mines. An estimated 7,000 visits occur annually on BLM lands within this RMA. Primary dispersed uses include hiking, horseback riding, mountain biking, all-terrain vehicle (ATV) use, wildlife/bird watching, caving, climbing and hunting. These activities occur in many locations in the Little Rocky Mountains, including many of the roads, trails and mountains in the vicinity of the Zortman and Landusky mines. Sightseeing (i.e., walking, biking, or driving on the access roads and trails throughout the area) and picnicking account for the majority of the use, with approximately 3,000 visits. BLM lands are open to off-road vehicle use on designated roads and trails. Zortman Mining Inc. gives tours of their mine operations. There were 360 visitors to the mines in 1992; 225 in 1993; and 92 in 1994.

The Azure Cave, located on the north side of Saddle Butte, has been designated as an Area of Critical Environmental Concern (ACEC) by the BLM, because of its unique geological and biological resources (see Section 3.13). Currently recreational use of Azure Cave is not allowed. A few caving groups have been granted access for inventory of cave features but access is very limited. Saddle Butte is used by recreationists for hiking and wildlife watching. Pony Gulch, a side canyon to Alder Gulch, is used in the winter for Christmas tree cutting. The access roads to both Saddle Butte and Pony Gulch would be crossed by the proposed conveyor route. Old Scraggy Peak, located approximately one mile east of the existing mine, provides semi-technical climbing opportunities, and is used by local climbers.

Mule deer hunting is the primary hunting use of the area, although on the plains south of the mountains prairie dog hunting is a very popular activity. Bighorn sheep, elk, and mountain lions are hunted within the Little Rocky Mountains. An outfitter based in Zortman provides guiding and outfitting services. Hunting is not a major recreation activity in the area, with use estimated at 200 visits annually.

In recent years the Fort Belknap Indian Reservation has made an effort to provide more recreational facilities to attract tourists and recreationists. Mission Canyon, located several miles north of the Landusky Mine, contains campgrounds, picnic areas, informational signing, a natural bridge, and an area used for Pow Wows. The Pow Wow grounds are located near the upper end of the South Fork of Little Peoples Creek. Participants in the Pow Wows come from many different tribes within Montana and surrounding states; Pow Wows are held several times a year. Portions of the Landusky mine can be seen from the Pow Wow grounds and from several viewpoints along the upper sections of

Mission Canyon Road. The Zortman mine is not visible from the Pow Wow grounds or other developed recreation facilities, although would be visible from viewpoints on the higher mountains and buttes which may be used for hiking and other uses.

The Missouri River, located over 20 miles south of the Zortman Mine, provides numerous recreational opportunities. West of U.S. Highway 191, a stretch of the Missouri River is a designated Wild and Scenic River. Recreational opportunities include floating, boating, hiking, dispersed camping, fishing, and wildlife watching. Two BLM Wilderness Study Areas (WSAs), Cow Creek (34,050 acres) and Antelope Creek (12,350 acres), are located north of the Missouri River, approximately 10 miles southeast from the Zortman and Landusky mines. Approximately 9,600 acres within the Antelope Creek WSA and 21,590 acres within the Cow Creek WSA have been recommended as suitable for wilderness designation. BLM management direction is to manage these lands to maintain their wilderness values. Mining activity in the Little Rocky Mountains, including portions of the Landusky and Zortman mines, can occasionally be seen from high ground within the WSAs.

A portion of the Nez Perce National Historic Trail (NPNHT) is located along the Missouri River and the Cow Creek WSA. The Lewis and Clark National Historic Trail (LCNHT) runs the length of the Missouri River south of the study area. Both of these trails provide interpretive opportunities and are managed to protect their scenic and cultural values. The Cow Creek ACEC (14,000 acres) is located on the west side of the Cow Creek WSA. It includes segments of the NPNHT, LCNHT and Cow Island Trail. The area is managed for scenic, interpretive, recreational and paleontological values. An 80-mile, self-guided tour route, the Missouri Breaks Backcountry Byway, traverses the badlands topography south of the Missouri River. Several points of interest along the route include views of the Little Rocky Mountains and the Landusky mine.

The western portion of the Charles M. Russell National Wildlife Refuge (CMR) is located approximately 15 miles south of the Zortman Mine site. The CMR is managed by the USFWS. The CMR management objective is to preserve, restore and manage portions of the nationally significant Missouri River Breaks and associated ecosystems for wildlife resources and compatible human uses associated with wildlife and wildlands.

Big game hunting is the most popular recreational use on the CMR. Hunting for big game takes place between the first week of September and the last week of November, and includes both archery and rifle hunting. Other dispersed recreation activities occurring on the CMR include fishing (especially in the spring after the ice melts off the river), boating, canoeing, hiking, photography and wildlife viewing. A 20-mile, self-guided auto tour route starts on State Highway 191 just north of the Missouri River and travels east along the river for approximately six miles before turning north along Bell Ridge and heading back to State Highway 191. An estimated 5,000 people use the auto tour route annually. Mining operations in the Little Rocky Mountains are visible from several locations along the higher ridges within the CMR, but are not visible from recreation sites along the river itself.

Developed recreation sites in the western portion of the CMR include the James Kipp Recreation Area, Rock Creek and Turkey Joe recreation sites. The James Kipp site is managed by the BLM, the Rock Creek and Turkey Joe sites are managed by the USFWS. The takeout point of the Upper Missouri National Wild and Scenic River is located at the James Kipp site. In 1991, the BLM estimated 55,000 visitor days at James Kipp.

The 1992 Judith-Valley-Phillips Resource Management Plan (RMP) details the land use management guidelines for BLM lands in the Little Rocky Mountains. Briefly, decisions made in the RMP that pertain directly to the Little Rocky Mountains state that the area is:

- Closed to oil and gas leasing;
- Open to locatable minerals except for approximately 260 acres;
- Available for mineral material disposal;
- Closed to livestock grazing except for two temporary permits;
- Generally open to off-road vehicles. However, use is restricted to designated roads and trails in the Camp Creek and Montana Gulch campgrounds, and the Azure Cave ACEC; and
- A Recreation Management Area with two campgrounds, one recreation site, and dispersed recreation opportunities.

In addition,

- Communication sites are confined to Antoine Butte;
- Intensive fire suppression for the recreation and communication sites will be employed;
- 26,240 acres are bighorn sheep habitat
- Public lands are not identified for disposal with the exception of the Zortman and Landusky townsites; and

- The Azure cave was designated as an ACEC (140 acres).

More detailed information can be found in the RMP. The post-mine land use objective for the Zortman and Landusky mines are for those lands to return to productive multiple uses. Objectives are to reclaim the lands disturbed by mining activity to: maintain and enhance wildlife habitat; to develop and maintain opportunities for dispersed recreation including hiking, scenic and wildlife viewing, and hunting; to improve the visual quality of disturbed lands, and; to improve and maintain the general ecological condition of watersheds, including soil productivity, surface and groundwater quality and vegetation.

Agriculture is the predominant land use occurring in Phillips and Blaine counties. Within Phillips County, rangeland and cropland account for approximately 97.5 percent of land use with woodland, water areas, urban and built-up areas, roads, and non-farm residences accounting for the remaining 2.5 percent. Land in Phillips County is zoned agricultural, except where a special use permit has been approved by the county. Privately-owned lands that would be affected by the proposed heap leach pad and conveyor system are currently used for livestock pasture. These lands are currently owned by ZMI and are being leased to local ranchers.

3.8 VISUAL RESOURCES

3.8.1 Study Area and Methodology

This section identifies and describes the visual resources which could be affected by the proposed project. The study area includes those areas that viewers may travel through, recreate in, or reside in, or where existing views may be affected by the proposed action.

The description of the visual resources of the study area are based on the methodology described in the BLM's Visual Resource Inventory Manual (BLM 1986b). The visual inventory consists of three factors: (1) a scenic quality evaluation, (2) a sensitivity analysis, and (3) distance zone analysis. The scenic quality evaluation involves the rating of the scenic beauty of an area, which takes into consideration such factors as landform, vegetation, water, color, adjacent scenery, scarcity and cultural modifications. Sensitivity analysis is a measure of the public's concern for the scenic quality of an area, and is based on factors such as number of viewers, type of users (e.g., commuters or recreationists), public interest, and adjacent land use. Landscapes are also classified into distance zones based on visibility from travel routes or other possible sensitive viewing locations. Three distance zones are noted, including the foreground/middleground (0-5 miles), background (5-15 miles), and a seldom-seen zone (>15 miles or not seen).

Based on these three factors, lands are placed into one of four resource inventory classes. These Visual Resource Management (VRM) classes represent the relative value of the visual resource and provide a basis for considering visual values in the resource management planning process. Each VRM class has specific visual objectives defining how the visual environment is to be managed, with VRM Class I the most protective of the resource, and VRM Class IV allowing the most modification to the existing character of the landscape. The objective of each class is defined as follows (BLM 1986b):

- <u>Class I</u> is intended to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

- <u>Class II</u> is intended to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

- <u>Class III</u> is intended to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural r\features of the characteristic landscape.

- <u>Class IV</u> is intended to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

3.8.2 Baseline Conditions

The study area is in the Missouri Plateau section of the Great Plains physiographic province (Fenneman 1931). Located between the Missouri and Milk Rivers, the Little Rocky Mountains are an isolated group of domed mountains in an area roughly 10 miles in diameter. Their rounded crests rise nearly 3,000 feet above the surrounding plain, with steeply tilted hogbacks encircling the higher mountains. The topographic relief, colors, and textures of the mountains and their vegetation provide a contrast to the relatively homogenous terrain, lines, forms, colors and textures of the adjacent plains. In an assessment of the visual quality of the Little Rocky Mountains done by the BLM in 1979, the area was rated as Class A scenery and given a Class II VRM rating. Private lands affected by the proposed project are not included in the BLM visual resource designation.

The project study area includes both prairie grasslands and mountains. The Goslin Flats heap leach pad, a section of the proposed conveyor route, and other possible alternative facilities would be located on the flat to rolling grasslands south and east of Whitcomb and Saddle Buttes. This is an open, generally level landscape with smooth textures and simple, indistinct lines and forms. Colors in the landscape come primarily from the grasses, and are mostly subtle shades of green during the spring and summer growing season, and shades of brown during the fall and winter seasons. Ruby Creek drainage provides some variation in the terrain and vegetation pattern. This area is highly visible to viewers on both U.S. Highway 191 and the county road (7 miles) leading to the town of Zortman, as well as from several of the surrounding buttes and peaks. Currently, the land is used as pasture and, except for some livestock improvements, is generally undisturbed and natural in appearance.

As the viewer moves up the project area into the foothills and mountains (where the current mining activities at Landusky and Zortman are located), the scenery changes from rolling grasslands to steep slopes and drainage bottoms. The landforms, colors and textures of the landscape have become more varied than the plains, and represent a unique scenic resource within the High Plains province. Forms are more distinct, and range from sharply angular along ridges separating the many drainages, to the more rounded forms of the tops of the buttes. Coniferous vegetation provides year-round green color. The scattered open, grassy areas, rock outcroppings, and areas with dense tree cover provide variation in the overall textures and patterns of the landscape.

Although mountain scenery is of high value within the Little Rocky Mountains, portions of the project site itself have been heavily impacted by historic and modern mine exploration and operation activities. Prior to 1979, which was the year in which modern surface mining operations began at both the Zortman and Landusky mines, surface disturbance associated with historic mining activity was visible in Alder and Ruby Gulches near Zortman and in the area of Gold Bug Butte near Landusky. Visual contrasts were caused by access roads, exploration pits, surface mining, adits and waste rock stockpiles. Visibility of these disturbed areas was generally confined to a small local viewshed and not visible from the main travel routes.

Current disturbances to the landscape include those activities associated with the existing Zortman and Landusky mines. These visual contrasts include open pits, waste rock dumps, heap leach pads, plant facilities, and changes in vegetation pattern caused by logging and forest fires. Roads, built for mine exploration and access, and for past BLM logging and fire-fighting activities, crisscross the surrounding slopes. Contrasts created by the existing facilities include color contrasts between the exposed soil and rocks and the surrounding vegetation, and contrasts caused by the alteration of topography. These contrasts, especially disturbance at the Landusky Mine, are visible from many vantage points in the vicinity of the project area, as well as from more distant viewing locations including areas along the Missouri River over 20 miles to the south, including portions of the Missouri Breaks National Backcountry tour route.

3.9 NOISE

3.9.1 Site-Specific Baseline Noise Measurements

Noise measurements were collected in the project area during March, 1991 to estimate baseline and operational noise levels associated with mining activities. The noise levels were collected along the periphery of the Zortman and Landusky mines, adjacent to mining and leaching operations, and around the town of Landusky. Noise measurements were collected over a 24-hour period using a Larsen Davis Laboratories Model 710 Dosimeter/Sound Level Meter, and were recorded as equivalent continuous noise levels (Leq). This sound level meter meets the instrument standards established by the federal government.

Baseline noise levels were collected on March 10 and 17, 1991 to determine normal ambient levels with minimal contribution from mining activities. During these two monitoring days, mining operations were suspended, with only the Landusky process plant, the Mill Gulch leach pad, and plant and security patrols in operation. Ambient baseline noise levels at study area monitoring locations are presented in Table 3.9-1. For comparison, Table 3.9-2 presents general information for the reader regarding the annual average noise levels associated with activity interference and hearing loss, to protect public health and welfare with an adequate margin of safety. Note that an annual Leq of 55 A-weighted decibels (dBA) or greater is considered to interfere with outdoor activities; and an annual Leq of 70 dBA may cause hearing loss over a 40-year exposure period. The A-weighting scale is used in noise level measurements to approximate the frequency response of the human ear.

The 24-hour Leq noise levels recorded on March 10, 1991 in the project area ranged from 47.8 dBA at the mouth of Rock Creek entering Landusky to 74.4 dBA at the east fenceline of the Landusky 1991 pad. During the March 17, 1991 monitoring period, the range of 24-hour Leq noise levels were from 35.9 dBA at the ridgeline above Ereaux cabin site in Mill Gulch to 96.2 dBA measured at the access road across the 1984 Landusky pad dike. The high value recorded at this site was due to the vehicular traffic using the road during the monitoring period. The second highest 24-hour Leq was 51.3 dBA measured at the Landusky townsite along the north fenceline of the Lewis property.

Although these noise level measurements exceed the criteria outlined in Table 3.9-2, note that project area noise measurements were collected during windy conditions, and the levels in Table 3.9-2 assume calm wind conditions. Winds greater than 10 mph can significantly increase the ambient noise levels, by as much as 10-20 dBA. On March 10, 1991 wind speeds averaged over 29 mph, and on March 17, the average wind speed was approximately 13 mph. Therefore, a major contribution to the ambient noise levels (as much as 10-20 dBA) was likely caused by the windy conditions.

3.9.2 Existing Operational/Blasting Noise Measurements

Additional noise monitoring data were collected on September 18, 1990 at the Fort Belknap Indian Reservation Mission Canyon Pow Wow Grounds. Noise measurements were taken to assess background noise levels and blasting noise levels at the Pow Wow Grounds. Noise levels prior to blasting ranged from 35 dBA to 58 dBA with a 10-minute Leq of 43.6 dBA. The blasting operations took place in the vicinity of the Gold Bug Pit, approximately 2.5 miles from the Pow Wow Grounds. The blasting noise level measured at the Pow Wow Grounds was 65.0 dBA. Another noise measurement was made about halfway from the blast site to the Pow Wow Grounds at the Mission Canyon boundary gate. Blasting noise levels in this area were 89.1 dBA. Noise from the blast lasted approximately 1 to 3 seconds. For reference, blasting noise levels measured at other mines ranged from 115 dBA to 125 dBA at 900 feet from the blast (USFS/DSL/DHES 1992).

Noise levels in the towns of Landusky and Zortman were not collected during this blasting event. However, these noise levels can be estimated using the Pow Wow Grounds data and the estimation of noise reduction with distance of 6 dBA with each doubling of distance. The nooise level at Mission Canyon boundary gate, about 1.5 miles from the blast site, was measured at 89.1 dBA. Because the Town of Landusky is about ½ mile closer to the blast site, the estimated noise level is higher (93 dBA) than that measured at the boundary gate. The estimated noise level at the Town of Zortman, about 4 miles from the blast site, is 81 dBA. These noise level approximations are probably higher than actual levels experienced because the elevated terrain between the mines and the towns and meteorological conditions (wind, humidity) would further reduce noise levels. However, conditions such as direct wind from the noise site to the receptor can also result in higher than predicted levels.

TABLE 3.9-1

BASELINE AMBIENT NOISE LEVELS (dBA) MEASURED IN THE PROJECT AREA[1]

Site	Location	March 10, 1991	March 17, 1991
1	East fenceline of the Landusky 1991 pad	74.4	47.5
2	North fenceline of the Landusky 1991 pad	63.1	44.8
3	Below the Rock Creek contingency pond	59.9	43.5
4	At the Mill Gulch contingency pond	54.4	39.8
5	Along the north ridge line adjacent to the Mill Gulch leach pad	66.8	46.8
6	Northwest pit floor island of the Queen Rose Pit	64.7	44.5
7	Mission Canyon gate	54.8	41.8
8	King's Creek Monitoring well location	54.8	---
9	West Timberline of the King's Crerek reclamation project	55.4	41.5
10	Lower east ridge of the Montana Gulch reclamation project	58.6	42.8
11	Access roadway across the 1984 Landusky pad dike	65.1	96.2[2]
12	West fence line of the Landusky 1983 leach pad	65.6	43.3
13	North fenceline of the 1979 Landusky contingency pond	65.7	43.4
14	Along the ridgeline above the Landusky main access gate	61.8	38.6
15	Ridgeline above the Ereaux cabin site in Mill Gulch	50.0	35.9
16	Mouth of Rock Creek entering Landusky	47.8	42.2
17	Landusky townsite along north fenceline of the Lewis property	60.9	42.1
	AVERAGE	60.1	51.3

[1] Mining operations suspended during these measurements.
[2] Noise levels at this location biased by vehicular traffic.

Source: Gelhaus 1991b

TABLE 3.9-2

YEARLY AVERAGE[1] EQUIVALENT SOUND LEVELS IDENTIFIED AS REQUISITE TO PROTECT THE PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

		Indoor			Outdoor		
	Measure	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects (b)	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq(24)}$		70				
Commercial	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq(24)}$	(a)	70	(a)			
Industrial	$L_{eq(24)}$(d)	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq(24)}$		70			70	
Educational	$L_{eq(24)}$	45		45	55		55
	$L_{eq(24)}$(d)		70			70	
Recreational Areas	$L_{eq(24)}$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq(24)}$				(a)	70	70(c)

Source: EPA 1974.

Sheet 1 of 2

TABLE 3.9-2 - YEARLY AVERAGE[1] EQUIVALENT SOUND LEVELS
(Concluded)

Code:

(a) Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communications is a critical activity.

(b) Based on lowest level.

(c) Based only on hearing loss.

(d) An $L_{eq}(8)$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than L_{eq} or 60 dB.

Note: Explanation of identified level for hearing loss: The exposure period which results in hearing loss at the identified level is 40 years.

[1] Refers to energy rather than arithmetic averages.

L_{dn} - Day/night noise level - Calculation of average noise level with a 10-decibel penalty (increase) added to nighttime levels (11 PM - 7 AM).

3.10 SOCIOECONOMICS

Socioeconomics topics discussed in this section are employment, income, and population, local economic effects of the existing Zortman and Landusky mines, facilities and services, (including the effects on public water quality of the existing Zortman and Landusky mines), local government fiscal conditions, the direct effect of the existing Zortman and Landusky mines on local government revenue, and social conditions within the study area.

3.10.1 Study Area

The socioeconomics section describes existing conditions and trends in Phillips and Blaine counties and the Fort Belknap Indian Reservation with sub-area descriptions, as required, to address the study area for the proposed extensions of operations and modification of reclamation procedures at the Zortman and Landusky mines.

3.10.2 Economic Conditions

The economy of the study area is based on production, extraction and use of natural resources. These resources include land for agriculture (consisting of both crops and livestock), oil and gas, hardrock minerals, and water and wildlife offering outdoor recreation opportunities. The industries that depend upon these resources are primarily export-based, in that goods and services produced are exported from the study area, providing new dollars to the area's economy. The following sections profile economic conditions in Phillips and Blaine counties and within the Fort Belknap Indian Reservation. The emphasis is on economic conditions that could be affected by the Company Proposed Action (CPA) and alternatives at both the Zortman and Landusky mines.

3.10.2.1 Phillips County

The job base in Phillips County has grown moderately over the past two decades (Table 3.10-1). In 1991, the total number of jobs located in Phillips County was 2,786, which was down about 3 percent from 1990 (2,876) but up about 24 percent from 1970. During the same period, the composition of the economic base has shifted due to a decline in agriculture and an increase in mining. In 1991, agriculture provided 25 percent of all jobs available in Phillips County, down from 37 percent in 1970, while mining provided 15 percent of all jobs available, up from less than one percent in 1970. The shift is even more pronounced when it is measured in terms of earnings, a component of personal income composed of wages and salaries paid to employees, other labor income, and proprietor's income (Table 3.10-1). In 1990 and 1991, agriculture contributed 13 and 7 percent, respectively, of total earnings generated in the county, down from 50 percent in 1970, while mining contributed 31 percent, up from less than one percent. The difference in agriculture's relative contribution to earnings in the years 1990 and 1991 indicates this sector's volatility and dependence on factors such as markets, government programs, and the weather.

In spite of its economic performance, agriculture continues to employ the largest share of employed persons who live in Phillips County according to the 1990 Census. In 1990, 28 percent of employed persons residing in Phillips County held jobs in agriculture. Trade was the second largest employer (18 percent), followed by health and educational services, including those provided by government agencies (13 percent), and business and personal services (12 percent). About 6 percent each of Phillips County's workers were employed in mining, construction, manufacturing, and public administration (Table 3.10-2). Since 1970, unemployment in Phillips County typically has been below the Montana state average (Table 3.10-3). Per capita personal income in Phillips County was $13,680 in 1991 (Table 3.10-4), ranking 43rd out of 56 counties in the state, with 87 percent of the Montana state average and 72 percent of the national average. In real terms (and as adjusted for inflation using the urban Consumer Price Index for all items), per capita income in Phillips County grew an average of one percent per year between 1970 and 1990 (Table 3.10-1).

Note that in 1990 there were many fewer Phillips County residents employed locally in mining (Table 3.10-2) than there were mining jobs held in Phillips County (Table 3.10-1). This indicates that workers commute into Phillips County to work in mining. It also suggests that most Phillips County residents employed locally in mining work for the Zortman and Landusky mines which is the county's largest mining employer. Therefore, the small but important share of the local labor force that depends on mining probably depends most on the Zortman and Landusky mines for employment. Also, the Zortman and Landusky mines are attracting workers from other counties, and may have stimulated in-migration of workers when the number of jobs at the mine increased. A comparison of Tables 3.10-1 and 3.10-2 indicate that, overall, Phillips County is a net importer of workers largely due to the availability of jobs in mining, trades and services.

TABLE 3.10-1

EARNINGS, EMPLOYMENT, AND EARNINGS PER EMPLOYEE IN PHILLIPS COUNTY, 1970-91

(earnings in thousands of 1991 dollars)

	1970	1970%	1980	1980%	1990	1990%	1991	1991%	%Chg '70-91
Earnings - Total	$46,261	100%	$33,573	100%	$50,760	100%	$44,348	100%	-4.1%
Agric. & Agric. Services	$22,976	50%	($2,461)	-7%	$6,590	13%	$3,275	7%	-85.7%
Construction	$1,372	3%	$2,104	6%	$1,590	3%	$1,500	3%	9.4%
Government	$7,110	15%	$6,232	19%	$8,501	17%	$8,328	19%	17.1%
Manufacturing	$575	1%	$1,127	3%	$633	1%	$663	1%	15.2%
Mining	$210	0%	$8,141	24%	$15,177	30%	$13,962	31%	6533.7%
Services	$3,953	9%	$6,194	18%	$7,589	15%	$6,109	14%	54.5%
T.C.P.U. & F.I.R.E.	$3,922	8%	$5,153	15%	$3,956	8%	$3,983	9%	1.6%
Trade	$6,142	13%	$7,083	21%	$6,725	13%	$6,528	15%	6.3%
Employment - Total	$2,246	100%	$2,574	100%	$2,876	100%	$2,786	100%	24.0%
Agric. & Agric. Services	$838	37%	$709	28%	$696	24%	$687	25%	-18.0%
Construction	$56	2%	$93	4%	$82	3%	$82	3%	46.4%
Government	$400	18%	$343	13%	$454	16%	$437	16%	9.3%
Manufacturing	$35	2%	$56	2%	$39	1%	$42	2%	20.0%
Mining	$9	0%	$220	9%	$432	15%	$417	15%	4533.3%
Services	$306	14%	$437	17%	$448	16%	$402	14%	31.4%
T.C.P.U. & F.I.R.E.	$214	10%	$272	11%	$240	8%	$244	9%	14.0%
Trade	$388	17%	$444	17%	$485	17%	$475	17%	22.4%

TABLE 3.10-1 - EARNINGS, EMPLOYMENT, AND EARNINGS/EMPLOYEE (PHILLIPS COUNTY)
(Concluded)

	1970	1970%	1980	1980%	1990	1990%	1991	1991%	%Chg '70-91
Earnings/Employee									
Average	$20.597		$13.043		$17.650		$15.918		-22.7%
Agric. & Agric. Services	$27.418		($3.471)		$9.468		$4.767		-82.6%
Construction	$24.492		$22.622		$19.385		$18.293		-25.3%
Government	$17.776		$18.169		$18.726		$19.057		7.2%
Manufacturing	$16.437		$20.127		$16.223		$15.786		-4.0%
Mining	$23.386		$37.004		$35.131		$33.482		43.2%
Services	$12.919		$14.174		$16.941		$15.197		17.6%
T.C.P.U. & F.I.R.E.	$18.326		$18.945		$16.482		$16.324		-10.9%
Trade	$15.830		$15.953		$13.866		$13.743		-13.2%

Source: BEA Regional Economic Information System on CD-ROM, May 1993 (USDOC 1993). Earnings adjusted for inflation by Planning Information Corporation.

Notes: T.C.P.U. - Transportation, Communication, and Public Utilities
F.I.R.E. - Finance, Insurance, and Real Estate

TABLE 3.10-2

STUDY AREA RESIDENT EMPLOYMENT BY INDUSTRY, 1990

	Phillips County		Blaine County					
			Total		Non-FBIR		FBIR	
	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct
Employed Persons (aged 16+)	2,304	100%	2,706	100%	2,101	100%	605	100%
Agric. & Agric. Services	635	28%	814	30%	741	35%	73	12%
Mining	136	6%	29	1%	13	1%	16	3%
Construction	128	6%	132	5%	89	4%	43	7%
Manufacturing	69	3%	61	2%	56	3%	5	1%
T.C.P.U.	127	6%	107	4%	87	4%	20	3%
Trade	417	18%	448	17%	390	19%	58	10%
F.I.R.E.	66	3%	76	3%	54	3%	22	4%
Services	275	12%	289	11%	235	11%	54	9%
Health & Education Services	307	13%	541	20%	346	16%	195	32%
Public Administration	144	6%	209	8%	90	4%	119	20%

Source: Census of Population and Housing, 1990

Notes: FBIR - Fort Belknap Indian Reservation
T.C.P.U. - Transportation, Communication, and Public Utilities
F.I.R.E. - Finance, Insurance, and Real Estate
Table presents employed persons who reside in each sub-area of the study area regardless of place of work, which may be in another sub-area of the study are or outside the study area altogether.

TABLE 3.10-3

UNEMPLOYMENT RATES IN THE STUDY AREA, 1970-90
(percentage)

	1970	1980	1990
Montana	4.3	6.1	7.0
Phillips County	4.2	4.2	6.5
Blaine County	10.6	8.5	10.2
Fort Belknap Indian Reservation	NA	41.9	26.9

Sources: 1970 and 1980 data from SDS Economic Consultants 1990 for Montana and Phillips County. Economic Consultants Northwest 1991 for Blaine County and Fort Belknap Reservation. All 1990 data from 1990 Census of Population and Housing Summary Tape File 3 on CD-ROM.

TABLE 3.10-4

PER CAPITA PERSONAL INCOME 1970-91, PHILLIPS & BLAINE COUNTIES
(1991 dollars)

	1970	1980	1990	1991	% Chg. '70-90%
Phillips County	$11,769	$11,104	$14,429	$13,680	23%
Blaine County	$10,680	$10,030	$12,729	$10,534	20%

Source: BEA Regional Economic Information System 1993 (USDOC 1993). Adjusted for inflation by Planning
Information Corporation.

3.10.2.2 Blaine County

The job base in Blaine County has remained about the same over the past two decades (Table 3.10-5). The total number of jobs located in Blaine County in 1991 was 2,898 which was down about 4 percent from 1990 and up about 6 percent from 1970. However, the composition of the economic base has shifted due to the decline in the relative importance of agriculture and the increase in government jobs and revenue. In 1991, agriculture provided 26 percent of all jobs available in Blaine County, down from 34 percent in 1970, while government provided 24 percent, up from 20 percent. The trend is more striking when evaluated in terms of earnings (Table 3.10-5). In 1990 and 1991, agricultural sectors contributed 28 and 2 percent, respectively, of total earnings generated in the county, down from 43 percent in 1970, while government contributed 29 and 44 percent of total earnings, up from 20 percent. In Blaine County, as in Phillips County, agricultural earnings have varied considerably from year to year during the study period.

Nevertheless, agriculture continues to employ the largest number of workers living in Blaine County. According to the 1990 Census, 30 percent of employed persons residing in Blaine County held agricultural jobs (Table 3.10-2). Twenty percent of employed persons held jobs in health and educational services (including those provided by government agencies), 17 percent in the trade sectors, and 11 percent in business and personal services. About 8 percent of Blaine County's residents were employed in public administration, and 5 percent were employed in construction. Since 1970, unemployment in Blaine County typically has been higher than the Montana state average (Table 3.10-3). Per capita income in Blaine County was $10,534 in 1991, ranking last in the state, with 67 percent of the state average and 55 percent of the national average. Real per capita income grew less than one percent in 1991 compared to 1990, partly because of a large decline in the number of jobs in the service sector and partly due to inflation (Table 3.10-5; Peacock 1994).

Note that in 1990 there were many more Blaine County residents employed in mining (Table 3.10-2) than there were mining jobs held in Blaine County (Table 3.10-5). This indicates that Blaine County residents commute outside the county to find work in the mining industry. It also suggests that they may be finding mining work at the Zortman and Landusky mines which is located within commuting distance of some Blaine County communities. Therefore, a small but important share of the Blaine County labor force employed in mining depends on the Zortman and Landusky mines for employment. A comparison of the two tables also indicates that overall, Blaine County is a net importer of workers by a small margin due to the availability of jobs in trade and services.

3.10.2.3 Fort Belknap Indian Reservation

About 80 percent of the physical area of the Fort Belknap Indian Reservation is located within Blaine County. This part of the reservation contains the communities of Hays and Lodgepole and about 96 percent of the population residing on the reservation in 1990. The remainder of the physical area and population of the reservation is located within Phillips County. Therefore, socioeconomic statistics for both Blaine and Phillips counties include information about the population on the Fort Belknap Indian Reservation. However, statistics about Blaine County are much more heavily influenced by the reservation population, which was about 34 percent of the total population of Blaine County in 1990. In Phillips County, the reservation population was about 4 percent of the total county population in 1990.

The Fort Belknap Indian Reservation has a limited job base and few private employers. The three largest employers located on the reservation are government agencies. The Fort Belknap Indian Community employs about 135 people, the Fort Belknap Agency of the Bureau of Indian Affairs (BIA) employs about 55 people, and the Indian Health Service of the Department of Health and Human Services employs about 35 people. Many of these jobs are in public administration, health services, and home construction. Other jobs are available in Fort Belknap Indian Community-owned enterprises, the Fort Belknap Gaming Operation bingo hall and the Fort Belknap Kwik-Stop convenience store, and in a few private enterprises scattered about the reservation. Agriculture provides jobs and personal income on the reservation directly through crop and livestock production or through the leasing of land owned by tribal enrollees and residents. The Fort Belknap Indian Community also has invested in off-reservation industrial development in the past (Economic Consultants Northwest 1991).

According to the 1990 Census, 32 percent of employed persons residing on the Fort Belknap Indian Reservation held jobs in health and educational services (including those provided by government agencies), and 20 percent held public administration jobs. Twelve percent of resident workers were employed in

TABLE 3.10-5

EARNINGS, EMPLOYMENT, AND EARNINGS PER EMPLOYEE IN BLAINE COUNTY, 1970-91
(earnings in thousands of 1991 dollars)

	1970	1970%	1980	1980%	1990	1990%	1991
Earnings - Total	$51,870	100%	$35,629	100%	$49,226	100%	$32,967
Agric. & Agric. Services	$22,233	43%	$63	0%	$13,861	28%	$787
Construction	$1,807	3%	$2,824	8%	$1,654	3%	$1,477
Government	$10,408	20%	$12,087	34%	$14,464	29%	$14,404
Manufacturing	$2,028	4%	$193	1%	$466	1%	$569
Mining	$42	0%	$770	2%	$165	0%	$167
Services	$4,444	9%	$7,315	21%	$9,618	20%	$6,001
T.C.P.U. & F.I.R.E.	$2,929	6%	$4,421	12%	$2,665	5%	$3,464
Trade	$7,980	15%	$7,956	22%	$6,333	13%	$6,098
Employment - Total	2,743	100%	2,864	100%	3,012	100%	2,898
Agric. & Agric. Services	921	34%	727	25%	775	26%	761
Construction	95	3%	140	5%	76	3%	7
Government	553	20%	625	22%	700	23%	695
Manufacturing	81	3%	21	1%	20	1%	23
Mining	2	0%	17	1%	4	0%	4
Services	446	16%	538	19%	643	21%	485
T.C.P.U. & F.I.R.E.	156	6%	221	8%	188	6%	240
Trade	489	18%	575	20%	606	20%	612

Sheet 1 of 2

TABLE 3.10-5 - EARNINGS, EMPLOYMENT, AND EARNINGS PER EMPLOYEE (BLAINE COUNTY)
(Concluded)

	1970	1970%	1980	1980%	1990	1990%	1991
Earnings/Employee							
Average	$18,910		$12,440		$16,343		$11,376
Agric. & Agric. Services	$24,140		$87		$17,885		$1,034
Construction	$19,016		$20,174		$21,766		$18,936
Government	$18,821		$19,340		$20,662		$20,725
Manufacturing	$25,031		$9,208		$23,297		$24,739
Mining	$21,047		$45,302		$41,173		$41,750
Services	$9,965		$13,596		$14,958		$12,373
T.C.P.U. & F.I.R.E.	$18,776		$20,004		$14,177		$14,433
Trade	$16,320		$13,836		$10,451		$9,964

Source: BEA Regional Economic Information System on CD-ROM, May 1993 (USDOC 1993).

Notes: Table presents employment in terms of jobs held in the county, regardless of the place of residence of the persons holding the jobs.
T.C.P.U. - Transportation, Communication, and Public Utilities
F.I.R.E. - Finance, Insurance, and Real Estate

agriculture, 10 percent in trade, 3 percent in business and personal services, and 7 percent in construction (Table 3.10-2).

Unemployment on the Fort Belknap Indian Reservation is very high and much higher than the surrounding counties and state as a whole (Table 3.10-3). However, the level of unemployment on the reservation has declined over the past decade. Unemployed persons were about 27 percent of the labor force in 1990, according to the federal decennial census, down from about 42 percent in 1980. This improvement may be due to the growing importance of government as an employer on the reservation. According to federal census data, about 64 percent of employed persons on the Fort Belknap Indian Reservation worked for government in 1990, up from about 54 percent in 1980. The percentage of employed persons working in the private sector remained about the same between 1980 and 1990.

Income is lower on the reservation compared to other areas, but there also has been some improvement in reservation income level over the past decade. Median family income in 1989 (measured by the 1990 census) was $14,583 in the Fort Belknap Indian Reservation, compared to $26,862 in Phillips County, $21,347 in Blaine County as a whole, and $28,044 in the state of Montana as a whole. Reservation median family income in 1989 was up by about 6 percent in real terms from the 1979 level of $13,812 (as adjusted for inflation and expressed in 1989 dollars). By this measure, the reservation fared better than Blaine County as a whole where 1989 median family income was down by about 16 percent in real terms from the 1979 level of $25,335 (in 1989 dollars).

3.10.2.4 Tourism and Recreation Based Economy at Hays on the Fort Belknap Reservation

Visitors to the Little Rocky Mountains generally contribute to business activity at Hays. Mostly, the effect is from visitors accessing the scenic, historic, and recreational values of Mission Canyon and of Little Peoples Creek. The main attractions are the resources found in Mission Canyon. Some of these are identified on the Official Montana Highway Map. The highlighting of these places on the map appears to generate some visitation by calling them to the attention of tourists looking for places of interest to visit.

Another potential attraction is the St. Paul's Mission Church in Hays. Resources in Mission Canyon include the Pow Wow grounds; the Sundance (or medicine) Lodge grounds; the natural bridge; the Kid Curry hideout; scenery, swimming, wading and fishing in Little Peoples Creek; informational signage; and picnic and campgrounds. Events that occur in Mission Canyon are the annual Pow Wow and Sundance during July, and a number of large family reunions each summer. Apart from this, general tourist and recreation visitors seek out the canyon for unscheduled use as the weather permits, which is primarily in the summer.

The two businesses in Hays that receive the primary benefit from Mission Canyon visitors are (1) a convenience store/cafe and (2) a convenience store/gas station. Visits to Hays and Mission Canyon have been promoted over the past several years by the owner of the second of these, and the qualitative analysis of this promotion effort indicates that tourism has increased as a result (Martin 1993). It may be noted that the observed increase has co-existed with the presence of the existing Zortman and Landusky mines. The level of visitation to Mission Canyon and its relationship to business activity in Hays is not recorded, and cannot be estimated from readily available information.

3.10.2.5 Perceived Aesthetic Effects, Health Risks and Resultant Economic Effects Under Existing Conditions

Spiritual activity of Native Americans also motivates visits to the Little Rocky Mountains. There is, or may be, a spiritual aspect to organized public events, such as the Pow Wow and Sundance, or organized private events, such as family reunions. Other spiritual activities are intensely personal. By outward appearances, the public activities have continued to be well-attended (Martin 1993). However, by some accounts, some persons intending to participate in the Sundance and or in personal spiritual activity may have been discouraged from participating by the presence of the existing Zortman and Landusky mines. However, information is not available to indicate whether, if this response has occurred, how extensive it is or if it has affected business activity in Hays.

A concern has been expressed during EIS scoping that recreational use of Little Peoples Creek in Mission Canyon may be a public health hazard. The concern is that chemicals entering the water and sediment from waste piles of past gold mining operations may be harmful if contacted or ingested, so warnings should be posted. If the creek were to be posted, this might discourage visitor recreation and affect related business activity. The Federal Public Health Service (PHS) of the Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR) has assessed this concern. After testing samples, ATSDR reported that the chemical concentrations do not pose a public health hazard; therefore, posting warning signs in the area was deemed unnecessary. ATSDR did recommend characterization of the chemical composition of mine waste which may be accessible to the public (Orloff 1992b; Muza 1993).

3.10.2.6 Population

The study area population in 1990 was about 11,900 (see Table 3.10-6), including Phillips County (5,136) and Blaine County (6,728). Communities within Phillips County with measured populations are Malta (2,340) and Dodson (137). Communities with measured populations in Blaine County are Chinook (1,512) and Harlem (882). The 1990 population of the Fort Belknap Indian Reservation was 2,508, including 189 in the Phillips County portion and 2,319 in the Blaine County portion of the reservation.

Population change within the study area has been consistent with local economic conditions. Total study area population declined by approximately 4 percent in 1990 from 1980, continuing a trend dating back several decades (SBS Economic Consulting 1990; Economic Consultants Northwest 1991). Phillips County population was 5,163 in 1990, down 4 percent from 1980. Blaine County population was 6,728 in 1990, down 4 percent from 1980. The decline in Blaine County population off the reservation was much larger than 4 percent because the growth in the reservation population offset the loss. For example, Chinook and Harlem, both off-reservation towns, declined about 9 percent and 14 percent, respectively, during this period.

The decline in population throughout most of the study area was due to people migrating from the area rather than into the area, largely because of minimal economic diversity and opportunity. This trend was heightened by recent declines in oil and gas activity and reductions in agricultural production and supporting businesses (SBS Economic Consulting 1990, Economic Consultants Northwest 1991). The exception to the overall trend was the Fort Belknap Indian Reservation, where reported population increased by approximately 28 percent from 1980 to 1990. In part, growth on the reservation is due to an increase in on-reservation residency of tribal enrollees because of increased availability of jobs and housing (Economic Consultants Northwest 1991).

Trends in population characteristics within the study area are consistent with the overall decline in population (see Table 3.10-7). The population in Phillips County aged during the decade and had a median age of about 34 in 1990 compared to about 30 in 1980. In 1990, median age in Phillips County was about the same as for the state of Montana as a whole. In contrast, Blaine County's population has tended to be younger than that of the state as a whole, largely due to the younger population on the Fort Belknap Indian Reservation. In 1990, median age was about 32 in Blaine County and about 23 on the Fort Belknap Indian Reservation. The two counties differ in racial composition, again due to the presence of the reservation in Blaine County. In 1990, Native Americans comprised about 7 percent of the population in Phillips County and about 40 percent of the population in Blaine County.

Phillips County is projected to grow very slowly, then to experience declines, and then to grow very slowly again for a net of almost no change in population over the next two decades (see Table 3.10-8). The projection assumes no major change in the current economic base of the county (SBS Economic Consulting 1990). Blaine County is projected to grow slowly for a total population increase of approximately 6 percent over the next two decades, an average annual growth rate of less than one-half of one percent. This projection assumes a continuation of past trends in employment in the county (Economic Consultants Northwest 1991).

3.10.2.7 Economic Effects of the Existing Zortman and Landusky Mines

The existing Zortman and Landusky mines have been in operation in Phillips County since 1979. At that time, no other economic activity approached agriculture in importance in Phillips County and in the Little Rocky Mountains area. Over time, the mines have added diversity to an economy hampered by limited natural resources and distance from population centers. Initially, the mines created about 30 to 40 direct jobs in Phillips County (DSL 1979a) a level that equated to about 1 percent of all the jobs available in the county in 1980. By 1985, there were about 190 direct jobs at the mines, consisting of about 90 jobs with Zortman Mining, Inc. and about 100 jobs with contract miner N.A. Degerstrom (DSL/BLM 1990). This 1985 direct employment level equated to about 7 percent of all jobs available in Phillips County at the time.

Currently employment at the mines averages about 200 workers. The mines also employ about 20 additional

TABLE 3.10-6

POPULATION IN THE STUDY AREA, 1970-90

	1970	1980	1990	% Change 1980-1990
Montana	694,409	786,690	799,065	1.6%
Study Area	12,113	12,366	11,891	-3.8%
Phillips County	5,386	5,367	5,163	-3.8%
Malta	2,195	2,367	2,340	-1.1%
Dodson	196	158	137	-13.3%
Other	2,995	2,842	2,686	-5.5%
Blaine County	6,727	6,999	6,728	-3.9%
Chinook	1,813	1,660	1,512	-8.9%
Harlem	1,094	1,023	882	-13.8%
Other	3,820	4,316	4,334	0.4%
Fort Belknap Indian Reservation	1,398	1,961	2,508	27.9%
Phillips County	NA	NA	189	NA
Blaine County	NA	NA	2,319	NA

Sources: (1) Census of Population 1990, (2) SBS Economic Consultants 1990, (3) Economic Consultants Northwest 1991.

TABLE 3.10-7

SELECTED STUDY AREA POPULATION CHARACTERISTICS (1980 and 1990)

	Montana	Phillips County	Blaine County	Fort Belknap Reservation
Median Age				
1980	29.0	29.5	27.5	20.0
1990	33.9	34.0	31.6	23.1
Race, % White				
1980	92.8	92.4	NA	NA
1990	94.1	92.6	60.0	6.1
Race, % American Indian				
1980	4.7	6.7	NA	NA
1990	6.0	7.1	39.6	93.2

TABLE 3.10-8

POPULATION PROJECTIONS FOR PHILLIPS AND BLAINE COUNTIES, 1990 to 2010

	Montana	Phillips County	Blaine County
1990	799,065	5,163	6,728
1995	802,800	5,187	6,786
2000	798,700	5,160	6,862
2005	797,000	5,147	6,978
2010	799,000	5,160	7,122
Projected growth 1990-2010	0.0%	-0.1%	5.9%
Projected annual growth rate 1990-2010	0.0%	0.0%	0.3%

Sources (both tables): (1) Census of Population 1990, (2) SBS Economic Consulting 1990, (3) Economic Consultants Northwest 1991.

persons annually between April and October to perform reclamation and other seasonal work. Typically 15 of the seasonal workers are college students on a 3-month summer hire program. The students are children of mine employees. The remaining 5 seasonal workers are temporary employees hired locally for a period of five to six months. The temporary employees are eligible for unemployment when the season ends (Ryan 1994). Based on average employment levels, the mine's payroll currently is about $6.7 million per year, plus about $2.2 million in benefits (1993 dollars). Average earnings are about $44,000 per employee including benefits. The mine currently purchases about $23 million per year of goods and services used in operations (Eickerman 1993). Table 3.10-9 summarizes these data.

Two hundred jobs at the Zortman and Landusky mines represented about 50 percent of all mining jobs located in Phillips County and about 7 percent of all Phillips County jobs based on a comparison with general economic data from 1991. For the same period, the earnings of Landusky and Zortman employees represented 55 percent of earnings in the mining sector, and 17 percent of total earnings generated within Phillips County. (Since general economic data from 1991 are the latest available for Phillips County, dollar amounts of earnings were converted to 1991 equivalents for use in this comparison.)

As of October of 1993, mine employment was 223, about 89 percent of whom lived within the study area -- just under 77 percent (or 171 employees) lived in Phillips County; and just under 13 percent (or 28 employees) lived in Blaine County (Eickerman 1993). Forty-one employees of the existing mine are Native Americans, and all live within the study area. A breakdown of employee residency by study area community is presented in Table 3.10-10.

Of school-age children, 234 are associated with the mine workforce at this time and 212 attend schools within the study area (Eickerman 1993). A breakdown of school-age children by community also is presented in Table 3.10-10. The Zortman and Landusky mines' effect on total population within the study area is estimated to be about 460 persons in Phillips County communities, about 80 persons in Hays, and about 20 persons in other Blaine County communities. This estimate is based on household size factors from the 1990 census for Phillips and Blaine counties and the Fort Belknap Indian Reservation, as adjusted to account for specific household characteristics implied by information reported by the mine. See Table 3.10-10 for estimated mine-related population by community. Assuming about 89 percent of the mines' employees live in the study area, the mines' study area payroll was about $5.2 million in 1993.

A little less than 20 percent of total operating expenditures by the mine in 1993, or $4.6 million, were made within the study area, with about 99 percent of that amount spent in Phillips County. About 97 percent of expenditures within Phillips County occur in Malta, with the remainder spread among Zortman, Dodson and Saco (Thompson 1993). The mine purchases electrical power, fuels, and light vehicles from Phillips County suppliers. The small amounts expended in Blaine County are in Harlem, Chinook and Hays (Geyer and Erickson 1993).

A little more than 40 percent of total expenditures by the mine in 1993, or about $9.9 million, were made outside the study area but within other parts of the state of Montana. Of these expenditures, most were made in Billings (about $6.7 million) and Helena (about $1.2 million). Other Montana cities capturing more than $100,000 a year in mine expenditures are Butte, Bozeman, Missoula, Lewistown, and Havre. The remainder of the mines' expenditures in 1993, about $9 million or 40 percent, were made outside of Montana.

In 1993, $60,000 in operating expenditures represented purchases from Native American-owned businesses.

The earnings of local employees (less taxes) and business purchases from state and local suppliers are the Zortman and Landusky mines' direct contribution to the economy of the State of Montana and the study area. Additional business activity and employment is generated as these amounts circulate through the state and local economy.

Throughout the State of Montana, the 200 jobs, $6.7 million in payroll, and $23.0 million in operating expenditures by the Zortman and Landusky mines generated an additional 317 jobs and $6.4 million in earnings. These impacts included 87 jobs and $1.7 million in earnings, and within the study area consisting of Phillips and Blaine counties (see Table 3.10-9). The remaining economic impacts within the state occur mainly in the larger cities of Montana where equipment companies, chemical suppliers, and other vendors of goods and services utilized in the mining industry, are located. Examples of cities which capture a large share of the mine's purchases are Billings, Helena, Butte, Bozeman, and Missoula. Economic impacts also occur in communities that capture the remainder of the mine's Montana business spending and in communities outside of Phillips and Blaine counties where mine employees reside. (The impacts presented here were estimated

TABLE 3.10-9

ECONOMIC PROFILE FOR EXISTING ZORTMAN/LANDUSKY MINE: DIRECT AND SECONDARY EFFECTS

October 1993

(expenditures in millions of 1993 dollars, all values on average annual basis)

	Direct Effects	Secondary Effects (additional jobs and earnings)	
		Total In State of Montana (including Study Area)	In Study Area Only (Phillips and Blaine counties)
Employment	200	317	87
Labor Expenditures	$8.9	NA	NA
Payroll (excluding benefits)	$6.7	$6.4	$1.7
Benefits	$2.2	NA	NA
Operating Expenditures	$23.0	NA	NA

Sources: Eickerman 1993 for direct effects.
Estimates of secondary effects by Planning Information Corporation.

TABLE 3.10-10

DIRECT EMPLOYMENT, SCHOOL AGE CHILDREN, POPULATION BY COMMUNITY: ESTIMATED EFFECTS OF THE EXISTING LANDUSKY/ZORTMAN MINE

October 1993

	Employment			School-Age Children		Population (est)	
	Number	% Total	% Study Area	Number	% Study Area	Number	% Study Area
Total	223	100.0%		234			
Study Area	199	89.2%	100.0%	212	100.0%	556	100.0%
Phillips County	171	76.7%	85.9%	180	84.9%	457	82.2%
Dodson	10	4.5%	5.0%	11	5.2%	27	4.9%
Malta	108	48.4%	54.3%	146	68.9%	365	65.6%
Saco	4	1.8%	2.0%		0.0%	8	1.4%
Zortman	49	22.0%	24.6%	23	10.8%	57	10.3%
Blaine County	28	12.6%	14.1%	32	15.1%	99	17.8%
Chinook	2	0.9%	1.0%	6	2.8%	10	1.8%
Harlem	3	1.3%	1.5%	2	0.9%	8	1.4%
Hays	23	10.3%	11.6%	24	11.3%	81	14.6%
Other Counties	24	10.8%		22			
Fergus	21	9.4%		22			
Other	3	1.3%		0			

Source: Eickerman 1993 for employment and school-age children by community.
Population estimates by Planning Information Corporation.

using RIMS II multipliers for the State of Montana and procedures similar to those described in USDOC 1992. A multiplier is an economic ratio used to estimate the secondary economic repercussions of a direct economic impact.)

3.10.3 Facilities and Services

This section describes the availability and specific limitations of facilities and services within the study area in Phillips and Blaine counties and on the Fort Belknap Indian Reservation. Facilities and services described are law enforcement, fire protection, solid waste, water and wastewater, utilities, planning, education, housing, medical and long-term care, and emergency response. The description focuses on communities which have the most potential to be affected by population change brought on by the proposed action and alternatives. The identification of potentially affected areas is based on where current Landusky and Zortman mine employees live. Communities considered in this section include those within the study area where three or more current mine employees reside (see Table 3.10-10). Therefore, Harlem (Blaine County) is considered, but Chinook (Blaine County) is not. Facilities and services available in unincorporated areas of the county also are described. In the counties (excluding the reservation), most services are provided by public agencies such as county and city government, school districts, and special districts. These agencies rely almost entirely on local public revenues. The fire and ambulance services are all staffed by volunteers. On the reservation, law enforcement, hospital, medical, and ambulance services are provided by the BIA with federal funds.

3.10.3.1 Phillips County

Table 3.10-11 summarizes the facilities and services available in unincorporated Phillips County and in the communities of Malta, Zortman, and Dodson. In general, facilities and services, though limited, are adequate and within the range of expectation for a sparsely populated county lacking a community of more than 2,500 and far from other population centers. Limitations observed are no juvenile detention facility, difficulty responding to fires in rural areas in winter, a space shortage at the elementary school in Malta, a single hospital with no intensive care or surgical services, no 911 emergency calling, and no local air ambulance transport.

3.10.3.2 Blaine County

Table 3.10-12 summarizes the facilities and services available in unincorporated Blaine County and in the communities of Harlem and the Fort Belknap Indian Reservation, including Hays. In Blaine County (excluding the reservation), facilities and services are also limited though adequate for a sparsely-populated, rural county. Limitations noted in Blaine County (reservation excluded) include understaffing of the sheriff's department, present and historic lack of elementary school capacity at Harlem, no hospital, one long-term care facility (in Chinook) operating at capacity, past space shortages at the Harlem elementary school, understaffing of the Chinook ambulance station, and the existence of remote areas of the county where it may be quicker to call the air ambulance out of Great Falls than the local ambulance. Some limitations, such as the lack of a county hospital, are offset by proximity to Havre (Hill County).

Many facilities and services on Fort Belknap Indian Reservation are provided by either the Fort Belknap Indian Community or the BIA. Observed limitations include needs for jail renovation, a fire hall in Hays, a new solid waste disposal system, alternatives to electricity for home heating, relief from elementary school overcrowding in Hays, and retention and replacement of the aging Indian Health Service (IHS) hospital.

3.10.4 Local Government Fiscal Conditions

Fiscal conditions are presented in the following subsections for Phillips County, the City of Malta, Malta High School, Malta Elementary School, Dodson High School, and Landusky Elementary School. These jurisdictions derive revenues directly from the existing Zortman and Landusky mines. Fiscal conditions are also presented for Blaine County and the Fort Belknap Indian Reservation. Finally, the current direct contribution of the existing Landusky and Zortman mines to local taxing jurisdictions in Phillips County is estimated.

TABLE 3.10-11

FACILITIES AND SERVICES IN PHILLIPS COUNTY

	Unincorporated Phillips County	City of Malta	Zortman	Landusky	Dodson
Law Enforcement	Phillips County Sheriff's Office in Malta. *Juvenile detainees sent to Billings.*	Phillips County Sheriff's Office under contract to city.	See unincorporated Phillips County.	See unincorporated Phillips County.	See unincorporated Phillips County.
Fire Protection	Volunteer fire district with stations in Malta, Zortman. Wildland fire trucks in Malta, Zortman, Dodson, Loring. *Rural response difficult, especially in winter.*	Volunteer fire station.	Volunteer fire district station.	See unincorporated Phillips County.	See unincorporated Phillips County.
Solid Waste	County-wide sanitation district. *Sites and collection points NA.*	County-wide sanitation district. *Sites and collection points NA.*	County-wide sanitation district. *Sites and collection points NA.*	County-wide sanitation district. *Sites and collection points NA.*	County-wide sanitation district. *Sites and collection points NA.*
Water and Wastewater	Well and septic.	City operated. *Old water mains. Wastewater at 80% capacity.*	Public water system. Septic.	Private water wells and septic tanks.	See unincorporated Phillips County.
Utilities	Natural gas, electricity, telephone generally available.	Natural gas, electricity, telephone.	See unincorporated Phillips County.	See unincorporated Phillips County.	See unincorporated Phillips County.
Planning	Building permits. 1987 master plan.	Building permits. Zoning.	See unincorporated Phillips County.	See unincorporated Phillips County.	See unincorporated Phillips County.

Sheet 1 of 3

TABLE 3.10-11 - FACILITIES AND SERVICES (PHILLIPS COUNTY)
(Continued)

	Unincorporated Phillips County	City of Malta	Zortman	Landusky	Dodson
Education	Public elementary in Malta, Dodson, Landusky, Saco, Second Creek and Whitewater. Public secondary in Malta, Dodson, Saco and Whitewater. *See limitations noted under other locations.*	Public elementary and secondary. Parochial elementary. *As of 1990, no public K-6 capacity to absorb additional pupils without adversely affecting accreditation.*	Public elementary. High school in Malta. *Two-classroom building. One teacher*	Public elementary. High school in Malta or Dodson.	Public elementary and secondary. *All grades in one 13-classroom building.*
Housing	New construction permitted with building permit and adequate sewage disposal. Change of use, survey, soil and drainage reports may be required. *Availability NA.*	Housing generally available for sale and rent. New construction permitted. Mobile homes permitted in designated zones.	See unincorporated Phillips County. *Availability NA.*	See unincorporated Phillips County. *Availability NA.*	See unincorporated Phillips County. *Limited availability of housing, lots.*
Medical	See Malta.	Hospital, medical clinic, home nursing service. *No intensive care or operating room services.* *Emergency medical service sometimes on call.* Alcohol and drug counseling.	See Malta.	See Malta.	See Malta.

TABLE 3.10-11 - FACILITIES AND SERVICES (PHILLIPS COUNTY)
(Concluded)

	Unincorporated Phillips County	City of Malta	Zortman	Landusky	Dodson
Long-Term Care	See Malta.	Personal care home. Skilled nursing home. Retirement apartments.	See Malta.	See Malta.	See Malta.
Emergency Response	Volunteer ambulance district stations in Saco, Whitewater. *No 911. Emergency call may be long distance.* *No Jaws-of-Life.* *No local emergency air transport.*	Volunteer ambulance district station. *No 911.* *No Jaws-of-Life.* *No local emergency air transport.*	Volunteer ambulance district station. *No 911. Emergency call may be long distance.* *No Jaws-of-Life.* *No local emergency air transport.*	See unincorporated Phillips County.	See unincorporated Phillips County.

Source: SBS Economic Consulting 1990.

Notes: Table identifies services available and describes *any known limitations (in Italics)*
"NA" in table means this location was not addressed in the source document and, therefore, information is currently not available.

TABLE 3.10-12

FACILITIES AND SERVICES IN BLAINE COUNTY

	Unincorporated Blaine County	Harlem	Fort Belknap Indian Reservation and Hays
Law Enforcement	Blaine County Sheriff's Department in Chinook. *More patrol officers, one corrections officer required for current workload.* *Harlem has working relationship with BIA on pursuit of offenders.*	Harlem Police Department *Harlem police have working relationship with BIA police on pursuit of offenders.*	BIA Police Department in Fort Belknap Agency. *Needed jail renovation is pending.*
Fire Protection	Volunteer fire service in Chinook, Harlem, Fort Belknap Reservation. Brush-fire trucks located on farms in rural areas.	Volunteer fire service in Harlem.	Fort Belknap Community Fire Department for structure fires. Volunteers in Fort Belknap Agency, Hays, Lodgepole. BIA Fire Department for wild fires. *Development of Hays fire hall pending.*
Solid Waste	Consolidated refuse district has container sites in Harlem, Chinook.	Consolidated refuse district container site.	Open pit landfills. *Fort Belknap Community has joined consolidated refuse district. Landfill closure and new collection method pending.*
Water and Wastewater	Well and septic.	Harlem municipal systems.	Hays community water supply serves most homes. Others on wells. Hays wastewater system serves some homes. Others on septic. *1992 samples from several private wells in Hays contained levels in excess of EPA Secondary Maximum Contaminant Levels (SCML) of naturally occurring inorganic chemicals often found in groundwater throughout the area. See Section 3.10.3.2.*

TABLE 3.10-12 - FACILITIES AND SERVICES (BLAINE COUNTY)
(Continued)

	Unincorporated Blaine County	Harlem	Fort Belknap Indian Reservation and Hays
Utilities	Natural gas, electricity, telephone generally available.	Natural gas, electricity, telephone.	Electricity, telephone available in Hays. *Wood and propane are used as alternatives to electricity for home heating.*
Planning	*Comprehensive plan pending.*	Zoning and regulation for residential, mobile home, business location.	NA
Education	Public elementary and secondary schools in Chinook and Harlem.	Public elementary and secondary schools in Harlem. *In 1991 overcrowding existed K-6, but was accommodated through use of excess capacity 7-12.*	Public elementary at Lodgepole and secondary at Hays. Parochial elementary at Hays. *In 1991 overcrowding was accommodated by housing K-5 at Lodgepole and 6-12 at Hays.*
Housing	Home construction permitted under Montana state subdivision and public health. *No county building code.* *Housing availability NA.*	Some houses available for sale. Some apartments available for rent. New home construction permitted. Mobile homes permitted in designated zones. *Mobile home space availability NA.*	*On-reservation program housing restricted to American Indians.* *Non-program housing availability NA.*
Medical	Medical clinic, mental health counseling, home health nurse in Chinook. *Hospitals in Havre and Malta.*	See unincorporated Blaine County.	Indian Health Service (IHS) hospital, medical clinic, chemical dependency treatment in Fort Belknap Agency. Satellite medical clinic in Hays. *On-reservation services restricted to American Indians.* *New hospital construction pending.*
Long-Term Care	Nursing home in Chinook. *Operating at capacity or more.*	Nursing home.	*No on-reservation long-term care facilities.*

TABLE 3.10-12 - FACILITIES AND SERVICES (BLAINE COUNTY)
(Concluded)

	Unincorporated Blaine County	Harlem	Fort Belknap Indian Reservation and Hays
Emergency Response	Volunteer ambulance service stations at Chinook, Harlem, Turner. *Understaffed.* *In remote areas air ambulance from Great Falls may be quicker.*	Volunteer ambulance service.	IHS ambulance service at Fort Belknap Agency, Hays.

Source: SBS Economic Consulting 1990.

Notes: Table identifies services available and describes any *any known limitations (in Italic)*
"NA" in table means this location was not addressed in the source document, and therefore, information is currently not available.

3.10.4.1 Phillips County

Table 3.10-13 presents total taxable value and total property tax levies in Phillips County through the present. Total taxable value was about $20.3 million in 1993 and is estimated to be about $19.8 million in 1994. The estimated 1994 level is a decrease of 45 percent from 1990 and represents a continuation of a declining trend since 1985. The total property tax levy was 43.63 mils in 1993 and is estimated to be 47.76 mils in 1994, an increase of about 65 percent since 1990. Components of the current tax base are presented in Table 3.10-14. Centrally assessed property (including pipelines, gas companies, railroads and net proceeds from oil and gas valuation) is the largest component (32 percent), followed by personal property (27 percent), agricultural property (18 percent), and improved real property (13 percent).

In fiscal year (FY) 1993, Phillips County reported budgeted revenues of about $6 million, up 13 percent from FY 1990 (Table 3.10-15). As a share of total revenue, property taxes decreased to 14.2 percent in FY 1993, down from a 19 percent share in FY 1990, a decrease in property tax revenue of about 17 percent between FY 1990 and FY 1993. The category of "Other Revenues," the largest share of the county's revenue base, doubled between FY 1990 and FY 1993. This was due to the need to develop other revenue sources in order to offset a decrease in property tax revenues. The decline in property tax revenues reflected, in part, a decline of more than 40 percent in taxable value during the same period. In the same period, budgeted expenditures went from $4.5 million to $ 3.5 million, a 21 percent decrease. Nearly 40 percent of all expenditures went towards public works and highway construction and maintenance. The next largest category is general government (23 percent), which covers financial and legislative services and facilities administration. More than 16 percent of expenditures went to cover police, fire, and judicial responsibilities.

3.10.4.2 City of Malta

Total taxable value for the City of Malta (Table 3.10-15) was $2,183,957 in FY 1993, down about 3 percent from in FY 1990. The City of Malta general fund covers the functions of public safety, general government, and public works. Water, sewer, and refuse are handled through enterprise funds. Total budgeted resources were $837,212 in FY 1993, up 14 percent from FY 1990. Revenues from property taxes were almost unchanged in FY 1993 compared to FY 1990 and other taxes increased about 5 percent. Property tax revenues were a 30 percent share of total resources in FY 1993, down from 34 percent in FY 1990. Between FY 1990 and FY 1993, total budgeted general fund expenditures increased from $445,270 to $452,713 (up about 2 percent). About 50 percent of general fund expenditures went to public safety, followed by general government (32 percent) and recreation and culture (18 percent).

3.10.4.3 Malta High School District

Fiscal conditions of the Malta High School District are presented in Table 3.10-16. Malta High School had an average number of students belonging (ANB) of 222 in FY 1993, up 2.3 percent from 217 in FY 1990. In FY 1994, ANB is expected to be 231, up about 4 percent (Baden 1993). In FY 1993, Malta High School operated on a budget of about $1.2 million (excluding comprehensive insurance), up about 15 percent from about $1.1 million in 1990. About 85 percent of the FY 1993 budget was in the general fund. In FY 1993, property tax revenues financed about 15 percent of total budgeted expenditures, down from 32 percent in FY 1990. Property tax revenues were about $178,000 in FY 1993, down about 48 percent from FY 1990. The decline in property tax revenues was offset by other forms of state and local revenue, such as state and county education equalization funds. Taxable value in the Malta High School District was $9.2 million in FY 1993, up 13 percent from $8.2 million in FY 1990. In FY 1994 taxable value is expected to be about $8.4 million, down about 10 percent (Baden 1993). The total levy for the district was 19.24 mils in FY 1993, down by about 50 percent from 41.33 in FY 1990. The mill levy is expected to increase to 33.86 mils in FY 1994. Similar to other school districts in Phillips County, the Malta High School District receives a large share of total revenues from ad valorem taxes directly associated with the existing Zortman and Landusky mines.

3.10.4.4 Malta Elementary School District (including Zortman Elementary)

Fiscal conditions of the Malta Elementary School District, which includes the Zortman Elementary School, are presented in Table 3.10-16. The district maintains schools in Malta, Tallow Creek, Loring, and Zortman. ANB for the district was 463 in FY 1993, down 6.5 percent from 495 in FY 1990. ANB in FY 1994 is expected to decrease by 2 (Baden 1993). Malta Elementary School operated on a budget of $1.9 million in FY 1993, up 21 percent from $1.57 million in FY 1990. About 84 percent of FY 1993 expenditures were

TABLE 3.10-13

PHILLIPS COUNTY TAXABLE VALUE AND PROPERTY TAX LEVIES
(current dollars)

Fiscal Year	Taxable Value	Total Levy
1980	$19,152,182	62.55
1985	39,347,917	32.55
1990	36,275,397	28.88
1993	20,295,327	43.63
1994	19,865,693	47.76

Source: Barnard 1993, Phillips County Assessor, Phillips County budget documents.

TABLE 3.10-14

COMPONENTS OF PHILLIPS COUNTY TAXABLE VALUE, FY 1994
(estimated current dollars)

Property Type	Market Value	Taxable Value
Agricultural	$12,249,426	$3,674,827
Non-Agricultural	13,719,289	474,320
All Improvements	73,457,273	2,613,888
Total Allocations	64,253,862	6,391,345
Gross Proceeds	41,408,877	1,242,266
Personal Property	73,930,287	5,465,159
Intra-County Co-Op	129,604	3,888
Total	$279,148,618	$19,865,693

Source: Barnard 1993, Phillips County Assessor.

TABLE 3.10-15

SELECTED GENERAL PURPOSE GOVERNMENT IN PHILLIPS COUNTY, BUDGETED REVENUES AND EXPENDITURES, FY 1990-93

(current dollars)

	Phillips County			City of Malta		
	FY	FY	% Change	FY	FY	% Change
	1990	1993	FY '90-93	1990	1993	FY '90-93
Revenues[1]						
Property Taxes	$1,033,913	$860,494	-16.8%	$247,159	$247,177	0.0%
Other Revenues	1,335,598	2,714,390	103.2%	389,387	406,718	4.5%
Cash less Liability	2,975,054	2,466,916	-17.1%	208,250	183,317	-12.0%
Total Resources	$5,344,565	$6,041,800	13.0%	$732,030	$837,212	14.4%
Expenditures[1]						
General Govt.	$815,710	$803,862	-1.5%	$145,162	$144,1775	-0.7%
Public Safety	553,040	572,185	3.5%	231,297	224,540	-2.9%
Social/Health	469,539	466,246	-0.7%	1,050	400	-61.9%
Rec. Culture	153,700	120,935	-21.3%	64,180	79,647	24.1%
Public Works	2,080,338	1,496,831	-28.0%	3,581	4,000	12.0%
Misc.	410,655	63,630	-84.5%	NA	NA	NA
Total	$4,482,982	$3,523,689	-21.4%	$445,270	$452,713	1.7%

[1] City of Malta data exclude enterprise activity expenses and revenues.

Source: Phillips County budget documents, City of Malta budget documents.

TABLE 3.10-16

SELECTED SCHOOL DISTRICTS IN PHILLIPS COUNTY, BUDGETED REVENUES AND EXPENDITURES, FY 1990-93
(current dollars)

	Malta Elementary School District[1]			Malta High School District			Landusky Elementary School District			Dodson High School District		
	FY 1990	FY 1993	% Change 90-93	FY 1990	FY 1993	% Change 90-93	FY 1990	FY 1993	% Change 90-93	FY 1990	FY 1993	% Change 90-93
Property Tax Revenues												
General	$280,487	$354,207	26.3%	$324,711	$155,789	-52.0%	$9,782	$7,966	-18.6%	$143,662	$97,191	-32.3%
Mils	37.01	41.69	12.6%	39.56	16.81	-57.5%	3.04	3.00	-1.3%	29.82	23.00	-22.9%
Transportation	$60,194	$24,722	-58.9%	$14,032	$20,460	45.8%	$1,300	$0	-100.0%	$26,156	$26,960	3.1%
Mils	7.95	2.96	-62.8%	1.71	2.21	29.2%	0.41	0	-100.0%	5.43	6.38	17.5%
Debt Service	$250	$961	284.4%	$478	$1,998	318.0%	$0	$0	0.0%	$33,056	$37,101	12.2%
Mils	0.04	0.12	200.0%	0.06	0.22	266.7%	0.00	0.00	0.0%	6.86	8.78	28.0%
Tuition	$19,572	$1,686	-91.4%	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%
Mils	2.59	0.20	-92.3%	0.00	0.00	0.0%	0.00	0.00	0.0%	0.00	0.00	0.0%
Adult Education	$0	$0	0.0%	$0	$0	0.0%	$0	$0	0.0%	$0	$1,997	
Mils	0.00	0.00	0.0%	0.00	0.00	0.0%	0.00	0.00	0.0%	0.00	0.48	
Total Revenues	$360,503	$381,576	5.8%	$339,221	$178,247	-47.5%	$11,082	$7,966	-28.1%	$202,874	$163,249	-19.5%
Total Mils[2]	47.59	44.97	-5.5%	41.33	19.24	-53.4%	3.45	3.00	-13.0%	42.11	38.64	-8.2%
Taxable Value	$7,579,493	$8,351,331	10.2%	$8,209,623	$9,254,987	12.7%	$3,226,113	$2,654,595	-17.7%	$4,818,804	$4,225,705	-12.3%

TABLE 3-10.16 - SELECT SCHOOL DISTRICT BUDGETED REVENUES AND EXPENDITURES
(PHILLIPS COUNTY)
(Concluded)

	Malta Elementary School District[1]			Malta High School District			Landusky Elementary School District			Dodson High School District		
	FY 1990	FY 1993	% Change 90-93	FY 1990	FY 1993	% Change 90-93	FY 1990	FY 1993	% Change 90-93	FY 1990	FY 1993	% Change 90-93
Expenditures by Fund												
General	$1,275,982	$1,607,805	26.0%	$917,069	$1,049,894	14.5%	$29,235	$33,315	14.0%	$429,684	$483,336	12.5%
Transportation	112,650	116,000	3.0%	59,968	67,000	11.7%	4,742	2,847	-40.0%	61,573	64,083	4.1%
Retirement	169,500	190,135	12.2%	93,500	109,555	17.2%	2,629	3,050	16.0%	38,600	56,000	45.1%
Debt Service	900	1,500	66.7%	900	2,500	177.8%	0	0	0.0%	60,670	62,992	3.8%
Tuition	20,707	2,250	-89.1%	0	0	0.0%	0	0	0.0%	0	0	0.0%
Adult Education	0	0	0.0%	0	0	0.0%	0	0	0.0%	1,936	4,800	147.9%
Total Budget[2]	$1,579,739	$1,917.690	21.4%	$1,071,437	$1,228,949	14.7%	$36,606	$39,212	7.1%	$592,463	$671,211	13.3%
ANB	495	463	-6.5%	217	222	2.3%	13	8	-38.5%	41	50	22.0%

Source: Final Budget Report, Montana Office of Public Instruction 1993.

[1] The Malta Elementary School District includes the Zortman Elementary School.
[2] The total mill levy for each district excludes comprehensive insurance.

Notes: ANB - Average Number Belonging

in the general fund. Property tax revenues were about 20 percent of expenditures in FY 1993, down about 6 percent from 22 percent in FY 1990. Total revenue from property taxes was $381,576 in FY 1993, up about 6 percent from $360,503 in FY 1990. Taxable value was $8.3 million in FY 1993, up about 10 percent from $7.5 million in FY 1990. In FY 1994, taxable value is expected to be about $7.5 million, down about 11 percent. The total property tax levy was 44.97 mils in FY 1993, down from 47.59 mils in FY 1990. The total levy for FY 1994 is expected to be 66.93 mils, up 48 percent (Baden 1993).

3.10.4.5 Landusky Elementary School District

Fiscal conditions of the Landusky Elementary School District are presented in Table 3.10-16. ANB for the district was 8 in FY 1993, down from 13 in FY 1990. Because of its small size, ANB for the Landusky Elementary School is hard to predict. Local officials are expecting an ANB of 10 in FY 1994 (Williams 1993). Landusky Elementary School operated on a budget of $39,212 in FY 1993, up from $36,606 in FY 1990. About 85 percent of FY 1993 expenditures were in the general fund. Property tax revenues were 20 percent of expenditures in FY 1993, down from 42 percent in FY 1990. Total property tax revenues were $7,966 in FY 1993, down from $11,082 in FY 1990. Taxable value was $2.6 million in FY 1993, down about 18 percent from $3.2 million in FY 1990. The total property tax levy was 3.00 mils in FY 1993, down from 3.45 mils in FY 1990. The total levy for FY 1994 is expected to be 28.09 mils. The additional 22.7 mils would finance the cost of a new multi-purpose building (Williams 1993).

3.10.4.6 Dodson High School District

Fiscal conditions of the Dodson High School District are presented in Table 3.10-16. The district operates within a single building and serves grades K-12. ANB for the district was 50 in FY 1993, up from 41 in FY 1990 (+22 percent). Dodson High School operated on a budget of $671,211 in FY 1993, up from $592,463 in FY 1990 (+13 percent). About 72 percent of FY 1993 expenditures were in the general fund. Property tax revenues were about 24 percent of expenditures in FY 1993, down from 34 percent in FY 1990. Total revenue from property taxes was $163,249 in FY 1993, down from $202,874 in FY 1990 (-19.5 percent). Taxable value was about $4.2 million in FY 1993, down from $4.8 million in FY 1990 (-12.3 percent). The total property tax levy was 38.64 mils in FY 1993, down from 42.11 mils in FY 1990 (-8.2 percent). The total levy for FY 1994 is expected to be 38.40 mils, which represents a slight decrease (Baden 1993).

3.10.4.7 Blaine County

Total Blaine County taxable value was approximately $13.8 million in FY 1993, down 52 percent from FY 1990. The property tax levy was 74.19 mils in FY 1993, up more than 13 percent from 65.29 mils in FY 1990. Budgeted property taxes for Blaine County government were about $1 million in FY 1993, down 45 percent from FY 1990. Property taxes were about 28 percent the total FY 1993 budgeted expenditures, down from a 39 percent share in FY 1990. Total budgeted expenditures were $3.6 million in FY 1993, down 24 percent from $47 million in FY 1990. Twenty-eight percent of expenditures were budgeted for public works and highway construction and maintenance followed by general government (22 percent).

3.10.4.8 Fort Belknap Agency

The FY 1993 budget for the Fort Belknap Agency was $7.3 million. About $2.7 million (38 percent) was for tribal priority allocations used to support on-going programs of the Fort Belknap Indian Community. Tribal priority allocation has increased substantially over the past three or four years. Other major funding categories were $1.8 million for recurring programs which include human services, community development, and resource management; $1.3 million for resource management, including project construction and survey design; and $144,900 for fire management and pre-suppression (Boxer 1993).

3.10.4.9 Hays-Lodgepole School District

The Hays-Lodgepole School District is a K-12 district which operates schools on the Fort Belknap Indian Reservation within Blaine County. The Hays-Lodgepole School District houses the lower grades in facilities at Hays and the upper grades at facilities in Lodgepole. In FY 1993, virtually all of the district's revenues were due to Federal and state entitlement programs. The largest of these entitlements was Federal Impact Aid, a program of direct payments to school districts that educate students who live on Federal land, including Indian land. Most of the rest of the district's revenues are from two Montana school finance programs: the state-county foundation program and the guaranteed tax base program. Local ad valorem property taxes are an extremely small part of the revenue base of the Hays-Lodgepole School District. In any case, no facilities or property belonging to the Zortman and Landusky mines are located within the taxing jurisdiction of this school district (Anderson 1994).

3.10.4.10 Fiscal Contribution of Existing Zortman and Landusky Mines

Taxes directly levied upon the existing Zortman and Landusky mines benefit the State and a number of local taxing jurisdictions. All of the local jurisdictions are within Phillips County. Taxing jurisdictions within Blaine County do not levy taxes directly on the existing mine because it is located entirely within Phillips County (Barnard 1993 or 1994?). Neither is there a direct fiscal contribution by the mine to the Fort Belknap Indian Reservation in the form of rents or royalties because no mine property is located on any reservation ground (Ryan 1994).

The existing Zortman and Landusky mines pay ad valorem property taxes on the taxable value of real and personal property and the taxable value of the operation's net proceeds (the value of the mineral produced less certain costs, which is how mineral-bearing property is assessed in the State of Montana). For FY 1994, ZMI's operations had an estimated taxable value of about $4.0 million, or about 20 percent of the total taxable value of property within Phillips County. (Barnard 1993 or 1994?). Taxable value is established by Montana statute as a percentage of market value for each type of property or minerals.

Property taxes for use by general purpose governments are levied on the existing Zortman and Landusky mines by Phillips County government and on some residences owned by ZMI by the City of Malta. Property taxes for public education are assessed at several different jurisdictional levels. The State of Montana levies property taxes for the state university system and for programs that support local public schools. State levies for local school support are pooled and redistributed by formula. Therefore, they may indirectly benefit schools within Phillips County through the State school funding equalization programs.

Other State mandated public education property taxes are assessed at the county level for support of public schools within the county and for school transportation and personnel retirement programs. These funds are pooled at the county level and redistributed by formula to schools within the county.

Still other public education property taxes are levied directly by the local school districts where ZMI property is located. These are the Malta Elementary School District, which operates elementary schools in Malta and Zortman; the Malta High School District, which serves high school students from Malta, Zortman, and other communities in Phillips County; the Landusky Elementary School District, which operates the Landusky Elementary School; and the Dodson High School District, which serves high school students from Landusky, Dodson and other communities in Phillips County.

The existing mine is also assessed the metal mines license tax on the gross value of shipped product in excess of $250,000 (Hines 1993). Twenty-five percent of that tax is allocated directly to Phillips County; the remaining 75 percent goes to the State of Montana. At least 40 percent of the county allocation goes to the County Hard-Rock Mine Trust Reserve Account. That fund had an FY 1993 balance of approximately $1.1 million. The remainder is distributed as follows: (1) one-third to the county's Metal Mines Tax Reserve Account, (2) one-third to the affected high school districts of Malta and Dodson, and (3) one-third to the affected elementary school districts in Landusky and Malta. Funds allocated to the County are earmarked for impact mitigation, planning, and economic development. School districts may use their allocations for general purposes.

The total direct tax contribution for FY 1994 of the existing Zortman and Landusky mines is estimated as about $1.7 million (see Table 3.10-17). The distribution of these amounts may be summarized as follows: about $522,000 accrued to the general fund and other funds of the State of Montana and about $473,600 accrued to the State- and County-level public school funding programs. Some of the latter benefit schools within Phillips County through allocations from these school funding programs. The remainder of about $665,500 accrued directly to a variety of taxing jurisdictions in Phillips County for local government services and public education. These amounts were derived from a combination of property taxes and distributions of the metal mines license tax. The estimates assume FY 1994 mineral production, gross mineral value, and property tax mill levies.

As a measure of their importance, the amounts may also be expressed as a percent of current budgeted revenues for selected jurisdictions: Landusky Elementary School District, $95,600 or 81 percent of budgeted revenues; Dodson High School District, $124,600 or 20 percent; Phillips County, $289,000 or 9 percent; Malta Elementary School, $99,400 or 5 percent; and Malta

TABLE 3.10-17

FISCAL CONTRIBUTION OF THE EXISTING ZORTMAN/LANDUSKY MINE, FY 1994 (estimated)

	Ad Valorem Property Tax[1]	Metal Mines License Tax	Total	%	% Total Budgeted Revenues
State of Montana[2]	$23,800	$498,200	$522,000	31	NA
State/County School Funding[3]	473,600	NA	473,600	29	NA
Phillips County[4]	189,400	99,600	289,000	17	9
City of Malta[4]	1,100	NA	1,100	<1	<1
Malta Elementary School District[5]	82,800	16,600	99,400	6	5
Malta High School District[5]	39,200	16,600	55,800	3	5
Landusky Elementary School District[5]	79,000	16,600	95,600	6	81
Dodson High School District[5]	108,000	16,600	124,600	8	20
Total	$996,900	$664,200	$1,661,100	100	NA

[1] Includes gross proceeds tax, plus tax on real and personal property.

[2] Property tax accrues to university system. Metal mines license tax accrues to general fund and Resource Indemnity Trust Fund.

[3] Countywide education levies accrue to state and county equalization programs, county transportation, and county elementary and high school retirement.

[4] Includes only revenues attributable to taxes paid directly by ZMI. Excludes taxes, fees, charges for service, etc. paid by resident mine employee households.

[5] Property taxes include only those directly levied by the school district.

NA - Calculation of this statistic is not appropriate for this level.

Source: Phillips County Assessor, Phillips County Clerk.
Estimates by Planning Information Corporation.

High School, $55,800 or 5 percent. The City of Malta received $1,100, less than one percent of budgeted revenues.

As noted above, the State allocates 25 percent of metal mines license tax collections from ZMI to Phillips County and requires the County to save at least 40 percent of its allocation in the Hard-Rock Mine Trust Reserve Account (Montana Code Annotated 15-37-117 Date, Ref?). The purpose of this allocation is to have mining operations contribute to the mitigation of the eventual economic and fiscal impacts of closure. Money in the County's Hard-Rock Mine Trust Reserve Account is to be available for local use at mine closure as defined by statute. At that time, at least one-third of the balance in the account must be allocated to local schools for use in mitigating their fiscal impacts. The remainder may be used by the County for debt repayment, property tax relief, economic development, industry recruitment, job development incentive programs, and grants and loans to other impacted local jurisdictions.

The existing Zortman and Landusky mines also pay other state taxes which indirectly benefit Phillips and Blaine counties. These taxes include corporate income taxes and payroll taxes. A share of these tax revenues are allocated to local governments on a per capita or other proportional basis determined by state statute. The contribution to state and local jurisdictions has not been estimated in this analysis.

Although 13 percent of the mine work force (or about 28 workers) live in Blaine County, note that Blaine County receives no tax revenue from the mines. This situation has not had a fiscal impact on Blaine County since the mine opened in 1979 according to a local official. This is because most mine workers who reside in Blaine County were local hires from the Hays area on the Fort Belknap Indian Reservation. These workers lived in the area before the mines reopened, and probably would continue to live there if the mines closed (Benson 1994).

3.10.5 Social Conditions

In this section, objective indicators of social well-being (that is, selected measures of population characteristics) are presented for Phillips County and Blaine County, including the Fort Belknap Indian Community centered on the Fort Belknap Indian Reservation. Then, an overview of social values (or other aspects of the population not captured in reports on employment or income) is presented for each county and for the Fort Belknap Indian Community. Finally, the potentially affected communities are discussed in terms of their ability to adapt to change.

3.10.5.1 Social Well-Being in Phillips County

Indicators of social well-being in Phillips County (Table 3.10-18) present a mixed picture, suggesting the positive and negative factors associated with rural areas. The county lacks some basic services: the number of physicians per 100,000 population is much lower than state and national averages, educational attainment is lower, and the proportion of housing lacking some or all plumbing (an indicator of housing quality) is higher than state averages. Per capita income (1991) is lower than the state and nation, and median family income is lower than for the state. Out-migration from 1980 to 1987 was somewhat higher than for the state as a whole. On the other hand, the percent of families below the poverty line (Economic Consultants Northwest 1991) was slightly lower than state averages, the unemployment rate (1991) was lower than state averages, and the crime rate (1991) was lower than state averages. Other positive factors are the sparse population (which contributes to the low crime rate), plentiful opportunities for recreation, and a predominance of family ranching operations.

3.10.5.2 Social Well-Being in Blaine County

Table 3.10-18 presents information about social well-being in Blaine County much of which is available for the county as a whole (including the Fort Belknap Indian Reservation) but in some cases may not be available separately for the Fort Belknap Indian Reservation. The picture that emerges of this part of the study area is mixed. Educational attainment is much lower than the state and national averages, and the proportion of housing lacking some or all plumbing is higher than state averages. Blaine County as a whole has a much lower rate of physicians to population than the state and national averages. (This characteristic is not available for the Fort Belknap Indian Reservation, where medical care is provided by the IHS.) In Blaine County, per capita income in 1991 (not available for the Fort Belknap Indian Reservation) is lower than state and national averages and, in Blaine County and the reservation, median family income is also lower than both reference areas. In addition, the percent of families below the poverty line and the unemployment rate (both for 1989) were higher than state averages, especially on the Fort Belknap Indian Reservation, and

TABLE 3.10-18

OBJECTIVE INDICATORS OF SOCIAL WELL-BEING

	Phillips County	Blaine County	FBIR[1]	Montana	United States
Physicians per 100,000 population (non-federal) 1985[2]	18	28	(8)	136	197
Education level-percent population completing high school 1990[3]	74.1%	70.4%	67.4%	81.0%	75.2%
Percent housing lacking some or all plumbing 1990[3]	8.0%	2.2%	3.2%	1.9%	1.1%
Per capita personal income 1991[4]	$13,680	$10,534	NA	$15,680	$19,091
Median family income 1989[3]	$26,862	$21,347	$14,583	$28,044	$35,225
Percent families below the poverty level 1989[3]	11.5%	23.2%	40.6%	12.0%	10.0%
Percent population in the working age group 18-64 yrs old[5]	54.4%	53.6%	50.3%	58.9%	61.8%
Percent net migration 1980-1987[6]	-4.1%	-9.8%	NA	-3.7%	NA
Unemployment rate 1989[7]	4.9%	8.5%	75.3%	5.9%	NA
Major crime rate per 1,000 population 1989[7]	24.0	8.8	NA	38.1	NA

[1] FBIR - Fort Belknap Indian Reservation (part within Phillips County and part within Blaine County, includes communities of Hays and Lodgepole)

[2] Source: City and County Data Book 1988.

[3] Source: 1990 Census of Population and Housing, STF3A on CD-ROM for counties, reservation, and Montana. City and County Data Book 1994 or Statistical Abstract of the United States 1993 for the United States.

[4] Source: Bureau of Economic Analysis Regional Economic Information System on CD-ROM, May 1993. (USDOC 1993)

[5] Source: 1990 Census of Population and Housing, STF1A on CD-ROM for counties, reservation and Montana. City and County Data Book 1994 for the United States.

[6] Source: USDI for Phillips County. Economic Consultants Northwest for other areas. (1991)

[7] Source: SBS Economic Consulting for Phillips County. Economic Consultants Northwest for other areas. (1991)

[8] On-reservation medical care provided by Indian Health Service.

NA - Data not available for this geographic level.

out-migration in Blaine County for the available period was higher. On the other hand, the crime rate in Blaine County was lower than state averages. Again, positive characteristics are sparse population, plentiful opportunities for recreation, and a predominance of family ranching operations. In addition, persons on the Fort Belknap Indian Reservation receive targeted federal assistance for medical care, housing, nutrition, and education which can contribute to a higher level of social well-being.

3.10.5.3 Social Values in Phillips County

Residents of Phillips County place considerable value upon self-reliance, small-town life, and the availability of natural resources. Self-reliance is typified by the provision of many essential public safety and health services through volunteerism. Fire and ambulance services are all volunteer, and employers generally support their employees obligation to be on 24-hour call. Phillips County residents also value the positive attributes of rural, small-town life such as good, friendly people; uncrowded surroundings; good schools for children; access to outdoor recreation; lack of crime, and lack of urban congestion. Negative attributes are lack of commercial transportation, limited availability of goods and services, lack of cultural activities, and an undiversified economy. For long-term residents of Phillips County, the positive attributes generally outweigh the negative. Natural resources and other aspects of the environment are important to Phillips County residents economically because many still rely on agriculture for a livelihood, for the recreational opportunities they afford, and for the appeal of undeveloped or minimally developed space (SBS Economic Consulting 1990).

3.10.5.4 Social Values in Blaine County

Social values in Blaine County vary among the three largest social groups: farmers and ranchers, townspeople, and Native Americans of the Fort Belknap Indian Community. Social values of Native Americans residing on the Fort Belknap Indian Reservation are described in another section (Ref?). Blaine County farmers and ranchers are generally political conservatives whose predominant social values are frugality, self-reliance, and hard work. Independence and a close tie to the land are dominant elements of this group's lifestyle. Although independence is important to farmers and ranchers, social interchange is also valued (Economic Consultants Northwest 1991).

Townspeople of Harlem and Chinook value the attributes of local, small-town life: informal, personal interaction with others; knowledge and awareness of the personal and socioeconomic characteristics of neighbors; a quiet, predictable pace of life; mutual support among families and friends; volunteerism in the provision of essential public safety and social services; and religious affiliation. Lack of access to local shopping is somewhat offset by proximity to Havre (Hill County). However, the growth of the commercial sectors in Havre at the expense of stores in Chinook and Harlem is a source of concern and has stimulated concerted community action for economic development (Economic Consultants Northwest 1991).

3.10.5.5 Social Values of the Fort Belknap Native American Community

Most of the information presented in this section on social values of the Fort Belknap Native American Community has been paraphrased from available reports. The use of existing reports has been supplemented by a review and analysis of the public scoping meeting records, as well as by informal discussions with knowledgeable individuals selected due to convenience, availability, and willingness to speak (Bigby 1993, King 1993, Spencer 1993). No additional formal research has been undertaken for this study to define (a) the social values of the Fort Belknap Indian Community in general, or (b) the community's attitudes toward mining in general and the Zortman and Landusky mines in particular.

The Fort Belknap Indian Community, centered on the Fort Belknap Indian Reservation, encompasses two tribal groups, the Assiniboine and the Gros Ventre, which have distinct tribal histories, experience, and concerns. The two tribal groups share a joint government and English as a primary language. Intermarriage also occurs between members of the two tribes. There is some geographic grouping by tribal affiliation within the Reservation: the Assiniboine have grouped near the Fort Belknap Agency, in Lodgepole and by Peoples Creek near Dodson; and the Gros Ventre have grouped at Hays near the Little Rocky Mountains, in Dodson and in Fort Belknap Agency housing. Within tribal groups, sub-groups may be defined by age, tribal blood degree, traditionalism, and assimilation. On-reservation residency of tribal enrollees has been increasing over the past two decades because of increased availability of jobs and housing (Economic Consultants Northwest 1991).

As a group, the Assiniboine characterize themselves as sticking together, getting along with one another, and looking for direction to the oldest, wisest and most spiritual among them (tribal elders). Native American religion and traditions are highly valued. As a group, the Gros Ventre characterize themselves as valuing occupational accomplishment, educational attainment and, to an extent, economic well-being. A tendency to compete with the majority culture and with other Native Americans is said to exist among the Gros Ventre (Economic Consultants Northwest 1991).

The Fort Belknap Indian Community also may be grouped in terms of attitudes toward the Zortman and Landusky mines, which have been a focus of attention within the Fort Belknap Indian Community since even before the advent of the Zortman mine extension proposal. Some members of the Native American community object to the existing mine and the proposed extension because of potential effects upon lifestyle and cultural values, the natural environment, and economic development potentials based on natural and cultural resources. Formal organizations have been among the most publicly outspoken groups within the community. Organizations opposing the existing mine and proposed extension include Red Thunder, Inc. and Island Mountain Protectors (Ref?).

Part of the concern among Native Americans over the existing mine and proposed extension may be linked to use of locations in the Little Rocky Mountains for the practice of religion. Areas that are sought for such purposes are generally remote and usually free of modern land uses. These characteristics are sought because the activities Native Americans wish to pursue require uninterrupted solitude, availability of specific kinds of plants or other special and scarce resources. These locations have become less and less available with modern development and, therefore, more important to Native Americans. The activities that express traditional cultural values include vision questing, ceremonial sweats, collection of plants for ceremonial and medicinal purposes, and the collection of various minerals for paints. Native Americans do not usually equate the conduct of these activities with specific localities. but with a more generalized setting that affords the opportunities they feel are important (BLM 1987). The Little Rocky Mountains are such an area, according to comments made by several Native Americans and comments made at the EIS scoping meetings. The reader would find more information on the uses of the Little Rocky Mountains by Native Americans in Section 3.12, Cultural Resources.

Strahn (1992) provides information on the meaning of mining in Little Rocky Mountains to the Fort Belknap Indian Community. According to Strahn, current attitudes toward the Zortman and Landusky mines grow from an ongoing sociocultural "revitalization movement" on the Fort Belknap Indian Reservation characterized by the revival of traditional customs, values and views of nature. Strahn says the reawakening of traditional values and practices in recent years has coincided with the resumption of heap-leach gold mining in the Little Rocky Mountains. In turn, cultural revival has fueled the environmental activism and opposition to mining which may be seen today within the Fort Belknap Indian Community: "In many respects the extent to which the Assiniboine and Gros Ventre again practice the religion of their ancestors echoes the degree to which there is a revised environmental awareness in their community ... This interrelationship is demonstrated in the case of Fort Belknap where an environmental crisis has helped promote and strengthen a religious revival in recent years" (Strahn 1992, p. 3).

At Fort Belknap, the synergy between cultural revival, environmentalism, and anti-mining sentiment stems from the "immense cultural significance [of the Little Rocky Mountains]" (Strahn 1992, p. 6). The Little Rocky Mountains are holy and sacred to the Fort Belknap tribes because of their historical and now reborn role as a wellspring, repository, and symbol of Native American tradition. According to Strahn, the Little Rocky Mountains are "a place in which the Creator was more abundantly manifested" than anywhere else on earth, "a storehouse, cemetery, ceremonial arena, and sacred shrine" (Strahn 1992, pp. 5-6). This is reinforced by the century of tribal confinement to the reservation adjacent to the mountains without the benefits of ownership. In this context, the Little Rocky Mountains are both symbol and substance of tribal tradition, of the loss of traditional tribal resources and values, and of the potential to regain traditional values and restore continuity between present and past.

3.10.5.6 Ability to Adapt to Change in Phillips County

Information in this section is taken from the Judith Valley Phillips Resource Management Plan EIS, which in turn was based on discussions with area residents conducted by BLM employees in April, 1989 (BLM 1992b). Additional information was taken from the socioeconomic report of SBS Economic Consulting

(1990). Note that the discussions with study area residents that are referenced in these sources were not specifically intended to assess the community's ability to adapt to change. The findings, as reported in the referenced documents, have been reinterpreted for use in this study.

In Phillips County, commercial mining and oil and gas production have been part of the local economy since the early 1900s. The gold district of the Little Rocky Mountains was in commercial production using a cyanide process almost continuously from 1903 until 1949. After a 30-year hiatus, gold mining resumed in 1979, when the Zortman and Landusky mines were opened in their current form. Bentonite mining and milling took place in Phillips County from 1979, until the mine was closed and the plant was torn down in 1988. The Bowdoin gas field, which is partly in Phillips County, has been in production since 1913 and continues to be the largest gas producer in the area. Two natural gas pipelines cross Phillips County, and their construction created short employment bursts: the Northern Border Pipeline segment of the Trans-Alaska Pipeline system in 1981 and 1982, and the Whitewater Gathering System from 1978 to 1986 (SBS Economic Consulting 1990).

Malta, the county seat and principal community, retains its identification with agriculture. Residents who discussed social conditions with the BLM in 1989 described Malta as a small, friendly, rural, and cooperative community. However, they noted several changes within the recent past that have affected community diversity and the distribution of power and resources within the community. Although Phillips County and Malta are considered progressive and have a good business climate, the economy is stagnant and young people often must leave because of the lack of job opportunities. Malta also has a growing elderly population because medical facilities and housing attract retirees from the surrounding countryside. Losing the bentonite plant in 1988 did away with a large number of relatively high-paying mining jobs. Although people employed at the Zortman and Landusky mines are a mainstay of the community, there has been an increase in the number of workers employed in recreation and tourism-related businesses.

Residents of Phillips County are independent and self-reliant, but social interchange is a valued part of local lifestyles. In the late 1970s and early 1980s, weekend dances in Malta attracted large local crowds. Today, with the population aging, residents increasingly depend on family and friends for security and support and on churches, school-based organizations, and volunteer service providers such as the fire department and the search and rescue group for social activity (Boothe 1994). Residents are well aware that decisions about mining, oil and gas, agriculture, and transportation that have a crucial effect on local economic well-being are made by corporations based elsewhere or by agencies subject to more outside than local influence (SBS Economic Consulting 1990).

In Phillips County, attitudes expressed toward mining in the 1989 interviews were generally positive. This was mainly due to the belief that the Zortman and Landusky mines have had a positive effect on the local economy. Some who had positive attitudes toward mining acknowledged having concerns about water quality and visual impacts; however, they seemed to feel the environmental effects of mining could be managed. There was also concern about the cyclical nature of mining and its potential for economic ups and downs due to forces beyond local control.

3.10.5.7 <u>Ability to Adapt to Change in Blaine County</u>

Information in this section is taken from the West Highline Resource Management Plan EIS, which in turn was based on a study of Blaine County completed by ABT Associates in 1980 (BLM 1987). Additional information is taken from the socioeconomic report of Economics Consultants Northwest (1991).

Although Blaine County is mainly agricultural, mining has historically contributed to local economic development, and local attitudes toward mining reflect this belief. Commercial mining within the county has focused on oil, gas, and coal. Major oil and gas fields begun in the first half of the century are still in production. A refinery was in operation east of Chinook until the 1970s, and an asphalt plant fed by oil was in operation from 1961 to 1964. Commercial coal mining occurred from 1930 to 1970 near Chinook. Granite quarrying took place during the 1930s as part of the Fort Peck Dam project. Blaine County has also participated in the gold mining history of the broader region because it is adjacent to Little Rocky Mountains (Economic Consultants Northwest 1991).

The social structure of Blaine County is an adaptive one which addresses local issues through cooperative action and provides mutual support in the face of change that is beyond local control. Although people in the area are independent, social interchange is among the most valued elements of the local lifestyle. People know each other well and are part of networks of family and friends that provide a sense of security. In Blaine County, one may feel empowered within the local web of civic, social, fraternal and religious organizations. These groups have cooperated with each other to address community issues of housing and neighborhood revitalization and economic development. At the same time, residents are well aware that decisions about mining, oil and gas, agriculture, and transportation that have a crucial effect on local economic well-being are made by agencies and corporations appearing to have little affinity for local society (Economic Consultants Northwest 1990).

Local attitudes toward mining are generally positive. However, there is also a wariness towards mining because of its cyclical nature and potential to conflict with the recreation and visual resources that are an important part of the local sense of well-being.

3.10.5.8 Ability to Adapt to Change in The Fort Belknap Indian Community

Information in this section is taken from the economic and social section of the BLM's Judith-Valley-Phillips Resource Management Plan Management Situation Analysis (BLM 1989), the socioeconomics report of Economic Consultants Northwest (1991) prepared for Pegasus Gold, the work of Strahn (1992), and the West Highline Resource Management Plan EIS (BLM 1987). Note that the discussions with study area residents that are referenced in these sources were not specifically intended to assess the community's ability to adapt to change. The findings, as reported in the referenced documents, have been reinterpreted for use in this study.

The Fort Belknap Indian Community looks back on a history of conflict with mining development. During the 1880s, widespread illegal mining occurred in the Little Rocky Mountains. In 1895, this led to the dispatch of a presidential commission to negotiate with the financially distressed Assiniboine and Gros Ventre for the cession of the mining district. In 1896, an agreement was reached by the tribes to sell 28 square miles for $350,000 including most of the Little Rocky Mountains. In the years since, attempts by the tribes to regain ownership of the land have been unsuccessful, but the effort has not been abandoned. The contemporary Zortman and Landusky mines have also been a source of conflict for the Fort Belknap Indian Community depending on how mining effects, including socioeconomic and environmental effects, are perceived.

The social structure of the Fort Belknap Indian Community is complex. Although divided in many ways, the community shows increasing evidence of group action on local issues. Reservation society is stratified by Native American versus non-Native American; tribal affiliation; whether one works for the Bureau of Indian Affairs or the Fort Belknap Indian Community Council; whether one is employed or unemployed; whether one has land or is landless; and by age, kinship, place of residence, and spiritual orientation. Most group action to promote economic well-being and solve social problems involves agencies of the Fort Belknap Indian Community Council. Recent examples include a drug abuse program, a joint housing initiative with the National Indian Housing Council, a parenting skills program for teens, a population and labor force census of enrolled members to support employment programs and grants, a campaign to save the IHS hospital, and the promotion of hunting, fishing, and tourism on the reservation (Economic Consultants Northwest 1991).

Attitudes toward mining within the Fort Belknap Indian Community are conditioned by the historical experience with mining in the Little Rocky Mountains. Today, the mines are accepted by some within the Fort Belknap Indian Community as a general economic benefit and source of employment. For others, the economic benefits do not offset attitudes of resentment and opposition. Strahn (1992) argues that opposition to mining in the Little Rocky Mountains on the reservation typically goes hand-in-hand with a revived adherence to native religious and secular traditions. The combination of the two represents a new political and cultural consensus within the Fort Belknap Indian Community, according to Strahn.

Strahn also says that opposition to mining on the Fort Belknap Indian Reservation is a majority opinion. As evidence of this, he cites the recent defeat in a popular referendum of a proposal to allow mining on the reservation side of the Little Rocky Mountains. Opposition to mining also has been expressed by Red Thunder, Inc., a private interest group which is highly visible and makes effective use of modern techniques of politics, communications, and laws to oppose mining and advance traditionalism.

To summarize, residents of Phillips and Blaine counties feel their way of life--small communities surrounded by a relatively unspoiled environment and outdoor recreation opportunities--is desirable. However, they observe with real concern the aging of the population and the out-migration of younger generations due to a lack of job opportunities. This leads to conflicts over resource development including mining. In general, residents favor economic growth through resource development or other industry because it would provide employment for them and their children and would promote overall economic well-being. On the other hand, they wish to continue to enjoy the lifestyle associated with outdoor recreation, sparse population, and undeveloped natural surroundings.

The Fort Belknap Indian Community is also torn over the mining issue, but in a different way. Like the surrounding Euro-American communities, the Fort Belknap Native Americans are concerned about a lack of economic opportunity for young and old alike. However, this is offset by opposition to mining in the Little Rocky Mountains because of the environmental concern and activism that have accompanied a revival of traditional Native American beliefs, values, and culture, and because of a longstanding goal to restore to tribal ownership the land that contains the Zortman and Landusky mines.

3.11 TRANSPORTATION

This section describes both the historic and current transportation network which provides access to the Zortman/Landusky project area and other portions of the Little Rocky Mountains in the vicinity of the project area. Discussions address road conditions, maintenance responsibilities, traffic volumes, problems with accidents, inclement weather, transport of hazardous materials, and other transportation issues. This discussion focuses primarily on roads that (a) provide access to the proposed extended Zortman and Landusky mining operations; and (b) those which serve local communities, such as Zortman, Landusky, Lodgepole, and Hays.

3.11.1 Study Area

The study area for transportation includes major highways and minor roads in Blaine and Phillips counties that provide access to the Zortman/Landusky project area. Regional highways and roads provide the primary means of access in and out of the project area while local roads provide access to the communities of Zortman and Landusky, as well as the southern Little Rocky Mountains including the Zortman/Landusky mining areas. Due to the fact that potential transportation impacts are most likely to occur near the mine sites on roads that access the Little Rocky Mountains and local communities, more detail will be given for the roads that serve that portion of the overall study area.

3.11.2 Transportation Network in the Project Region

3.11.2.1 Major Highways

State and federal highways provide the main access routes to the project region. The major transportation network in the study area consists of three highways: U.S. Highway 2, an important east-west transportation route which traverses Blaine and Phillips counties roughly 40 miles to the north of the project area; U.S. Highway 191, which is the primary access route to the Zortman area; and State Route 66, which runs north-south through the Fort Belknap Indian Reservation and provides primary access to the communities of Harlem, Hays, and Landusky. Descriptions of each highway are presented below. These highways are maintained by the Montana Department of Transportation. Historic and current traffic counts (1975 to 1993) for each of these highways are provided in Table 3.11-1.

U.S. Highway 2 is an important east-west transportation route, following the HiLine across northern Montana. It is a paved, two-lane undivided highway serving the communities of Chinook, Harlem, Fort Belknap Agency, Dodson, and Malta in the study area. Despite its regional significance, traffic volumes along this highway are low, averaging roughly 3,770 vehicles per day near Harlem in 1993 (MDOT 1994). In terms of traffic hazards and accidents, U.S. Highway 2 averaged 14 accidents per year during the 1980-1989 time period (MDOT 1991).

U.S. Highway 191 is the primary route connecting the project area and the Little Rocky Mountains with larger service areas such as Malta and Lewistown. It is a paved, two-lane undivided highway. In general, traffic volumes along this highway are low due to the sparse population of the area it serves. In 1993, average daily traffic on this highway was approximately 426 vehicles per day (MDOT 1994). U.S. Highway 191 is generally well maintained and kept open on a year-round basis, although it is subject to brief closures during heavy storm events. In terms of traffic hazards and accidents, U.S. Highway 191 averaged 13 accidents per year during the 1979-1989 time period (MDOT 1991).

State Route 66 provides access to the Landusky and Zortman areas and the Little Rocky Mountains from the north and west. It runs through the Fort Belknap Indian Reservation and is used primarily by residents of the reservation. It is a paved, two-lane undivided highway. Traffic volumes on this highway are low due to the sparse population of the area it serves. In 1993, average daily traffic was approximately 415 vehicles per day (MDOT 1994). In terms of traffic hazards and accidents, State Route 66 averaged 5 accidents per year during the 1980-1989 time period (MDOT 1991).

3.11.2.2 Local Roads

Aside from the major highways described above, the vast majority of roads in the project region are gravel-surfaced or dirt roads designed to service sparsely populated areas, small scale economic activities, and recreational use of the Little Rocky Mountains. Local roads are generally maintained by the counties, although local roads within the Fort Belknap Indian Reservation are maintained by the reservation. Roads within the Zortman/Landusky mining areas are maintained by Zortman Mining, Inc. Figure 2.6-3 provides a map of local roads in the study area.

In terms of project area access, the town of Zortman and the Zortman Mine can be reached by two local

TABLE 3.11-1

AVERAGE DAILY TRAFFIC IN THE ZORTMAN/LANDUSKY STUDY AREA

Highway	ADT 1975	ADT 1980	% Change 1975-1980	ADT 1985	ADT 1990	% Change 1980-1990	ADT 1993
U.S. 2[1] E. of Harlem	1,812	2,320	28%	2,300	2,520	9%	3,770
Route 66[1] between Hays and Landusky Rd.	180	420	133%	630	500	19%	415
U.S. 191[2] SW. of Zortman	220	310	41%	270	390	26%	426
U.S. 191[2] NE. of Zortman	222	560	152%	350	400	-28.6%	—

[1] Montana Department of Highways, Safety Management Section, Helena. April 1991. Unpublished traffic and accident data.

[2] Montana Department of Highways, Safety Management Section, Helena, April 1990. Unpublished traffic and accident data.

ACCIDENT HISTORY OF ROADS IN THE ZORTMAN/LANDUSKY MINE EXPANSION STUDY AREA

	Before Active Mining		Active Mining		Active Mining	
Highway	Average Annual Accidents 1972-1978[3]	Accident Rate 1972-1978 (per million trips)	Accidents 1980	Accidents 1989	Average Annual Accidents 1980-1989	Accident Rate 1980-1989 (per million trips)
U.S. 2[1], E. of Harlem	31	47	16	10	14	16
Route 66[1]	13	198	3	9	5	30
U.S. 191[2], S. of Malta	14	173	---	---	13	74

[1] Montana Department of Highways, Safety Management Section, Helena. April 1991. Unpublished accident data.

[2] Montana Department of Highways, Safety Management Section, Helena. April 1990. Unpublished accident data.

[3] Montana DOT Highway Patrol, Unpublished Traffic and Accident Data, Compiled 1994.

roads from U.S. Highway 191. A dirt road also runs to the Zortman Mine from Landusky and the Landusky Mine. Prior to commencement of mining activities in 1979, this road was also open for public use. The road was subsequently closed to the public. The following is a description of the local roads used to access Zortman and the Zortman Mine, and Landusky and the Landusky Mine.

Bear Gulch Road crosses through the southeast corner of the Fort Belknap Indian Reservation and is the best route to Zortman from Malta and other areas to the northeast. It is paved from Highway 191 to its intersection with Seven Mile Road. From the intersection to the town of Zortman, the road is gravel-surfaced. Bear Gulch Road is often impassable during winter months due to snow. Steep grades and winter driving hazards preclude the use of this road by trucks. All trucks bound for the town of Zortman and the Zortman mine use Seven Mile Road.

Seven Mile Road extends due north from U.S. Highway 191 to Zortman and is maintained by Phillips County. It is kept open on a year-round basis although it is sometimes closed temporarily due to drifting snow.

Zortman Mine Access Road extends up Ruby Gulch from the Town of Zortman to the Zortman Mine. It is a crushed-rock/gravel-surfaced road that has been closed to the public since mining resumed in 1979. The access road grade does not presently exceed 10 percent. The road is maintained by the mine and is open on a year-round basis with the exception of heavy snow storms that temporarily restrict access.

Landusky Access Road is a gravel road that provides vehicular access to the community of Landusky from State Route 66. The access road is roughly four miles in length. The road continues east to the Landusky Mine, although public access has been restricted above the community of Landusky since mining resumed in 1979.

Mission Canyon Road provides access to the Landusky Mine from Hays and the Fort Belknap Indian Reservation. The road is paved from Hays to near the entrance to Mission Canyon and is gravel from that point to its terminus at the Landusky Mine. This road is used primarily by the public for cultural and recreational activities in Mission Canyon. Historically, this road was open to the general public over its entire length. At present, public access to the Landusky Mine is restricted by a gate near the top of Mission Canyon. A small number of workers commute up this road from the Hays area to the Landusky Mine when the weather permits.

3.11.2.3 Other Transportation Systems

Rail service in the study area is provided by the Burlington Northern Railroad for shipment of freight and by AMTRAK for passenger service. Both railroads run along an east-west route, known as the "HiLine," that parallels U.S. Highway 2 roughly 40 miles north of the Zortman area. With respect to Zortman, the closest freight and passenger rail stop is located in the City of Malta.

Commercial bus service is offered in Havre, roughly 95 miles northwest of Zortman. Passengers who board the bus in Havre then ride to Great Falls, where they can transfer to buses traveling elsewhere. No commercial bus service is available in Zortman, Landusky, Hays, Lodgepole, Malta or Harlem.

Commercial airline service has been available in recent years in Lewistown, Havre, and Glasgow. In addition, various small airstrips are present, including a landing strip at Zortman owned by ZMI. Passengers who wish to travel by air to destinations outside of the region must drive to Lewistown, Havre, Glasgow, Great Falls or Billings, where commercial airline service is connected to the nationwide network. Charter air service is available in Malta, Chinook, Glasgow, Havre, and Lewistown.

In general, rail, bus, and aircraft do not provide significant transportation services that are related to the operations of the Zortman and Landusky mines. The vast majority of project-related transportation trips utilize automobiles and trucks.

3.11.3 Transportation of Hazardous Materials

Prior to 1979, when the Zortman and Landusky mines began full-scale operations, there was minimal transportation of hazardous materials in the local Zortman/Landusky project area. The only notable exception was the transport of motor fuel in relatively small quantities to two local vendors in Zortman which sold fuel to the general public.

Since commencement of mining by ZMI in 1979, the Zortman and Landusky mining operations have used several reagents which are regulated hazardous materials. All of these materials are transported to the mines by trucks using the regional highways and local roads described above. Table 3.11-2 provides a summary of regulated reagents used by the mines since 1979, the present annual number of trips to the mines, and the transportation routes used to deliver them.

TABLE 3.11-2

SUMMARY OF TRANSPORTATION ROUTES AND HAUL TRIPS FOR HAZARDOUS REAGENTS USED BY THE ZORTMAN AND LANDUSKY MINES

Reagent	Transportation Route	Annual Trips to Zortman Mine Present	Annual Trips to Zortman Mine with Extension	Annual Trips to Landusky Mine Present and with Extension
Gasoline	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	4	48	50
Diesel	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	2	140	260
Oil and Lubricants	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	10	80	160
Antifreeze	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	5	18	17
Cyanide	Port of Butte north to Great Falls I-15, east to Lewistown U.S. 87 and north to Zortman/Landusky U.S. 191 or Port of Butte east to Big Timber I-90 and north to Zortman/Landusky on U.S. 191 (Truck)	2	300	87
Lime	Townsend north to Zortman/Landusky along U.S. Highway 12 and 191 (Truck)	6	1,800	900
Ammonium Nitrate	Butte north to Great Falls I-15, east to Lewistown U.S. 87 and north to Zortman/Landusky on U.S. 191 or Butte east to Big Timber I-90 and north to Zortman/Landusky U.S. 191 (Truck)	0	350	200
Hydrochloric Acid	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	6	13	5
Sodium Hydroxide	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	2	2	0
Anti-Scalants	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	1	25	8

TABLE 3.11-2
(Concluded)

Reagent	Transportation Route	Annual Trips to Zortman Mine Present	Annual Trips to Zortman Mine with Extension	Annual Trips to Landusky Mine Present and with Extension
Flocculents	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	1	1	1
Calcium Hypochlorite	Billings north to Zortman/Landusky along U.S. 87 and U.S. 191 (Truck)	1	1	0
	TOTAL	38	2,778	1,688

Source: Zortman Completeness Review Responses No. 2, 1992.

Sheet 2 of 2

3.12 CULTURAL RESOURCES

Cultural resources are broadly defined as cultural properties and traditional lifeway values, and are further defined by the BLM Manual, Section 8100 (BLM 1988), as follows:

> Cultural property: a definite location of past human activity, occupation, or use identifiable through field inventory (survey), historical documentation, or oral evidence. The term includes archaeological, historic, or architectural sites, structures, or places with important public and scientific uses, and may include definite locations (sites or places) of traditional cultural or religious importance to specified social and/or cultural groups. Cultural properties are concrete, material places and objects.
>
> Traditional lifeway value: the quality of being useful in or important to the maintenance of a specified social and/or cultural group's traditional systems of (a) religious belief, (b) cultural practice, or (c) social interaction, not closely identified with definite locations.

Cultural properties are considered by the National Historic Preservation Act (NHPA) and implementing regulations at 36 CFR 800. Certain traditional lifeway values are addressed by the American Indian Religious Freedom Act (AIRFA). While the significance of cultural properties has been well defined and protection steps codified, protection offered to traditional lifeway values has been interpreted much more broadly under AIRFA than under NHPA.

The discussion of baseline cultural resources for the Zortman mine extension project and Landusky Mine reclamation has been divided into three sections: prehistoric (archaeological) resources, historic resources, and ethnographic or traditional Native American resources. Studies have been conducted in the Zortman and Landusky vicinity to locate, record, and evaluate all three of these resource types, and to include archaeological and historic field surveys, historic records searches, and interviews with Native Americans (ethnographic studies). Native American cultural resources include the values Native Americans associate with each resource or resource class.

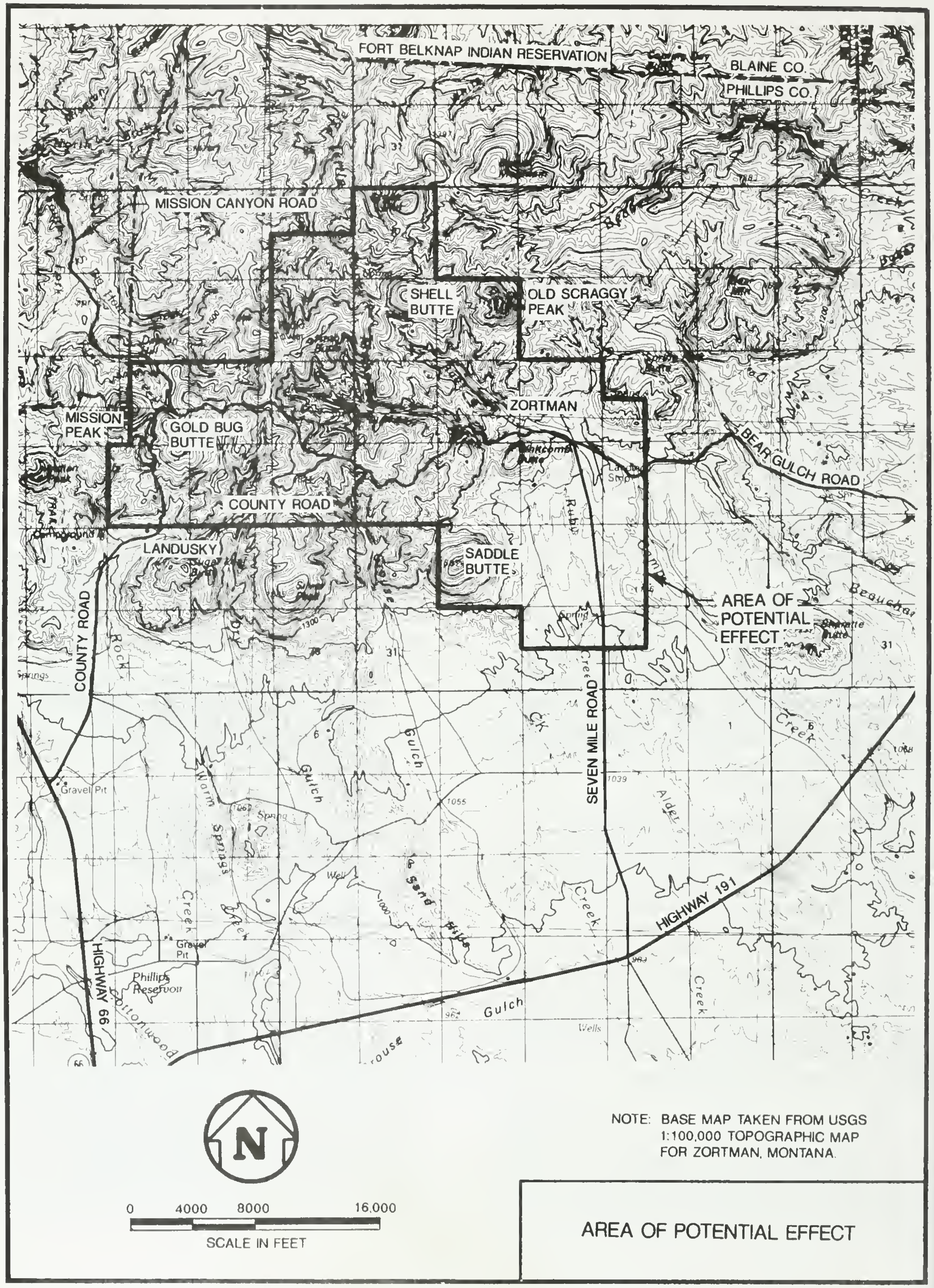
The BLM has defined an Area of Potential Effect (APE) for cultural properties, primarily archaeological and historical resources (see Figure 3.12-1), containing approximately 12,800 acres. Both direct and indirect impacts within the APE would be analyzed. Deaver and Kooistra (1992) note that many traditional Native Americans believe the Little Rocky Mountains are all interconnected (spiritually and physically), and one peak or butte cannot be separated from the range as a whole. This concept has been reiterated in the scoping meetings and subsequent interviews. Therefore, a larger study area would be used for analysis of impacts to these Native American cultural resources and the values associated with them.

3.12.1 Regulatory Setting and Significance Criteria

The key legislative directives for identifying and protecting historic properties are provided in Section 106 of the NHPA. Regulations implementing this legislation are found at 36 CFR 800. These regulations define procedural requirements for federal agencies to consult with the State Historic Preservation Office (SHPO), the Federal Advisory Council on Historic Preservation (Council), and other interested parties to ensure that historic properties are duly considered as federal projects are planned and implemented. These requirements are in addition to consideration given all resources under NEPA. The steps in the Section 106 consultation process are as follows:

- Define the Area of Potential Effect (APE);
- Identify and evaluate cultural properties that may be affected by a proposed undertaking;
- Assess the potential effects of the undertaking on historic properties;
- Consult with the SHPO, Council, and other appropriate interested parties to determine ways to avoid or reduce any adverse impacts if significant properties are identified;
- Provide the Council a reasonable opportunity to comment on the proposed undertaking and impacts to significant properties; and
- Proceed with the undertaking under the terms of a Memorandum of Agreement or taking into account Council comments, as required.

Cultural properties are identified as significant if they are determined eligible for inclusion in the National Register of Historic Places, a listing of historic properties established by the NHPA. Eligible properties include buildings, structures, sites, and groups of such resources forming historic districts, as well as objects and landscapes that are significant in American history,



NOTE: BASE MAP TAKEN FROM USGS
1:100,000 TOPOGRAPHIC MAP
FOR ZORTMAN, MONTANA.

AREA OF POTENTIAL EFFECT

FIG. 3.12 1

architecture, archaeology, engineering, and culture.

Properties may be considered eligible for inclusion in the National Register if they possess integrity of location, design, setting, materials, workmanship, feeling, and association. Properties must also meet at least one of the following four criteria listed in 36 CFR 60.4:

(a) Associated with events that have made a significant contribution to the broad patterns of our history;

(b) Associated with the lives of persons significant in our past;

(c) Embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; or that represent a significant distinguishable entity whose components may lack individual distinction; or

(d) Have yielded, or may be likely to yield, information important in prehistory or history.

Properties determined eligible according to these significance criteria are termed "historic properties." Sites that have been determined not eligible under all of the criteria require no further consideration under NHPA. However, access to certain locations may be protected under the American Indian Religious Freedom Act (AIRFA). These locations would not necessarily be eligible to the NHPA.

Sites and localities having significance to a group of Native Americans may have cultural importance and historic significance. To be eligible for the National Register, a site (place) must be significant to a group of people, not just to an individual. The site must have been significant through time, not just recently used. Sites of solely cultural significance (but not historic significance) are not eligible for the National Register, but may still be considered under AIRFA. Sites with historic significance may be eligible for the National Register in accordance with the significance criteria outlined in 36 CFR Part 60.4. In 1990, the National Park Service issued National Register Bulletin 38 (Parker and King 1990) which provides expanded guidance (not regulations) on assessing resource significance, particularly when applying criteria (a), (b), and (c) (36 CFR 60.4), in terms of the culture which generated the site. Bulletin 38 generally defines a Traditional Cultural Property (TCP) as one that is eligible for inclusion in the National Register based on its association with historically rooted cultural practices or beliefs of a living community that are important in maintaining the community's cultural identity. Like all sites eligible for the National Register, TCPs must retain integrity of location, setting, feeling, and association.

According to Bulletin 38, in order for a resource (most often a site, district, landscape, or object) to be recommended for National Register listing as a TCP, it must demonstrate integrity of relationship and integrity of condition. Integrity of relationship is realized if the property is recognized by contemporary groups as being important to their cultural heritage, and the tie between the two must generally be at least 50 years old. Integrity of condition is demonstrated if the resource physically retains the qualities making it significant to the traditional group.

AIRFA of 1978 reaffirms the rights of Native Americans to believe, express, and exercise their traditional religion and, like the NHPA, requires that federal agencies take into account the effects of their undertakings on traditional religious practices (lifeway values). AIRFA includes two types of significant resources not defined as TCPs under the NHPA: (1) resources associated with traditional spiritual activities that are less than fifty years old and (2) sites with strictly intangible spiritual values associated with particular locations, i.e., sites that lack a demonstrable tie between a thing at the location--either natural or man-made--and a spiritual value.

3.12.2 Prehistoric Cultural Resources

3.12.2.1 Introduction

A number of archaeological surveys have been conducted in the Little Rocky Mountains since 1978 to locate, record, and evaluate prehistoric resources, historic sites and traditional cultural properties.

3.12.2.2 Prehistory of the Little Rocky Mountains

The native population of North America responded to the changing physical and cultural environment to sustain their lifestyles. Archaeological evidence (the physical remains of human activity) and native oral tradition are the only records available prior to the coming of the Europeans to this continent. While the archaeological record reveals environmental conditions as well as subsistence patterns, more detailed, intimate information (e.g., language, religion, traditions) is often lacking and, therefore, open to supposition. Likewise, concrete evidence for ancestral ties between prehistoric people and extant Native American groups is scarce. Archaeological evidence can be supplemented with ethnographic research, especially for information pertaining to the latest period of occupation.

Early occupation of north-central Montana dates to a period of circa 11,000 to 8,000 years before present (BP), and has been identified as the Early Prehistoric Period (Brumley and Rennie 1993). Big game, including now-extinct mammals, apparently formed the subsistence base for the people of this period, generally called Paleoindians. Evidence for occupation in this part of Montana is limited to distinctive projectile point (spear) types that can be related to more extensive sites excavated elsewhere in the Northern Great Plains. No projectile points from this period have been reported from the Little Rocky Mountains.

The Middle Prehistoric Period is generally dated from circa 8,000 to 1,300 years BP. During this period the subsistence base expanded to include smaller game and more plant resources, although bison hunting remained the primary focus on the Northern Great Plains. There is some evidence of communal efforts to hunt groups of large mammals in the later part of the period. Sites dating to this period are often characterized by projectile points that presumably were designed to be used with a spear (or dart) thrower (atlatl).

The Late Prehistoric Period dates from circa 1,300 years BP to historic contact, which occurred in the general project area in 1805 with the Lewis and Clark expedition. Bison hunting remained the primary subsistence activity with many of the sites exhibiting evidence of communal behavior (Brumley and Rennie 1993). The bow and arrow became the hunting weapon of choice, and some groups utilized pottery. The ceramics were strongly related to Middle Missouri ceramics, suggesting trade with and migration from the east. The horse and Euro-American trade goods began filtering into the area in the early part of the eighteenth century resulting in drastic changes in the lifestyles of the native population.

3.12.2.3 Inventory

Ruebelmann (1983) hypothesized that the island mountains of north-central Montana were used only on a seasonal basis by the native prehistoric inhabitants. They visited the mountains for the resources contained therein and spent much more time on the plains and in the river bottoms. The types and numbers of sites located during inventories of the APE would seem to support this hypothesis.

All areas subject to physical impact in the APE have been surveyed to BLM Class III standards for prehistoric resources. No prehistoric sites were recorded by Hogan and Fredlund (1978) prior to commencement of surface mining by Pegasus. Rossillion (1993) recorded nine prehistoric sites, six of which consisted of one or more stone circles and other stone alignments/piles. Only two temporally diagnostic artifacts were recovered, suggesting occupation/use in the Late Prehistoric Period. Only one stone circle site (24PH2905) within the APE had enough artifactual material associated to recommend the site as eligible to the National Register. One other campsite (24PH2794) within the APE was also recommended as eligible. Eight of these sites are located in the APE, clustered in the southeast portion of the APE. Generally, the topography here is gentler, and at a lower elevation than much of the APE.

Munson (1994) has recently surveyed a possible waste rock repository location on Goslin Flats and recorded a single site (24PH3203). It consists of a large pile of rocks, tentatively identified as a collapsed structure or large hearth. It has been recommended as eligible to the National Register.

3.12.3 Historic Cultural Resources

3.12.3.1 Introduction

The APE for historic resources is the same as that described in Section 3.12 and depicted on Figure 3.12-1.

3.12.3.2 History of the Little Rocky Mountains

The following brief historic overview is taken mainly from the section written by Robert Murray in Hogan and Fredlund (1978), and from Deaver and Kooistra (1992). Additional information on the ethnographic history of the Little Rocky Mountains is included in Section 3.12.4.3.

Early recorded intrusions by non-Native Americans into the general area were by the Lewis and Clark expedition of 1805, although Lewis and Clark did not explore the Little Rocky Mountains. The archaeological and ethnographic records indicate that the general area had been occupied for thousands of years previously, and was occupied at the time of Euro-American exploration and use. Following exploration, early Euro-American use of the Little Rocky Mountains in the first part of the nineteenth century was by fur trappers, with prospectors following in the last decades of the century.

The first sustained Euro-American use of the Little Rocky Mountains was in 1884, when Pike Landusky and others developed the first paying placer mines in Alder Gulch, leading to the development of the town of Landusky. Landusky later staked the first patented lode claims in the Little Rocky Mountains (recorded in 1892), as the early placer workings had rapidly been depleted. The richest claim was the August, patented in 1893, on the Fort Belknap Indian Reservation. Because of the increased mining activity in the Little Rocky Mountains, Montana politicians influenced the establishment of a commission to negotiate further land concessions from the Native Americans. The result was the Grinnell Agreement of 1896, in which the Native Americans at Fort Belknap ceded a portion of the Little Rocky Mountains from the southern part of the reservation to the U.S. government for $360,000. Records indicate there was substantial pressure put on the Native Americans to cede this land, and the vote among the Gros Ventre and Assiniboine was not unanimous. Some accounts note that the Gros Ventre were especially upset, as they were generally inhabiting the area closer to the mine development, and had plans of their own to mine the gold (Strahn 1993). (See also Sections 3.12.4.3 and 3.12.4.6.)

Mine and mill development proceeded through the first two decades of the twentieth century. Zortman was established as a mining camp in 1903 with the construction of a cyanide mill in Alder Gulch. Other stamp and crusher mills were constructed (the Ruby Gulch Mill as one of the larger ones), processing ore from the Ruby and Independent mines. Ore processing included the use of cyanide which had been utilized in the Little Rocky Mountains since the 1890's. Zortman grew faster than Landusky or Whitcomb (abandoned in the 1940s), although growth was as sporadic as work in the mines. From the 1920s through 1942, mining could be characterized as cyclical. Ventures were formed with some development and production; however, production did not usually continue for more than a few years. The ore in the Little Rocky Mountains was not of consistently high quality to sustain most of the mines utilizing the mining techniques of the day. Additionally, sporadic fires impacted both towns and mining operations. Much of Zortman burned in 1929, and the 1936 fire burned over 23,000 acres of timber.

Mining continued sporadically through 1951, with a hiatus during World War II. After 1951, little serious activity occurred here until the modern, surface-mining operation opened in 1979. It has been estimated that over 380,000 ounces of gold were mined from the Little Rocky Mountains prior to 1979, contributing significantly to the region's economy.

3.12.3.3 Inventory

All areas of potential impact have been surveyed for historic properties, except the Seaford Clay Pit. Numerous sites relating to historic mining have been recorded in the APE. These sites include mines, mills, trash scatters, adits, exploration pits, a kiln, water control devices, structure foundations, and residential/ commercial structures. Two homesteads/ranches have also been recorded, along with the Zortman jail and ranger/fire station. Table 3.12-1 lists the historic sites recorded in the APE. This table also lists the National Register status of each site. BLM and the SHPO have determined there is one historic district eligible for the National Register within the APE. There are twelve individual sites included in the Alder Gulch Historic District; they are noted with a single asterisk in Table 3.12-1. Another proposed district is the Beaver Creek District, located outside the APE. Other historic sites proposed as eligible for the National Register within the APE include the Ruby Creek Mill (24PH255), site 24PH2849 (a mining camp), the Zortman Ranger Station (24PH2151), and 24PH2938 (a placer mine).

3.12.4 Native American Cultural Resources

3.12.4.1 Introduction

An ethnographic overview of the Little Rocky Mountains prepared by Ethnoscience (Deaver and Kooistra 1992) is the major reference for this section. Additional information is taken from Flemmer (1990, 1991), Melton 1990, 1993), Strahn (1992, 1993), Woods (1981), and supplementary sources as referenced. The original intent of the Deaver and Kooistra ethnographic study was to document the presence or absence of Traditional Cultural Properties (TCPs) in the proposed Zortman mine extension study area, located just south of the Fort Belknap Indian Reservation. The study area was expanded to include most of the Little Rocky Mountains, as well as a few locations beyond. This expansion of the study area allowed for the development of a larger comprehensive context, and a broader-based understanding of traditional cultural use and patterned distribution of TCPs than was previously recognized (Deaver and Kooistra 1992:1.10).

TABLE 3.12-1

HISTORIC SITES WITHIN THE AREA OF POTENTIAL EFFECT (APE)

Site No.	Type/Name	NR Eligibility (Agency/ SHPO Concurrence)
24PH254	Gold Bug Mine	No
24PH255	Ruby Mill	Yes
24PH256	August Mine	No
24PH257	Little Ben Mine	No
24PH2151	Zortman Ranger Station	Yes
24PH2184	Mining Camp	No
24PH2195	Zortman Jail	No
24PH2293	Cabin	No
24PH2295	Prospects	No
24PH2296	1930s Mining Camp	No
24PH2297	Prospect	No
24PH2298	Prospect	No
24PH2299	1940s Mining Camp	No
24PH2774	Adit	No
24PH2817	Ragtown	No
24PH2818	Mine	No
24PH2819	Runyon Place	No
24PH2820	Adit	No
24PH2821	Adits	Yes*
24PH2822	Mining Camp	Yes*
24PH2823	Mining Camp	Yes*
24PH2824	Alder Gulch Dam	Yes*
24PH2825	Miner's Shack	Yes*
24PH2826	Adit	Yes*
24PH2830	NE Landusky Residences	**
24PH2831	Mining Camp	Needs testing
24PH2832	Dam	No

Sheet 1 of 3

TABLE 3.12-1 - HISTORIC SITES WITHIN THE APE
(Continued)

Site No.	Type/Name	NR Eligibility (Agency/ SHPO Concurrence)
24PH2833	Dump	**
24PH2834	Adit	No
24PH2835	Adit	No
24PH2840	Mission Peak Fire Tower	No
24PH2841	Adit	No
24PH2845	Hawkeye Mine/Mill	No
24PH2848	Adit	No
24PH2849	Mining Camp & Foundation	Yes
24PH2850	Mining Camp	No
24PH2851	Pumphouse, 3 Adits	No
24PH2852	Adit	No
24PH2853	Adit	No
24PH2854	Adit	No
24PH2855	Mining Camp	Needs testing
24PH2856	Mining Camp	No
24PH2857	Adit	No
24PH2859	Mining Camp	No
24PH2860	Mining Camp	Yes *
24PH2862	Alder Gulch Mill & Camp	Yes *
24PH2863	Alder Gulch Lime Kiln	Yes *
24PH2864	Pony Gulch Adit	Yes *
24PH2865	Pole Gulch Mine	Yes *
24PH2866	Dump	No
24PH2867	Adit	Yes*
24PH2869	Ruby Gulch Dam	No
24PH2904	Sturman Ranch/Homestead	No
24PH2907	Goslin Ranch	No
24PH2936	Placer Mine	No

TABLE 3.12-1 - HISTORIC SITES WITHIN THE APE
(Concluded)

Site No.	Type/Name	NR Eligibility (Agency/ SHPO Concurrence)
24PH2937	Prospect Field	No
24PH2938	Placer Mine	Yes
24PH2939	Mine	No
24PH2940	Post-WW II Mine	No
24PH2942	Placer Mine Camp	Not determined ***
24PH2947	Trash Dump	Not determined ***
24PH2948	Cabin and Foundations	Not determined ***
24PH257	Little Ben Mine	No
24PH3024	Drainage Barriers	No
24PH2821	3 Adits	No

* Components of the Alder Gulch Historic District

** Recommended as not eligible by consultant and BLM, no comment has been received from SHPO.

*** BLM and SHPO have not resolved the eligibility.

The Deaver and Kooistra study (1992) included a cultural resources file search at the Montana SHPO. Appropriate BLM and BIA reports were consulted as well. An extensive review of ethnographic, ethnohistoric, historic and other relevant literature for the study area was completed. Interviews with 54 Native Americans and other knowledgeable individuals were undertaken, with some interviews involving field reconnaissance. The majority of the interviewees are members of the Fort Belknap Indian Community, with the remainder being members of Native American tribes outside Fort Belknap, including the Assiniboine at Fort Peck, Blackfeet, Chippewa-Cree, Crow, and Northern Cheyenne. In addition to the ethnographic research, nine archaeological sites were visited and recorded.

3.12.4.2 Data Limitations

The Deaver and Kooistra ethnographic overview is primarily a review of previous research in the area, and although they did interview a number of Native Americans regarding Native American resources in the Little Rocky Mountains, the intent was not to compile an exhaustive inventory of these resources. For the purposes of this report, however, the inventory data are used as a sample to represent the Native American cultural resources and associated Native American values extant in the Little Rocky Mountains.

Information collected from public meetings at Lodgepole and discussions with several Native American groups and individuals on the reservation over a two-day period revealed the range and intensity of concerns held by some of the Fort Belknap Gros Ventre and Assiniboine residents. No systematic interviewing was conducted, however, and no site visits were undertaken.

3.12.4.3 Ethnohistory of the Little Rocky Mountains

Most of the data used to identify the ancestors of modern tribal groups is based upon linguistic associations. Some researchers postulate that Algonkian speakers (contemporary groups include the Blackfeet, Arapaho, Gros Ventre, Cheyenne, Cree, and Chippewa) were in the Northern Plains prior to AD 1300, while others assert that Athapaskan speakers, ancestors to the Apache and Navajo, were also present.

By the 1400s, the Blackfeet had reached the plains just north of central Montana. During the 1500s, Salish and Kootenai groups apparently expanded their territories east of the Rockies, and the Bannock moved into western Montana. Also during the 1500s, westward migrations into eastern Montana increased, particularly for the Mountain Crow who entered the area in the 1550s following bison migrations. During the 1600s, the Mountain Crow expanded southwest along the Yellowstone River. The River Crow moved into central Montana after 1670. The Sioux also began pushing westward to escape conflicts with the Chippewa and to follow bison onto the plains.

By 1700, the Gros Ventre, coming from northern Minnesota, and the Arapaho shared territory ranging from eastern North Dakota to the eastern Montana border. In the 1720s, the Gros Ventre and Arapaho separated, with the Gros Ventre moving north into Canada and the Arapaho, by the end of the 18th century, moving into northeastern and central Montana. Also in the 1720s, the Plains Cree moved toward Blackfeet lands. After the Shoshone received horses from the Spanish in the 1720s, they controlled much of the High Plains including northern Montana. By the 1750s the Gros Ventre and Blackfeet alliance had obtained guns and horses and began to reclaim their land in northern Montana. After they forced the Shoshone to move south, the Blackfeet and Gros Ventre established their own territory in the Montana Rockies, including the Little Rocky Mountains and Project area.

The Assiniboine are members of the Siouan language family. They split from the Yanktonai Sioux in the mid-seventeenth century and moved west and north from ancestral lands in northern Michigan. Much of their territory was in Canada, but extended southward into northern Montana. By the 1860s, tribal warfare, disease, and Euro-American pressure had forced the Montana Assiniboine to split; one group allying with the Yanktonai Sioux and the other group with the Gros Ventre (McGinnis 1990). The former alliance (Assiniboine and Sioux) was later settled on the Fort Peck Reservation, and the latter alliance (Assiniboine and Gros Ventre) on the Fort Belknap Indian Reservation.

Beginning in the middle of the 19th Century, the U.S. Government initiated the first of several treaties with the Plains Indians, first to facilitate exploration and trading by delineating tribal territories and discouraging intertribal warfare, and later to open up former tribal lands to settlement for purposes of farming, ranching, and mining. The Fort Laramie Treaty of 1851 gathered all the Plains tribes together and "mapped out the domain of each tribe and obligated each tribe to respect the lands of its neighbors" (Malone and Roeder 1976). The Blackfeet and Gros Ventre were recognized as the occupants of the north central region of Montana, east of the continental divide. The Fort Laramie Treaty served as a catalyst for other treaties including the 1855 Treaty with the Blackfeet, Gros Ventre, Assiniboine, Nez Perce, Flat Head, and Pend d'Orielle (Woods 1981). Stemming from the efforts of Isaac I. Stevens, the 1855 Treaty created a vast Indian Reserve in northern Montana which was shared by Gros Ventre and Assiniboine with the Blackfeet. This Reserve included the Little Rocky Mountains.

In 1887, the Northwest Commissioners negotiated the formation of separate Blackfeet, Fort Belknap, and Fort Peck Reservations. This was in large part based upon Agent W. L. Lincoln's perception that the Indian Reserve established in 1855 was too large for it's Indian proprietors, and pressure from white miners, ranchers, and businessmen to open the northern part of the Reserve to white settlement. The Gros Ventre and Assiniboine insisted that the Little Rocky Mountains remain within their boundaries, and since the initial mining boom in the Little Rocky Mountains had already diminished, the government reluctantly agreed to this condition (Hundley 1985; Foley 1975). Ratified by Congress in 1888, the Treaty set the boundaries for the Fort Belknap Reservation as follows:

> *"Beginning at the point in the middle of the main channel of Milk River, opposite the mouth of Snake Creek; thence due south to a point due west of the western extremity of the Little Rocky Mountains; thence due east to the crest of said mountains at their western extremity, and thence following the southern crest of said mountains to the eastern extremity thereof; thence in a northerly direction in a direct line to a point in the middle of the main channel of Milk River opposite the mouth of Peoples Creek; thence up Milk River, in the middle of the main channel thereof, to the place of beginning." (Kappler, 1904, 1:265 in Woods 1981)*

In return, the Gros Ventre and Assiniboine were to receive $115,000 over a 10-year period to be spent on basic social services, such as health care and education, the erection of new agency buildings, and activities to promote their "civilization" (Berry 1974). The reservation underwent one final reduction in 1896 after gold was discovered in the Little Rocky Mountains. Under the Grinnell Agreement, the tribes ceded 14, 758 acres of land (Act of June 10, 1886, 29 Stat. 321, 350) in the Little Rocky Mountains on the southern end of the reservation for $360,000 in annuities. According to the land commission's report, the ceded tract contained over 40,000 acres of land, although only 14,758 acres (a parcel approximately 7 miles long and 4 miles wide) were actually purchased by the government (Deaver and Kooistra 1992). Members of Fort Belknap retain strong concerns about the Grinnell Agreement since (a) they feel that the Indians were coerced and intimidated into signing, (b) the vote to sell was split along tribal lines with the Gros Ventre generally opposed and the Assiniboine generally for, and (c) the understanding that they sold the mining rights, but not the right to the other natural and cultural resources in the Little Rocky Mountains (Deaver and Kooistra 1992; Strahn 1992, 1993).

As a direct result of these and related concerns, the Fort Belknap Community Council passed at least four resolutions petitioning the Department of the Interior, Bureau of Indian Affairs to return the Little Rocky Mountains which were withdrawn when gold was discovered. Resolution 84-73 also states that:

> *"parts of the Little Rocky Mountains have traditionally been held as sacred grounds and have even today special religious and historical meaning to the Fort Belknap Indian Community justifying a return of these lands to the Fort Belknap Indian Community."*

This Resolution, dated September 14, 1973 was drafted at a time when gold mining was at a virtual standstill in the Little Rocky Mountains.

Spiritual and Physical Characteristics of the Little Rocky Mountains

Prior to the exploration and occupation of northern Montana by Euro-Americans, the Little Rocky Mountains were a place of particular importance to the Native Tribes of the Northern Plains. Due to their topography, climate, and location, they provided a unique habitat for subsistence, social, and religious activities. In addition to the Gros Ventre and Assiniboine, a number of other plains tribes used the Little Rocky Mountains for these same activities. Included were the Sioux, Chippewa-Cree, Blackfeet, and Crow.

Early travel accounts lack specific reference to the Little Rocky Mountains, or "Island Mountains" as they were known to the native inhabitants of the area, although visitors to the Fort Belknap area just after the turn of the century note the use of the area for religious activities. Both groups retain fasting, prayer, and the vision quest as primary individual rites. In particular, accounts of Gros Ventre ceremonies include the Feathered Pipe, Flat Pipe, and Sacrifice Lodge (Sundance). The most important group ceremonies for the Assiniboine were the Sundance and the Horse Dance. Vision Questing is described as are paraphernalia and plants used by the Gros Ventre and the Assiniboine for ceremonial purposes. The diary and accounts of John Galen Carter, for example, detail the use of red, green, and yellow cloth, a cottonwood center pole, sweetgrass, willow branches, chokecherry bush, eagle feathers and body paints as some of the accessories of the Sundance celebration (Carter 1906-1907 cited in Deaver and Koistra 1992)

Interviews with contemporary Gros Ventre and Assiniboine conducted by Deaver and Kooistra (1992) and Derek Strahn (1992, 1993) also document use of the Little Rocky Mountains during the 1800s and 1900s. Citing oral history interviews with Assiniboine and Gros Ventre at Fort Belknap and literature sources, Strahn notes that small autonomous bands got together in the Little Rocky Mountains during the winter where food, water, and other necessary resources were readily available. During the summer, complex social activities were conducted here by a number of different tribes (Strahn 1993). In 1875, large numbers of Sioux held a grass dance on the eastern slopes of the Little Rocky Mountains and the Gros Ventre held their Old Man's Dance in approximately the same location four years later. This was also an important place for religious activities where supernatural knowledge and assistance was petitioned through prayers, offerings, fasting, and sacred dances. Annual Sundances were held here because they afforded the tribes a place to gather collectively and contained all the necessary natural resources to construct the lodge and undertake the ceremony. As such, "as a natural storehouse, marketplace, battleground and sacred shrine, the Little Rocky Mountains were, quite literally, a center of tribal being on the northwestern plains." (Strahn 1993)

The affected environment for the Little Rocky Mountains includes both its spiritual and physical characteristics which are traditionally seen as inseparable. The Little Rocky Mountains are one of a set of island mountain ranges recognized as the lodges/homes of the spirits, which are inhabited by eagles (spirit messengers), and contain various peaks (spirit lodges) symbolizing tipis in a Native American camp. The mountains are currently viewed as one of the last refuges where traditionalists can practice spiritual activities such as prayer, fasting, and making offerings. The area is the main watershed for the Fort Belknap communities. Warm water springs are exploited for their healing powers and are often chosen as sweatlodge locations by the Gros Ventre and Assiniboine. In addition, resource procurement was and continues to be an important activity in the Little Rocky Mountains.

Early ethnographers conducting research at Fort Belknap around the turn of the century also documented use of the Little Rocky Mountains for fasting and plant gathering. Kroeber (1908) describes Gros Ventre fasting in the hills and high places up on mountains to receive powers or become doctors and provides a list of thirty-five plants gathered for medicinal purposes. Lowie describes similar practices (Deaver and Kooistra 1992).

The Gros Ventre and Assiniboine have historically and continue today to gather and use portable resources from the Little Rocky Mountains. Deaver and Kooistra (1992), Flemmer (1990,1991), McConnell (1990) and others have described and documented the past and present importance of resource procurement. Included are the use of trees, shrubs, plants, grasses, animals and animal products, fossil remains, and minerals for domestic, food, medicinal, and ceremonial purposes. Virgil McConnell testified at the public hearings in Lodgepole on April 15, 1993, that there are over 100 plants gathered in the Little Rocky Mountains. Other Fort Belknap tribal members also testified to the importance of resource procurement in the Little Rocky Mountains. Deaver and Kooistra provide a list of 41 grass, plant, shrub, and tree resources (1992), many of which have multiple uses. Thirty of these resources are used for medicinal purposes, 15 for ceremonial purposes, 5 have domestic uses, and 2 are used for food. Trees, which themselves are sacred, provide fuel and building material, and have been used historically for tipi poles (lodgepole pine), sweatlodges (willow), and Sundance lodges (cottonwood center pole). Sweet pine and juniper are used as well. The area is also used for hunting, fishing, and domestic animal browsing. Primary plants include sweetgrass, sages, larb, peppermint, prickly pear, rose roots, cherry bark, chokecherries, and certain funguses.

Culwell et al. (1990) include a section on ethnobotany in their study of vegetation resources conducted for the proposed mine expansion. They note that the Little Rocky Mountains have historically been and are currently a source of plant materials for ethnobotanical uses, that the mountains provide a variety of species associated only with isolated mountain or forest grassland ecotones like the Little Rocky Mountains, and that the relatively small size of the range situated within a prairie setting provides an extensive list of useful plants within a small geographical area (1990). They identify 428 species of grasses, plants, forbs, shrubs, and trees within the Area of Potential Effect (APE) defined for vegetation resources for the project. They note that ethnobotanical use is documented for 200 of these species based upon research conducted in similar areas such as the Bear Paw Mountains, Cypress Hills, Sweetgrass Hills, Judith Mountains, Moccasin Mountains, and others. These species can reasonably be expected to occur throughout the Little Rocky Mountain range. Ethnobotanical studies have not been conducted for the Little Rocky Mountains. Of the 41 vegetal resources identified by Deaver and Kooistra, however, 25 (64 percent) are included by the Culwell et al. study as illustrated in Table 3.12-2. (This number would undoubtedly increase if the variation in scientific and common names could be accounted for.)

There has always been a preference for resources procured from the mountains since a great variety of species can be gathered in a fairly restricted geographical area and they are considered more potent than their counterparts gathered from lower elevations. Flemmer (1991) notes that currently this preference includes the lack of dust along with agricultural chemical contamination prevalent at the lower altitudes. McConnell (1990) notes that Native Americans come from all over, including Canada, to gather plants in the Little Rocky Mountains. For the Fort Peck Assiniboine, the Little Rocky Mountains are the closest source of sweetgrass necessary for ritual purification smudging ceremonies. A wide variety of birds are reported in the area including several types of hawks and golden eagles which are spiritually significant birds to both groups.

The Madison Limestones, which form a series of near vertical cliffs that encircle the Little Rocky Mountains, provide a material source for stone tool manufacture. The limestones form caves, many with Native American rock art, as well as crevasses, many of which contain burials respected and revered by the people of Fort Belknap. Fossils with traditional cultural uses include ammonites or "buffalo stones" and belemnites (used by prehistoric groups for ornaments and fetishes), as well as crinoid stars (used by modern Sundance leaders for rattles). A white clay substance (probably bentonite) is used by the Gros Ventre (known as the White Clay People) for staining their clothes and, today, to prepare hides. The Gros Ventre collect red and yellow paint pigments in the Little Rocky Mountains for use in a face painting rite. Rocks, especially granite, are also collected in the Little Rocky Mountains for use in the sweatlodge. Rocks are assigned spirits and are, in general, respected.

3.12.4.4 Inventory

Approximately 15 percent of the Little Rocky Mountains study area used for the ethnographic study has been archaeologically surveyed. A total of 35 prehistoric sites has been recorded in the Little Rocky Mountains, 16 of which are stone ring (tipi ring) sites found on the margins of the mountains. Remaining sites include five lithic scatters, three campsites, two rock art sites, one cairn, one bison kill site, and one set of vision quest structures. These sites have not been identified with a particular historic Native American group. Four cave sites with rock art near the southern portion of the study area have been identified. Several vision quest structures, many used within the past 20 years, have also been reported.

Numerous individual prehistoric, ethnographic, ethnohistoric, and historic sites were identified during the Deaver and Kooistra study (1992). Those sites with spiritual characteristics are the primary focus of this inventory. Six general site types with such characteristics were either documented or can be expected to occur in the Little Rocky Mountains. These are vision quest sites, anthropomorphic rock features, rock art sites, burials, battlefields, and camps containing special purpose structures such as Sundance lodges, buffalo corrals, and dance grounds.

Deaver and Kooistra (1992) recommend two groups of vision quest sites as eligible for nomination to the National Register as TCPs. Eagle Child Mountain District, located approximately three and one-half miles west of the proposed mine expansion, contains a number of vision quest structures. Beaver Mountain Vision Quest Sites, located approximately onef mile north of the proposed mine expansion, consist of several structures and include recent cloth offerings. Both sites are recommended as eligible under criterion (a) of 36 CFR 60.4 for their association with a major theme in tribal history, vision questing. The Beaver Mountain sites are also considered significant under criterion (c), due to the presence of structures representative of those types used historically and currently by Fort Belknap residents.

Six areas are identified as potential TCPs (i.e., areas that are thought to contain TCPs but that need further investigation to document the presence and importance of sites), including Chief Red Whip Battlefield Site, Mission/Monument Peak, Coming Day Butte, Gold Bug Butte, Thornhill Butte, and Coburn Butte. Thornhill and Coburn buttes and the Chief Red Whip Battlefield Site are located outside the APE.

The ethnographic study also identifies nine general areas of "intangible spiritual values" or areas of modern cultural resources (less than 50 years old) that are reportedly associated with traditional cultural practices. These resources are considered under AIRFA rather than their National Register eligibility. The people of

TABLE 3.12-2

ETHNOGRAPHIC CULTURAL RESOURCES: ETHNOBOTANY IN THE LITTLE ROCKY MOUNTAIN STUDY AREA

Deaver & Kooistra 1992			Culwell et al. 1990	
Scientific Name	Common Name	Native Uses	*Scientific Name*	Common Name
Lewisia rediviva	Bitterroot	Medicine		Absent
	Blackroot	Medicine		Absent
Symphoricarpos albus	Buckbrush	Medicine	*Symphoricarpos albus*	Common snowberry
Vaccinium spp.	Blueberries	Used to feed spirits during sweat		Absent
Opuntia fragilis	Cactus (Prickly pear)	Used as binder in ceremonial paint	*Opuntia polyacantha*	Plains pricklypear
Prunus emarginata	Cherry Bark	Medicine		Absent
Prunus virginiana	Chokecherry	Medicine, food	*Prunus virginiana*	Common chokecherry
Glycyrrhiza lepitdota pursh	Cocklebur	Medicine	*Glycyrrhiza lepidota*	American licorice
Populus spp.	Cottonwood	Juice used for medicine	*Populus angustifolia*	Narrow leaf cottonwood
	Cottonwood	Center pole in sundance	*Populus angustifolia*	Narrow leaf cottonwood
Juniperus horizontalis	Creeping juniper	Diarrhea medicine	*Juniperus horizontalis*	Creeping juniper
Unknown	Flax Seed	Poultice for flu	*Linum lewisii*	(Blue flax)
Melampsorella elatina	Fungus	Medicine		Absent
Parmelia spp.	Green Lichen	Medicine		Absent
Grindelia squarrosa	Gumweed	Medicine	*Grindelia squarrosa*	Curlycup gumweed
Equisetum hyemale L.	Horsetail	Medicine for kidneys	*Equisetum hyemale; arvense; laevigatum; variegatum*	Common scouring rush, horsetail
Juniperus spp.	Juniper	Berries used for offerings	*Juniperus scopulorum*	Rocky Mountain juniper
	Juniper Berries	Medicine for asthma	*Juniperus scopulorum*	Rocky Mountain juniper

Sheet 1 of 4

TABLE 3.12-2 - ETHNOGRAPHIC CULTURAL RESOURCES
(Continued)

Deaver & Kooistra 1992			Culwell et al. 1990	
Scientific Name	Common Name	Native Uses	*Scientific Name*	Common Name
Arctostaphylos uva-ursi	Larb	Tobacco	*Arctostaphylos uva-ursi*	Kinnikinnick
	Larb	Mixed with tobacco to make offerings	*Arctostaphylos uva-ursi*	Kinnikinnick
	Larb	Pipe plant	*Arctostaphylos uva-ursi*	Kinnikinnick
Pinus contorta	Lodgepole	Ceremonial	*Pinus contorta*	Lodgepole pine
Asclepias spp.	Milkweed	For the curing of warts		Absent
	Oregon grapes	Roots boiled to produce yellow paint for sundance and doctoring	*(Mahonia repens)*	Creeping Oregon grapes
	Oregon grapes	Medicine		Creeping Oregon grapes
Parmelia spp.	Pale green lichen	Used for medicine		Absent
Mentha arvensis L.	Peppermint	Ceremonial, medicinal	*Mentha arvensis*	Field mint
	Peppermint	For fevers	*Mentha arvensis*	Field mint
	Peppermint	Pipe plant	*Mentha arvensis*	Field mint
	Peppermint	Teas	*Mentha arvensis*	Field mint
	Peppermint	Medicine	*Mentha arvensis*	Field mint
	Peppermint	Tea	*Mentha arvensis*	Field mint
Chenopodium rubrum	Pig weed	Used as medicine in North Dakota		Absent
(Not provided)	Rasberry Roots	For fevers	*(Rubus spp.)*	Red raspberry
Cornus stolonifera	Red Willow	Tobacco	*Cornus stolonifera*	Red-osier dogwood
	Red Willow	Skinned and baked for white powder	*Cornus stolonifera*	Red-osier dogwood

TABLE 3.12-2 - ETHNOGRAPHIC CULTURAL RESOURCES
(Continued)

Deaver & Kooistra 1992			Culwell et al. 1990	
Scientific Name	Common Name	Native Uses	*Scientific Name*	Common Name
	Red Willow	Pipe tobacco	*Comus stolonifera*	Red-osier dogwood
	Red Willow	Pipe plant	*Comus stolonifera*	Red-osier dogwood
	Red Willow	Medicine	*Comus stolonifera*	Red-osier dogwood
Rosa spp.	Rose Roots	Medicine	*Rosa acicularis; arkansana; woodsii*	Prickly, prairie & wood's rose
Artemesia ludoviciana	Sage	Used in vision quest	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage	Pipe plant	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage	A tea for colds	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage (White)	Ceremonial	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage	Ceremonial at the sundance	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage	Medicine	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage	Burials	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
	Sage	Medicine	*Artemisia cana; tridentata*	Silver sagebrush/big sagebrush
Yucca glauca	Soapweed	Medicine	*Yucca glauca*	Soapwell yucca
Hierochloë odorata	Sweetgrass	Ceremonial		Absent
	Sweetgrass	Medicine		Absent

TABLE 3.12-2 - ETHNOGRAPHIC CULTURAL RESOURCES
(Concluded)

Deaver & Kooistra 1992			Culwell et al. 1990	
Scientific Name	Common Name	Native Uses	*Scientific Name*	Common Name
	Sweetgrass	Incense		Absent
	Sweetgrass	Used as smudge and as tea in ceremonies		Absent
Abies lasiocarpa	Sweet Pine	For a smudge ceremony		Absent
	Sweet Pine	Ceremonial		Absent
	Sweet Pine	Ceremonial		Absent
Evernia vulpina	Tree Lichen	A natural yellow dye		Absent
	Tree, lightning struck	Pitch in scar used for doctoring		Absent
Unknown	Wick-we(in Cree-rat root)	Ceremonial, medicinal		Absent
Daucus spp.	Wild carrot	Medicine		Absent
Lomatium orientale	Wild parsley	Pipe Plant	*Lomatium cous; foeniculaceum; macrocarpum; triternatum*	Several types of lomatiums and desert parsley
Rosa woodsii	Wild rose	Medicine	*Rosa woodsii*	Wood's rose
(Not provided)	Wild rhubarb	Medicine		Absent
Salix spp.	Willow	Used to construct sweat lodges	*Salix bebbiana; exigua; lutea; scouleriana*	Bebb, sandbar, yellow, scouler willow
	Willow	Ceremonial	*Salix bebbiana; exigua; lutea; scouleriana*	Bebb, sandbar, yellow, scouler willow
Pinus spp.	Yellow pine	Domestic use	*Pinus contorta; ponderosa*	Lodgepole and ponderosa
Yucca glauca	Yucca	Domestic use	*Yucca glauca*	Soapwell yucca

(   ) Editorial Additions

the Fort Belknap Indian Community appear to have strong spiritual attachments to these and other places regardless of existing physical remains. These resources include Mission Canyon, Travois Butte, Big Warm Creek, Bear Gulch, Indian Peak, Old Scraggy Peak, Silver Peak, Beaver Creek Area, and Mouse Canyon and Butte.

Classified according to primary site activity, the selected inventory of forty-one (41) Native American cultural resources provided in Table 3.12-3 includes 25 sites associated with Religion and Ritual, 4 rock art sites, 2 burial places, 2 healing places, 2 sundance sites, 2 resource procurement sites, 2 historic events, 1 flat pipe offering site, and 1 contemporary Pow Wow site. Most of these resources are, of course, multiple activity locations, e.g., a religion and ritual location may include vision questing and fasting as well as resource procurement. The emphasis is on vision quest sites and the locations are general. Deaver and Kooistra note on their confidential map of several vision questing and other sacred areas that, "Boundaries are indeterminate at this point in time. Further survey and consultation is needed to determine boundaries" (Pegasus Gold Corporation 1990). Still, the inventory represents the kinds of sites and associated values present within the Little Rocky Mountains and is adequate for the present analysis and assessment.

With several exceptions, specific resource procurement areas could not be included in the inventory due to lack of information on particular locations. It is safe to assume, however, that many of the resources discussed above are currently gathered, are an important part of contemporary Indian culture, and occur throughout the Little Rocky Mountains and the APE. A single Resource Procurement category is included in the inventory to recognize this activity. Similarly, only one specific burial location was identified, although the use of the Little Rocky Mountains for mortuary practices is well documented. A single Burial category is included in the inventory to recognize this activity as well.

3.12.4.5 The Little Rocky Mountains as a Traditional Cultural Property District

Certain segments of the Fort Belknap Indian Community, including Red Thunder, Inc., have maintained for some time that the entire Little Rocky Mountains are eligible for listing in the National Register of Historic Places, and have sent letters to the BLM, the BIA, and the Montana SHPO in this regard. They have also stated that additional, comprehensive studies of the significance of the entire Little Rocky Mountains to Native Americans are necessary, and that Native Americans should conduct these studies.

Deaver and Kooistra (1992) applied the significance criteria outlined in National Register Bulletin 38 to evaluate the entire Little Rocky Mountains as a potential National Register district. Interview data compiled during the ethnographic study indicate that an identifiable group of traditionalists regard the Little Rocky Mountains as significant in tribal history, particularly as a fasting area that has been used to help the Gros Ventre and Assiniboine in important decision-making processes. The integrity of this relationship is apparently intact, as the interview data indicate a continuing tie between the people of Fort Belknap and the Little Rocky Mountains.

Deaver and Kooistra (1992), however, raised concerns regarding the integrity of condition of the area, based on two factors: (1) not enough survey data exist to demonstrate that the vision questing properties present at sites in the Little Rocky Mountains are recognizable to Fort Belknap traditionalists, and (2) with few exceptions, interview data could not address whether or not modern and historic impacts have altered portions of the Little Rocky Mountains to the point where integrity of condition has been significantly diminished or destroyed.

A joint position on National Register eligibility was developed by the Fort Belknap Community Council, the Bureau of Indian Affairs, and the Bureau of Land Management who also entered into a Memorandum of Understanding in June of 1994 (copy attached) to form a special task force to further study the potential of the Little Rocky Mountains as a Historic District. The eligibility position paraphrases Bulletin 38 (Parker and King 1990) in stating that the Little Rocky Mountains are eligible as a TCP because they are:

> a location associated with the traditional beliefs of a Native American groups about its origins, culture history, and the nature of the world; are a location where Native American religious practitioners have historically gone, and are known to go today to perform ceremonial activities in accordance with traditional cultural rules of practice; and are a location where an identifiable community has carried out economic, artistic, and other cultural practices important in maintaining its historical identity.

TABLE 3.12-3

SELECTED INVENTORY OF NATIVE AMERICAN SITES WITHIN THE LITTLE ROCKY MOUNTAINS AND AREA OF POTENTIAL EFFECT

Site No.	Site Type	Site Activity	Site Location USGS 7.5' Quadrangle	Source of Identification
01	**Religion and Ritual**	Vision Questing Sacred Sites	Zortman	Deaver & Kooistra 1992 Flemmer 1991
02	**Religion and Ritual**	Vision Questing Fasting Burials	Zortman	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
03	**Religion and Ritual**	Vision Questing Fasting Burials	Zortman	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
04	**Religion and Ritual**	Fasting Plant Gathering Possible Burials	Zortman	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
05	**Religion and Ritual**	Fasting Sacred Sites	Zortman	Deaver & Kooistra 1992
06	**Religion and Ritual**	Vision Questing Fasting Burials	Zortman	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
07	**Religion and Ritual**	Vision Questing	Zortman	Deaver & Kooistra 1992 Flemmer 1990
08	**Religion and Ritual**	Vision Questing	Zortman	Deaver & Kooistra 1992 Flemmer 1991 McConnell 1990
09	**Religion and Ritual**	Vision Questing Coming Day Place Fasting	Bear Mountain	Deaver & Kooistra 1992 Flemmer 1991 McConnell 1990

TABLE 3.12-3 - SELECTED INVENTORY OF ETHNOGRAPHIC SITES (Continued)

Site No.	Site Type	Site Activity	Site Location USGS 7.5' Quadrangle	Source of Identification
10	**Religion and Ritual**	Vision Questing Fasting Sacred/Spiritual Place	Hays & Zortman	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
11	**Religion and Ritual**	Vision Questing Fasting Offerings Sacred Sites	Hays	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
12	**Religion and Ritual**	Fasting Burials Prehistoric Camps	Hays	Deaver & Kooistra 1992 Flemmer 1990, 1991 McConnell 1990
13	**Religion and Ritual**	Vision Questing Offerings	Hays	Deaver & Kooistra 1992 McConnell 1990 Flemmer 1990
14	**Religion and Ritual**	Vision Questing Offerings Sacred Sites	Bear Mountain	Deaver & Kooistra 1992 Flemmer 1991 McConnell 1990
15	**Religion and Ritual**	Vision Questing	Hays & Crazy Man Coulee	Deaver & Kooistra 1992 McConnell 1990
16	**Religion and Ritual**	Vision Questing Fasting Offerings	Bear Mountain	Deaver & Kooistra 1992 Flemmer 1991 McConnell 1990
17	**Religion and Ritual**	Vision Questing Rock Art Burials	DY Junction	Deaver & Kooistra 1992
18	**Religion and Ritual**	Vision Questing	Coburn Butte	Deaver & Kooistra 1992
19	**Religion and Ritual**	Fasting Sundances	Lodgepole	Deaver & Kooistra 1992
20	**Religion and Ritual**	Vision Questing	Lodgepole	Deaver & Kooistra 1992

TABLE 3.12-3 - SELECTED INVENTORY OF ETHNOGRAPHIC SITES (Continued)

Site No.	Site Type	Site Activity	Site Location USGS 7.5' Quadrangle	Source of Identification
21	**Religion and Ritual**	Offering Area	Hays	Flemmer 1990, 1991
22	**Religion and Ritual**	Fasting	Hays and Zortman	McConnell 1990
23	**Religion and Ritual**	Vision Questing	Zortman	Flemmer 1990
24	**Religion and Ritual**	Vision Questing	Zortman	Flemmer 1990
25	**Religion and Ritual**	Vision Questing	Zortman	Flemmer 1990
26	**Rock Art**	Prehistoric Site	Zortman	Flemmer 1991 Fredlund 1969
27	**Rock Art**	Prehistoric Site	Zortman	Flemmer 1991 Stickley 1969
28	**Rock Art**	Prehistoric Site	Zortman	Flemmer 1991 Barnier 1969
29	**Rock Art**	Prehistoric Site	Zortman	Flemmer 1991 Conner 1967
30	**Burial**	Burial	Hays	Flemmer 1990
31	**Burial**	Burial	Little Rocky Mountains	Deaver & Kooistra 1992
32	**Healing**	Medicinal Spring Curative Powers	Hays	Flemmer 1990
33	**Healing**	Healing Waters Modern Sweatlodges	Ball Coulee	Deaver & Kooistra 1992
34	**Sundance**	Sundance Site Ceremonial Plant Gathering Medicinal Plant Gathering	Hays	Deaver & Kooistra 1992 Flemmer 1991 McConnell 1990
35	**Sundance**	Sundance Grounds	Hays	Flemmer 1990

TABLE 3.12-3 - SELECTED INVENTORY OF ETHNOGRAPHIC SITES
(Concluded)

Site No.	Site Type	Site Activity	Site Location USGS 7.5' Quadrangle	Source of Identification
36	**Resource Procurement**	Ritual and Fossil Gathering Camping Area Bison Kill Offerings	Bear Mountain	Deaver & Kooistra 1992
37	**Resource Procurement**	Plant Resources Mineral Resources Animal Resources	Little Rocky Mountains	Deaver & Kooistra 1992 Flemmer 1991 McConnell 1990 Lutwell et. al 1990
38	**Historic Event**	Historic Battle Site	Hays	Deaver & Kooistra 1992 Flemmer 1990, 1991
39	**Historic Event**	Coming Day's Route to Escape Epidemic	Hays, Zortman, Lodgepole	Flemmer 1991
40	**Pipe Offering**	Flat Pipe Offering	Hays	Flemmer 1990
41	**Powwow**	Pow Wow Grounds	Hays	Flemmer 1990, 1991

The BLM and the Montana SHPO have concurred that the district is eligible under criterion (a) of 36 CFR 60.4, "associated with events that have made a significant contribution to the broad patterns of our history." It was also recognized, however, that other sites and smaller districts within the Little Rocky Mountains District may be individually eligible under other criterion. The task force also recognized that the boundaries were "working boundaries" and could be amended at a later date dependent on additional information and consultation. These boundaries encompass the APE.

3.12.4.6 Mining History in the Little Rocky Mountains and Traditional Cultural Practices

In order to establish an adequate baseline setting for the impact assessment which follows in Chapter 4.0, it is necessary to briefly review the history of mining in the Little Rocky Mountains and the effects of mining on the culture and society of the Gros Ventre and Assiniboine tribes at Fort Belknap.

During the early 1880s, prior to the formation of the Fort Belknap Indian Reservation, gold was discovered on the southern slopes of the Little Rocky Mountains and 2,000 miners stampeded across reservation boundaries, illegally establishing a mining district and a recorder to register their claims (Burlingame and Toole 1957). Coupled with the loss of the buffalo herds and increased settlement throughout Montana and the west, the relative independence and isolation of the Fort Belknap Gros Ventre and Assiniboine came to an end. Within ten years of the Grinnell Agreement, the Little Rocky Mountains mining district became the largest gold producer in Montana at that time. With the introduction of improved mining technology, machinery, and techniques, which included the cyanide leaching process, the mines remained productive until 1918 when a wartime economy slowed the pace. A brief revival in the 1930s was followed by a devastating forest fire in 1936 which in effect greatly reduced the pace of mining company operations (Strahn 1993).

U.S. Government policies of forced assimilation, aggressive religious proselytizing, and exposure to new ideas and technologies combined to work against the practice of traditional cultural practices during the late 1800s and continuing into the 20th Century. The religious effort was spearheaded at Fort Belknap by the establishment of a Mission and industrial school in the Little Rocky Mountains where Gros Ventre and Assiniboine children were physically removed and forcibly alienated from the traditional lifestyle of their parents and elders. The Mission, boarding schools, and outside influences replaced traditional forms of socialization, and tribal elders ceased to participate in tribal political and religious functions (Kelley 1894; Hays 1896). The path to ritual authority was questioned, and many elders who possessed knowledge of native doctoring, sacred songs, and religious protocols died without passing on their knowledge to their christianized children (Tucker 1981 in Strahn 1993). Reportedly, pow wows, naming ceremonies, giveaways, and social dances replaced the sacred rituals once practiced in the Little Rocky Mountains.

The Gros Ventre and Assiniboine populations dropped from a high of 1,700 in 1882 to a low of 1,145 in 1895, a reduction of 33 percent in a 13-year period. This may be attributed to a number of factors including poverty and illness, but certainly includes as well the loss of their traditional resource base. Agent J. M. Kelley noted that in 1894 the Gros Ventre lived near the Little Rocky Mountains while the Assiniboine resided along Milk River, but were dissatisfied and "gradually removing to more favored localities at the foot of the mountains, where wood is abundant and plentiful supply of cool mountain water always at hand" (Kelley 1894).

At the same time, the transformation of the Little Rocky Mountains from a natural landscape where traditional culture was practiced to an industrial landscape valued only for the exploitation of its mineral deposits, served to change native perceptions of the area.

> *"The pristine abundance, solitude and aesthetic beauty that once inspired the reverence of the Assiniboines and Gros Ventres rapidly deteriorated after 1895. Moreover, the traditional status once obtained through hunting, gathering, religious rituals and powers obtained through vision questing in the mountains was, with the ongoing development of mining in the area, nearly impossible to obtain. Alienated from their cultural landscape and prohibited from obtaining these customary means of power elsewhere, the reservation's younger generation struggled to find new places and ways in which to gain prestige within their respective societies (Strahn 1993)."*

Some of the ethnographers who conducted research on the reservation from the 1930s focused on the negative aspects of the social and psychological processes involved in the face of rapid change, or acculturation, which was academically popular at the time. Rodnick

(1938), for example, who assuming that the Indians passively accepted changes introduced from the outside, noted that "the disintegration of culture of the old days has been most amazingly rapid" and Dusenberry (1960) observed that both groups "seem to have lost more of their aboriginal culture--more in fact than one finds on other reservations today." While the acculturation approach yielded a wealth of information about the processes of change, some of its students saw the recipients of change blindly accepting the new and throwing out the old. Other investigators, however, have documented the selective nature of change and the ability for different cultural traditions, the old and the new, to function side by side in the same populations (Woods 1975).

Several scholars have reported the continued practice of traditional ways in the Little Rocky Mountains documenting sacrifice alone in the hills, fasting, and plant gathering (Cooper 1957), and, fasting in the hills during mourning, and experiencing visions of supernatural significance in the hills (Flannery 1953). Verne Ray disputes the notion of rapid acculturation and cultural disintegration, noting that the Gros Ventre have maintained a unique ethnic identity, different from Euro-American culture even though they have adopted material items of the Euro-American tradition (Ray 1975). Later researchers have focused on how the Indians have reacted and adjusted to change (Miller 1987) and the differing viewpoints of elderly Indians and younger Indians trying to learn and live in a traditional way (Fowler 1984,1987).

The literature published prior to 1988 lacks many specific statements about the sacredness of the Little Rocky Mountains and generally fails to identify specific vision quest locations. Deaver and Kooistra (1992) explain this apparent contradiction according to a combination of four factors: (1) vision questing is intensely personal and the experience and location are not to be discussed with others; (2) the religious practitioners and elders interviewed during the earlier studies withheld information from others not only because it was sacred, but because it was discouraged and at times illegal to engage in traditional religious rituals; (3) the Gros Ventre and Assiniboine believe that all places have spiritual qualities so that the identification of specific sacred places may be seen as nonsensical and arbitrary; and (4) researchers of the time were not particularly interested in particular localities. Studies focusing on the specific identification of sacred places and other localities are relatively recent, and are in large part, a response to federal agency needs to comply with requirements of AIRFA and Section 106 of the NHPA. Importantly, Deaver and Kooistra (1992) also note that the current attempt to document specific traditional cultural properties within the Little Rocky Mountains is a direct response to the intervention of Red Thunder, Inc. to mining Permit Amendment No. 10 filed in 1990.

In more recent times, many writers have noted a strong revival of interest in traditional cultural practices, including the sacrifice lodge (Sundance) and vision questing in the Little Rocky Mountains. Deaver and Kooistra (1990) surmise that this practice has become more common in the last 5-10 years; Flemmer (1990,1991) documents the practice and identifies some locations through interviews and field reconnaissance with tribal members; and Melton (1990,1993) provides similar kinds of information. Strahn (1992) also documents this resurgence of traditionalism, noting a relationship between this and environmental awareness and activism. Individual use of the Little Rocky Mountains for traditional practices was also apparent from the testimony of various tribal members during the public hearings for mine expansion held at Lodgepole on April 15-16, 1993 and in meetings and conversations with tribal members undertaken during that same time period (Woods 1993).

Mining in the Little Rocky Mountains can be characterized as heavy during the 1800s through the turn of the century, cyclical from the 1920s through the 1940s and sporadic through 1951. The forest fire in 1936, subsequent loss of terrain to heavy rains in 1937, and a hiatus during World War II contributed to the absence of the intensive mining activities which characterized the earlier periods. After 1951, little serious activity occurred in the Little Rocky Mountains until modern surface-mining operations were initiated in 1979. (See Section 3.12.3.2.)

The consequence of mining operations for vision questing and other traditional activities in the Little Rocky Mountains has been described in an Affidavit by Virgil McConnell, an Assiniboine elder and religious leader:

> *"Fasting Sites in the Little Rocky Mountains prior to the opening of the early mines in the 1800's consisted of many mountains: Gold Bug Butte, Mission Peak, Indian Peak, Silver Peak, Old Scraggy, Bear Mountain, Saddle Butte, Shell Butte (modern names). All of or most of these sites were lost by the mining operations of the 1800's. The start of heap mining in 1978 caused loss of McConnell Mountain, Damon Hill, McMeal Ridge, Monument Peak, all cliffs near the north side of the Little Rocky Mountains*

> *between Coming Day Butte and Whitehorse Canyon. At the present time, the people in the Hays area have only Eagle Child Peak and Otter Robe Ridge for fasting. Near Lodgepole, they only have cliffs between Brown Canyon and Kunnyhard Canyon, Coming Day Butte and Travois Butte. Expansion of the existing mines will threaten the remaining few sites. There is a resurgence of interest in traditional religion and the few remaining sites are even in more demand. Loss of fasting sites will take away the ability of local traditional people to practice their religion." (McConnell 1990)*

The onset of the period of modern mining (1979 to 1994) saw a sharp increase in activities which compromised the use of the Little Rocky Mountains for traditional cultural practices at the same time that a revival of interest in such activities was taking place. McConnell notes that a number of sites were "lost" prior to 1979 and others "lost" after 1979 with the initiation of heap leach mining. Prior to 1979, significant physical disturbance had occurred in Montana Gulch, Beaver Creek, Pony Gulch, and mill tailing were deposited in King Creek, Alder Gulch, and Ruby Gulch. Visual and audial disturbance to these and adjacent areas was ongoing. All of these previously disturbed areas are at or near important ethnographic sites. Since 1979, there has been additional physical disturbance to these areas and extensive physical disturbance to Antoine and Shell Buttes (Zortman), and Gold Bug Butte and Mission Peak (Landusky).

It is important to point out, however, that while some of these sites have been physically disturbed and altered, and others rendered less desirable because of the ongoing visual and audial disturbances, some are still in use, and some of those in use are within a mile of the existing operations at Landusky and Zortman. The best information available indicates that favored spiritual locations continue to be used by some individuals, even though they are in the vicinity of the mines. On Mission Peak, for example, there is evidence of recent vision questing on the west side of the peak, away from the mining activities to the east.

Currently however, there is no information available regarding the frequency of this practice or the frequency of vision questing or other cultural practices, such as resource procurement at other places further removed from the mining operations. The past, present, and future use of the Little Rocky Mountains for traditional cultural practices is reinforced by the concurrence determination that the Little Rocky Mountains are eligible for listing on the National Register of Historic Places as a Traditional Cultural Property District.

3.13 AREAS OF CRITICAL ENVIRONMENTAL CONCERN (ACEC)

Areas of Critical Environmental Concern (ACECs) are BLM land units that require special management to protect resource values. Azure Cave and prairie dog towns within the Prairie Dog 7km Complex are two areas that have recently been designated as ACECs by the BLM which may be impacted or are in close proximity to the proposed mine expansions. Three other areas have been nominated for consideration as ACECs, including Little Rocky Mountains, Saddle Butte, and Old Scraggy Peak.

3.13.1 Azure Cave

Azure Cave is designated as an ACEC for its significant geological and biological resources. Azure Cave ACEC contains a relatively large limestone solution cavern (1,580 feet of mapped passage and -220 feet in depth) located adjacent to the proposed mine expansion. Azure Cave has national significance because of its bat hibernaculum values. Azure Cave is currently used by at least three species of bats as a hibernaculum. These are the Townsend's big-eared bat, the little brown bat, and the long-legged myotis (Butts 1993). It has also been used by others such as the big brown bat, the northern long-eared myotis, and may be used by the western small-footed myotis as this species has been previously documented using the cave during late summer and early autumn months (Chester et al. 1979; Howard and Hintzman 1964). Bats reported to use the cave in summer include Northern long-eared myotis, little brown bat and big brown bat (BLM 1991).

Azure Cave contains more speleothems (rock formations) than any other cave in Montana except Lewis & Clark Caverns (Campbell 1978). The lower level has many stalactites and stalagmites, some of which are more than 6 feet long. Cave popcorn and flowstone decorate the walls of the cave. In one room, there is a very large cluster of helectites which may be the best in Montana. Formations are still growing since the cave is active and wet.

The most significant aspect of Azure Cave is its vertebrate biology. Although the population of 300-500 bats is small compared to other caves in the U.S., the bats make it a truly unique cave in Montana and the region (Chester et al. 1979).

Azure Cave and surrounding lands were transferred to the BLM from the National Forest System by Public Land Order No. 3938 on February 23, 1966. This order withdrew 139.41 acres around the entrance to Azure Cave for the protection of public recreation values and the significant cave values and resources it contains. This withdrawn area is the ACEC boundary. The withdrawal removed the land from all forms of appropriation under the public land laws.

3.13.2 Prairie Dog 7km Complex

The Prairie Dog 7km Complex ACEC is located south and east of the proposed project. This ACEC includes 12,346 acres of prairie dog towns on BLM land. The nearest delineated prairie dog town is located approximately 8 miles south of the project. This complex is unique because it contains habitat for about 75 wildlife species including burrowing owls, ferruginous hawks, and mountain plover. This area contains a significant amount of high quality habitat for the endangered black-footed ferret. Prairie dogs are essential as the primary prey species for ferrets. The 7km Complex meets USFWS habitat assumptions for ferret management because it encompasses two or more prairie dog towns that are not more than 7 kilometers apart. Thus, the proposed designation of this complex as an ACEC is based on meeting the relevance and importance criteria for ACECs and the need for special management (BLM 1992b). Black-footed ferret reintroduction plans call for ferrets to be released approximately 40 miles from the project area and ferrets were re-introduced into this complex in 1994.

3.13.3 Saddle Butte

The entire Saddle Butte area has been nominated for consideration as an ACEC due to unique vegetation communities. A savannah community, classified as *Pseudotsuga menziesii/ Andropogon scoparius*, is located on the upper southeast slopes of Saddle Butte. This plant association was previously identified as a rare community by the MNHP. Recently, the MNHP reevaluated this association and removed it from the MNHP State Classification list (Cooper 1995). This area is currently undergoing evaluation by the BLM to determine if it qualifies for further consideration as a potential ACEC.

3.13.4 Old Scraggy Peak

Old Scraggy Peak was nominated for consideration as an ACEC for Native American cultural and historic values.

This area is currently undergoing evaluation by the BLM to determine if it qualifies for further consideration as a potential ACEC.

3.13.5 Little Rocky Mountains

The entire Little Rocky Mountains area has been nominated for consideration as an ACEC because of its Native American cultural and historic values. This area is currently undergoing evaluation by the BLM to determine if it qualifies for further consideration as a potential ACEC.

3.14 HAZARDOUS MATERIALS

3.14.1 Introduction

A variety of potentially hazardous materials have been used in the mining, ore processing, and mine reclamation activities at the Zortman and Landusky mines. The rate of use for these materials has varied over the years, and some have replaced others to increase operational efficiency or to accommodate operational modifications.

The following sections describe the use, storage, and consumption of these materials at the mines as well as disposal of various types of wastes. The transportation of hazardous materials is addressed in Section 3.11. In addition, a history of accidental spills and releases of hazardous materials is presented, along with a description of emergency response and spill contingency planning that has been carried out to address potential spills or releases in the future.

3.14.2 Historic Use of Hazardous Materials (Pre-1979)

In general, very little information is available concerning hazardous materials use by historic mining operations in the Little Rocky Mountains prior to 1979. Sources of information on the history of mining in the Little Rocky Mountains indicate that amalgamation of gold ores was carried out at mills near the historic Gold Bug Mine and near Mill Gulch just above the town of Landusky (Bryant 1953). This process utilized mercury, although the quantities used are unknown. This process was used from 1893 to 1902 and was discontinued in favor of the more effective cyanidation process.

Following the use of mercury amalgamation for gold extraction, cyanide was used extensively at both the Ruby Mill, at the present day Zortman Mine, and at the Alder Gulch Mill for extraction of gold. The Alder Gulch Mill, located west of the present day Zortman Mine, was built in 1903 and only operated until 1908 (Little Rockies Miner 1908). This mill may have been the first to use cyanide for extraction of gold. Cyanide was also used in milling operations at the historic August and Gold Bug Mines in the vicinity of the Kings Creek and Montana Gulch drainages at the present day Landusky Mine (Bryant 1953). The use of cyanide in milling of ores continued sporadically until around 1957. With respect to potential contamination, it is important to note that sampling of tailing in the King Creek drainage revealed no detectable concentrations of cyanide (Muza 1993).

Although it is likely that other hazardous materials, such as gasoline or diesel, may have been used or consumed in the project area prior to 1979, no information was found describing such use and little evidence exists today that spills or releases of significance occurred.

3.14.3 Hazardous Materials Use - 1979 to Present

3.14.3.1 Chemical Use, Storage, and Consumption-Zortman Mine

The following is a description of chemicals used at the Zortman Mine from 1979 to the present. Over this time frame, some materials used have been replaced by others. For instance, petroleum-based solvents are no longer used at the mine, having been replaced by a citrus-based solvent substitute. Since the mining of ore ceased at the Zortman Mine in 1990, it is important to note that most of the chemicals presently consumed in the project area are associated with Landusky Mine operations.

The following chemicals have been used for makeup water, ore processing, and the water treatment plant:

Gasoline is used to power the mine's light vehicles. It arrives on site by bulk truck in 500 to 2,000 gallon batches and is off-loaded into a 1,000 gallon aboveground storage tank on a concrete containment pad located behind the ZMI office in the town of Zortman. The estimated annual usage of gasoline is 5,000 gallons at the Zortman Mine.

Diesel Fuel is used to power mine trucks and other heavy equipment. It arrives on site by tanker and is stored in a 1,000 gallon aboveground tank near the Zortman refinery. The diesel tank sits on a steel containment structure. Estimated annual consumption is 1,500 gallons.

Oil and Lubricants are used for lubrication of mine equipment. Oil products include rock drill oil, lubricant oils, hydraulic fluids, engine oils, and transmission fluids. Waste oil is stored in a 200 gallon aboveground tank in the Zortman light vehicle shop on a temporary basis.

Waste oil is typically transported by truck to the Landusky Mine, where it is stored in an 8,000 gallon aboveground tank on a concrete containment pad prior to transport off-site. Shipment sizes for these compounds vary. Annual usage for the Zortman Mine is approximately 1,000 gallons. Prior to 1990, when active mining occurred at the Zortman Mine, a heavy vehicle maintenance garage was operated near the 82 leach pad. Oil and lubricants were stored and used in this garage while it was in operation.

Antifreeze comprised of ethylene glycol is used as engine coolant for the mine fleet. It arrives in bulk trucks in 100 to 1,000 gallon batches and is off-loaded into a 1,500 gallon aboveground tank located on a concrete containment pad adjacent to the diesel fuel and oil tanks at the Landusky Mine. Estimated annual usage by vehicles at the Zortman Mine is 500 gallons.

Citrus-Based Solvent is non-hazardous and is used for parts washing. Estimated amount used at the Zortman Mine is 200 gallons per year. A private vendor periodically removes the spent solvent from the mine site and provides new solution.

Sodium Cyanide was used in the past at the Zortman Mine to dissolve the gold and silver in the leaching process. At present, it is only used in the refinery in smaller quantities. The dry sodium cyanide is stored on a concrete curb adjacent to the barren solution pond in the 200 pound barrels it was shipped in. Truck loads are approximately 20 tons. During active mining at the Zortman operation, the estimated quantity of sodium cyanide used per year was 600 to 700 tons. At present, consumption is roughly 40 tons/year.

Lime has been used in the past to control the pH of cyanide solution during the metal extraction process and pH control at the water treatment plant. At present, lime is only used at the water treatment plant. Lime is stored in an enclosed silo on a concrete slab near the processing plant. Lime is shipped to the mine in a tanker trailer carrying about 20 tons. At present, approximately 120 tons per year are consumed at the Zortman Mine water treatment plant.

Hydrochloric Acid (HCl) at a molar concentration of 11 is used to remove scaling on the clarifiers, pump intakes, impellers, spray lines and return lines. It arrives at the site by tanker truck and is off-loaded into a 5,000-gallon double-walled aboveground tank located in a concrete containment structure adjacent to the refinery on the 89 leach pad. It is usually shipped in relatively small quantities, arriving at the site in batches of 1,000 to 5,000 gallons. Approximately 15,000 gallons of HCl are used per year at the Zortman Mine.

Sodium Hydroxide (Caustic Soda) is used in the stripping circuit in the Zortman refinery to aid in desorption of gold and silver from the loaded carbon. The caustic soda is delivered to the mine in a 25 percent solution by a 4,500 gallon tanker truck. The solution is stored adjacent to the refinery in a 5,000 gallon aboveground tank within a 7,200 gallon concrete containment structure. Annual consumption is approximately 5,000 gallons.

Anti-Scalants are used to prevent scaling around the pump intakes and in the spray and return line. Anti-scalants are shipped to the mine site by truck in batches of about 1,000 to 2,000 gallons, and stored at the point of use in aboveground tanks. Approximately 800 gallons of anti-scalant are used per year at the Zortman Mine.

Flocculent is presently used at the water treatment plant to help settle sludge out of solution. The flocculent, Nalco 7852, is an aqueous solution of a polyquaternary amine used at the treatment plant. It is shipped in one-ton metal containers and is stored in the treatment plant on a concrete floor. Annual consumption at the Zortman Mine is 100 gallons.

Hydrogen Peroxide (H_2O_2) is used at the end of leach pad life to destroy cyanide in heap rinsate solution if natural degradation of cyanide needs to be accelerated. Hydrogen peroxide is shipped to the mine in double-walled tanker trucks which unload into a double-walled aboveground storage tank on the 82 leach pad. An estimated 10,000 to 20,000 gallons of 70 percent hydrogen peroxide may be required, depending on amount of natural degradation of cyanide compounds. Approximately 550 gallons of H_2O_2 are kept on hand at the mine.

Calcium Hypochlorite is used on a very infrequent basis to neutralize cyanide solution which may have leaked or spilled out of containment systems. This material is stored on the 82 leach pad in the shipping containers. Calcium hypochlorite is shipped in 100 pound containers. Annual usage is determined by the event and magnitude of spills requiring neutralization.

Laboratory Reagents are used in the Zortman Assay Lab in the town of Zortman for analyzing the metal content of ore samples. Those reagents are used in small quantities and are stored on concrete containment within the lab building.

3.14.3.2 Waste Disposal-Zortman Mine

Solid Waste from the mine, such as paper waste from the mine office, is disposed in accordance with the rules and regulations of the Waste Management Division of Montana Department of Health and Environmental Sciences. Municipal Class II solid waste is compacted and transported to the Fergus County sanitary landfill for disposal. Inert, Class III wastes such as wood and concrete are occasionally buried on-site in selected areas.

Used oil filters from the Zortman light vehicles garage are crushed and sent to the Fergus County landfill. "Floor dry" is an absorbent used to clean up spilled oils and lubricants in the light vehicle shop. Used "floor dry" is also sent to the county landfill for disposal. Used batteries are removed by a vendor for recycling. Broken glassware from the laboratories is triple rinsed with fresh water and sent to the county landfill for disposal. Filters and paper wastes from the labs are incinerated at the Zortman refinery. Empty cyanide containers are rinsed on a leach pad and the vast majority are returned to the vendor. A small percentage of empty cyanide drums and all flocculent containers are crushed and disposed of on the 89 leach pad. Zinc powder containers are rinsed and sent to the county landfill for disposal.

Solid Hazardous Wastes, including approximately 4 tons per year of cupels and slag generated from the assay lab, are barreled and shipped by truck to the ASARCO smelter in East Helena for disposal. Slag from the refinery and carbon fines from the Landusky processing plant are stored in containers on the Zortman 82 leach pad and are also sent to the ASARCO smelter for further refining and disposal.

Liquid Hazardous Wastes, such as assay and research lab solutions containing cyanide and acid, are collected in 55 gallon plastic barrels and disposed of on the Zortman 89 leach pad. MIBK, an organic compound used to aid in acid digestion, is collected and stored prior to shipping to an approved disposal site. Runoff solution from the fume scrubber on the assay lab is collected in drums and disposed on a leach pad. Non-salvageable materials that have had contact with cyanide solution have in the past been disposed by burial in active heaps, but all cyanide bins and a majority of empty cyanide barrels are now recycled back to the chemical supplier. ZMI is registered with the EPA and DHES as a Conditionally Exempt Small Quantity Generator of hazardous waste (ID# MTD089515495).

Other Wastes generated at the Zortman Mine include metal hydroxide sludge produced at the water treatment plant. This sludge is presently disposed of in a trench on the 89 leach pad. Approximately 2,000 tons of treatment plant sludge are generated and disposed of annually. Precipitate or sludge has settled on the bottom of various ponds at the Zortman Mine. At the time of closure and reclamation of these ponds, this sludge will be tested and may be disposed of on the waste rock repository directly, mixed with cement and disposed of on-site, or shipped to an approved disposal facility off-site, depending on the metals concentration and/or toxicity of the sludge and relevant regulatory requirements at that time.

3.14.3.3 Chemical Use, Storage, and Consumption-Landusky Mine

Unlike the Zortman Mine, which stopped producing ore in 1990, the Landusky Mine is currently producing and processing ore. As a result, chemical use at the Landusky Mine is considerably higher at present.

The following is a discussion of chemical use, storage, handling, and an estimate of the amount of each compound consumed specifically at the Landusky operation.

Gasoline is used to power the mine's light vehicles. It arrives on site by bulk truck in 500 to 2,000 gallon batches and is off-loaded into one 1,000 gallon tank on a concrete containment pad in the Landusky fuel farm area. The estimated annual usage of gasoline is 61,000 gallons at the Landusky Mine.

Diesel Fuel is used to power the mine trucks and vehicles. It arrives on site by tanker truck and is off-loaded into 4 - 10,000 gallon aboveground tanks, located in the contained fuel farm area near the vehicle maintenance shop. The diesel arrives at the mine site in 10,000 gallon lots. Estimated annual consumption is 2.6 million gallons per year. Smaller trucks and equipment are fueled at the fuel farm, while larger pieces of equipment are fueled by a tanker truck.

Oil and Lubricants are used for lubrication of mine equipment. Oil products include rock drill oil, lubricant oils, hydraulic fluids, engine oils, and transmission fluids. Oil is stored on the concrete fuel farm containment pad adjacent to the diesel fuel tanks in 3 - 8,000 gallon aboveground tanks in the contained fuel farm area and 1 - 3,000 gallon tank. Waste oil is stored in an 8,000 gallon tank prior to transport off-site. Shipment sizes for these compounds vary. Annual usage for the Landusky Mine is approximately 80,000 gallons/year.

Antifreeze comprised of ethylene glycol is used as engine coolant for the mine fleet. It arrives in bulk trucks in 100 to 1,000 gallon batches and is off-loaded into a 1,500 gallon aboveground tank located adjacent to the diesel fuel and oil tanks in the contained fuel farm area. Used antifreeze is stored in a 1,500 gallon aboveground tank in the same area. Estimated annual usage at the Landusky Mine is 8,500 gallons.

Citrus-Based Solvent is non-hazardous and is used for parts washing. Estimated amount used at the Landusky Mine is 800 gallons per year. Solvent is stored in the vehicle maintenance shop. A private vendor periodically removes the spent solvent from the mine site and provides new solution.

Sodium Cyanide is used to dissolve the gold and silver in the leaching process. The dry sodium cyanide is stored on the 87 leach pad in the flo bins it was shipped in. Empty cyanide bins are washed and sent back to the distributor on the same truck that brings the product to the plant. Truck loads are approximately 20 tons. Estimated quantity of sodium cyanide used per year for the Landusky Mine is 1,750 tons.

Lime is used to control the pH during the metal extraction process and is also used for pH control at the water treatment plant. Lime is stored in 100 ton silos near the processing plant and ponds. The lime is fed from the silos onto the transfer conveyors at the leach pad site. Lime is shipped to the mine in a tanker trailer carrying about 20 tons. At present, approximately 18,000 tons per year are consumed at the Landusky Mine.

Ammonium Nitrate is the main ingredient in the blasting agent "ANFO." It arrives at the site in a pneumatic tanker trailer. It is off-loaded to three 100-ton silos located near the 1984 pad where it is stored until usage. Annual usage is approximately 4,000 tons. About 65 tons are maintained on site.

Anti-Scalants are used to prevent scaling around the pump intakes and in the spray and return line. Anti-scalants are shipped to the mine site by truck in small batches of about 1,000 to 2,000 gallons, and stored on the 87 leach pad adjacent to the processing plants in a 3,100 gallon aboveground tank and adjacent to the barren pond in a 2,000 gallon tank. Approximately 8,200 gallons of anti-scalant are used per year at the Landusky Mine.

Flocculent is used to settle small particles out of the solution which create problems in the clarifiers in the metal extraction process. Flocculent is shipped to the Landusky Mine in one-ton metal containers and is stored on the 87 leach pad. Approximately 150 gallons of Nalco 7852 flocculent are used annually at the Landusky Mine. Empty containers are crushed and disposed of on the leach pad.

Powdered Zinc dust is used in the Merrill-Crowe plant at the Landusky Mine for extraction of gold. At present, approximately 110 tons per year are consumed in this process. Zinc is stored in 5 gallon buckets adjacent to the plant on the 87 leach pad. Used zinc barrels are rinsed with fresh water, crushed, and disposed of in the Fergus County landfill, along with other non-hazardous solid waste.

Hydrogen Peroxide is used at the end of mine life to destroy cyanide in heap leach rinsate solution if natural degradation of cyanide needs to be accelerated. Hydrogen peroxide is shipped to the Zortman Mine in double-walled tanker trucks which unload into a double-walled aboveground storage tank on the Zortman 82 leach pad. An estimated 10,000 to 20,000 gallons of 70 percent hydrogen peroxide may be required, depending on amount of natural degradation of cyanide compounds. Approximately 550 gallons of H_2O_2 are kept on hand at the Landusky Mine.

Calcium Hypochlorite is used on a very infrequent basis to neutralize cyanide solution which may have leaked or spilled out of containment systems. This material is stored in the shipping containers on the 82 leach pad at the Zortman Mine and is transported and used at the Landusky Mine only when needed. Calcium hypochlorite is shipped to the Zortman Mine in 100 pound containers. Annual usage is at the Landusky Mine determined by the event and magnitude of spills requiring neutralization.

3.14.3.4 Waste Disposal-Landusky Mine

Solid Waste from the Landusky Mine is disposed in accordance with the rules and regulations of the Waste Management Division of Montana Department of Health and Environmental Sciences. As described for the Zortman Mine and mine office, municipal Class II solid waste is compacted at the mine and transported to the Fergus County sanitary landfill for disposal. Inert, Class III wastes such as wood and concrete are occasionally buried on site in selected areas.

Used oil filters and "floor dry" absorbant from the Landusky vehicle maintenance shop are disposed of at the county landfill. Used vehicle batteries are removed by a vendor for recycling. Empty cyanide bins are rinsed on the 87 leach pad and shipped back to the manufacturer. Empty zinc barrels are rinsed, crushed, and disposed of at the county landfill, while empty flocculent containers are disposed of on the leach pad.

Solid Hazardous Wastes in the form of carbon fines from the carbon absorption plant are transported and stored at the Zortman Mine. Carbon fines are then shipped offsite for further refining and disposal at an approved site.

Liquid Hazardous Wastes, such as the waste oil and used citrus-based solvent, generated at the Landusky vehicle maintenance shop are stored in tanks on the containment pad in the fuel farm area and then picked up by an EPA-licensed vendor for reprocessing. Since all laboratory analyses are performed at the ZMI laboratory in the town of Zortman, no laboratory wastes are generated at the Landusky Mine.

Other Wastes generated at the Landusky Mine include precipitate or sludge on the bottom of on-site ponds. Similarly, iron precipitate has settled on the bottom of the 85/86 contingency pond from stored drainage from the Gold Bug Adit. As described for the Zortman Mine, the ultimate disposal of these precipitates or sludges will depend on their chemical composition, their toxicological properties, and relevant regulatory requirements at the time of closure and reclamation.

3.14.4 Accidental Spills and Releases of Hazardous Materials - 1979 to Present

Since the commencement of mining by ZMI in 1979, there have been five known accidental spills or releases of cyanide into the environment. The following is a summary of those releases, including a description of the suspected amount of material released. A discussion of environmental impacts associated with these releases is presented in Section 4.14.

- On November 1, 1982, cyanide was detected in the Kalal groundwater supply system, located in Alder Gulch near the town of Zortman. The source of the cyanide was found to be a spray line on the Zortman 1982 leach pad that was accidentally drained off of the lined surface to prevent freezing. It is estimated that about four pounds of cyanide were spilled.

- On December 9, 1982, roughly 75 gallons of cyanide solution containing roughly 2 pounds of cyanide were spilled at the Landusky Mine. This solution was immediately neutralized.

- In June 1986, a leak of cyanide solution was detected in the rock drain below the Landusky 86 leach pad. The source of the leak was faulty installation of the leach pad liner. Low level cyanide concentrations were detected in surface water in Montana Gulch as far downstream as the Montana Gulch Campground. In response, ZMI increased the frequency of surface and groundwater monitoring in the area, installed a temporary pumpback impoundment, neutralized cyanide solution in downstream areas, and removed the ore and relined the leaking portion of the leach pad. After corrective measures were taken cyanide concentrations dropped considerably and the leak was considered successfully repaired.

- In October 1987, cyanide was detected in Ruby Gulch below the Zortman 85-86 leach pad. The source was identified as a leak in the pad liner. In response, the level of the solution in the leach pad was lowered below the level of liner failure. Although much of the leaked solution was neutralized in stream using hypochlorite, trace amounts of cyanide have been detected in upper Ruby Gulch.

- On July 7, 1992, cyanide was detected in monitoring well ZL-108 adjacent to the Landusky processing plant. In response, an inspection was carried out, groundwater monitoring at that location was increased, and a Notice of Noncompliance was issued.

- In September 1993, cyanide was detected in monitoring wells adjacent to a process pond at the Landusky Mine. The source of the leak was found to be improper seaming of the newly relined pond. The pond was drained and relined. Pumpback efforts were initiated and additional wells were constructed. The amount of the leak is not known, but may have exceeded several thousand gallons. No offsite contamination of surface water or groundwater has been detected at monitoring sites.

In addition to the cyanide releases described above, one release of petroleum hydrocarbons, or diesel fuel, is known to have occurred at the Zortman Mine around

September 1991. This release occurred from a leaking underground storage tank located near the Zortman truck shop. The leak was discovered when the tank was being removed from the site. The release was reported to the Montana Department of Health and Environmental Sciences (DHES). In response, all visually contaminated soil was removed by ZMI, along with an additional 200 yd^3. Soil sampling revealed that concentrations of petroleum hydrocarbons were below the relevant DHES action level. Based on consultation with DHES, the excavated soil was spread on the surface to allow the contamination to volatilize. According to DHES, no further investigation or clean up activities are needed for this release (DHES 1995).

3.14.5 Emergency Response and Spill Contingency Planning

ZMI has developed two emergency response and spill contingency plans that mine employees have been trained to follow in the event of an accidental release of certain hazardous materials. The first of these plans is the "Cyanide Spill Contingency Plan", which was recently revised in 1995. In brief, this plan describes background information on the uses and applications of cyanide and chemical reactions that can occur with cyanide under different circumstances. More importantly, the plan describes personal safety, first aid, and medical treatment for individuals accidentally exposed to cyanide, as well as procedures for responding to accidental spills and transportation emergencies. The plan also describes cyanide unloading, handling, and storage procedures (Cyanide Spill Contingency Plan 1995).

The second emergency response plan that ZMI has prepared is the "Spill Prevention Control and Counter Measure Plan (SPCC) - Hydrocarbon Products". Specific objectives of the plan include: 1) reducing the potential for accidental spills and environmental contamination; 2) providing necessary information to operations staff to properly respond to a spill event; 3) defining responsibilities for spill notification and control of spills; and 4) providing a response and clean-up program which minimizes or eliminates environmental impacts (SPCC Plan 1995). The plan provides detailed information on hydrocarbon products used at the mines, storage areas, proper handling practices, inspection of tanks and storage facilities for leaks or spills, spill prevention, notification, and response training, and clean up or removal procedures for spilled fuel.

CHAPTER 4.0

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION TO IMPACT METHODOLOGY

This Chapter addresses the environmental consequences, or impacts, of each of the seven alternatives described in Sections 2.5 through 2.11. In accordance with the Bureau of Land Management's (BLM) National Environmental Policy Act (NEPA) Handbook (BLM Handbook H-1790-1), the critical elements of the human environment to be addressed in this analysis are presented in the sections which follow this introduction. However, the following elements have been reviewed and would not be effected by the proposed action or alternatives: prime or unique farm lands; wild and scenic rivers; and wilderness or wilderness study areas.

Types of Impacts

Impacts are assessed for each environmental and human resource with regard to direct effects, indirect effects, cumulative impacts, and impact significance. Significance, as referenced in the Council on Environmental Quality NEPA regulations, requires considerations of both context and intensity (40 CFR 1508.27). In other words, how does an impact fit in the local and regional context, and how adverse or beneficial is the effect on human and environmental resources?

Significance criteria are used by each resource specialist when an impact can be evaluated in quantitative terms, for example: a numerical or regulatory standard; number of acres of disturbance; nuisance level; years of economic effect; or population change that is deemed significant. This is then the threshold, measure, or standard against which an impact is compared to determine it's "significance." However, quantitative criteria may not always be available for impacts comparison. In these instances, resource specialists rely on relevant information sources, experience at the Zortman and Landusky mines and other similar mine sites, and professional judgement to determine if an impact is "significant."

The Baseline, or Basis for Impact Assessment at Zortman/Landusky

As described and illustrated in Chapter 1, little relative surface disturbance, other than exploration roads, was present in the current mine areas prior to 1979. The area around the Ruby pit, mill, and along Ruby Gulch was the notable exception. Therefore, the baseline discussion in Chapter 3, Affected Environment, focuses on conditions prior to the era of large-scale, modern mining and disturbance, which began in 1979 (see DSL 1979). For impact assessment the baseline, or basis for analysis, is the 1979 conditions present in the study area prior to commencement of modern mining operations. Each environmental resource discussion will chronicle impacts from activities in the past (1979-1994), and then go on to discuss future impacts of each alternative.

Impact Methodology

Impacts are discussed, and then rated, based primarily on technical and professional judgement in view of this particular project, its setting and context, other projects resource specialists have reviewed, and the effects of this project in both a site-specific and regional sense. A review of EIS scoping issues was performed by each environmental resource specialist prior to this analysis to assure that all relevant concerns expressed by the public and concerned entities were addressed.

For the impact analyses to be meaningful, and to allow a significance determination, they must be defined in terms of magnitude, incidence, and duration. "Magnitude" refers to the extent of the impact. Where possible, resource specialists have used numerical terms, such as the number of acres disturbed, to describe the magnitude of impact resulting from each alternative. When quantitative terms are not available or cannot be developed, resource specialists may define the impact magnitude relative to the effects associated with other alternatives.

"Incidence" is the frequency of impact occurrence. Some impacts may occur continuously, for the duration (or longer) of mining and reclamation. Other impacts, such as noise from mine pit blasting, may occur only on a periodic or sporadic basis.

"Duration" of impact refers to the time within which the impact will occur. For instance, air quality impacts from mining operations would dissipate quickly once mining operations stop, but groundwater contamination would likely persist for many years beyond the cessation of mine activities. To help differentiate impact durations, resource specialists may distinguish between "short term" and "long term" impacts, using criteria specific to each resource analysis.

Impact Direction

Impacts are also described in terms of the direction of change. This direction of resource change may be reflected by an improvement in the environmental resource. Resource specialists would term this trend "beneficial." Alternatively, continued or increased environmental degradation would be an "adverse" trend. However, it is important to remember that the direction of change, whether adverse or beneficial, is always relative to the baseline conditions existing prior to the start of modern mining operations in the Little Rocky Mountains. It is also important to remember that the impacts described are residual impacts; that is, those which would occur even after agency-required (DEQ/BLM) or proponent-committed (ZMI) mitigation measures take place. Alternative 1, the No Action alternative, does not incorporate any mitigations beyond those required by the existing permits.

In developing the analysis of impacts for this document each resource specialist initially presents their particular methodology to assess impacts. Then, the 1979-1994 impacts are compiled and presented for a historical perspective and to understand the current state of the environment at the project site. These impacts are documented by field observations, field sampling data and analyses, air photos, maps, and reports. Finally, each alternative (1-7) and its predicted impacts are disclosed. NEPA and MEPA also require an assessment of the following:

Cumulative impacts: Cumulative impacts for this Draft EIS are those from past, present, and reasonably foreseeable future actions that have or are expected to occur in the project area, aside from the Zortman and Landusky mining and reclamation. These include: 1) historic mining disturbances in Montana Gulch, Beaver Creek, and Pony Gulch, and the Hawkeye Mine; plus mill tailingss in King Creek, Alder Gulch, and Ruby Gulch; 2) impacts from 1979 through 1994; 3) impacts resulting from full implementation of all alternatives; and 4) Reasonable Foreseeable Future Actions, as described in Chapter 2 under each alternative. It is important to note that no other major non-mining actions are projected for this part of the Little Rocky Mountains which need be included in the cumulative imkpact analysis.

Unavoidable adverse impacts: These are adverse impacts that would not be mitigated below significance.

Short-term use/long-term productivity: This discussion identifies the tradeoffs between short-term use and long-term productivity of the resources involved in the alternative.

Irreversible or irretrievable commitments of resources: These are the resource commitments which would irreversibly limit potential uses of lands and resources, or irretrievably use, consume, destroy, or degrade these resources.

4.1 GEOLOGY AND TOPOGRAPHY

The methods used to evaluate geologic and topographic impacts are presented first, including the guidelines under which the impact analysis is conducted. Section 4.1.2 presents an overview of the impacts to geologic and topographic resources resulting from mining activities during the years ZMI has operated the Zortman and Landusky mines. Sections 4.1.3 through 4.1.9 describe the impacts associated with the three mine expansion denial alternatives (1, 2, and 3) and the four expansion alternatives (4, 5, 6, and 7).

4.1.1 Methodology

The evaluation of impacts to the geologic resources and topography of the Little Rocky Mountains is based on quantitative and qualitative analysis. Quantitative assessments of impacts are possible where the magnitude of impact is known or relatively predictable. For instance, the extent that topographic relief has already been modified in some areas of the Little Rocky Mountains is easily determined by comparing the elevation of selected areas prior to mining with the elevation of those same locations after approximately 15 years of mining. The magnitude of this impact is presented by a numerical elevation change. A quantitative assessment simplifies the comparison of alternatives. The magnitude of impact to geological resources is estimated based on the amount of material (i.e., clay, limestone, etc.) needed to fulfill the construction and reclamation requirements for each alternative.

Significance determinations are primarily based on the quantities and types of geologic resources consumed, and the extent of topographic modification. These are direct effects caused by implementation of a particular alternative. "No impact" only applies if geologic resources would not be mined for reclamation or construction purposes; there would be no resultant topographic modification.

Context is very important to the geologic significance determination. This is well illustrated by comparing the impacts on precious mineral resources against the impacts on reclamation resources. The clays and limestones used in construction and reclamation are available in large quantities locally, and virtually limitless quantities regionally. Because there is no potential for depletion of these resources by the alternative actions, the impact to these resources is not significant. However, gold and silver are considered precious metals with limited quantities available in the study area or even worldwide. Extraction of these metals by mine operations is a significant impact by virtue of the depletion of a limited local resource.

Topographic impacts are presented by evaluating the magnitude of alteration to the landscape and areas disturbed by the mining or reclamation activities. Most topographic disturbances to remove geologic resources are considered an adverse impact. Exceptions would include actions taken to restore landforms to their original, pre-mining topography.

A qualitative assessment is used where numerical determinations or estimates are not possible or within the scope of this analysis. As an example, the geologic hazard of a landslide has a higher probability of occurrence in Upper Alder Gulch than it does on the Goslin Flats. The absolute difference in stability for the two areas is not known but it is reasonable to conclude that the Goslin Flats site presents a lower landslide risk than a site in a relatively steep valley like Upper Alder Gulch. Geologic hazard significance is based on whether a facility has been, or could be, engineered to acceptable and appropriate safety standards.

The seven alternatives are evaluated for direct and indirect resource effects. Each impact is presented in terms of the change affected, where possible by: 1) a disclosure of the magnitude of the effect, as described above; 2) the relative length of time the effect will last, with short-term effects being those that occur during mining and reclamation, and long-term duration being an impact extending longer than mining or reclamation, and 3) the likelihood the impact will occur and on what frequency. The likelihood of an impact occurring is only mentioned where the impact is less than certain. The factors or events causing the effect are described. All assumptions used in assessing impacts to geologic and topographic resources are listed or available in the project files. Estimates of impacts, where used, are identified.

Cumulative impacts are presented by summing the impacts from past (pre-1979), present (1979 through implementation of each alternative), and reasonably foreseeable mining actions. Unavoidable adverse impacts, such as topographic modifications, are identified for each alternative. Statements are made for each alternative analysis concerning the relationship between short-term resource use and long-term productivity, and the extent that the resource commitments are irreversible or irretrievable.

Not all geologic resources described in Section 3.1 are evaluated for impacts under each alternative, either because the potential for impact is a concern for this project (paleontological resources) or there would be no impact under any of the alternatives (coal, gas, oil). The following two sections summarize the potential for impacts to these resources.

4.1.1.1 Paleontological Resources

No documentation is available to suggest that any significant paleontological resources have been noted, disturbed, or removed during activities associated with the Zortman and Landusky mines. Paleontological significance is based on the type and species of fossil found, and their relative abundance. Generally, invertebrate fossils are found in the Madison Group limestones in great abundance; their frequency and occurrence has been well documented, and fossils from these formations are not of value to the collector or scientific community.

Fossils of extinct vertebrate species tend to have more scientific and collectible value, hence greater significance, because they are found in much less abundance than most invertebrate fossils. ZMI has mined clay for use in facilities construction and reclamation covers from the Seaford and Williams quarries, both of which have the potential to contain vertebrate fossils. Clay at the Seaford pit is from the Bearpaw shale, which has produced fossil dinosaurs, fossil fish, and other vertebrate and invertebrate species. However, no significant fossil finds have been reported from the Seaford pit or the Williams pit.

The potential for an impact and the degree of impact to vertebrate paleontological resources is unknown, since it is not known whether these resources exist at the clay quarries and in what quantity or availability. The only alternative which would be certain to not have an impact on vertebrate fossils at the clay pits is Alternative 1, since no additional clay would be mine to support mining or reclamation activities. The potential for adverse impact would increase, if fossils are present, with each alternative in proportion to the amount of clay projected for mine construction and reclamation activities. Some impacts to invertebrate paleontological resources would occur for alternatives 3 through 7, since limestone would be mined for reclamation covers. However, these impacts would probably not be significant because of the prevalence of invertebrate fossils and fossil species in the limestone formations that would be mined, and the abundance of documentation on this fossil record.

4.1.1.2 Other Geologic Resources

As described in Section 3.1.7.5, some other important geologic resources are found in north-central Montana, including near the Little Rocky Mountains. Coal, and oil and gas deposits, have been produced from sedimentary formations in the region. Two exploration oil wells have been drilled in the Township near the Zortman Mine, with poor results, and some producing gas wells have been drilled in the Claggett Shale formation about 10 miles south of Landusky. Coal has been reported at one location on the flank of the Little Rocky Mountains uplift near Zortman, but this is not considered to be a viable reserve. For these reasons, it is expected that none of the alternatives would have an impact on these geologic resources.

Caves are an abundant geologic feature in the limestones of this region and the Little Rocky Mountains. Azure Cave is one well documented site which has been determined to have significant value, in part because of its geologic and mineralogic features. Potential impacts to Azure Cave are described in Section 4.13.2.

4.1.2 Impacts from Mining, 1979 to Present

Mining in the Little Rocky Mountains during the past fifteen years has irreversibly altered the landscape and irretrievably consumed local geologic resources. The following sections describe the impacts associated with current (1979 to the present time) mining operations.

4.1.2.1 Geologic Resources

Mining at the Zortman and Landusky mines has resulted in the irretrievable commitment of gold and silver ore, "waste" rock excavated during ore removal, clay, and a small amount of limestone. The only significant impact results from the depletion of gold and silver from the area, as these metals are considered precious and present in very limited quantities worldwide. Waste rock (various sedimentary, metamorphic and igneous lithologies), clay, and limestone are present in essentially limitless quantities in the local and regional area, and the commitment of these resources in the Zortman and Landusky mining operations is of little consequence.

Approximately 20 million tons of gold and silver bearing ore have been removed from the Zortman Mine during the years 1979 to 1994, and about 100 million tons of ore have been removed from the Landusky Mine by ZMI during the same years. It is estimated that about 1.3 million ounces of gold and 5.0 million ounces of silver have been recovered from that ore during the years 1979 through 1994. ZMI has removed over 75% of the gold and silver ever produced from the Little Rockies Mining District, with an estimated combined value over $550 million (assuming gold valued at $400/Troy ounce and silver valued at $6/Troy ounce). Additional gold and silver ore is known to occur in the Little Rockies Mining District, as evidenced by ZMI's proposed expansion plans and the belief that other ore deposits, such as that found in Pony Gulch, exist in the vicinity of the Zortman and Landusky mines. Lower grade ores which may not be feasible to mine using current technologies are also present. It is not possible to estimate the percentage of available gold and silver which has been removed from the Little Rockies by present mining operations, but it is reasonable to assume that the ore removed represents a significant portion of a limited resource.

Clay has been mined at the Seaford and Williams clay pits for use in facilities construction and as reclamation materials. About 4.2 acres have been disturbed by clay mining at the Seaford pit, with approximately 250,000 yd^3 of clay removed for use at the Zortman Mine. About 26 acres have been disturbed at the Williams clay pit for use at Landusky facilities.

Limestone was mined from the King Creek quarry north of the Landusky Mine for use in the King Creek cleanup project during 1994. Approximately 50,000 yd^3 of limestone were permitted for removal from this site, which had been disturbed prior to 1979 for use in a public service project not affiliated with the Landusky Mine. Approximately 3 acres of disturbance has resulted from the quarry operations.

4.1.2.2 Topography

Ore and waste rock removal by ZMI through 1994 has significantly altered the local topography of the southern portion of the Little Rocky Mountains. Mining operations have reduced the elevation and modified the shape of some landforms by blasting and excavation of ore, waste rock and reclamation materials. At the same time, new landforms (open pits and ore/waste rock facilities) have been created.

The most dramatic and significant impact to topography is the result of hardrock mining in the ore zones at both mines. The elevation of the pre-mining land surface at the current Zortman Mine pit was over 5,200 feet mean sea level (msl). As shown in Chapter Two on a typical north-south Zortman Mine cross section in Figure 2.8-5, two prominent hills have been reduced in elevation by 200 feet or more to an existing ground surface less than 5,000 feet msl in some areas.

Topographic alteration to the Landusky Mine landscape has been greater than at Zortman because about five times as much ore and waste rock has been removed during the past 15 years of ZMI mining. The elevation of the pre-mining land surface at the current Landusky Mine pit was about 5,400 feet msl at the highest point. As shown in Chapter Two on a typical cross section of the Landusky Mine in Figure 2.8-19, one prominent hill has been reduced in elevation by approximately 500 feet to an existing ground surface less than 4,900 feet msl, while another high point has been reduced by about 300 feet, from over 5,100 feet msl to an existing ground elevation of about 4,800 feet msl.

The rock moved from high areas at both mines has been redistributed to a number of heap leach pads and waste rock facilities. The resultant landscape is flattened, with select high areas removed and some topographic depressions filled in. Significant topographic modification has occurred at both mines from the mining activities conducted during the years 1979 through 1994.

The topographic alterations create far-reaching, indirect impacts beyond the direct aesthetic effects. The changed topography has resulted in significant modification to the natural water balance and quality of water resources in the area. For instance, exposed waste rock dumps, mine pits, and heap leach pads have increased the surface area and allow ready infiltration of surface water and reduced natural runoff. In addition, the type of surface has changed from undisturbed with low infiltration capability to highly porous disturbances of broken up rock and sediment. Water infiltrating through these surfaces is able to readily dissolve minerals and degrade water quality. Therefore, as a result of the topographic changes imposed by mining, seepage to groundwater has increased and the quality of water resources has decreased. Pit walls exposed by mine pit development have been shown to generate acid when contacted by surface water or groundwater seepage, increasing the potential for water quality degradation. The impacts to water resources resulting from mining operations are further explored in Section 4.2.

4.1.2.3 Geologic Hazards

There is little risk of failure due to seismic activity for facilities at the Zortman and Landusky mines. This assessment is based on the fact that the Little Rocky Mountains are situated in an area of low earthquake hazard. This means the likelihood of earthquakes occurring, and of those earthquakes to be of significant magnitude, is very low. Based on the probabilistic earthquake acceleration and velocity map for the United States (Algermisson *et al.* 1990), the Little Rocky Mountains are within the lowest risk area designated (Earthquake Zone 1). The National Geophysical and Solar Terrestrial Data Center of the National Oceanic and Atmospheric Administration conducted a search of recorded earthquakes within a radius of 200 miles of the mining area (Golder Associates 1992). The largest earthquake of record, with a Magnitude of 5, occurred in 1968 approximately 77 miles away (that is, the estimated distance of the earthquake loci or center to the Little Rocky Mountains). The horizontal acceleration at the Zortman Mine from this event would have been approximately 0.01 g, a unit expressing a percentage of the earth's gravitational pull. Three relatively recent earthquakes have occurred, ranging from 20 to 60 miles from the southern Little Rocky Mountains, all with a magnitude of 3 or less. Algermisson *et al.* (1982) report that the Little Rocky Mountains would have a 10% chance in 50 years of exceeding a 0.04 g acceleration due to earthquake. The low probability that an earthquake of sufficient magnitude to affect facilities at the mines will occur indicates that the facility failure risk due to earth shaking is low.

There are no known inherently unstable areas within the existing permit boundaries for either mine, although rockslides and landslides are always a potential hazard where steep slopes and ridges are common, such as in the interior of the Little Rocky Mountains. Pit walls have not been reclaimed or regraded, and are estimated to reside at a 1H:1V slope, with benches every 60 feet. The potential for pit wall weathering or rock spalling is significant at these slopes. Wall failure is dependent on factors such as the inherent competence of the rock, water seepage infiltration, freeze/thaw action, and joint and fracture patterns.

There is always a potential that an existing facility containing large quantities of ore and waste rock could cause earth movement as a result of load capacities exceeding the strength of the formation on which the facility is located. Overloading could result from earth movement or slumping, or less commonly an actual slip in the lithologic units (fracturing or faulting) usually influenced by water infiltration and saturation. Many of the waste rock facilities at the Zortman and Landusky mines were constructed by dumping unconsolidated materials, which would have a greater likelihood to settle and shift than constructed facilities. In addition, many of the facilities have been constructed or dumped at 2H:1V slopes. The greater the slope angle, the greater the risk of failure. However, there is no evidence that such an event is likely or probable at either mine; no facilities which have already been constructed and loaded to capacity have failed. Geotechnical studies were conducted to design existing facilities to standard engineering safety and stability factors. It is important to remember, though, that deep-seated instability is not always readily predictable or detected.

4.1.3 Impacts from Alternative 1

Geologic Resources: Impacts to geologic resources would be limited under this alternative to the currently permitted actions. Because no additional gold and silver mining would be permitted at either mine impacts to geologic resources would occur as a result of actions associated with facilities reclamation. The existing Zortman Mine permit does not require the use of clay or limestone in reclamation covers, so no additional disturbance would occur at the Seaford clay pit, and a limestone quarry would not be developed in the local area. No impact would occur. Limited clay and non-acid generating waste rock were required for reclamation of the Mill Gulch waste rock dump, Gold Bug waste rock repository, and 91 leach pad dike. No additional use for limestone and/or clay exists under this alternative for the Landusky Mine. Again, no impact would occur.

Topography: There would be no additional topographic impact at either mine under this alternative because no additional mining would be permitted and existing disturbances would be unaltered. Mine pits would remain at existing form, depth, and area of disturbance. Pit walls would remain at approximately a 45 degree slopes. These topographic alterations would persist for a long duration until natural erosive forces reduce topographic relief.

Geologic Hazards: Because no new mining would occur, and facilities would remain at essentially their current configuration, the concern over geologic hazards would be as described in Section 4.1.2.3 for the existing conditions. The potential for pit wall slumping or failure would be significant. Some facilities, particularly those constructed of unconsolidated materials at relatively steep slope angles, have the potential to move as materials settle and erode. Much of the exposed pit walls would be expected to continue to generate acid, as described in Section 4.2.3.

4.1.3.1 Cumulative Impacts

No reasonably foreseeable actions are anticipated which would increase the impacts to geologic and topographic resources from this alternative, although future mining is not precluded by a no-action alternative. Cumulative impacts would be as described for the existing conditions since this alternative would result in no additional impact to geologic resources or topographic modifications. Disturbance at the Seaford clay pit would remain at about 4.2 acres, and disturbance at the Williams clay pit would remain at about 26 acres. Disturbance at the King Creek limestone quarry would remain at about 3 acres. The cumulative impact to the topography in the Little Rocky Mountains would remain as current conditions. There would be no increase or decrease of risk associated with geologic hazards. Cumulative, indirect effects to water quality resulting from topographic modifications are described in Section 4.2.3.

4.1.3.2 Unavoidable Adverse Impacts

There are no unavoidable adverse consequences to geologic resources predicted from this alternative. Existing topographic modifications would remain. Significant unavoidable adverse consequences to other resources such as water, soils, vegetation, and habitat would occur as an indirect result of these topographic alterations. These impacts are described in subsequent sections of this Chapter.

4.1.3.3 Short-term Use/Long-term Productivity

Long-term productivity of geologic resources would not be affected by this alternative. Significant and viable mineral deposits would remain for consideration of future mine ventures. Geologic resources would provide no short-term, beneficial use.

4.1.3.4 Irreversible or Irretrievable Resource Commitments

There are no additional irreversible or irretrievable commitments of geologic resources under this alternative.

4.1.4 Impacts from Alternative 2

Geologic Resources: Impacts to geologic resources would be limited under this alternative to the currently permitted actions and mining for enhanced reclamation materials in Section 2.6. Because no additional gold and silver mining would be permitted at either mine impacts to geologic resources would only occur as a result of actions associated with company-proposed facilities reclamation. All impacts associated with extraction of reclamation materials would occur in the near-term and be of short duration, extending until reclamation is completed. Table 4.1-1 summarizes the quantities of reclamation materials (other than cover soil, see Section 4.3) used for each mine.

The Seaford clay pit would be disturbed an estimated 3 additional acres to remove an estimated 242,000 yd^3 of clay for reclamation covers. This estimate of clay used is based on the assumption that sulfur concentrations would exceed 0.5% at all waste rock facilities, leach pads, and mine pit exposures which have not already been reclaimed. These facilities, with a combined estimated disturbance of 300 acres, would require capping with Reclamation Cover A (see Section 2.6.2.2). It is assumed that facilities already reclaimed would not have sulfur concentrations in excess of 0.5% and would not need clay in the reclamation cover. This alternative does not include the use of limestone or other non-acid generating rock in reclamation covers, so a limestone quarry would not be impacted in the local area.

The Williams clay pit would be disturbed an estimated 6 additional acres to remove approximately 516,000 yd^3 of clay for reclamation covers. This estimate is based on the assumption that sulfur concentrations would exceed 0.5% at all waste rock facilities, leach pads, and mine pit exposures which have not already been reclaimed. These facilities, with a combined estimated disturbance of 640 acres, would require capping with Reclamation Cover A.

Limestone and suitable non-acid generating waste rock are not required for reclamation at either Mine under this alternative.

Topography: There would be no additional modification to the topography of either mine under this alternative and no topographic impact, because no additional mining would be permitted and existing disturbances would be unaltered. Mine pits would remain at existing form, depth, and area of disturbance. Pit walls would remain at approximately a 45 degree slope. These topographic alterations would persist for a long duration until natural erosive forces reduce topographic relief.

Some additional mining would occur at the Seaford and Williams clay pits to provide reclamation materials. Little alteration of the landscape would occur at the Seaford clay pit, since the amount of clay to be mined is relatively small and the site has already been disturbed. A greater degree of topographic impact would occur at the Williams clay pit, based on the estimated volume of clay required and the resultant disturbance. Impacts to topography would be of long duration, until future materials excavation and reclamation occurs, or natural erosive forces modify the landscape further. The road to the limestone quarry would be reclaimed to approximate original contour.

Geologic Hazards: Because no new mining would occur, and facilities would remain at essentially their current configuration, the concern over geologic hazardous would be as described in Section 4.1.2.3 for the existing conditions. The potential for pit wall slumping or failure would be significant. Some facilities, particularly those constructed of unconsolidated materials at relatively steep slope angles, have the potential to move as materials settle and erode. Much of the exposed pit walls would be expected to continue to generate acid, as described in Section 4.2.3.

4.1.4.1 Cumulative Impacts

No reasonably foreseeable actions are anticipated which would increase the impacts to geologic and topographic resources from this alternative, although future mining is not precluded by this alternative. Cumulative effects would result from the added impacts noted above to the Seaford and Williams clay pits. Total disturbance at the Seaford clay pit from past and current mining would be 7.3 acres. Total disturbance at the Williams clay pit from past and current activities would be 32 acres. Disturbance at the King Creek limestone quarry would remain at about 3 acres.

The cumulative impact to the topography in the Little Rocky Mountains would remain as current conditions. There would be no increase or decrease of risk associated with geologic hazards. Cumulative, indirect effects to water quality resulting from topographic modifications are described in Section 4.2.3.

4.1.4.2 Unavoidable Adverse Impacts

The disturbances of geologic resources at the Seaford and Williams clay pits are an unavoidable consequence of mining these reclamation materials. Topographic modifications at the Seaford and Williams clay pits would also be unavoidable. Significant unavoidable

TABLE 4.1-1

RECLAMATION MATERIALS FOR ALTERNATIVE 2

Alternative 2 Resources	Additional Acres of Disturbance			Cubic Yards of Material		
	Zortman	Landusky	Total	Zortman	Landusky	Total
Clay	3	6	9	242,000	516,000	758,000
Limestone	0	0	0	0	0	0
Non-Acid Generating[1]	---	---	---	0	0	0

[1] Materials in this category would probably consist of waste rock which meets the non acid generating criteria for this alternative, as described in Section 2.6.

TABLE 4.1-2

RECLAMATION MATERIALS FOR ALTERNATIVE 3

Alternative 3 Resources	Additional Acres of Disturbance			Cubic Yards of Material		
	Zortman	Landusky	Total	Zortman	Landusky	Total
Clay	3.5	9	12.5	368,000	786,000	1.24 million
Limestone	13	19	32	750,000	1.6 million	2.35 million
Non-Acid Generating[1]	---	---	---	N/A	N/A	N/A

[1] Materials in this category would consist of waste rock which meets the non acid generating criteria for this alternative, as described in Section 2.7.

N/A = Not Available. No waste rock would be generated, and it is assumed that waste rock within existing facilities could not be segregated as to suitability for use in reclamation covers. Therefore, only limestone would be available for use as capillary break in reclamation covers.

adverse consequences to other resources such as water, soils, vegetation, and habitat would occur as an indirect result of the topographic alterations. These impacts are described in subsequent sections of this Chapter.

4.1.4.3 Short-term Use/Long-term Productivity

The geologic resources used under this alternative would provide a limited beneficial short-term use as reclamation materials to protect other environmental resources such as surface water and groundwater. Long-term productivity of geologic resources would not be affected. Significant and viable mineral deposits would remain for consideration of future mine ventures.

4.1.4.4 Irreversible or Irretrievable Resource Commitments

Removal of clay for use in reclamation covers constitutes an irretrievable commitment of resources. Because these resources are available locally and regionally in essentially unlimited quantities, the impact is not significant.

4.1.5 Impacts from Alternative 3

Geologic Resources: Impacts to geologic resources would be limited under this alternative to the currently permitted actions and agency-mitigated reclamation procedures as described in Section 2.7. Because no additional gold and silver mining would be permitted at either mine, impacts to geologic resources would occur as a result only of actions associated with facilities reclamation. All impacts associated with extraction of reclamation materials would occur in the near-term and be of short duration, extending until reclamation is completed. Table 4.1-2 summarizes the quantities of reclamation materials (except for cover soil, see Section 4.3) used for each mine.

The Seaford clay pit would be disturbed by an estimated 3.5 additional acres to remove an estimated 368,000 yd^3 of clay for reclamation covers. This estimate is based on the assumption that 300 acres of disturbance would have to be reclaimed. It is estimated that 155 acres of this disturbance would be capped with Reclamation Covers B or Modified C. The remaining 145 acres, including footprints of facilities removed for backfill into the pit complex, would be capped with Reclamation Cover A.

The Williams clay pit would be disturbed to remove approximately 786,000 yd^3 of clay for reclamation covers. This estimate is based on the assumption that 650 acres of disturbance would have to be reclaimed. It is estimated that 330 additional acres of this disturbance would be capped with Reclamation Cover B or Modified C. The remaining 320 acres, including footprints of facilities removed for backfill into the pit complex, would be capped with Reclamation Cover A.

Limestone (or suitable non-acid generating waste rock) is required for those facilities which would be capped with Reclamation Covers B or Modified C. Based on the disturbance assumptions presented above, approximately 750,000 yd^3 of limestone would be required for reclamation of Zortman Mine facilities, and 1.6 million yd^3 of limestone would be required for reclamation of the Landusky Mine facilities. Limestone for the Zortman Mine would come from approximately 13 acres of disturbance at a new quarry developed just northwest of Shell Butte. Limestone for the Landusky Mine would come from approximately 19 additional acres of disturbance at the King Creek quarry. Calculations for limestone needed in reclamation are based on the assumption that no suitable waste rock would be available and capillary break material would have to consist entirely of limestone.

Topography: There would be some minor modification to the topography of both mines resulting from implementation of this alternative. Modifications would result from partial backfilling of the Zortman pit with waste rock and spent ore, and backfilling of the Landusky pit to the 4,900 foot level. Pit walls would remain at approximately a 45 degree slope. Resloping of spent ore heaps and waste rock facilities to a 3H:1V slope would alter the landforms by reducing angles and enlarging facility footprints. The drainage cutout at the Landusky pit would create a V-shaped notch approximately 100 feet deep, to the level of the backfill in the pit. These topographic alterations would persist until natural erosive forces reduce topographic relief.

Some additional mining would occur at the Seaford and Williams clay pits, and King Creek limestone quarry to provide reclamation materials. New disturbance would occur at LS-1, the proposed site to quarry limestone for the Zortman Mine. Little alteration of the landscape would occur at the Seaford clay pits, since the amount of clay to be mined is relatively small and the site has already been disturbed. However, the modification would be greater than that anticipated under Alternatives 1 or 2. A greater level of topographic impact would occur at the Williams clay pit, based on the estimated volume of clay required and the resultant disturbance of approximately 9 acres. This impact would also be greater than that anticipated under Alternatives 1 or 2.

The topographic modification at LS-1, the proposed limestone quarry for the Zortman Mine, would be significant because it would represent a new disturbance and alteration of the landscape. If limestone is the only suitable material available for use as capillary break, the topographic modification at the King Creek quarry would also be noticeable. Under this scenario, ZMI would remove more than 20 times the amount of limestone from this quarry than has been mined by ZMI previously, expanding the quarry shape from current conditions. Roads to limestone quarries would be reclaimed to approximate original contour. Impacts to topography would be of long duration, until future materials excavation and reclamation occurs, or natural erosive forces modify the landscape.

Geologic Hazards: The risk to Zortman and Landusky mine facilities from geologic hazards would be reduced from those presented under Alternatives 1 or 2. The reduction in risk is a result of particular reclamation mitigations. Flattening of waste rock facility and ore heap slopes would increase stability and thus reduce the potential for these facilities to move laterally by gravity or settlement, or to fail catastrophically as a result of seismic activity. Mine pit and limestone quarry wall slopes would not be flattened, but requirements to cover and revegetate benches could help reduce other, indirect effects such as the formation of acid drainage.

Alternative 3 incorporates a mitigation to increase the clay thickness in Reclamation Cover C from 3 inches to a minimum of 6 inches when compacted. This cover modification would increase the performance capabilities and reduce the potential for cover failure. Modified Reclamation Cover C would also be easier to construct than a cover with a thinner clay layer.

4.1.5.1 Cumulative Impacts

No reasonably foreseeable actions are anticipated which would increase the impacts to geologic and topographic resources, although future mining is not precluded by this alternative. Cumulative effects would result from the added impacts noted above to the Seaford and Williams clay pits, and King Creek limestone quarry, as well as new disturbance at the LS-1 quarry. Total disturbance at the Seaford clay pit from past and current mining would be 7.7 acres. Total disturbance at the Williams clay pit from past and current activities would be 35 acres. Total disturbance at the King Creek quarry from past and current activities would be 21 acres. Total disturbance at the LS-1 quarry would be the 13 acres associated with Alternative 3 activities.

The cumulative impact to the topography in the area of the Zortman and Landusky mines would be altered somewhat as a result of reclamation activities. Topographic impacts would occur primarily from the reduction in sideslopes of spent ore heaps and waste rock facilities, backfilling of mine pits, and the 100-foot deep drainage notch created at the Landusky Pit leading to Montana Gulch.

Overall, the topographic modifications would result in decreased risks of facility failure. The cumulative effect of more protective reclamation covers and pit bench reclamation would be to lessen adverse indirect impacts to water quality.

4.1.5.2 Unavoidable Adverse Impacts

The disturbances of geologic resources at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries are an unavoidable consequence of mining these reclamation materials. Topographic modifications at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries would be unavoidable. Significant, indirect adverse consequences to other resources such as water, soils, vegetation, and habitat would continue; however, the enhanced reclamation covers and other reclamation mitigations should lessen these impacts relative to Alternatives 1 and 2. These impacts are assessed in subsequent sections of this Chapter.

4.1.5.3 Short-term Use/Long-term Productivity

The geologic resources used under this alternative would provide a beneficial short-term use as reclamation materials to protect other environmental resources such as surface water and groundwater. Long-term productivity of geologic resources could be affected, as follows. A significant and viable mineral deposit is proven to exist in deeper zones below the Zortman and Landusky Mine pits. Pit backfilling would place a significant load of "waste rock" on top of these deposits. In the case of the Zortman Mine pit, an estimated 14 million tons of material would be backfilled. This material would have to be removed for a future mine operation to access deeper ore reserves, adding significant, possibly prohibitive startup costs to any new mine venture.

4.1.5.4 Irreversible or Irretrievable Resource Commitments

Removal of clay and limestone for use in reclamation covers constitutes an irretrievable commitment of resources. Because these resources are available locally and regionally in essentially unlimited quantities, the impact is not significant. If pit backfill effectively prohibits future mining it could result in an economically irreversible loss of the precious metal deposits.

4.1.6 Impacts from Alternative 4

Geologic Resources: Impacts to geologic resources would be based on the activities associated with expansion of the Zortman and Landusky mines and ZMI's proposed reclamation procedures for new and existing disturbances. These activities were described in Section 2.8. Approximately 80 million additional tons of ore and 60 million additional tons of waste rock would be generated at the Zortman Mine. Approximately 7.6 million tons of ore and 7 million tons of waste rock would be generated at the Landusky Mine. Assuming an average content of 0.020 ounces of gold per ton of ore, and a historic recovery efficiency of 55% of the gold present, approximately 960,000 ounces of gold would be produced. For reference, only about 1.7 million ounces of gold have been produced from the Little Rockies Mining District during it's entire history of mining and ZMI or predecessors has produced about 75% of that total. All impacts associated with mine expansion and extraction of reclamation materials would occur in the near-term and be of short duration, extending until reclamation is completed.

Table 4.1-3 summarizes the quantities of construction and reclamation materials (except for cover soil, see Section 4.3) used for each mine.

The resource requirements listed in Table 4.1-3 were developed by ZMI as part of the mine permit amendment applications for the Zortman and Landusky mines. ZMI would use clay in construction of the Goslin Flats heap leach pad and for facilities reclamation. The Seaford clay pit would provide approximately 347,000 yd^3 of clay for liner construction and 800,000 yd^3 reclamation covers. The Williams clay pit would be disturbed to remove approximately 650,000 yd^3 of clay for reclamation covers. Impacts to clay resources at both sites are low.

For the Zortman Mine expansion and reclamation, this analysis assumes that all clay would be mined at the Seaford pit. However, the Thermopolis Shale is present near the surface at the site of the proposed leach pad at the Goslin Flats. Since this area would be disturbed for leach pad construction, large volumes of clay may be available for reclamation. This source would reduce direct impacts to the Seaford clay pit, and reduce indirect impacts to other resources, such as traffic use.

Reclamation materials for Alternatives 1 through 3 were estimated based on the assumption that suitable non-acid generating (NAG) waste would not be available for use as capillary break in reclamation covers. However, this alternative includes expanded mining activities at both the Zortman and Landusky mines, and a program by ZMI to characterize waste rock generated during mining activities which could be used in reclamation covers. As a result, the quantities of limestone needed under this alternative have not increased for the Zortman Mine, and they have decreased significantly for the Landusky Mine, relative to Alternative 3.

Limestone or suitable NAG waste rock is required for those facilities which would be capped with Reclamation Covers B or C. ZMI has estimated that 741,000 yd^3 of limestone would be used for reclamation of the Goslin Flats leach pad at the Zortman Mine. Limestone for the Zortman Mine would come from approximately 13 acres of disturbance at a new quarry, LS-1, developed just northwest of Shell Butte. ZMI has estimated that only 35,000 yd^3 of limestone would be required for reclamation of Landusky Mine facilities. This material would come from approximately 3 additional acres of disturbance at the King Creek quarry. Total disturbance at this quarry from past and proposed mining operations would be 6 acres.

ZMI has estimated that 2.9 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Zortman Mine. This material represents approximately 3.2% of the total waste rock volume that would be generated during expanded mining operations,

TABLE 4.1-3

RECLAMATION AND CONSTRUCTION MATERIALS FOR ALTERNATIVE 4[1]

Alternative 4 Resources	Additional Acres of Disturbance			Cubic Yards of Material		
	Zortman	Landusky	Total	Zortman	Landusky	Total
Clay	10	7	17	1.17 million	650,000	1.82 million
Limestone	13	3	16	741,000	35,000	776,000
Non-Acid Generating[2]	---	---	---	2.9 million	2.0 million	4.9 million

[1] Estimates prepared by Zortman Mining Inc. for application for mine permit amendment.

[2] Materials in this category would consist of waste rock which meets the non acid generating criteria for this alternative, as described in Section 2.8

TABLE 4.1-4

RECLAMATION AND CONSTRUCTION MATERIALS FOR ALTERNATIVE 5

Alternative 5 Resources	Additional Acres of Disturbance			Cubic Yards of Material		
	Zortman	Landusky	Total	Zortman	Landusky	Total
Clay	11.5	9	20.5	1.12 million	786,000	1.9 million
Limestone	13	3	16	741,000	35,000	776,000
Non-Acid Generating[1]	---	---	---	1.09 million	1.60 million	2.69 million

[1] Materials in this category would probably consist of waste rock which meets the non acid generating criteria for this alternative, as described in Section 2.9

and an estimated 34% of the suitable waste rock (NAG, or "Blue Waste") that would be produced. In other words, based on ZMI's proposed definition of NAG waste, sufficient quantities should be available for use in reclamation covers.

ZMI has estimated that 2.0 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Landusky Mine. This material represents approximately 30% of the total waste rock volume that would be generated during expanded mining operations at this mine. However, ZMI has estimated that only 220,000 yd^3 of NAG waste would be produced during expanded mining operations. This represents a shortfall in reclamation materials which would have to be made up from existing waste rock stockpiles, increased use of limestone in reclamation covers, and/or the use of suitable waste produced at the Zortman Mine expansion.

The heap leach pad to be constructed under this alternative would be located in the Goslin Flats, an open area south of the town of Zortman where Ruby Creek and other ephemeral drainages coalesce. The decrease in gradient at this location has led some prospectors to speculate that gold could be present in minable quantities in placer deposits on the Flat. The potential for this area to contain gold, and for the Goslin Flats leach pad to cover or displace placer deposits, was evaluated by Onstream Resource Managers, Inc. (1993). Data collected and documented in this reference provides evidence that gold is present in alluvial deposits at Goslin Flats in concentrations greater than those typically found in the earth's crust. However, the highest concentrations of assays done for samples from the Goslin Flats are well below the lowest grade of gold placer deposit which is being commercially mined today. In addition, the samples with the highest grades are from an area which would not be affected by the Goslin Flats leach pad and supporting facilities. There would be no significant impact to mineral resources of any value by construction and operation of a heap leach pad in the Goslin Flats.

<u>Topography</u>: There would be some modification to the topography of both mines resulting from implementation of this alternative. Expanded mining operations would create larger and deeper mine pits at both facilities. As seen on Figure 2.8-5, ZMI has projected that mining in the Zortman pit complex would extend the pit depth over 400 feet, to below 4,600 feet msl. Partial backfilling to facilitate drainage would create a final pit floor elevation of approximately 4,800 feet msl.

Figure 2.8-19 in Chapter Two illustrates the modifications which would occur at the Landusky Mine. Continued mining would extend the pit depth another 200 feet or more in some areas, to approximately 4,500 feet msl. Approximately 20 more acres would be disturbed. ZMI would partially backfill the Landusky pit complex to the 4,600 foot level to facilitate drainage to the August drain tunnel, which discharges into Montana Gulch.

Some additional mining would occur at the Seaford and Williams clay pits, and King Creek limestone quarry to provide reclamation materials. New disturbance would occur at LS-1, the proposed site to quarry limestone for the Zortman Mine. Approximately 10 acres would be disturbed at the Seaford Clay pit. This disturbance would be greater than that anticipated under the first three alternatives. Approximately 7 acres would be disturbed at the Williams Clay pit. This disturbance would be greater than project for Alternatives 1 and 2, but less than for Alternative 3.

The topographic modification at LS-1, the proposed limestone quarry for the Zortman Mine, would be significant because it would represent a new disturbance of about 13 acres and alteration of the landscape. The change to the LS-1 topography would be the same as for Alternative 3. However, the topographic impact to the King Creek quarry would be minimal, and much less than anticipated under Alternative 3. Roads to limestone quarries would be reclaimed to approximate original contour. Impacts to topography would be of long duration, until future materials excavation and reclamation occurs, or natural erosive forces modify the landscape further.

Two new major facilities would be constructed which would impact the area topography. A waste rock repository constructed in Carter Gulch would modify the existing shape in this area by filling in the upper portions of this valley. The increase in surface elevation of approximately 450 feet would occur in the repository center, which would change from 4,600 feet msl to 5,050 msl. The Goslin Flats leach pad would create a new landform up to 140 feet above the existing landscape. Both actions represent a significant direct impact to existing topography. Impacts to visual resources associated with these landscape alterations are described in Section 4.8.

<u>Geologic Hazards</u>: The risk to Zortman and Landusky mine facilities from geologic hazards would be low, and relatively lower than the risks for Alternatives 1 or 2, but marginally higher than that presented by Alternative 3. The difference stems primarily from reclamation provisions to reslope existing waste rock facilities and ore heaps. This alternative only calls for resloping of

facilities (new and existing) to 3H:1V where topography allows and to meet specific design criteria for stability. Therefore, some facilities would likely continue to have slopes steeper than 3H:1V, and up to 2H:1V. Facilities remaining at these steeper slopes would not be considered unstable or a high failure risk, but slope reduction does reduce the potential for failure.

The Goslin Flats leach pad would be designed to meet or exceed all standard engineering safety factors. The facility would be located in an area which is not known to have been affected by rockslides or other mass wasting events. The fairly level terrain of the Goslin Flats suggests the potential for leach pad movement is low. The geologic units underlying the surface dip gently, further reducing the potential for slip between different lithologies.

The geology of the Goslin Flats area does provide for easier containment and management of leach pad solution if leaks develop, such as through liner rupture. Some of the underlying lithologies have a significant natural carbonate content, which would help to buffer acidic drainage. The underlying shales would provide relatively tight, impermeable boundaries to downward migration of leachate. A solution recovery system using pumpback wells or trenches would be technically feasible to implement.

4.1.6.1 Cumulative Impacts

Reasonably foreseeable actions which would increase the cumulative impacts to geologic and topographic resources are limited to new mining operations and exploration activities. These were described in Section 2.8.6. Cumulative impacts from these developments, combined with past and present impacts and effects caused by implementation of Alternative 4, are summarized here.

Two million tons of ore could be mined at the Pony Gulch deposit. This action would raise the ore total mined at the Zortman Mine up to about 102 million tons. It is reasonably foreseeable that another 12.2 million tons of ore would be mined from existing pits at the Landusky Mine, raising the total ore removed from this operation to about 136 million tons. New or expanded ore processing and waste rock storage facilities would have to be prepared to accommodate the above developments. It is likely that these actions would take place on already permitted ground, but there would be some resultant landscape alteration. Impacts due to open pit mining in a previously undisturbed or little disturbed area would be significant.

Additional construction and reclamation materials would also be required for these developments, thereby increasing disturbances at the Seaford and Williams clay pits, and the King Creek and LS-1 limestone quarries. Alternative 4 implementation would raise the total disturbance from past and proposed mining at the Seaford pit to about 14.2 acres. Total disturbance from this alternative combined with past mining at the Williams pit would be about 33 acres. Total disturbance at the King Creek quarry from past, proposed and reasonably foreseeable development activities would be 10 acres. A new limestone source, with a disturbance of up to 7 acres, could be developed for reasonably foreseeable Landusky mine expansions. Total disturbance at the LS-1 quarry would be the 13 acres associated with Alternative 4 activities.

The cumulative impact to the topography in the area of the Zortman and Landusky mines would be altered as a result of new and reasonably foreseeable reclamation activities. Approximately 10 million tons of waste rock would be backfilled to the Zortman pit, resulting in a final pit floor elevation of 4,800 feet msl. Approximately 1 million tons of waste rock would be backfilled to the Landusky pit, resulting in a final pit floor elevation of 4,600 feet msl. Some spent ore heaps and waste rock facilities would be reduced in slope.

Mine exploration activities are also reasonably foreseeable, as described in Section 2.8.6.3. Approximately 128 acres of disturbance could occur for road construction, drill pad development, and exploration trenches. Exploration disturbances would be reclaimed and impacts should not be significant.

Overall, the topographic modifications would result in decreased risks of facility failure compared to present conditions. The cumulative effect of more protective reclamation covers and pit bench reclamation would be to lessen adverse indirect impacts to water quality.

4.1.6.2 Unavoidable Adverse Impacts

The disturbances of geologic resources at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries are an unavoidable consequence of mining these reclamation materials. Topographic modifications in the mine areas, and at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries would be unavoidable. Significant, indirect adverse consequences to other resources such as water, soils, vegetation, and habitat would continue; however, the enhanced reclamation covers and other reclamation mitigations should lessen these impacts relative to

Alternatives 1 and 2. These impacts are assessed in subsequent of this Chapter.

4.1.6.3 Short-term Use/Long-term Productivity

The geologic resources used under this alternative would provide a beneficial short-term use as reclamation materials to protect other environmental resources such as surface water quality. Long-term productivity of geologic resources would not be affected.

4.1.6.4 Irreversible or Irretrievable Resource Commitments

Removal of clay and limestone for use in reclamation covers constitutes an irretrievable commitment of resources. Because these resources are available locally and regionally in essentially unlimited quantities, the impact is not significant. Removal of gold and silver from the ore deposits is a significant and irretrievable commitment of resources.

4.1.7 Impacts from Alternative 5

Geologic Resources: Impacts to geologic resources would be based on the activities associated with expansion of the Zortman and Landusky mines and the agencies' expansion modifications and reclamation mitigations. Modifications and mitigations to ZMI's proposed mine operations were described in Section 2.9. These modifications do not impact the type and amount of ore and waste rock generated during mine operations, as summarized in Section 4.1.6. All impacts associated with mine expansion and extraction of reclamation materials would occur in the near-term and be of short duration, extending until reclamation is completed. Table 4.1-4 summarizes the quantities of construction and reclamation materials (except for cover soil, see Section 4.3) used for each mine.

Clay would be used in construction of the Upper Alder Gulch heap leach pad. Approximately 300,000 yd^3 of clay would be needed for liner construction. The Seaford clay pit would also be disturbed to remove an estimated 820,000 yd^3 of clay for reclamation covers. Total disturbance to the Seaford clay pit from this alternative would be 1.12 million yd^3 of clay removed. This estimate is based on the assumption that all Zortman Mine waste rock facilities and leach pads, and mine pit exposures would require re-reclamation. Approximately 300 acres of existing disturbance would have to be reclaimed. It is estimated that 155 acres of this disturbance would be capped with Reclamation Covers B or Modified C. The remaining 145 acres, including footprints of facilities removed for backfill into the pit complex, would be capped with Reclamation Cover A. Approximately 330 acres of new disturbance for the Upper Alder Gulch leach pad and Carter Gulch waste rock repository would need reclamation cover. Of this, about 165 acres would be capped in Modified Reclamation Cover C and 165 acres in Reclamation Cover B. In addition, it is estimated that 75 acres of new pit disturbance would require reclamation using Reclamation Cover A.

The Williams clay pit would be disturbed to remove approximately 786,000 yd^3 of clay for reclamation covers, as described for Alternative 3 in Section 4.1.5.

Limestone or suitable NAG waste rock is required for those facilities which would be capped with Reclamation Covers B or Modified C. This analysis assumes that the volume of limestone estimated by ZMI for reclamation of the Goslin Flats leach pad would also be appropriate for Alternative 5. Approximately 741,000 yd^3 of limestone would be used for reclamation of the Upper Alder Gulch leach pad (with the remainder of the capillary break material in this facility composed of suitable NAG waste rock). Limestone for the Zortman Mine would come from approximately 13 acres of disturbance at a new quarry, LS-1, developed just northwest of Shell Butte. Limestone requirements for reclamation of the Landusky Mine would be as described in Alternative 4 with almost no impact to limestone resources. About 35,000 yd^3 of limestone would be required for reclamation of Landusky Mine facilities. This material would come from approximately 3 additional acres of disturbance at the King Creek quarry.

Approximately 1.09 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Zortman Mine. This material represents approximately 1.3% of the total waste rock volume that would be generated during expanded mining operations, and an estimated 14% of the suitable waste rock (NAG, or "Blue Waste") that would be produced using ZMI's method of classifying waste rock based on total sulfur content. This Alternative requires a more stringent classification of NAG waste, and a lesser volume would be available. However, sufficient quantities should be available for use in reclamation covers.

It is estimated that 1.6 million yd^3 of suitable NAG waste would be needed as capillary break in reclamation covers for the Landusky Mine under this Alternative. This material represents approximately 32% of the total waste rock volume that would be generated during expanded mining operations at this mine. However, ZMI has estimated that only 220,000 yd^3 of NAG waste would be produced during expanded mining operations. As with the Zortman requirements, the agencies would impose a more stringent NAG classification criteria, resulting in even lesser amounts of suitable waste rock being available. There would be a shortfall in reclamation materials which would have to be made up from existing waste rock stockpiles, material derived from the fill removal at the head of King Creek, increased use of limestone in reclamation covers, and/or the use of suitable waste produced at the Zortman Mine expansion.

Topography: There would some modification to the topography of both mines resulting from implementation of this alternative. Expanded mining operations would create larger and deeper mine pits at both facilities. As seen on Figure 2.8-5, ZMI has projected that mining in the Zortman pit complex would extend the pit depth over 400 feet, to below 4,600 feet msl. This alternative would require backfilling of the Zortman pit with 9 million tons more of spent ore, tailings, and waste rock, combined with ZMI's scheduled 6 million tons, to bring the final pit floor elevation to 4,900 ft msl or higher. As described in Section 4.2.7, this action would indirectly benefit water quality by creating a free draining surface and reducing the amount of surface water infiltration through the pit floor.

Figure 2.8-19 in Chapter Two illustrates the modifications which would occur at the Landusky Mine. Continued mining would extend the pit depth another 200 feet or more in some areas, to approximately 4,500 feet msl. This alternative would require ZMI to backfill the Landusky pit complex to an elevation of 4,850 feet msl or higher. This action would require the use of approximately 9 million tons of spent ore, waste rock, or other material as backfill. Another modification would result from the removal of rock fill at the head of King Creek to allow for freely flowing pit drainage into this surface water system. This would restore flow to the natural pre-mining drainage, an impact discussed in Section 4.2.7.

Some additional mining would occur at the Seaford and Williams clay pits, and King Creek limestone quarry to provide reclamation materials. New disturbance would occur at LS-1, the proposed site to quarry limestone for the Zortman Mine. About 11.5 acres would be disturbed at the Seaford clay pit. This disturbance would be greater than that anticipated under the first four alternatives. About 9 acres would be disturbed at the Williams clay pit. This disturbance would be greater than that anticipated under the first four alternatives.

The 13 acre disturbance at LS-1, the proposed limestone quarry for the Zortman Mine, would be significant because it would represent a new disturbance and alteration of the landscape. However, the topographic impact to the King Creek quarry would be minimal, as described under Alternative 4. Roads to limestone quarries would be reclaimed to appropriate original contour. Impacts to topography would be of long duration, until future materials excavation and reclamation occurs, or natural erosive forces modify the landscape further.

Two new major facilities would be constructed which would impact the area topography. The topographic change caused by construction of a waste rock repository in Carter Gulch was described in Section 4.1.6. A new heap leach facility would be constructed in the Upper Alder Gulch. A conceptual design of this facility indicates it would extend for over 3,000 feet along the valley and raise the valley floor (i.e, the final surface of the leach pad) by more than 400 feet at its greatest thickness. Although there has been mining disturbance, the size and extent of the new facility would create a significant topographic impact. Impacts to visual resources associated with these landscape alterations are assessed in Section 4.8.

Geologic Hazards: Risks from geologic hazards would be relatively comparable to those described for Alternatives 3 and 4. Facilities would be designed to accepted standards of engineering safety. More stable facilities would result from this alternative's modified reclamation requirement to reslope all waste rock facilities and heap leach pads to no more than a 3H:1V slope. The slope flattening on these facilities would decrease the potential for facility settlement or movement.

The Upper Alder Gulch heap leach pad design described in Section 2.9 calls for a constructed heap slope of 3H:1V, which would withstand any foreseeable ground movements. These facilities would be constructed on bedrock so that the risk of failure in the underlying lithologies should be low. The Upper Alder Gulch area is more susceptible to rockslides and slumps off the steep valley walls than facilities in areas like the Goslin Flats. The steep terrain of the Upper Alder Gulch would create difficulties in foundation preparation and liner installation. There would be a greater potential for slippage between the clay and synthetic layers of the leach pad liner. Also, solution control and corrective action in the Upper Alder Gulch site would be more difficult to implement than on the Goslin Flats.

Alternative 5 incorporates a mitigation to increase the clay thickness in Reclamation Cover C from 3 inches to a minimum of 6 inches when compacted. This cover modification would increase the performance capabilities and reduce the potential for cover failure.

4.1.7.1 Cumulative Impacts

Reasonably foreseeable actions which would increase the cumulative impacts to geologic and topographic resources are limited to new mining operations and exploration activities. These were described in Section 2.9.6. Cumulative impacts from these developments, combined with past and present impacts and effects caused by implementation of Alternative 4, are summarized here.

No additional mining would be immediately foreseeable at the Zortman Mine. It is reasonably foreseeable that another 12.2 million tons of ore would be mined from existing pits at the Landusky Mine, raising the total ore removed from this operation to about 136 million tons. New or expanded ore processing and waste rock storage facilities would have to be prepared to accommodate this development. It is likely that this action would take place on already permitted ground, but there would be some resultant landscape alteration. The cumulative impact to the topography in the area of the Zortman and Landusky mines would be altered as a result of new and reasonably foreseeable reclamation activities. However, this significant impact results from the past, present, and Alternative 5 disturbances; the reasonably foreseeable action does not substantively add to the impact significance.

Additional construction and reclamation materials would also be required for these developments, thereby increasing disturbances at the Seaford and Williams clay pits, and the King Creek and LS-1 limestone quarries. This action would raise the total disturbance from past and proposed mining at the Seaford pit to about 15.7 acres. Total disturbance from this alternative combined with past mining at the Williams pit would be about 35 acres. Total disturbance at the King Creek quarry from past and current activities would be 10 acres. A new limestone source, with a disturbance of up to 7 acres, could be developed for reasonably foreseeable Landusky mine expansions. Total disturbance at the LS-1 quarry would be the 13 acres associated with Alternative 5 activities, primarily the use of limestone in leach pad reclamation.

Overall, the topographic modifications would result in decreased risks of facility failure compared to present conditions. The cumulative effect of more protective reclamation covers and pit bench reclamation would be to lessen adverse indirect impacts to water quality.

4.1.7.2 Unavoidable Adverse Impacts

The disturbances of geologic resources at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries are an unavoidable consequence of mining these reclamation materials. Topographic modifications in the mine areas, and at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries would be unavoidable. Significant indirect adverse consequences to other resources such as water, soils, vegetation, and habitat would continue, at least in the short term; however, the modified reclamation covers and other reclamation mitigations would lessen these impacts relative to other alternatives. These impacts are assessed in subsequent sections of this Chapter.

4.1.7.3 Short-term Use/Long-term Productivity

The geologic resources used under this alternative would provide a beneficial short-term use as reclamation materials to protect other environmental resources such as surface water quality. Long-term productivity of geologic resources would not be affected.

4.1.7.4 Irreversible or Irretrievable Resource Commitments

Removal of clay and limestone for use in reclamation covers constitutes an irretrievable commitment of resources. Because these resources are available locally and regionally in essentially unlimited quantities, the impact is not significant. Removal of gold and silver from the ore deposits is a significant and irretrievable commitment of resources.

4.1.8 Impacts from Alternative 6

Geologic Resources: Impacts to geologic resources would be based on the activities associated with expansion of the Zortman and Landusky mines and the agencies' expansion modifications and reclamation mitigations. Modifications and mitigations to ZMI's proposed mine operations were described in Section 2.10. These modifications do not impact the type and amount of ore and waste rock generated during mine operations, as summarized in Section 4.1.6. All impacts associated with mine expansion and extraction of reclamation materials would occur in the near-term and be of short duration, extending until reclamation is completed. Table 4.1-5 summarizes the quantities of reclamation materials used for each mine.

The Seaford clay pit would be disturbed to remove an estimated 1.06 million yd^3 of clay for reclamation covers and construction of the Goslin Flats heap leach pad liner. This estimate also includes material for construction of a liner in the Ruby Flats waste rock repository. Also, this estimate is based on the assumption that all Zortman Mine waste rock facilities and leach pads, and mine pit exposures would require re-reclamation. Approximately 300 acres of existing disturbance would have to be reclaimed. It is estimated that 155 acres of this disturbance would be capped with Reclamation Covers B or Modified C. The remaining 145 acres, including footprints of facilities removed for backfill into the pit complex, would be capped with Reclamation Cover A. Approximately 413 acres of new disturbance for the Goslin Flats heap leach pad and Ruby Flats waste rock facility would need reclamation cover. Of this, about 48 acres would be capped in Modified Reclamation Cover C and 365 acres in Reclamation Cover B. In addition, it is estimated that 75 acres of new pit disturbance would require reclamation using Reclamation Cover A. As described for Alternative 4, the Goslin Flats may also serve as a ready source of clay for construction and reclamation. Ruby Flats may also have materials suitable for use in construction and reclamation.

The Williams clay pit would be disturbed to remove approximately 786,000 yd^3 of clay for reclamation covers, as described for Alternative 3 in Section 4.1.5.

This analysis assumes that the volume of limestone estimated by ZMI for reclamation of the Goslin Flats leach pad would also be appropriate for Alternative 6. Approximately 741,000 yd^3 of limestone would be used for reclamation of the Goslin Flats leach pad, with the remainder of the capillary break composed of suitable NAG waste rock. Limestone for the Zortman Mine would come from approximately 13 acres of disturbance at a new quarry, LS-1, developed just northwest of Shell Butte. Limestone requirements for reclamation of the Landusky Mine would be as described in Alternative 4. About 35,000 yd^3 of limestone would be required for reclamation of Landusky Mine facilities. This material would come from approximately 3 additional acres of disturbance at the King Creek quarry.

Approximately 1.88 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Zortman Mine. This material represents approximately 3% of the total waste rock volume that would be generated during expanded mining operations, and an estimated 27% of the suitable waste rock (NAG, or "Blue Waste") that would be produced using ZMI's method of classifying waste rock based on total sulfur content. This Alternative requires a more stringent classification of NAG waste, and a lesser volume would be available. However, sufficient quantities should be available for use in reclamation covers.

It is estimated that 1.6 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Landusky Mine under this Alternative. This material represents approximately 23% of the total waste rock volume that would be generated during expanded mining operations at this mine. However, ZMI has estimated that only 220,000 yd^3 of NAG waste would be produced during expanded mining operations. As with the Zortman requirements, the agencies would impose a more stringent NAG classification criteria, resulting in lesser amounts of suitable waste rock being available. There would be a shortfall in reclamation materials which would have to be made up from existing waste rock stockpiles, material derived from excavation of the drainage notch, increased use of limestone in reclamation covers, and/or the use of suitable waste produced at the Zortman Mine expansion.

<u>Topography</u>: There would some modification to the topography of both mines resulting from implementation of this alternative. Expanded mining operations would create larger and deeper mine pits at both facilities. The estimated extent of pit development was shown in Chapter Two on Figures 2.8-5 and 2.8-19. Impacts from Zortman Mine pit development would be as described for Alternative 4 and reclamation of the pits would be as described for Alternative 5. Approximately 15 million tons of material would be backfilled in the pit, resulting in a final pit floor elevation of about 4,900 feet msl. The Landusky Mine pit development would result in the impacts described for Alternative 4. Reclamation for this pit would be similar to that described for Alternative 3. The final pit floor elevation would be at about 4,900 feet msl as a result of placing about 13 million tons of backfill into the pits. A significant topographic impact would result from the creation of a drainage notch between the August pit and Montana Gulch at the Landusky mine, directing surface water to Montana Gulch immediately below the waste rock dump.

TABLE 4.1-5

RECLAMATION AND CONSTRUCTION MATERIALS FOR ALTERNATIVE 6

Alternative 6 Resources	Additional Acres of Disturbance			Cubic Yards of Material		
	Zortman	Landusky	Total	Zortman	Landusky	Total
Clay	12	9	21	1.06 million	786,000	1.85 million
Limestone	13	3	16	741,000	35,000	776,000
Non-Acid Generating[1]	---	---	---	1.88 million	1.60 million	3.48 million

[1] Materials in this category would consist of waste rock which meets the non acid generating criteria for this alternative, as described in Section 2.10.

TABLE 4.1-6

RECLAMATION AND CONSTRUCTION MATERIALS FOR ALTERNATIVE 7

Alternative 7 Resources	Additional Acres of Disturbance			Cubic Yards of Material		
	Zortman	Landusky	Total	Zortman	Landusky	Total
Clay	4	0	3	347,000	0	240,000
Limestone	13	3	16	741,000	35,000	776,000
Non-Acid Generating[1]	---	---	---	1.79 million	2.09 million	3.88 million

[1] Materials in this category would consist of waste rock which meets the non acid generating criteria for this alternative, as described in Section 2.11.

Some additional mining would occur at the Seaford and Williams clay pits, and King Creek limestone quarry to provide reclamation materials. New disturbance would occur at LS-1, the proposed site to quarry limestone for the Zortman Mine. Approximately 12 acres would be disturbed at the Seaford clay pit, a greater impact than for any other alternative. Approximately 9 additional acres would be disturbed at the Williams clay pit.

The topographic modification at LS-1, the proposed limestone quarry for the Zortman Mine, would be a significant impact because it would represent a new disturbance and alteration of the landscape. The change to the LS-1 topography from the disturbance of about 13 acres would be the same as for Alternative 4. Approximately 3 acres would be disturbed to provide limestone from the King Creek quarry to the Landusky Mine. Roads to limestone quarries would be reclaimed to approximate original contour. Impacts to topography would be of long duration, until future materials excavation and reclamation occurs, or natural erosive forces modify the landscape further.

Two new major facilities would be constructed which would impact the area topography. A waste rock repository constructed in Ruby Flats would have a significant impact on the existing topography in this area. This waste rock facility would rise to an elevation of 4,100 feet msl or higher, approximately 250 to 300 feet above the existing landscape. A new heap leach facility would be constructed in the Goslin Flats, just west of the Ruby Flats waste rock facility. The leach pad would rise approximately 140 feet above the existing landscape. Topographic impacts from these new facilities would be significant since they represent abrupt alterations to existing topography and disturbance in areas previously undisturbed by mining activities. Impacts to visual resources associated with these landscape alterations are assessed in Section 4.8.

Geologic Hazards: Risks from geologic hazards would be relatively comparable to but less than those described for Alternative 4. Facilities would be designed to accepted standards of engineering safety. More stable facilities would result from this alternative's modified reclamation requirement to reslope all waste rock facilities and heap leach pads to no more than a 3H:1V slope. The slope flattening on these facilities would decrease the potential for facility slump or settlement. Waste rock facility engineering for the Ruby Flats site would be easier, with less risk of facility failure, than a valley-fill site like Carter Gulch. Solution control, liner and cover installation, and groundwater corrective action, if needed, would all be easier to implement at the Ruby Flats than in a site like Carter Gulch.

Alternative 6 incorporates a mitigation to increase the clay thickness in Reclamation Cover C from 3 inches to a minimum of 6 inches when compacted. This cover modification would increase the performance capabilities and reduce the potential for cover failure.

4.1.8.1 Cumulative Impacts

Reasonably foreseeable actions which would increase the cumulative impacts to geologic and topographic resources are limited to new mining operations and exploration activities. These were described in Section 2.10.6. Cumulative impacts from these developments, combined with past and present impacts and effects caused by implementation of Alternative 6 would be similar to those presented for Alternative 4 in Section 4.1.6.1. These include mining of a deposit at Pony Gulch and additional expansion of the Landusky Mine pits.

Additional construction and reclamation materials would also be required for these developments, thereby increasing disturbances at the Seaford and Williams clay pits, and the King Creek and LS-1 limestone quarries. This action would raise the total disturbance from past and proposed mining at the Seaford pit to about 16.2 acres. Total disturbance from this alternative combined with past mining at the Williams pit would be about 35 acres. Total disturbance at the King Creek quarry from past, proposed and reasonably foreseeable activities would be 10 acres. A new limestone source, with a disturbance of up to 7 acres, could be developed for reasonably foreseeable Landusky mine expansions. Cumulative disturbance at the LS-1 limestone quarry, approximately 13 acres, would be a result of Alternative 6 implementation.

The cumulative impact to the topography in the area of the Zortman and Landusky mines would be only slightly greater than already described for past and Alternative 6 disturbances.

Overall, the cumulative topographic modifications would result in decreased risks of facility failure compared to present conditions. The cumulative effect of more protective reclamation covers and pit bench reclamation would be to lessen adverse indirect impacts to water quality.

4.1.8.2 Unavoidable Adverse Impacts

The disturbances of geologic resources at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries are an unavoidable consequence of mining these reclamation materials. Topographic modifications in the mine areas, on Goslin Flats and Ruby Flats, at the Seaford and Williams clay pits, and King Creek and LS-1 limestone quarries would be unavoidable. Significant indirect adverse consequences to other resources such as water, soils, vegetation, and habitat would continue, at least in the short term; however, the modified reclamation covers and other reclamation mitigations should lessen these impacts relative to other alternatives. These impacts are assessed in subsequent sections of this Chapter.

4.1.8.3 Short-term Use/Long-term Productivity

The geologic resources used under this alternative would provide a beneficial short-term use as reclamation materials to protect other environmental resources such as surface water quality. Long-term productivity of geologic resources would not be affected.

4.1.8.4 Irreversible or Irretrievable Resource Commitments

Removal of clay and limestone for use in reclamation covers constitutes an irretrievable commitment of resources. Because these resources are available locally and regionally in essentially unlimited quantities, the impact is not significant. Removal of gold and silver from the ore deposits is a significant, irretrievable commitment of resources.

4.1.9 Impacts from Alternative 7

Geologic Resources: Impacts to geologic resources are based on the activities associated with expansion of the Zortman and Landusky mines and the imposed expansion modifications and reclamation mitigations. Modifications and mitigations to ZMI's proposed mine operations were described in Section 2.11. These modifications do not impact the type and amount of ore and waste rock generated during mine operations, as summarized in Section 4.1.6. All impacts associated with mine expansion and extraction of reclamation materials would occur in the near-term and be of short duration, extending until reclamation is completed. Table 4.1-6 summarizes the quantities of reclamation materials used for each mine.

The most significant modification incorporated into Alternative 7 is the use of water balance reclamation covers for virtually all facilities, as opposed to the water barrier reclamation covers for Alternatives 3 through 6. One result of this modification is a decrease in impact to geologic resources and topography, particularly at the clay pits because clay is not a component of the water barrier covers. The Seaford clay pit would be disturbed to remove an estimated 347,000 yd^3 of clay for construction of the Goslin Flats heap leach pad. The Williams clay pit would only be disturbed to provide materials for capture pond and drainage ditch construction.

Approximately 1.79 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Zortman Mine. Material needed for capillary break represents less than 4% of the total waste rock volume that would be generated during expanded mining operations, and an estimated 28% of the suitable waste rock (NAG, or "Blue Waste") that would be produced using ZMI's method of classifying waste rock based on total sulfur content. This Alternative requires a more stringent classification of NAG waste, and a lesser volume would be available. However, sufficient quantities would be available for use in reclamation covers.

It is estimated that 2.09 million yd^3 of suitable NAG waste would be used as capillary break in reclamation covers for the Landusky Mine under this Alternative. This material represents approximately 30% of the total waste rock volume that would be generated during expanded mining operations at this mine. However, ZMI has estimated that only 220,000 yd^3 of NAG waste would be produced during expanded mining operations. As with the Zortman requirements, the agencies would impose a more stringent NAG classification criteria, resulting in lesser amounts of suitable waste rock being available. There would be a shortfall in reclamation materials which would have to be made up from existing waste rock stockpiles, material derived from excavation of the drainage notch, increased use of limestone in reclamation covers, and/or the use of suitable waste produced at the Zortman Mine expansion.

These estimates are based on the assumption that all Zortman Mine waste rock facilities and leach pads, and mine pit exposures would require re-reclamation, unless geochemical testing indicates re-reclamation of some areas is not necessary. Approximately 300 acres of existing disturbance would have to be reclaimed. Approximately 455 acres of new disturbance for the Goslin Flats heap leach pad and new waste rock facility on existing facilities would need reclamation cover. In addition, it is estimated that 75 acres of new pit disturbance would require reclamation using 3.5 feet of non-acid generating material overlain by 12 inches of topsoil. Estimates for the Landusky Mine assume that all disturbance, approximately 650 acres, would require reclamation using the water balance covers.

For the purpose of this analysis, it is also assumed that the volume of limestone estimated by ZMI for reclamation of the Goslin Flats leach pad would be appropriate for Alternative 7. Approximately 741,000 yd^3 of limestone would be used at the Goslin Flats leach pad, with the remainder of the capillary break composed of suitable NAG waste rock. Limestone for the Zortman Mine would come from approximately 13 acres of disturbance at a new quarry, LS-1, developed just northwest of Shell Butte. Limestone requirements for reclamation of the Landusky Mine would be as described in Alternative 4. About 35,000 yd^3 of limestone would be required for reclamation of Landusky Mine facilities. This material would come from approximately 3 additional acres of disturbance at the King Creek quarry.

Topography: There would some modification to the topography of both mines resulting from implementation of this alternative. Expanded mining operations would create larger and deeper mine pits at both facilities. The estimated extent of pit development was shown in Chapter Two on Figures 2.8-5 and 2.8-19. Significant topographic impacts from Zortman Mine pit development would be as described for Alternative 4. The agencies estimate that 15 million tons of material would be backfilled in the pit, resulting in a final pit floor elevation of about 4,900 feet msl.

The Landusky Mine pit development would result in the impacts described for Alternative 4. Reclamation for this pit would be similar to that described for Alternative 5. The final pit floor elevation would be at about 4,850 feet msl as a result of placing about 9 million tons of backfill into the pits. A significant topographic impact would result from the creation of a drainage notch between the August pit and King Creek at the Landusky mine, directing surface water to King Creek.

Some additional mining would occur at the Seaford clay pits and King Creek limestone quarry to provide reclamation materials. New disturbance would occur at LS-1, the proposed site to quarry limestone for the Zortman Mine. Approximately 4 acres would be disturbed at the Seaford clay pit. No new disturbance would occur at the Williams clay pit.

The topographic modification at LS-1, the proposed limestone quarry for the Zortman Mine, would be a significant impact because it would represent a new disturbance and alteration of the landscape. The change to the LS-1 topography from the disturbance of about 13 acres would be the same as for Alternative 4. Approximately 3 acres would be disturbed to provide limestone from the King Creek quarry to the Landusky Mine. Roads to limestone quarries would be reclaimed to approximate original contour. Impacts to topography would be of long duration, until future materials excavation and reclamation occurs, or natural erosive forces modify the landscape further.

Two new major facilities would be constructed which would impact the area topography. A waste rock repository constructed on top of existing facilities would have an impact on the existing topography in this area. This waste rock facility would rise to an elevation of 5,220 feet msl east of the mine pit, up to 370 feet higher than existing topography in some areas. However, the topography in this area has already been substantially altered by mining, thereby lessening the significance of any new disturbance.

A new heap leach facility would be constructed in the Goslin Flats. The leach pad would rise approximately 140 feet above the existing landscape. Topographic impacts from the new leach pad would be significant since it represents an abrupt alteration to existing topography and disturbance in an area previously undisturbed by mining activities. Impacts to visual resources associated with these landscape alterations are assessed in Section 4.8.

Geologic Hazards: As with other alternatives, facilities would be designed to accepted standards of engineering safety. More stable facilities would result from this alternative's modified construction and reclamation requirements. The new Zortman Mine waste rock facility and heap leach pad would be constructed at average slopes of 3H:1V. Other facilities at both mines not covered by the new waste rock repository or backfilled to the pits would be reclaimed to 3H:1V slopes. The slope flattening on these facilities would decrease the potential for facility slope instability.

Engineering for the waste rock facility in this alternative would be more difficult than, for instance, a facility in Ruby Flats. Solution control, liner and cover installation, and groundwater corrective action, if needed, would all be more difficult to implement.

The new waste rock facility would be constructed over existing facilities at the Zortman Mine which were not initially anticipated to hold large quantities of additional waste rock overburden. For this reason, ZMI conducted a stability analysis of the proposed repository (see

Golder Associates, Inc. 1995). All facilities were projected to meet the appropriate safety factors.

Another potential concern for the new waste rock repository would be settlement. Settlement would be greater for the thick lifts of waste rock than thin lifts. However, with slow placement over the years most of the settlement would occur during construction. Settlement is projected to range from 0.2 to 0.5 percent, with most settlement occurring during the first few years after construction is complete. Waste rock would be placed in lifts ranging from 5 feet to 25 feet thick, in an effort to minimize settlement. In higher settlement risk areas, such as between existing heaps, waste would be placed in 5 foot lifts. Following these and other construction and reclamation procedures described in Section 2.11.1.5 should result in no significant problems from facility settlement. Also, the tops of the heaps would be crowned with the center higher to compensate for settlement.

The increased thickness of reclamation covers on pit benches at both mines would reduce adverse indirect impacts. For instance, surface water would have less contact with potentially acid generating surfaces of pit walls and benches, and impacts to water quality would be reduced. These impacts are more fully assessed in subsequent sections of this Chapter.

4.1.9.1 Cumulative Impacts

Reasonably foreseeable actions which would increase the cumulative impacts to geologic and topographic resources are limited to new mining operations and exploration activities. These were described in Section 2.11.6. Cumulative impacts from these developments, combined with past and present impacts and effects caused by implementation of Alternative 7 would be similar to those presented for Alternative 4 in Section 4.1.6.1. These include mining of a deposit at Pony Gulch and additional expansion of the Landusky Mine pits. Limited additional construction and reclamation materials would also be required for these developments.

Increased disturbance would occur at the Seaford clay pit, and the King Creek and LS-1 limestone quarries. This action would raise the total disturbance from past and proposed mining at the Seaford pit to about 8.2 acres. There would be no increased effect at the Williams clay pit; total disturbance would be projected to remain at about 26 acres. Total disturbance at the King Creek quarry from past and current activities would be 10 acres. A new limestone source, with a disturbance of up to 7 acres, could be developed for reasonably foreseeable Landusky mine expansions. Cumulative disturbance at the LS-1 limestone quarry, approximately 13 acres, would be a result of Alternative 7 implementation.

The cumulative impact to the topography in the area of the Zortman and Landusky mines would be altered as a result of new and reasonably foreseeable reclamation activities. Approximately 15 million tons of waste rock would be backfilled to the Zortman pit, resulting in a final pit floor elevation of 4,900 feet msl. Approximately 9 million tons of waste rock would be backfilled to the Landusky pit, resulting in a final pit floor elevation of 4,850 feet msl. Some spent ore heaps and waste rock facilities would be reduced in slope. A significant new landscape alteration would be the drainage notch constructed between the August/Little Ben mine pit and King Creek.

Overall, the cumulative topographic modifications would result in decreased risks of facility failure compared to present conditions. The cumulative effect of more protective reclamation covers and pit bench reclamation would be to lessen adverse indirect impacts to water quality and other resources.

4.1.9.2 Unavoidable Adverse Impacts

The disturbances of geologic resources at the Seaford clay pit, and King Creek and LS-1 limestone quarries are an unavoidable consequence of mining these reclamation materials. Topographic modifications in the mine areas, on Goslin Flats, at the Seaford clay pit, and King Creek and LS-1 limestone quarries would be unavoidable. Significant indirect adverse consequences to other resources such as water, soils, vegetation, and habitat would continue, at least in the short term; however, the water balance reclamation covers and other reclamation mitigations should lessen these impacts relative to other alternatives. These impacts are assessed in subsequent sections of this Chapter.

4.1.9.3 Short-term Use/Long-term Productivity

The geologic resources used under this alternative would provide a beneficial short-term use as reclamation materials to protect other environmental resources such as surface water quality. Long-term productivity of geologic resources would not be affected.

4.1.9.4 Irreversible or Irretrievable Resource Commitments

Removal of clay and limestone for use in reclamation covers constitutes an irretrievable commitment of resources. Because these resources are available locally and regionally in essentially unlimited quantities, the impact is not significant. Removal of gold and silver from the ore deposits is a significant and irretrievable commitment of resources.

4.2 WATER RESOURCES AND GEOCHEMISTRY

The primary goals of this impact analysis are to estimate whether the alternatives will (1) mitigate existing water quality problems, and (2) prevent the development of similar water quality degradation. The analysis of the first three (no expansion) alternatives concentrates almost entirely on the ability of the proposed reclamation measures to mitigate existing and possible future water quality problems.

4.2.1 Methodology

4.2.1.1 Infiltration Modeling

The Hydraulic Evaluation of Landfill Performance (HELP) model was used in this analysis to provide a semi-quantitative assessment of the effectiveness of proposed reclamation covers at minimizing infiltration. HELP is a deterministic water balance model that uses climatic, soil and design data to determine the water budget of a landfill (Schroeder et al. 1988). The facilities evaluated for reclamation are not landfills, but the HELP model is applicable because the performance goals (minimize infiltration and leachate generation) are the same as for a landfill. The HELP model provides a useful tool for relative comparisons between capping scenarios; however, due to the many assumptions inherent in the modeling, the calculated volumes of infiltration and discharge should be considered as estimates only.

Discharge at the toe of a facility is made up of infiltration through the facility, surface water draining underneath facility, and groundwater springs or seeps discharging from beneath the facility. These additional sources of flow are expected to be reduced to varying degrees depending on the reclamation cover used on the facilities and in reclamation of the mine pits. The volume of groundwater discharge beneath a particular facility has been estimated by modeling infiltration under current non-reclaimed conditions and subtracting this volume from total seepage measured in the field at the toe of the facility. Estimates of total seepage for each alternative have been made based on the infiltration modeling for each reclamation cover type and by adjusting the groundwater seepage volume depending on the type and extent of reclamation proposed for the upgradient recharge area.

4.2.1.2 Water Quality at Mine Waste Sites

Waste rock piles and leach pads are composed of heterogeneous materials. When water and oxygen percolate through such materials, they react with sulfides and other soluble minerals map (see acid rock drainage sidebar, Chapter 1). Some of the pathways followed by the infiltrating water generate acid rock drainage, others may result in little or no acid formation or dissolution of metals. The latter pathways will generate leachates that actually dilute acid rock drainage. Placement of covers having low permeability clay layers or thick layers of topsoil is intended to reduce the volume of water and associated oxygen infiltrating into the waste rock and heap leach piles, thereby reducing the rate of acid rock drainage formation.

The success of capping may be measured in concentrations or loads of chemical constituents found in liquids draining from mine facilities. A concentration is the mass of a chemical constituent in a unit volume and is commonly expressed in mg/l. A load is the mass transported per unit time and is calculated by multiplying the mass by the total flow. Loads are commonly expressed in lbs/day. An increase in concentration of a contaminant can be beneficial if the overall load decreases.

It has been assumed that acid and metal concentrations measured in the toe drain leachates emanating from the bottom or "toe" of facilities) may actually increase or, at best, remain roughly unchanged for the first few years after capping. The constituent loads, however, are expected to be reduced quite rapidly. It is anticipated that concentrations may also decrease in the toe-drain leachates several years after capping. This pattern has been demonstrated at capped waste piles in northern Australia (Gibson and Pantelis 1988; Harries and Ritchie 1984; Bennett, Gibson et al. 1989; Ritchie 1994), at the Heath Steele Mines in New Brunswick, Canada (Bell, Riley and Yanful 1994) and at the Bersbo site in Sweden (Håkansson, et al. 1994). However, these assumptions about the effects of capping on future concentrations and loads are quite tentative. There were very few studies located during development of this Draft EIS that reported actual monitoring results following capping, especially over extended time periods. The Australian studies already mentioned give general guidance, but represent very different precipitation (tropical), evapotranspiration, slopes and underlying sediment conditions as compared to the Zortman - Landusky sites. Also the Australian caps contained a sandy loam layer above the clay layer to aid in moisture retention. In a tropical climate the clay would remain saturated, and it appears that its success in reducing contamination has been largely due to the reduction in oxygen transport through the cap rather than the reduction of water infiltration. Even the Australian experiences have been relatively short-term; data are available from capped waste rock for less than ten years. Ritchie (1994) states that it is still uncertain whether the environmental impact may return to its pre-capping level within 30 years time. The Canadian waste pile covers were also intended to retain a high degree of water saturation, as well as having a low hydraulic conductivity. The Canadian authors state (Bell, Riley and Yanful 1994):

> *"While a saturated fine-grained soil layer, having a hydraulic conductivity of 10^{-7} cm/sec or less, can provide an effective barrier to the movement of both water and oxygen, studies indicate that a single soil layer that is initially saturated will, when placed on a waste rock pile, ultimately desaturate by drainage and moisture losses due to evaporation. As the soil desaturates, the diffusion coefficient of oxygen will increase with time, resulting in increased oxygen diffusion into the pile. Furthermore, a single cover soil designed to have a low hydraulic conductivity could dry out and crack over time, especially if the soil has a high clay content."*

The Zortman/Landusky facilities may respond quite differently to capping than either the Australian or Canadian examples.

Older unremediated waste rock piles have a greater chance of having ferrous iron (Fe+2) oxidized to ferric iron (Fe+3) in significant quantities. Ferric iron is the primary oxidant of sulfides when the pH is below about 3.5. Thus it is likely that capping would not be as successful at slowing the rate of acid rock drainage at older, more oxidized facilities, as it may be at younger less oxidized sites.

Mining activity in general and acid rock drainage in particular can result in high sediment loads which can smother bottom-dwelling aquatic organisms and destroy their habitat. Acid rock drainage also releases acidity and relatively high metal concentrations, both of which may be chemically toxic to aquatic plants and animals and to the fish that feed on them. Toxic responses such as fish kills may result from acute events like an accidental release from a process chemical pond, or from chronic, long-term, exposure resulting from contact with waste rock or tailing leachates. Long-term ingestion of acid rock drainage-contaminated water may also be toxic to mammals such as livestock.

4.2.1.3 Post-Reclamation Water Quality

Post-reclamation water quality has been estimated by studying the present measured concentrations and flow volumes emanating from facilities, and evaluating the impact attained by reducing flow of water through the facilities for each alternative. Wherever possible, current water quality conditions from monitoring stations at or directly below the toe drains have been used, but in many cases, existing data are restricted to monitoring stations immediately above a capture pond or at some distance downstream where flow is received from one or more upstream facilities. Surface water quality has been used as the primary medium to evaluate the impacts to all water resources. This is due to the fact that impacts to alluvial groundwater parallel those to surface water (see Section 3.2.6). Also, surface water quality usually represents "worst-case" conditions when compared to adjacent groundwater, particularly bedrock groundwater which is much less likely to be impacted than alluvial groundwater. Monitoring stations referred to can be located on Exhibit 1 for the Zortman Mine and Exhibit 2 for the Landusky Mine.

A large percentage of flow observed at these monitoring stations appears to be derived from groundwater recharge from undisturbed catchment surrounding the facilities or groundwater recharged within the open pits, discharging to the surface beneath the facility. The ratio of flow infiltrating through the facilities to that derived from the surrounding catchment and beneath the facilities plays a significant part in estimating the degree of improvement in water quality as a result of capping. Where facilities take up the majority of the headwaters of their drainages, it is expected that the proportion of baseflow underneath the facilities would decrease significantly as surface recharge is diverted by the cover.

Extensive review of the mine water quality literature shows that accurate and precise predictions of post reclamation water quality cannot be made given the current state of the art. Because mineralogy and other factors affecting the potential for acid rock drainage are highly variable from site to site, predicting the potential for acid rock drainage is currently difficult, costly and of questionable reliability (USEPA 1994). Given that some of the Zortman/Landusky wastes have already had quantities of lime or limestone added to the facilities (e.g., the Gold Bug repository and the Mill Gulch dump), reliable prediction is made even more tentative. As such, estimates of post-reclamation water quality have been made primarily by professional judgement after considering all the factors discussed above.

Anticipated water quality from spent ore piles was discussed in Section 3.2.2. As mentioned, after the ores have been leached, and immediately after the cessation of pad flushing, leachates would likely have alkaline pH's, relatively high TDS concentrations and high concentrations of elements mobile at alkaline pHs such as arsenic, selenium and molybdenum. However, as remnant sulfides react, subsequent leachates may become acidic and metal-laden. The impacts analysis for spent ore piles presented in this document considers the later acid rock drainage-generating phase when comparing future impacts, not the early alkaline leachate phase. Kinetic tests and actual field measurements from existing spent ore heaps show that spent ore is likely to generate acid.

The majority of the streams within the Little Rocky Mountains are not perennial and therefore do not support fish populations. Water quality in the lower reaches of the streams surrounding the Little Rocky Mountains is of good quality. This appears to be the results of the Madison Limestone over which most drainages flow, buffering the upstream drainage water quality. As discussed in Section 3.2.5.2, the water quality of the regional limestone aquifer surrounding the Little Rocky Mountains does not appear to be impacted by mining related activities although local recharge by acid rock drainage (ARD) contaminated waters has occurred. Lastly, natural water quality within the shales underlying Goslin Flats has high TDS and high salinity, and is not suitable for most agricultural or domestic purposes.

4.2.1.4 Significance Criteria

Beneficial uses of water resources in the Little Rocky Mountains include domestic water supply, recreation, terrestrial wildlife drinking supply, and fish and macroinvertebrate habitats. As a result, significance criteria selected to assess impacts to water resources include the following: EPA maximum freshwater criterion, continuous criteria, and Human Health criteria for consumption of water and organisms (40 CFR Part 131). Criteria for a suite of metals often associated with acid rock drainage are included in Table 4.2-1. Other significance criteria used to assess impacts to water resources under each alternative include the following:

- Acreage of drainage area disturbed
- Impacts to beneficial use

Present day and estimated future downstream surface water quality are shown on Table 4.2-1. Disturbed or diverted drainage area acreages for each alternative are summarized on Tables 4.2-2(a) and 4.2-2(b). Schematic figures in Sections 4.2.5.6 and 4.2.8.6 illustrate how each alternative is expected to approach these criteria in the long-term.

4.2.1.5 Alternatives Ranking

The analysis and eventual ranking of each alternative has been partially based on predicted water quality at the toe of waste rock piles and leach pad dikes. The ranking is also based on estimated volumes that would require capture and treatment under each alternative. Downstream water quality is primarily a product of the effectiveness of the upstream capture and treatment systems (Table 4.2-1). Predictions of water quality at selected points of interest (points of beneficial use) have been carried out based on downstream trends in water quality established from historic monitoring data. Due to the expected effectiveness of the capture systems and contingency measures under the Water Quality Improvement Plan (see Appendix A), little difference in impact is expected between alternatives at these downstream locations. However, short-term downstream water quality is expected to vary depending on the amount of suspended solids released during construction of facilities in the drainages. The ranking assigned to cumulative impacts taken into consideration for each alternative. Positive and negative attributes of each alternative are tabulated in a summary table (presented in Section 4.2.10.3), and a ranking is assigned based on the detailed review of these attributes in the following text.

4.2.2 Impacts from Mining - 1979 to Present

As described in Section 3.2.5, water quality in the majority of the southern drainages within the Little Rocky Mountains has been adversely impacted to some degree by mining activity. Geologic materials and mine wastes derived from past and present mining operations have generated acid rock drainage and released these products to surface water and, in some cases, groundwater.

The rock removed from high areas during open pit mining at both mine sites has been redistributed to a number of heap leach pads and waste rock facilities. The excavation and redistribution of this rock has significantly increased the amount of potentially acid generating rock exposed to the atmosphere, thereby accelerating the rate of weathering and geochemical reactions that have a negative impact on surface and groundwater quality. Additionally, the mining operation has significantly altered the water balance of the Little

TABLE 4.2-1

EXISTING AND ESTIMATED SHORT-TERM POST RECLAMATION DOWNSTREAM WATER QUALITY

WATER QUALITY STANDARDS

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Max Freshwater Criterion (Acute)	>7.0			0.12 @ 100mg/l hardness	0.082 @ 100mg/l hardness	0.018 @ 100mg/l hardness	0.36	1.4 @ 100mg/l hardness	
Continuous Criterion (Chronic)	>7.0			0.11 @ 100mg/l hardness	0.0032 @ 100mg/l hardness	0.012 @ 100mg/l hardness	0.19	0.16 @ 100mg/l hardness	
Human Health - consumption of water and organisms	>7.0			-	-	-	1.8×10^{-5}	0.61	

ZORTMAN

Ruby Gulch - Station Z-1B (Above Zortman Town Site)

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	7.0	131	21	0.08	0.20	0.02	0.13	<0.01	
Estimated Baseline	6.5-8.0	-	100-200	-	-	-	-	-	Baseline from Station Z-1
Alternatives 1-7 estimated concentrations	7.0	131	21	0.08	0.20	0.02	0.13	<0.01	(No significant change expected)

Z-32 (Below the Proposed Ruby Terrace Waste Rock Repository

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	8.1	567	207	<0.01	<0.01	<0.01	<0.005	0.03	1993, 1991 for Cu, As, Ni
Estimated Baseline	7.5-8.5	-	-	-	<0.01	-	-	-	
Alternatives 1-5 and 7	8.1	567	207	<0.01	<0.01	<0.01	<0.005	0.03	(No significant change expected)
Alternative 6	6-7	500-1000	200-600	<0.01	<0.01	<0.01-0.03	<0.005-0.15	<0.01-0.15	Minor degradation primarily due to exposing bedrock to further oxidation

Note:

- Standard or data not established

EPA 40 CFR Part 131 Water Quality Standards

TABLE 4.2-1
(Continued)

ZORTMAN

Alder Gulch Z-16 (Above Zortman Town Site)

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	7.4	189	65	0.09	0.02	<0.01	<0.005	<0.01	
Estimated Baseline	7.0-8.0	-	25-100	-	<0.02	-	-	-	
Alternatives 1-3, 6 and 7	7.4	189	65	0.09	0.02	<0.01	<0.005	<0.01	(no significant change expected)
Alternatives 4 and 5	6-7	150-300	60-100	0.5-1.0	0.02	<0.01-<0.03	<0.005-0.15	<0.01-0.15	Minor degradation due to water bypassing capture systems

Goslin Gulch Z-22 (Downstream of Goslin Gulch Leach Pad)

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	7.5	1,390	773	0.01	0.01	<0.01	<0.005	<0.01	1993 data
Estimated Baseline	6.5-8.0	-	700-1000	-	0.005-0.03	-	-	-	
Alternatives 1-3 and 5	7.5	1,390	773	0.01	0.01	<0.01	<0.005	<0.01	(No change expected)
Alternatives 4, 6 and 7	6.0-7.0	1,200-3,000	700-2,000	0.01	0.01	<0.01-0.03	<0.005-0.15	<0.01-0.15	Minor degradation primarily due to exposing bedrock to oxidation

Lodgepole Creek Z-7

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	8.4	189	17	0.02	<0.01	<0.01	<0.005	<0.01	
Estimated Baseline	7-8	-	10-50	-	<0.01	-	-	-	
Alternatives 1-7	8.4	189	17	0.02	<0.01	<0.01	<0.005	<0.01	(No change expected)

TABLE 4.2-1
(Continued)

LANDUSKY

Rock Creek L-23 (At Landusky Town Site)

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	8.2	343	99	<0.01	<0.01	<0.01	<0.005	<0.01	From L-27 Upstream
Estimated Baseline	6.5-7.5	-	10-75	-	<0.01	-	-	-	
Alternatives 1-7	8.2	343	99	<0.01	<0.01	<0.01	<0.005	<0.01	(No significant change expected)

Mill Gulch L-7 (Above Confluence With Rock Creek)

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	8.1	846	410	0.03	<0.01	<0.01	<0.005	<0.01	Based on pre 1983, but 1994 for Cu, As, Ni
Estimated Baseline	7.6	100	16	0.08	-	-	-	-	
Alternatives 1-7	8.1	200-600	200-400	<0.03	<0.01	<0.01	<0.005	<0.01	(Reduction in concentrations as majority of precipitation is diverted to surface runoff)

Montana Gulch L-2 (Above Confluence With Rock Creek)

	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	8.1	628	373	0.32	<0.01	<0.01	0.013	0.004	
Estimated Baseline	8.4	330	61	-	0.20	-	-	-	
Alternatives 1 and 2	8.1	628	373	0.32	<0.01	<0.01	0.013	0.04	(No significant change expected)
Alternative 3	7.0-8.0	500-800	300-500	<0.3	<0.01	<0.01-0.03	<0.005-0.15	<0.01-0.15	Minor degradation in short term due to reducing amount of diluting water
Alternatives 4, 5, 6, and 7	7.0-8.0	400-600	200-350	<0.03	<0.01	<0.01	<0.05	<0.01	Improvement due to reduction of Gold Bug and August Adit flow contributors of elevated metals

TABLE 4.2-1
(Concluded)

LANDUSKY									
King Creek L-6 (Downstream Rock Creek)									
	pH	TDS mg/L	Sulfate mg/L	Zinc mg/L	Lead mg/L	Copper mg/L	Arsenic mg/L	Nickel mg/L	Comments
Existing Conditions	7.9	328	114	0.01	<0.01	<0.01	<0.005	<0.01	
Baseline	7.5	306	95	-	<0.01	-	-	-	
Alternatives 1-4 and 6	7.9	328	114	0.01	<0.01	<0.01	<0.005	<0.01	(No significant change expected)
Alternative 5 and 7	6.5-8.0	300-600	100-300	0.01	<0.01	<0.01	<0.005	<0.01	(Some slight increase in concentrations of nitrated due to rehabilitation

TABLE 4.2-2(a)

DRAINAGE AREA DISTURBANCES (acres) AND ESTIMATED VOLUMES OF WATER REQUIRING CAPTURE AND TREATMENT IN THE SHORT-TERM (20 years) AT THE ZORTMAN MINE

Drainage Name	Watershed Total Area (Acres)	Facility Type In Drainage	Impacted Flow Currently Being Captured (gpm)	ALTERNATIVE 1			ALTERNATIVE 2			ALTERNATIVE 3		
				Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]	Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]	Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]
Ruby Gulch[1]	1333	Pits		65.1	4.8		65.1	4.8		65.1	4.8	
		Waste Rock		11.3	0.85		11.3	0.85		11.3	0.85	
		Heap Leach		55	4.1		55	4.1		20.4	1.4	
		TOTAL	80	131.4	9.8	79-89	131.4	9.8	68-78	96.8	7.05	34-44
Carter Gulch[2]	145	Pits		6.7	4.5		6.7	4.5		6.7	4.5	
		Waste Rock		18.7	13		18.7	13		0	0	
		Heap Leach		6.2	4.3		6.2	4.3		6.2	4.3	
		TOTAL	10	31.6	21.8	4-7	31.6	21.8	4-7	12.9	8.8	0-4
Alder Spur[3]	302	Waste Rock	10	56.7	19	12-15	56.7	19	11-14	56.7	19	5-7
		Heap Leach										
		TOTAL										
Alder Gulch[4]	2182	Heap Leach	0	0	0	0	0	0	0	0	0	0
Goslin Gulch[5]	1313	Leach Pad	0	0	0	0	0	0	0	0	0	0
Ruby Creek[6]	5758	Waste Rock	0	0	0	0	0	0	0	0	0	0
Camp Creek[7]	2779	Waste Rock	0	0	0	0	0	0	0	0	0	0
Lodgepole Creek[8]	4522	Pits	0	26	0.6	0	26	0.6	0	26	0.6	0
TOTALS			**100**			**95-111**			**83-99**			**39-55**

TABLE 4.2-2(a)

DRAINAGE AREA DISTURBANCES (acres) AND ESTIMATED VOLUMES OF WATER REQUIRING CAPTURE AND TREATMENT IN THE SHORT-TERM (20 years) AT THE ZORTMAN MINE

Drainage Name	Watershed Total Area (Acres)	Facility Type In Drainage	ALTERNATIVE 4			ALTERNATIVE 5			ALTERNATIVE 6			ALTERNATIVE 7		
			Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]	Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]	Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]	Disturbed Acres[a]	% of Total Drainage Area[b]	Estimated Volume Requiring Capture (gpm)[c,d]
Ruby Gulch[1]	1333	Pits	113	8.48		113	8.48		113	8.48		113	8.43	
		Waste Rock	11.3	0.85		11.3	0.85		11.3	0.88		50.1	3.76	
		Heap Leach	55	4.1		55	4.1		55	4.1		55	4.1	
		TOTAL	178		34-44	178	13.4	34-44	178	13.4	34-44	218	16.29	34-44
Carter Gulch[2]	145	Pits	6.7	4.5		6.7	4.5		6.7	4.5		6.7	4.5	
		Waste Rock	131	91		131	91		18.7	13			13	
		Heap Leach	6.2	4.3		6.2	4.3		6.2	4.3		6.2	4.3	
		TOTAL	144	99.8	12-16	144	99.8	13-21	31.6	21.8	0-4			0-4
Alder Spur[3]	302	Waste Rock	56.7	19	5-7	56.7	19	5-7	56.7	19	6-7	21.2	38	9-11
		Heap Leach										66.8	22	
		TOTAL										88	60	
Alder Gulch[4]	2182	Heap Leach	0	0	0	185	8.5	17-25	0	0	0	0	0	0
Goslin Gulch[5]	1313	Leach Pad	250	19	20	0	0	0	250	19	20	250	19	20
Ruby Creek[6]	5758	Waste Rock	12.5	0.003	0	0	0	0	124	2	8	0	0	0
Camp Creek[7]	2779	Waste Rock	0	0	0	0	0	0	91.3	14	8	0	0	0
Lodgepole Creek[8]	4522	Pits	67	1.5	0	67	1.5	0	67	1.5	0	67	1.5	0
TOTALS					**71-87**			**69-97**			**76-91**			**63-79**

[a] Disturbed acres were planimetered from EIS Facility Maps

[b] Drainage areas were defined as shown in points (1) through (8) below.

[c] Volumes from ZMI monitoring records.

[d] Volume based on HELP modeling of reclamation covers and reclamation of recharge areas (e.g. pits).

Drainage Areas Defined as Follows:

[1] Downstream to the Town of Zortman
[2] Downstream to Confluence with Alder Gulch
[3] Downstream to Confluence with Alder Gulch
[4] Downstream to Confluence with Ruby Gulch
[5] Downstream to Confluence with Ruby Creek
[6] Downstream to Monitoring Station Z-35.
[7] Downstream to Study Area Boundary.
[8] Downstream to Reservation Boundary.

NOTE: HELP Modeling Assumed An Average Annual Rainfall of 22-1/2 inches.

TABLE 4.2-2(b)

DRAINAGE AREA DISTURBANCE (acres) AND ESTIMATED VOLUMES OF WATER REQUIRING CAPTURE AND TREATMENT IN THE SHORT-TERM (20 years) AT THE LANDUSKY MINE

Drainage Area	Total Acres	Facility Type	Impacted Flow Currently Being Captured	Disturbed Acres[a]	% of Total Drainage Area[b]	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
						Estimated Volume Requiring Capture & Treatment (gpm)[c,d]	Estimated Volume Requiring Capture & Treatment (gpm)[c,d]	Estimated Volume Requiring Capture & Treatment (gpm)[c,d]
Sullivan Creek[1]	212	Leach Pad	20	118	55.5	25-28	24-26	11-15
Mill Gulch[2]	580	Pits		5.7	1.1			
		Waste Rock		60	11.3			
		Leach Pad		93	17.6			
		TOTAL	40	158	30	29-30	28	27-31
Montana Gulch[3]	1,148	Waste Rock		108	9.4			
		Leach Pad		77	6.6			
		TOTAL	50-80	185	16.1	239-289	237-287	187-237
King Creek[4]	671	Pits		83.6	12.5			
		Waste Rock		5.9	0.9			
		TOTAL	0	89.5	13.2	0	0	0
Swift Gulch[5]	721	Pits	0	33.5	4.7	0	0	0
TOTALS			**110-150**			**293-347**	**289-341**	**225-283**

TABLE 4.2-2(b)

DRAINAGE AREA DISTURBANCE (acres) AND ESTIMATED VOLUMES OF WATER REQUIRING CAPTURE AND TREATMENT IN THE SHORT-TERM (20 years) AT THE LANDUSKY MINE

			ALTERNATIVE 4	ALTERNATIVE 5	ALTERNATIVE 6	ALTERNATIVE 7
Drainage Area	**Total Acres**	**Facility Type**	**Estimated Volume Requiring Capture & Treatment (gpm)[c,d]**	**Estimated Volume Requiring Capture & Treatment (gpm)[c,d]**	**Estimated Volume Requiring Capture & Treatment (gpm)[c,d]**	**Estimated Volume Requiring Capture & Treatment (gpm)[c,d]**
Sullivan Creek[1]	212	Leach Pad	23-27	23-27	23-27	15-19
Mill Gulch[2]	580	Pits				
		Waste Rock				
		Leach Pad				
		TOTAL	27-31	27-31	27-31	18-22
Montana Gulch[3]	1,148	Waste Rock				
		Leach Pad				
		TOTAL	138-188	112-162	112-162	107-157
King Creek[4]	671	Pits				
		Waste Rock				
		TOTAL	0	0	0	0
Swift Gulch[5]	721	Pits	0	0	0	0
TOTALS			**188-246**	**162-220**	**162-220**	**140-198**

[a] Disturbed acres were planimetered from EIS Facility Maps

[b] Drainage areas were defined as shown in points (1) through (8) below.

[c] Volumes from ZMI monitoring records.

[d] Volume based on HELP modeling of reclamation covers and reclamation of recharge areas (e.g. pits)

Drainage Areas Defined as Follows:

1 Downstream to Confluence with Rock Creek
2 Downstream to Confluence with Rock Creek
3 Downstream to Confluence with Rock Creek
4 Downstream to Confluence with Little Peoples Creek
5 Downstream to Confluence with Little Peoples Creek

NOTE: No additional disturbance acreages are required at Landusky.

Rocky Mountains, increasing infiltration in the open pit areas and proportionally reducing flows in the upper reaches of the drainages.

Table 4.2-1 includes water quality data from individual 1994 sampling events downgradient of waste rock dumps, leach pads, and buttresses at Zortman and Landusky, illustrating the present day downstream surface water quality status.

4.2.2.1 Zortman

With the exception of Lodgepole Creek, all the major drainages in the vicinity of the Zortman mine have been significantly impacted by mining activities (see Section 3.2.5.2). The upper reaches of Carter Draw, Alder Spur and Ruby Gulch presently have elevated concentrations of sulfate, TDS, metals, nitrates and occasional detections of cyanide. This water fails to meet aquatic life standards and human health criteria, and is therefore currently being captured and treated before being discharged to Ruby Gulch. The lower reaches of Alder Gulch and Ruby Gulch show a record of being significantly impacted by acid rock drainage or process chemicals after specific release events or periods of extreme precipitation or snowmelt (see Section 3.2.5.2). Impacts to surface water and groundwater throughout the mid- and lower reaches of these drainages have been significantly reduced as a result of installation of capture systems (see Section 3.2.5.2).

Impacts to beneficial uses at the Zortman mining site since 1979 have included:

- A cyanide leak in 1984 caused contamination of the once-utilized alluvial groundwater source for the town of Zortman in Alder Gulch. An alternative community water supply was developed (Z-8A).

- Ongoing degradation of wildlife drinking water and macroinvertebrate habitat in the upper reaches of Ruby Gulch, Alder Spur, and Carter Gulch.

- Diversion of recharge from approximately 26 acres of Lodgepole Creek catchment into the Zortman pits. This diversion of flow is not considered significant as it constitutes only a minor part of a large undisturbed drainage area.

4.2.2.2 Landusky

With the exception of Swift Gulch, all the major drainages within the vicinity of the Landusky mine have been impacted to some degree by acid rock drainage and/or releases of process chemicals (see Section 3.2.5.2). Capture sumps or ponds have been installed within Sullivan Creek, Mill Gulch and Montana Gulch in order to protect the lower reaches of the drainages from any further impact. Water captured below leach piles and waste rock dumps at Sullivan Creek and Mill Gulch is currently recirculated into the process circuit rather than undergoing any direct treatment. At Montana Gulch water discharging from the Gold Bug adit is captured and oxygenated to reduce iron concentrations. At monitoring station L-2 (downstream Montana Gulch), impacts from mining since about 1960 have been in the form of slightly elevated metal concentrations, derived primarily from drainage from the Gold Bug and August Adits. King Creek, draining the north-western side of the mining operation has progressively incurred minor mining-related impacts in its upper reaches since 1979, including elevated concentrations of nitrates and moderate increases of TDS and sulfate.

Impacts to beneficial uses at the Landusky mining site since 1979 have included:

- Periodic events of surface water and alluvial groundwater degradation near the Montana Gulch campground limiting recreation use.

- Degradation of macroinvertebrate habitat and wildlife drinking water supplies in upper Sullivan Creek, Mill Gulch, Montana Gulch, and King Creek.

- Diversion of recharge from approximately 89 acres of King Creek catchment area into the Landusky pits. This ongoing impact is considered significant as it makes up approximately 13% of the King Creek drainage area above the confluence with the south fork of Little Peoples Creek.

4.2.3 Impacts from Alternative 1

Closure and reclamation activities under Alternative 1 would be limited to actions required under the existing permit requirements combined with the requirements set out in the Water Quality Improvement Plan. In accordance with requirements set forth in the Improvement Plan, all seepage water capture systems would be resized to handle flow from the 6.33 inch 24-hour event. Other features that would be required under the Improvement Plan to enhance the capture and treatment of mine drainage would include:

- Lined capture ponds
- Installation of monitoring and recovering wells
- Interceptor trenches and/or
- Sumps
- An improved water quality monitoring program

Infiltration Modeling

Table 4.2-3(a) illustrates the HELP-modeled water budget at individual facilities, assuming application of 8 inches of cover soil and poorly established vegetative cover. A condition in which soil lies directly over potentially acid generating rock creates the potential for acidic fluids to rise into the soil by capillary action, and adversely impact plant growth. It is estimated that only 25% vegetative cover would be attained in the long-term and that vegetation would be of a poor quality. With the exception of the Mill Gulch waste rock repository and the 87/91 Pad, all other side slopes are modeled as having 2H:1V side slopes as the slope differences make a negligible difference to the water budget calculations. With the exception of the Mill Gulch waste rock repository and the 89/91 pad, all other side slopes are modeled as having 2H:1V side slopes as the slope differences make a negligible difference to the water budget calculations. The amount of evapotranspiration expected under this alternative is approximately 66% of available precipitation; surface runoff is modeled at 12 to 16%; and infiltration through the soil is estimated to be approximately 21% on the gentle slopes and 19% on the side slopes. HELP modeling of non-reclaimed conditions at waste rock piles (no soil cover) suggests that approximately 41% of available precipitation currently returns to the atmosphere through evapotranspiration, approximately 11% goes to surface runoff and approximately 48% infiltrates into the facility (Table 4.2-3(b)). Similar ratios of discharge would be expected for the leach pads if the liners were perforated without being reclaimed first (Table 4.2-3(b)). The difference between the estimates for non-reclaimed conditions and that of the 8 inches of soil cover under Alternative 1 is primarily due to the increased level of evapotranspiration (enhanced by the presence of some vegetative cover).

Post-Reclamation Water Quality

Table 4.2-3(a) summarizes present day water quality conditions and estimated post-reclamation conditions for selected monitoring stations directly below heap leach pads and waste rock dumps under Alternative 1. Under all the alternatives, impacted water would be captured in ponds, sumps, and recovery wells below the facilities and treated or returned to the process circuit.

The heap detoxification process for this alternative would be as described in Sections 2.5.2.4 and 2.5.4.1. Rinsing would continue until 0.22 mg/l WAD cyanide has been maintained within the pile for a period of 6 months. The liner would not be perforated until monitoring of the effluent indicates that "water quality compliance" has been met and the risk of formation of acid rock drainage is established to be minimal. Given that under Alternative 1 a significant amount of precipitation would infiltrate into the spent ores following capping (approximately 21%), it is probable that ongoing acid rock drainage formation would occur. Although rinsate chemistry may indicate low cyanide and metal concentrations, the remaining spent ore may still have an appreciable sulfide content. Based on the kinetic testing performed, these materials are likely to form acid rock drainage in the longer-term (see Section 3.2.2.6) (Schafer and Assoc. 1994). This contaminated infiltration would add to current volumes requiring capture and treatment, since it would not be allowed to accumulate in the interior of the leach pads.

At Ruby Gulch it is estimated that only approximately 13% of the water flowing in the headwaters of the drainage is currently derived from seepage through the waste rock dumps and or heap leach pad dikes (Table 4.2-3(b)). If the leach pads were perforated without surface reclamation, the drainage from the facilities would be on the order of 41% of the total drainage flow (Table 4.2-3(b)). The remainder is likely derived from precipitation infiltrating into the Zortman pit complex and discharging to the drainage under the 1985/1986 leach pad as baseflow (see Section 3.1.5.1). Under Alternative 1, no low permeability cover is proposed for the pits; thus, little decrease in the volume of baseflow to Ruby Gulch is expected. Estimated short-term (10 year) water quality within the upper reaches of Ruby Gulch are summarized on Table 4.2-3(a)). Total flow requiring treatment in the short-term at Ruby Gulch under this alternative is estimated at 79 to 89 gpm (Table 4.2-3(a)).

Approximately 52% of flow monitored in Alder Spur is estimated to be derived from seepage through the unlined portions of the facilities in that drainage (Table 4.2-3(b)). Estimated short-term water quality at the

TABLE 4.2-3(a)

ALTERNATIVE 1:
NO ACTION, PERMITTED RECLAMATION ONLY

1 At Zortman, reclamation covers will consist of 8 in of cover soil to be placed on all disturbed (non-reclaimed) areas (no testing required)
2 At Landusky, reclamation covers for presently non-reclaimed waste rock dumps and leach pads will consist of 8 in. of cover soil and and caps B and C for the Mill Gulch Waste Rock Dump, and the Gold Bug Waste Repository (see Sec. 2)

Help Model Results	Flat Surfaces	Side Slopes
Surface Runoff (as percent of precipitation)	12.82	15.60
Evapotranspiration (as percent of precip.):	65.78	65.64
Lateral Drainage (as percent of precip.)		
Infiltration (as percent of precipitation):	21.4	18.76

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 10-yr. Water Quality (italics & shaded)				Comments
				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
ZORTMAN												
- 85/86 Leach Pad & Dike	Ruby Gulch	7.7						2.9	2760	1920	5.4	Z-37
- 89 Leach Pad & Dike	Ruby Gulch	3.6						*3.0-5.0*	*2,000-3,000*	*1,000-2,000*	*3.0-5.0*	*Z-37*
- Ruby Gulch Waste Rock Dump	Ruby Gulch	0.6										
- OK Pit Waste Dump	Ruby Gulch	1.7										
- 82 Leach Pad (free draining)	Ruby Gulch	2.6										
- 79/80/81 Leach Pad (free draining)	Ruby Gulch	3.3						3	878	615	5.06	Z-1 (downstream)
	RUBY GULCH:	19.5	69.3	60	70	79	89	*3.0-5.0*	*500-900*	*300-700*	*3.0-5.0*	***Estimated water quality at Ruby Gulch capture system***
- 84 Leach Pad & Dike	Alder Spur	4.6										
- 83 Leach Pad & Dike	Alder Spur	4.1						4.1	2310	1460	1.98	Z-14 (downstream)
	ALDER SPUR:	8.6	4.8	3	6	12	15	*4.5-6.0*	*1,000-2,500*	*500-1,600*	*1.0-3.0*	***Estimated water quality at Alder Spur capture system***
- Alder Gulch Waste Rock Dump	Carter Gulch	4.2						3.4	5450	3480	10.4	Z-13
	CARTER GULCH	4.2	-0.3	0	3	4	7	*3.0-5.0*	*3,000-6,000*	*2,500-4,000*	*4.0-9.0*	***Estimated water quality at Carter Gulch capture system***
LANDUSKY												
- 87/91 Leach Pad & Dike 1-3	Mill Gulch/Sullivan Creek	20.8										
- Mill Gulch Waste Rock Dump	Mill Gulch	5.4						4	2460	1620	8.43	
- 79 Leach Pad (free draining)	Mill Gulch	0.9										
- 80/81/82 Leach Pad (free draining)	Mill Gulch	0.9										
	MILL GULCH:	28.1	1.9	1	2	29	30	*4.0-5.0*	*2,000-3,000*	*1,500-2,000*	*5.0-9.0*	***Estimated water quality at Mill Gulch capture system***
- 87/91 Leach Pad & Dike 1-3	Mill Gulch/Sullivan Creek	20.8										
- Sullivan Park Waste Rock Dump	Sullivan Creek	2.3						2.8	14700	9960	25.4	L-28 (downstream; 1992)
	SULLIVAN CREEK:	23.1	2.9	2	5	25	28	*4.0-5.0*	*2,000-3,000*	*1,500-2,000*	*5.0-9.0*	***Estimated water quality at Sullivan Creek capture system***
- Gold Bug Pit Waste Rock Repository	Montana Gulch	17.4										
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	9.2										
- 84 Leach Pad & Dike	Montana Gulch	2.9										
- 85/86 Leach Pad & Dike	Montana Gulch	5.5						7.7	806	489	0.52	L-16
- 1983 Leach Pad & Dike	Montana Gulch	3.9						6.6	4670	2920	1.56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	38.9	250.2	200	250	239	289	*7.0-8.0*	*700-1,000*	*400-600*	*0.4-0.7*	***Estimated water quality at Montana Gulch capture system***
	TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):					388	458					

Notes
1. "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions
2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc. under each alternative.

TABLE 4.2-3(b)

MODELING OF UNRECLAIMED SURFACES

Help Model Results

	Flat Surfaces	Side Slopes
Surface Runoff (as % of precipitation)	10.60	10.75
Evapotranspiration (as percent of precip.)	42.14	42.07
Lateral Drainage (as percent of precip.)	n/a	n/a
Infiltration (as percent of precipitation)	47.26	47.18

		LEACH PADS NOT PERFORATED				LEACH PADS PERFORATED			
Facility	Drainage	Modeled Seepage Through Facility Including from Dumps, Waste Rock Piles, & Dikes (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Measured Total Seepage Volume (gpm)	Percent of Total Seepage Volume that Drains Through Dumps, Waste Rock Piles, & Dikes	Modeled Seepage from all Facilities (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Calculated Total Seepage Volume (gpm)	Percent of Total Seepage Volume that comes from All Facilities
ZORTMAN									
- 85/86 Dike only	Ruby Gulch	1.7				19.0			
- 89 Dike only	Ruby Gulch	3.4				8.8			
- Ruby Gulch Waste Rock Dump	Ruby Gulch	1.4				1.4			
- OK Pit Waste Dump	Ruby Gulch	4.1				4.1			
- 82 Leach Pad (free draining)	Ruby Gulch	n/a				6.3			
- 79/80/81 Leach Pad (free draining)	Ruby Gulch	n/a				8.1			
	TOTAL RUBY GULCH:	10.7	69.3	80.0	13.4	47.7	69.3	117.0	40.8
- 84 Dike only	Alder Spur	2.6				11.0			
- 83 Dike only	Alder Spur	2.6				9.9			
	ALDER SPUR:	5.2	4.8	10.0	52.4	20.9	4.8	25.7	81.5
- Alder Gulch Waste Rock Dump	Carter Gulch	10.3				10.3			
	TOTAL CARTER GULCH:	10.3	-0.3	10.0	102.6	10.3	-0.3	10.0	102.6
LANDUSKY									
- 87/91Dike only	Mill Gulch /Sullivan Creek	5.4				50.8			
- Mill Gulch Waste Rock Dump	Mill Gulch	32.8				32.8			
- 79 Leach Pad (free draining)	Mill Gulch	n/a				2.1			
- 80/81/82 Leach Pad (free draining)	Mill Gulch	n/a				2.1			
	MILL GULCH	38.1	1.9	40.0	95.3	87.8	1.9	89.7	97.9
- 87/91Dike only	Mill Gulch /Sullivan Creek	5.4				50.8			
- Sullivan Park Waste Rock Dump	Sullivan Creek	11.7				11.7			
	SULLIVAN CREEK	17.1	2.9	20.0	85.5	62.5	2.9	65.4	95.6
- Gold Bug Pit Waste Rock Repository	Montana Gulch	41.1				41.1			
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	21.4				21.4			
- 84 Dike only	Montana Gulch	1.6				7.2			
- 85/86 Dike only	Montana Gulch	1.7				13.6			
- 1983 Dike only	Montana Gulch	3.0				9.2			
	MONTANA GULCH:	68.8	250.2	319.0	21.6	92.5	250.2	342.8	27.0
TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):				*479.0*				*650.6*	

Notes

1 "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage Through Facilities" computed for Current Non Reclaimed Non Perforated Conditions

capture system in the headwaters of Alder Spur is summarized in Table 4.2-3(a). The volume of this flow requiring capture and treatment is estimated at 12 to 15 gpm (Table 4.2-3(a)).

Under Alternative 1, the Carter Gulch waste rock dump would remain in place and be covered with approximately 8 inches of soil. Modeling indicates that close to 100% of the seepage flowing at station Z-13 is derived from the dump (Table 4.2-3(b)). As the Alder Gulch waste rock dump is currently covered with 8 inches of topsoil, water quality and of the volume seepage from this facility is expected to stay similar to presently observed. Volumes requiring capture and treatment are estimated at 4 to 7 gpm (Table 4.2-3(a)).

At Landusky, it is estimated that 85% of the current flow in Sullivan Creek's upper reaches comes from infiltration through the Sullivan Park waste rock dump and the 91 Leach pad dike. If the 91 leach pad were to be perforated, drainage from the facilities would make up approximately 96% of the total discharge flow. This is not surprising, as the facility takes up the entire recharge area (Exhibit 2 in EIS map pocket). Under Alternative 1, upstream post-reclamation water quality is expected to maintain similar concentrations as those presently observed (Table 4.2-3(a)). Flows requiring capture and treatment under Alternative 1 are estimated at 25 to 28 gpm.

At Mill Gulch, the Mill Gulch waste rock dump and the 1987 leach pad take up the majority of the upper catchment area (Exhibit 2 EIS map pocket), and as a result they contribute approximately 95% of the flow in the upper reaches of the creek (Table 4.2-3(b)). Under Alternative 1, water quality is expected to remain similar to what is observed today. The volume requiring capture and treatment is estimated at around 30 gpm (Table 4.2-3(a)).

Finally, the waste rock dump and leach pad dikes located within Montana Gulch are estimated to contribute approximately 22% of the current total flow in the upper reaches of the drainage (Table 4.2-3(b)). The remainder is derived from the Gold Bug adit (up to 250 gpm), the August adit (20-30 gpm, Water Management Consultants, 1995), and the large area of undisturbed catchment surrounding the facilities. Existing water quality draining from these facilities has a neutral pH and only moderate TDS and sulfate concentrations. Reclamation under Alternative 1 is expected to maintain this present water quality, as shown on Table 4.2-3(a). Estimated volumes requiring capture and treatment are also expected to remain similar to present quantities at 240 to 290 gpm (Table 4.2-3(a)).

The 1994 Decision Record for the Landusky Mine requires that Landusky drainage and capture systems be expanded to be able to handle a 6- to 7-inch 100-year event. The Improvement Plan also requires that all remaining capture systems be expanded to handle a 6.33 inch 24-hour storm (Appendix A). Under these conditions, overtopping is unlikely for the expanded ponds, but if such an event did occur it would result in a short-term slug of acidic, high metal content water discharging into surface drainages, followed by a period of degraded alluvial groundwater quality slowly improving thereafter.

The proposed land application area for all alternatives is located on gentle slopes on the southern side of the Little Rocky Mountains (See Exhibit 1). Surface water drainages in the area are intermittent to perennial and are used primarily for livestock watering. A shallow (perched) groundwater table exists in the area, but the soil and underlying permeable limestone aquifer are separated by saturated low permeability shales. This reduces the potential for any vertical percolation of degraded groundwater. EPA standards for total loading of metals for land application of municipal sludge are significantly higher than barren solution concentrations (Trace Element Irrigation Standards, EPA 1981), although these standards may not be strictly applicable to mine solution disposal.

Soil in the Goslin Flats area are relatively thick (18 to 36 inches) and moderately permeable (mean K of 1.25 x 10^{-3}cm/s) reducing the potential for any ponding or significant runoff. Vegetation is well established and consists primarily of sagebrush and grass (see section 3.4). These factors combined with the intention to not undertake any LAD within a 100 feet of the Ruby stream would limit the potential for any significant threat to vegetation or human health. However, some increased concentrations of LAD-associated constituents in Ruby Gulch surface waters is anticipated following storm events causing a potentially significant short-term impact on a local scale. As the same general LAD area and plan is proposed for all the extension and non-extension alternatives, impacts are anticipated to be similar for all alternatives.

Generally, downstream surface water constituent concentrations under Alternative 1 would be similar to those observed during 1994. Table 4.2-1 summarizes existing water quality at downstream monitoring stations close to identified areas of "beneficial use". These data are representative of conditions gathered after capture systems had been installed. Downstream surface water quality is expected to be maintained close to, if not within, freshwater and human health criteria (Table 4.2-1).

Estimated water quality at upstream capture points under Alternative 1 is expected to exceed aquatic life and human health criteria and would likely be in excess of the ranges estimated for baseline (pre-1979) surface water quality in the Little Rocky Mountains (Table 3.2-9). The total volume of impacted water from both mines that would require capture and treatment in the short-term under Alternative 1 is estimated at between 388 and 458 gpm (Table 4.2-3(a)).

Beneficial uses of these upstream water resources are limited to wildlife and macroinvertebrate populations although the quality of water derived from upstream is critical to all downstream uses.

Overall water quality from reclamation of facilities under this alternative is expected to remain similar in concentrations and loads to what is observed today. Long-term water quality trends expected under this alternative are shown schematically on the summary figure in Section 4.2.10.1. As no improvement in water quality is expected in the long-term, thus capture and treatment would likely be required indefinitely to meet water quality standards.

Pit Reclamation

Under the existing reclamation plan (Amendment 011, 1989) pit floors would be sloped/graded, then topsoiled and revegetated. Pit walls would be left at 1H:1V slopes with 30-foot-wide benches every 60 vertical feet. Infiltration of runoff into the pit floors would continue. The highwall runoff study carried out at the Zortman mine (Schafer 1993 and 1994) illustrates the acid generating potential of the exposed pit highwalls. Pit floors are likely to receive acidic (pH 2.0 - 5.0), metalliferous drainage from highwall-runoff that would negatively impact any vegetation contacted on the pit floors. Also, as demonstrated by the seep at the base of the 85/86 leach pads in Ruby Gulch, such degraded highwall drainage has the potential to infiltrate into groundwater and to discharge within the headwaters of the southern and potentially northern drainages. This flow to the south is facilitated by the apparent physical/hydrogeologic connection of the ore body and Ruby Gulch.

Reclamation Materials

Under Alternative 1, no additional sources of non-acid generating rock, clay or limestone would be required. Water quality impacts at the existing Williams clay pit would consist of periods of elevated suspended solid concentrations. It is anticipated that ongoing sediment runoff would be controlled by construction of appropriately sized sediment traps and settling ponds.

4.2.3.1 Cumulative Impacts

Cumulative impacts associated with past, current and foreseeable activities at the Zortman and Landusky mine site under Alternative 1 would be essentially as described in Section 4.2.3, including.

- Continued degradation of the surface water and alluvial groundwater in the upper reaches of the majority of the drainages surrounding the Zortman and Landusky mines.
- Continued degradation of bedrock groundwater in the upper reaches of many of the drainages surrounding the Zortman and Landusky mines.
- Little improvement in current water quality conditions and the likely need for long-term capture and treatment.
- New disturbances, related to exploration and production activities would occur in the future. Such activities have the potential to increase the amount of suspended solids, TDS and other constituents in presently unaffected drainages. This degradation would likely be short-lived, or only occur in response to extreme precipitation events.

Reclamation of existing exploration would cause short-term elevated total suspended solids. The cumulative effect of Alternative 1 would be to maintain degraded water quality conditions. Impacts are rated as moderately negative rather than high negative, as there would be some mitigating effects from implementation of the Water Quality Improvement Plan.

4.2.3.2 Unavoidable Adverse Impacts

Operation of a treatment plant results in significant volumes of surface water being removed from many drainages for treatment and/or recirculation through the process circuit. At the Zortman Mine, water is captured from Carter Gulch, Alder Spur and Ruby Gulch. Carter Gulch and Alder Spur seepage flow pumped to the treatment plant averages <10 gpm each, while approximately 80 gpm is captured and treated from Ruby Gulch. Once the water is treated it is all discharged to the Ruby Gulch drainage (see Section 3.2.5-2). On the Landusky side, capture facilities currently remove water from Sullivan Creek, Mill Gulch and Montana Gulch, and a capture facility is under development for King Creek. Seepage captured and recirculated to the 1987 leach pad averages 20 gpm at Sullivan Creek and 40 gpm at Mill Gulch. Oxygenated water from the Montana Gulch capture system overflows into Montana Gulch. After closure, seepage water would be piped to the Zortman Treatment Plant. Unless a similar plant is constructed at the Landusky Mine. This redistribution of flow to Ruby Gulch would result in continued low flow or intermittent flow conditions in many drainages that could otherwise provide supplies for wildlife and habitat for fish or macroinvertebrate populations. At Montana Gulch, flow reduction could potentially reduce the recreational use of the stream if it becomes intermittent.

Tables 4.2-3(a) and 4.2-3(b) summarize the estimated volumes that may require capture and treatment from each drainage under Alternative 1. These volumes have been estimated from HELP modeling results and present day field observations and should be regarded as estimates only.

As discussed in Section 4.2.3.1, rinsing of leach pads would be discontinued after the solution maintains a cyanide WAD concentration of <0.22 mg/l for a period of 6 months. After this time, the leach pad liners would be perforated. Chemical testing discussed in Section 3.2.2 suggests that perforating the rinsed and flushed leach pads as proposed under this alternative would result in a short period of alkaline drainage followed by an acidic, metalliferous seepage requiring capture and treatment in the long-term.

4.2.3.3 Short-term Use/Long-term Productivity

The long-term reclamation requirement expected under the no action alternative is for collection of impacted waters, treatment to acceptable standards, and discharge of the treated waters into surface drainages. Under this alternative the impacts to water resources caused by the relatively short-term mining use (approximately 25 years) is expected to have impacts on the quality and availability of the water resource to possible users for an indefinite period of time. Facility seepage to the upper reaches of presently impacted drainages above capture systems would render the habitat unsuitable for aquatic life and unsuitable as a water source for terrestrial wildlife.

4.2.3.4 Irreversible or Irretrievable Resource Commitments

Continued infiltration of precipitation into the pit complexes results in an irretrievable loss of flow to the surrounding tributaries and a diversion of this flow to other tributaries. This occurs via fractured bedrock flow or adit discharges and by loss to the deep groundwater system. At Zortman this includes areas of the Lodgepole Creek catchment. A similar loss of catchment has also occurred since 1979 at Landusky within the King Creek drainage. Recharge to approximately 26 acres of the Lodgepole drainage area has been diverted into the pit complex as a result of mining. Although no pre-1979 flow data exist for Lodgepole Creek, diversion of 26 acres of its drainage area represents only 0.6 percent of the total drainage area (Table 4.2-2(a)). Therefore, the potential impact due to loss of flow to Lodgepole Creek is not considered significant.

At King Creek approximately 89 acres of drainage area has been diverted by excavation of the pits. This comprises approximately 13 percent of the King Creek total drainage area and thus represents a significant impact to the volume of flow in King Creek (Table 4.2-2(b)).

Approximately 33 acres of the original Swift Gulch drainage area has been diverted to the south by excavation of the Landusky Pit complex (Table 4.2-2(b)). This existing disturbance represents approximately 4.7 percent of the total drainage area, and subsequently is considered a moderate impact to downstream flow.

4.2.4 Impacts from Alternative 2

Under Alternative 2, reclamation plans would be revised to include company-proposed low permeability barriers for reclamation covers on spent heap leach ore, waste rock dumps and other disturbed areas. Existing facilities would be tested to ascertain if they have the potential to generate acid rock drainage (see Section 2.7.2.2). Areas shown to have acid generating potential would be capped with 6 inches of compacted clay overlain by 8 inches of topsoil. Areas shown to be non-acid-generating would be covered with 8 inches of topsoil only, as proposed in Alternative 1. Under Alternative 2, all facilities would be reclaimed with the same side slopes as proposed for Alternative 1 (see Section 4.2.3).

Infiltration Modeling

HELP modeling of this alternative assumes that 50% of the tested facilities would be shown to be acid-generating and would thus be capped with the 6 inches of compacted clay overlain by 8 inches of soil. Under this scenario it is expected that revegetation would be more successful than under Alternative 1, although revegetation is only expected to attain 35% coverage of fair vegetation. This slight improvement in revegetation is expected as the 6-inch layer of compacted clay would reduce the potential for acidification of the overlying soil and plants roots entering the potentially acidic waste rock and spent ore. The 6 inches of compacted clay would also reduce the amount of water infiltrating into the facility. However, the long-term competence of the clay is expected to be poor. This poor competence is primarily due to the desiccation expected from freeze-thawing, which is reported to equal or exceed three feet below the surface in Montana (Splangler & Handy 1982) and secondly due to dehydration of the clay. It is also possible that burrowing animals may penetrate the clay barrier, significantly reducing its long-term usefulness. The lack of any stabilizing layer between the clay and the soil also increases the potential for erosional processes to expose or remove the clay cover (see Section 4.3.4). With the exception of the Mill Gulch waste rock repository and the 87/91 Pad, all other side slopes are modeled as having 2H:1V side slopes as the remaining slope differences make a negligible difference to water budget calculations.

Breakdown of the 6-inch clay layer due to freeze-thawing, dehydration, burrowing animals, and erosion was considered in the HELP modeling by increasing the hydraulic conductivity of the clay layer from what would usually be expected. Assuming an elevated average hydraulic conductivity (K) of 6.4×10^{-3} cm/s for the clay, HELP runs indicate that approximately 65% of available precipitation would be lost to evapotranspiration and approximately 15% to surface runoff. On the gentle slopes infiltration is estimated at approximately 20% of available precipitation, and approximately 18% infiltration is estimated on the side slopes. Table 4.2-4 illustrates the results of HELP modeling assuming a degraded 6-inch clay layer.

Post-Reclamation Water Quality

Impacts from leach pad detoxification and perforation under Alternative 2 would be as described for Alternative 1 in Section 4.2.3.

The slight reduction in infiltration due to the use of a low permeability clay layer is expected to raise concentrations of acid rock drainage constituents at the toe. This is caused by a relative decrease in overall infiltration through the facilities; however, the overall load of acid rock drainage would likely decrease, along with the volume of contaminated discharge.

Estimated short-term water quality conditions under Alternative 2 are summarized on Table 4.2-4. In general, slight increases in TDS, sulfate, and metal concentrations are expected during the first few years at most facilities. At Montana Gulch slight increases may be seen in TDS, sulfate, and metal concentrations, but the water would maintain its near-neutral pH.

In the long-term it is likely that the integrity of the low permeability layer would be degraded, allowing greater infiltration of water and diffusion of oxygen into the facility. This situation would result in water quality concentrations and loads returning to similar levels as observed today. Long-term water quality trends expected for this alternative upstream of capture systems are shown on the schematic summary figure in Section 4.2.5.6.

Downstream of capture systems, water quality is expected to be similar to that currently observed (Table 4.2-1). The quality may actually improve due to the enlargement of drainage and capture systems and to the added cutoff walls and recovery wells required as part of the Water Quality Improvement Plan reducing the volume of water bypassing the capture systems (see Appendix A).

Estimated concentrations for facility drainage above the capture systems exceed both aquatic life and human health criteria. These concentrations represent a significant detrimental impact on a local scale, but downstream concentrations should remain close to or less than relevant significance criteria (Table 4.2-1). Beneficial use of upstream water is limited to wildlife drinking water and potential macroinvertebrate habitat, although its quality has an impact on all downstream uses. Estimated volumes of drainage requiring capture and treatment in the short-term within each drainage are summarized on Tables 4.2-2(a) and 4.2-2(b). The total volume of impacted water that would require capture and treatment in the short-term under Alternative 2 is estimated at between 372 and 440 gpm (Table 4.2-4). Long-term water quality trends expected under this alternative are shown schematically on the summary figure in Section 4.2.10.1.

TABLE 4.2-4

ALTERNATIVE 2:
MINE EXPANSION NOT APPROVED, COMPANY PROPOSED RECLAMATION

1 At Zortman, depending on testing, potential acid generating facilities will be covered with 6 in. of compacted clay overlain by 8 in. of topsoil cover soil, non-acid generating 8 in. cover topsoil only

2 At Landusky, depending on testing, 6 in. of compacted clay overlain by 8 in. of topsoil or 8 in. of cover soil only and caps B and C for the Mill Gulch Waste Rock Dump 87/91 leach pad and the Gold Bug waste repository (see Sec 2)

Help Model Results

	Flat Surfaces	Side Slopes
Surface Runoff (as % of precipitation)	15.09	16.81
Evapotranspiration (as percent of precip):	65.21	65.23
Lateral Drainage (as percent of precip)	0.00268	0.0395
Infiltration (as percent of precipitation)	19.83113	17.82466

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 5-yr. Water Quality (italics & shaded)				Comments
				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
ZORTMAN												
- 85/86 Leach Pad & Dike	Ruby Gulch	7.3						2.9	2760	1920	5.4	Z-37
- 89 Leach Pad & Dike	Ruby Gulch	3.4										
- Ruby Gulch Waste Rock Dump	Ruby Gulch	0.6										
- OK Pit Waste Dump	Ruby Gulch	1.6										
- 82 Leach Pad (free draining)	Ruby Gulch	2.5										
- 79/80/81 Leach Pad (free draining)	Ruby Gulch	3.1						3	878	615	5.06	Z-1 (downstream)
	RUBY GULCH:	**18.4**	69.3	50	60	68	78	***4.0-6.0***	***3,000-4,000***	***1,500-2,500***	***3.0-6.0***	***Estimated water quality at Ruby Gulch capture system***
- 84 Leach Pad & Dike	Alder Spur	4.3										
- 83 Leach Pad & Dike	Alder Spur	3.8						4.1	2310	1460	1.98	Z-14 (downstream)
	ALDER SPUR:	**8.1**	4.8	3	6	11	14	***3.0-4.0***	***2,000-3,500***	***1,000-2,000***	***1.5-3.0***	***Estimated water quality at Alder Spur capture system***
- Alder Gulch Waste Rock Dump	Carter Gulch	4.0						3.4	5450	3480	10.4	Z-13
	CARTER GULCH:	**4.0**	-0.3	0	3.0	4	7	***3.0-5.0***	***4,000-7,000***	***3,000-5,000***	***7.0-12.0***	***Estimated water quality at Carter Gulch capture system***
LANDUSKY												
- 87/91 Leach Pad & Dike 1-3	Mill Gulch/Sullivan Creek	19.7										
- Mill Gulch Waste Rock Dump	Mill Gulch	5.4						4	2460	1620	8.43	
- 79 Leach Pad (free draining)	Mill Gulch	0.9										
- 80/81/82 Leach Pad (free draining)	Mill Gulch	0.9										
	MILL GULCH:	**26.8**	1.9	1	1.5	28	28	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Mill Gulch capture system***
- 87/91 Leach Pad & Dike 1-3	Mill Gulch/Sullivan Creek	19.7										
- Sullivan Park Waste Rock Dump	Sullivan Creek	2.3						2.8	14700	9960	25.4	L-28 (downstream, 1992)
	SULLIVAN CREEK:	**22.0**	2.9	2	4	24	26	***4.0-5.0***	***2,000-3,000***	***1,500-3,000***	***5.0-9.0***	***Estimated water quality at Sullivan Creek capture system***
- Gold Bug Pit Waste Rock Repository	Montana Gulch	16.3										
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	8.6										
- 84 Leach Pad & Dike	Montana Gulch	2.8										
- 85/86 Leach Pad & Dike	Montana Gulch	5.2						7.7	806	489	0.52	L-16
- 1983 Leach Pad & Dike	Montana Gulch	3.7						6.6	4670	2920	1.56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	**36.6**	250.2	200	250	237	287	***7.0-8.0***	***700-1,200***	***500-800***	***0.4-1.0***	***Estimated water quality at Montana Gulch capture system***
	TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):					***372***	***440***					

Notes
1 "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" **less** "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions
2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc under each alternative

Pit Reclamation

Reclamation of the Zortman and Landusky open pits would consist of leaving the pit wall slopes at 1H:1V (as for Alternative 1) and resloping and grading of the pit floor where possible. The pit floor would then be covered with 24 inches of non-acid generating (NAG) waste and topsoiled. The NAG material is expected to provide a stable base for revegetation and may effectively isolate the revegetation from any underlying sulfide-rich bedrock. As shown by the HELP modeling, a healthy vegetative cover would enhance evapotranspiration. However, the absence of an impermeable layer (Alternatives 1 and 2) would limit the cover's ability to stop the remaining water from infiltrating into the bedrock. Infiltrating water would become acid and a significant proportion of the infiltration is expected to discharge to the surrounding tributaries by fracture flow paths or adit drainage, thereby increasing the volume of water requiring long-term captures and treatment.

Reclamation Materials

Under Alternative 2 an additional source of clay is required for the company proposed low permeability barrier. This clay would be mined by expanding the Seaford and Williams clay pits. Water quality impacts associated with further excavation of the Seaford and Williams clay pits would result in short-term periods of elevated suspended solids concentrations and longer-term buildup of fine sediments in the streambed (see Section 4.2.3.1). Elevated suspended solids concentrations are expected to be limited to periods of extreme precipitation; therefore, the impact is considered negligible on a regional scale.

4.2.4.1 Cumulative Impacts

Total impacts associated with past, current and foreseeable activities at the Zortman and Landusky mine sties under Alternative 2 would be essentially as described in Section 4.2.3, with the following exception:

- Moderately poor reclamation success is expected under Alternative 2, resulting in only a slight improvement to current water quality conditions by reducing the amount of flow requiring capture and treatment. However, this would be a moderately short-term phenomenon.

The cumulative affect of Alternative 2 would be to maintain degraded water quality. Cumulative impacts are rated as being moderately negative.

4.2.4.2 Unavoidable Adverse Impacts

As illustrated in Section 3.2.2, geochemical testing has shown that some waste rock having total sulfur concentrations less than 0.2 percent (especially some types of Tertiary igneous rock) may already be acid or may have the potential to generate acid rock drainage. As such, some of the disturbed areas may generate acid rock drainage in the long-term, even when reclaimed according to Alternative 2.

As with Alternative 1, it is expected that capture and treatment would be required below all waste rock and ore leaching facilities in the long-term. As discussed in Section 4.2.3.3 this results in water being diverted away from their respective drainages for treatment. Tables 4.2-3(a) and 4.2-3(b) summarize the estimated volumes that would be required to be captured and treated for each drainage under Alternative 2. As the majority of the streams in the Little Rocky Mountains are not perennial in their upper reaches, the impact of diverting acid rock drainage seepage to the Zortman water treatment plant would be minimal.

The lack of any coarse-grained layer overlying the clay in Alternative 2 reclamation covers may result in the clay dehydrating during the summer months. Development of unsaturated conditions could lead to cracking of the clay, and diffusion of water and oxygen through the cap (see Section 4.3.4). Freeze-thaw action would also diminish the effectiveness of this cover.

4.2.4.3 Short-term Use/Long-term Productivity

With or without the 6 inch clay barrier, it is expected that some degree of capture and treatment would be required indefinitely, reducing the long-term productivity of the affected lands.

4.2.4.4 Irreversible or Irretrievable Resource Commitments

As for Alternative 1, continued infiltration of precipitation into the pit results in an irretrievable loss of flow from the northern Lodgepole and King Creek tributaries. See Section 4.2.3.4 for discussion of the significance of this loss.

4.2.5 Impacts from Alternative 3

The emphasis of Alternative 3, as opposed to the previous "No Expansion" alternatives, is on source control. All existing reclaimed and unreclaimed facilities would be assumed to be potentially acid generating, therefore all facilities would be reclaimed using agency modified measures (see Section 2.7.2 for detailed description of covers). Under Alternative 3, all waste rock piles and leach pads could be reclaimed with side slopes of 3H:1V, reclaimed dikes would be broken down to 2.5H:1V slopes.

Infiltration Modeling

Table 4.2-5 summarizes the HELP modeled water budget conditions at each facility assuming all slopes greater than 5% are covered with Reclamation Cover B and all slopes less than 5% are covered with Modified Reclamation Cover C (Figure 2.2-1). Both these caps appear efficient at limiting infiltration and providing a stable substrate for vegetation. The HELP modeling is carried out with all side slopes at a 3H:1V slope as the 2.5H:1V steeper slope proposed for the dikes makes a negligible difference to the water budget calculations.

Modified Reclamation Cover C has 6 inches of compacted clay, overlain by a geomembrane (PVC) liner. Properly designed and constructed geomembrane liners are seldom installed completely free of flaws. Geomembrane flaws can range in size from pinholes that are generally a result of manufacturing flaws, to larger defects resulting from seaming errors, to abrasion or punctures occurring during installation. The use of a low permeability soil (clay) immediately below the liner decreases the rate of leakage through any hole in the geomembrane.

Because the clay layer within Reclamation Cover B is approximately 4 feet below the surface, it would be insulated from the impacts of freeze thawing. However, it is expected that the clay would dehydrate to some extent and has therefore been assigned a hydraulic conductivity of 3.6 x 10^{-4} cm/sec (slightly higher than a typical compacted clay).

The HELP modeling of the composite Modified Reclamation Cover C assumes a pinhole density of 0.75 holes per acre for the geomembrane layer. Typical liner installations achieve between 0.5 and 1 pinhole per acre (HELP 3 User Guide). The quality of the installation is assumed to be good with a HELP model defect density rating of 7. This is based on a typical density rating of 4 to 10 per acre for a fair installation (HELP 3 User Guide). The 6 inch compacted clay layer underlying the geomembrane was designated a hydraulic conductivity of 3.6 x 10^{-5}cm/sec, representative of a typical compacted clay.

For Covers B and C, HELP modeling estimates that overall 71% of available precipitation would go to evapotranspiration and approximately 10% to surface runoff. The flat areas reclaimed with the composite PVC/clay liner are expected to lose approximately 0.1% of precipitation to infiltration and approximately 10% to infiltration on the side slopes.

Post-Reclamation Water Quality

A number of facilities and materials currently contributing acid rock drainage and/or suspended solids to the Zortman drainages would be excavated and placed in the Zortman pit complex as backfill. These sources consist of the existing Alder Gulch waste rock dump, the 85/86 leach pad and dike, the O.K. waste rock dump and the historic tailing in Ruby Gulch. Removal of these materials is expected to lower dissolved solids concentrations in Ruby Gulch, and because these facilities are known sources of present-day acid rock drainage, their removal is expected to improve the general water quality downstream.

Leach pile detoxification criteria for Alternative 3 are discussed in Section 2.8.2.4. The main difference between this agency mitigated criterion and those of the other non-extension alternatives is that the liner would not be perforated until water quality management objectives have been met for a period of ten years.

Formation of significant volumes of ARD contaminated water from the spent ore pads is less likely in Alternative 3 than under Alternatives 1 and 2. This is because of the lengthy duration of sampling to establish acceptable cyanide and metal concentrations and because of minimal amount of infiltration expected from enhanced reclamation. However, the likely remnant sulfide content does have the potential to form acid rock drainage.

Estimated short-term water quality under Alternative 3 is summarized on Table 4.2-5. In general increases in TDS, sulfate and metal concentrations are expected in

TABLE 4.2-5

ALTERNATIVE 3:
MINE EXPANSION NOT APPROVED WITH AGENCY MITIGATION

1 At Zortman, slopes >5% would have reclamation cover B, slopes <5% would have reclamation cover C, no testing required as all facilities assumed to have acid generating potential

2 At Landusky, slopes >5% would have cover B, slopes <5% would have reclamation cover C including the Mill Gulch Waste Rock Dump, 91/87 Leach Pad and the Gold Bug Waste Repository (see Sec 2)

Help Model Results

	Flat Surfaces	Side Slopes
Surface Runoff (as % of precipitation)	10.05	10.16
Evapotranspiration (as percent of precip.)	71.32	71.34
Lateral Drainage (as percent of precip.)	18.42	8.07
Infiltration (as percent of precipitation)	0.12	10.35

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 5-yr. Water Quality (italics & shaded)				Comments
ZORTMAN				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
- 85/86 Leach Pad & Dike (removed)	Ruby Gulch	0.0						2.9	2760	1920	5.4	Z-37
- 89 Leach Pad & Dike	Ruby Gulch	1.6										
- Ruby Gulch Waste Rock Dump (removed)	Ruby Gulch	0.0										
- OK Pit Waste Dump (removed)	Ruby Gulch	0.0										
- 82 Leach Pad (free draining)	Ruby Gulch	0.9										
- 79/80/81 Leach Pad (free draining)	Ruby Gulch	1.6						3	878	615	5.06	Z-1 (downstream)
	RUBY GULCH:	**4.1**	**69.3**	**30**	**40**	**34**	**44**	***4.0-6.0***	***2,000-4,000***	***500-1,000***	***3.0-6.0***	***Estimated water quality at Ruby Gulch capture system***
- 84 Leach Pad & Dike	Alder Spur	1.8										
- 83 Leach Pad & Dike	Alder Spur	1.7						4.1	2310	1460	1.98	Z-14 (downstream)
	ALDER SPUR:	**3.4**	**4.8**	**2**	**4**	**5**	**7**	***4.5-6.0***	***1,000-2,500***	***1,500-2,000***	***1.0-3.0***	***Estimated water quality at Alder Spur capture system***
- Alder Gulch Waste Rock Dump (removed)	Carter Gulch	0.0						3.4	5450	3480	10.4	Z-13
	CARTER GULCH:	**0.0**	**-0.3**	**0**	**4**	**0**	**4**	***5.0-7.0***	***1,000-2,000***	***3,000-4,000***	***1.0-3.0***	***Estimated water quality at Carter Gulch capture system***
LANDUSKY												
- 87/91 Leach Pad & Dike 1-3	Mill Gulch/Sullivan Creek	8.7										
- Mill Gulch Waste Rock Dump	Mill Gulch	5.4						4	2460	1620	8.43	
- 79 Leach Pad (free draining)	Mill Gulch	0.1										
- 80/81/82 Leach Pad (free draining)	Mill Gulch	0.2										
	MILL GULCH:	**14.5**	**1.9**	**1**	**2**	**16**	**17**	***4.0-5.0***	***2,000-3,000***	***2,000-2,500***	***5.0-9.0***	***Estimated water quality at Mill Gulch capture system***
- 87/91 Leach Pad & Dike 1-3	Mill Gulch/Sullivan Creek	8.7										
- Sullivan Park Waste Rock Dump	Sullivan Creek	2.3						2.8	14700	9960	25.4	L-28 (downstream, 1992)
	SULLIVAN CREEK:	**11.1**	**2.9**	**0**	**4**	**11**	**15**	***4.0-5.0***	***2,000-3,000***	***900-1,200***	***5.0-9.0***	***Estimated water quality at Sullivan Creek capture system***
- Gold Bug Pit Waste Rock Repository	Montana Gulch	4.9										
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	2.2										
- 84 Leach Pad & Dike	Montana Gulch	1.5										
- 85/86 Leach Pad & Dike	Montana Gulch	2.5						7.7	806	489	0.52	L-16
- 1983 Leach Pad & Dike	Montana Gulch	1.0						6.6	4670	2920	1.56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	**12.2**	**250.2**	**175**	**225**	**187**	**237**	***7.0-8.0***	***700-1,200***	***500-800***	***0.4-1.0***	***Estimated water quality at Montana Gulch capture system***
	TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):					***253***	***324***					

Notes

1 "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions

2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc under each alternative

the short term. Reduced constituent loads are expected at Ruby Gulch and Carter Gulch due to the removal of the 1985/1986 leach pad and buttress and the Alder Gulch waste rock dump. A reduction in the volumes requiring capture treatment is also expected if precipitation falling on removed facilities footprint can be diverted around the capture ponds. Seepage from the remaining facilities is expected to develop increased TDS, sulfate and metals concentrations in the short-term. At Landusky, short-term increases in TDS, sulfate and metals concentrations may occur at Sullivan Creek, Mill Gulch, and Montana Gulch. While these concentrations are expected to rise due to the lack of diluting water, loads are expected to be reduced rapidly. Table 4.2-5 summarizes the estimated volumes that may require capture and treatment from each drainage under Alternative 3. Significant reduction in the volume of baseflow is expected for most drainages due to the effective capping and contouring of the open pit complexes. Long-term water quality trends expected under Alternative 3 are shown schematically on the summary figure in Section 4.2.10.1, with drainage from the facilities potentially reaching conditions that would not require active treatment.

The capillary break included in modified covers B and C reduces infiltration by enhancing lateral drainage, acts as a good footing for the soil cover, and stops animal burrowing. The coarse-grained capillary break would also act as a storage layer for water, helping to maintain a higher moisture content within the underlying low permeability clay layer.

As all surface water control systems would be upgraded to be consistent with the Improvement Plan (Appendix A), ultimate downstream water quality is expected to be similar to that projected for Alternatives 1 and 2.

Under Alternative 3, estimated concentrations for facility drainage above the capture system would exceed both aquatic life and human health criteria in the short-term. These concentrations, as in Alternatives 1 and 2, make the negative impact significant on a local scale, although downstream concentrations should remain close to or less than relevant significance criteria. Beneficial use upstream is limited to wildlife drinking water, although its quality impacts all downstream uses. The total volume of impacted water that would require capture and treatment in short-term under Alternative 3 is estimated at between 250 and 320 gpm (Table 4.2-5).

Pit Reclamation

Under Alternative 3, the Zortman pit complex would be backfilled to approximately 4,900 feet above mean sea level (msl). This allows runoff to drain freely into Ruby Gulch, where the proposed capture systems would collect runoff/drainage, and if necessary, route it to the Zortman water treatment plant prior to discharge. The final pit floor would be covered with Reclamation Cover B to limit surface water infiltration and minimize any further impact to groundwater. Poor quality runoff from the highwall would be captured in lined drains and routed directly to the capture pond or plant to avoid any impact to the pit floor vegetation or to good quality runoff water.

The Landusky pit complex would be backfilled to an elevation of at least 4,800 feet above msl in order to create a surface which would freely drain into Montana Gulch. The drainage ditch is expected to be up to 200 feet deep with concurrent backfill in the August pit of about 200 feet. Additional backfilling above 4,800 feet would reduce the depth of the required drainage notch between the pit and Montana Gulch. Capping of the Landusky pit floors with cover B is expected to significantly reduce recharge to the underlying adits, thereby decreasing the volume of base flow under the 1985/1986 leach pad and the Montana Gulch waste dump in Montana Gulch. Runoff from the reclaimed pit surface would be routed to Montana Gulch and is expected to be of good quality. The remaining flow discharging below the facilities would be captured and routed to the water treatment plant and then returned to Montana Gulch. Overall as treated and diverted waters are to be returned to Montana Gulch, no significant net loss of flow is expected.

Acidic highwall runoff from the Landusky pits would require capture and treatment. The treatment plant constructed at Landusky avoids the need to pipe impacted water to Zortman for treatment.

Construction of a low permeability cover in the pits at Zortman and Landusky and establishment of a free drainage surface is expected to considerably reduce the volume of ARD contaminated waters discharging in the upper reaches of the drainages. This would in turn reduce the volume of seepage requiring capture and treatment.

Reclamation Materials

In order to obtain materials for limestone underdrains and the NAG cover rock, and clay material required for the agency-enhanced reclamation covers, mining would be required at the Seaford and Williams clay pits and the King Creek and LS-1 limestone quarries. Impacts associated with the operation of these quarries would be limited to short-term sediment runoff, resulting in elevated suspended solids concentrations in their respective drainages as discussed in Section 4.2.3. Erosion control measures would also be required in the headwaters of Lodgepole Creek under this alternative, where the haulage road to the LS-1 quarry is proposed (Exhibit 1). Impacts associated with the activities discussed above would be short-term elevated levels of suspended solids and some longer-term increase in stream bottom sediment. These negative impacts are considered to be moderate on a local scale.

4.2.5.1 Cumulative Impacts

Cumulative impacts associated with past, current, and foreseeable activities at the Zortman and Landusky mine sites under Alternative 3 would primarily be a reduction in the volume of water requiring capture and treatment. Good reclamation success is expected under Alternative 3, resulting in an improvement in water quality conditions due to significantly reducing the amount of surface water flow requiring capture and treatment. This improvement on current conditions, coupled with the possibility that capture and treatment may not be required in the long-term, results in cumulative impacts being rated as moderately positive, as implementation of Alternative 3 would establish a positive trend moving toward baseline conditions.

4.2.5.2 Unavoidable Adverse Impacts

As discussed in Section 4.2.3.2, capture and treatment would reduce flows in several streams of the Little Rocky Mountains. Estimated volumes of drainage requiring capture and treatment under Alternative 3 are summarized on Table 4.2-5. As the majority of the streams in the Little Rocky Mountains are not perennial in their upper reaches, the impact of diverting acid rock drainage seepage to a treatment plant may be negligible in most cases.

Water treatment and generation of waste sludge is unavoidable in the short-term and has not been ruled out in the long-term.

4.2.5.3 Short-term Use/Long-term Productivity

The enhanced reclamation covers are expected to reduce volumes of acid rock drainage such that in the long-term passive treatment techniques may be able to maintain acceptable water quality below the reclaimed facilities. Therefore the volumes of water adversely impacted in the long-term would be considerably less than under Alternatives 1 and 2. Although it is possible that some water treatment would still be required in the long-term, the long-term productivity of the water resources of the Little Rocky Mountains is expected to be higher under Alternative 3 than for Alternatives 1 or 2.

4.2.5.4 Irreversible or Irretrievable Resource Commitments

Drainages such as Lodgepole Creek and King Creek have had catchment removed as a result of mining. This catchment area would not be returned to its original flow status, constituting an irretrievable loss of flow from the north of the Little Rocky Mountains. See Section 4.2.4 for discussion of the significance of this loss.

4.2.6 Impacts from Alternative 4

Alternative 4 is the proposal by ZMI for additional mining beyond that currently permitted at the Zortman and Landusky mines, together with proposed modifications to reclamation plans at each mine (described in detail in Section 2.8).

Pit Reclamation

Mine expansion would involve lateral and vertical extension of the Zortman pit complex. This would result in an additional surface disturbance of 103 acres. Pit expansion would also lower the pit floor to an elevation of about 4,500 feet. A pit water inflow study carried out by Hydro-Geo Consultants (1992) simulated inflow into the O.K. and Independent pits. The modeling showed that after excavation reached approximately the 4,700 foot elevation, groundwater would start to flow into the O.K. Pit. This calculated water level is below the proposed breach between the O.K. Pit and Ruby Gulch and thus would result in inflow into the pit, rather than drainage into Ruby Gulch.

The inflow of water into the Zortman pit complex may cause a reduction in the discharge of some springs and seeps in the headwaters of surrounding drainages during pit operation. After backfilling, spring discharge in the upper reaches of the streams should resume although discharge volumes are expected to be significantly less than those observed today. After reclamation, the lower 140 feet of the backfill would be saturated. This saturated fill would receive recharge of oxygenated water from the pit walls and likely become a source of continued discharge. Backfilling consolidates the rock and may slow the oxidation (rates) of sulfides. Nevertheless, backfilling the open pits with mined material -- either waste rock or spent ore -- is likely to degrade the water quality relative to baseline even if the waters do not become acidic. Chemical constituent concentrations would increase in the pit backfill, primarily because the mining process has increased the reactive surface area of the geological materials (see Section 3.2.2.1). Also, as fill materials react with the originally oxygenated waters, the oxidation potential of the deeper backfill would eventually drop making some metal forms more soluble (e.g., Fe, Mn, As, Zn) (Ribet, et al. 1995).

Potentially degraded water from the Zortman pit backfill is expected to discharge to the headwaters of Ruby Gulch. This preferred flow path is presently evidenced by the significant volume of degraded discharge from the base of the 85/86 pad (see Section 3.2.5.1).

Alternative 4 also proposes mining of an additional 7.6 million tons of ore and 7 million tons of waste rock from the Landusky Mine. This material would come primarily from the August pit. The final Queen Rose pit floor elevation prior to backfilling would be 4,600 feet and the August pit final elevation would be 4,400 feet. The Gold Bug adit is at an elevation of 4,580 feet and the August adit elevation is 4,604 feet.

An investigation has been completed by Water Management Consultants into the groundwater conditions of the August Pit and the likely conditions during mining and after reclamation of the pit. Collectively, the adits and the natural groundwater discharge have caused the water table in the vicinity of the August pit to be at an elevation of 4,630 to 4,635 feet. The final pit floor would, as a result, be 230 to 235 feet below the current water table although mining below the water table is expected to last only one year (Water Management Consultants 1995). After mining reaches 4,400 feet, groundwater would start to flow from the intrusive rocks, flooding the backfill material until it reaches the elevation of the August Drain Adit (4,604 feet) and discharges at 30 to 40 gpm (Water Management Consultants 1995).

In the Landusky case the majority of any acid rock drainage generated by pit backfill would discharge through the August adit and be captured by the capture system below the Montana Gulch waste rock dump. No negative downstream impact associated with the acid rock drainage contaminated water from the pit backfill is expected, as it would be intercepted by the capture system. Highwall runoff would be captured in drains prior to running on to the reclaimed pit surface and pumped to a water treatment plant. This would further reduce recharge that currently reaches perennial Montana Gulch if not returned to the drainage after treatment.

Flow from the Gold Bug adit is reported to have been reduced since the Gold Bug pit was lined and backfilling began. Flow is likely to be further reduced once final reclamation covers are placed on the backfill. It is unclear if deepening of the August Pit would further reduce recharge to the Gold Bug adit. However, drainage from the August Adit would likely cease while mining below the adit elevation. Although water from pit dewatering could replace this loss of flow it may require treatment prior to being discharged to the drainage. A reduced state of discharge is expected to return once the backfill becomes saturated to the level of the adit.

Under Alternative 4 it is also proposed to route the surface runoff from the reclaimed pit floor into the August adit. This would result in relatively good quality surface runoff mixing with the poorer quality seepages from the pit backfill and highwall runoff increasing the volume of water requiring capture and treatment at Montana Gulch.

Significant reductions in surface water flow are expected at Montana Gulch due to short-term pit dewatering and a long-term reduction in recharge to the Gold Bug and August Adits. This reduction could cause Montana Gulch to become intermittent, impacting its use as a recreational area and limiting its potential as an aquatic habitat.

A higher, perched water table has also been discovered in blast holes in a fault zone area of the August/Little Ben/Queen Rose Pits (Water Management Consultants 1995). The elevation of this water table coincides with the level of spring L-5 in King Creek. For this reason it is expected that discharges from spring L-5 would decrease or cease as a result of deepening the pit. This is not expected to noticeable change the current flow conditions in King Creek as the spring is typically dry.

Infiltration Modeling

Under Alternative 4, the composite reclamation cover C would have only 3 inches of compacted clay underlying the geomembrane layer (Figure 2.8-6). It is anticipated that the hydraulic conductivity of the clay layer would be significantly increased due to puncture during compaction of such a thin layer over coarse material. The leakage factor of the geomembrane is also expected to be higher due to the increased likelihood of puncturing from below.

HELP model simulations of the CPA reclamation cover assume a leakage factor of 0.1 (higher than average conditions) and a hydraulic conductivity of 6.4 x 10^{-3} cm/s for the 3 inches of underlying clay.

HELP modeling also assumed that all facilities would be found to be potentially acid-generating and thus capped with reclamation covers B and C. Under the Company Proposed Action, all dikes would be reclaimed with side slopes at 2H:1V as proposed for Alternative 3. Alternative 4 also states that final post reclamation surfaces on waste rock piles and leach pads would be 3H:1V where possible and no steeper than 2H:1V, HELP modeling of this alternative assumes that 70% of the side slopes would be completed at 3H:1V, the remaining 30% at 2H:1V. Table 4.2-6 summarizes the estimated water budgets for new facilities proposed under Alternative 4.

HELP model simulations of reclamation covers B and C estimates that approximately 71% of available precipitation would go to evapotranspiration and 10% to surface runoff. The flat areas reclaimed with the composite PVC/clay liner lose approximately 0.1% of precipitation to infiltration. Approximately 10% of precipitation infiltrates on the 3H:1V and 2H:1V slopes.

Volumes of drainage requiring capture and treatment under Alternative 4 are shown on Table 4.2-6. Notable differences occur at Goslin Flats, Alder Gulch, and Montana Gulch due to the construction of the new waste rock and leach pad facilities and the deepening and then backfilling of the Landusky pit.

Haul road areas shown to have significant acid generating potential would be capped with 6 inches of clay overlain by 8 inches of topsoil. As discussed in Section 4.2.4, the competence of a clay layer underlying only 8 inches of soil is expected to be poor due to desiccation from freeze-thawing and dehydration. This desiccation is expected to considerably reduce the success of revegetation overlying rock with acid generating potential. The poor vegetative coverage would also increase the amount of soil loss and general erosion on the reclaimed haul roads. Impacts from this potentially acidic water with a high suspended solids content could be significant if it was allowed to communicate with the surface water system directly. Under Alternative 4, roads would thus further contribute to short-term periods of downstream water quality degradation during storm events.

Post-Reclamation Water Quality

The proposed Carter Gulch waste rock repository would be a valley fill facility, built on steep terrain. The scree covering these slopes would allow natural drainage beneath the waste rock. In areas where scree depths are insufficient (mainly in the valley bottom), rock finger drains would be constructed. The quality of water discharged from the Carter Gulch waste repository underdrains has the potential to be similar to that presently at monitoring station Z-13 below the Alder Gulch waste dump, which has a pH of 3.4, and TDS and sulfate concentrations around 5,400 and 3,500 mg/l respectively.

Effective water quality management is made difficult in this steep terrain due to the high degree of interaction between surface water and groundwater (Section 3.2). This relationship makes it difficult to capture all the drainage by use of a surface impoundment, even with cutoff walls and recovery wells. As a result, the ability to avoid impacts from acid rock drainage in the drainage area below the proposed repository would rely heavily on the success of the proposed source control measures (see Section 2.9.1.6).

Estimated total seepage from the proposed Carter Gulch waste rock repository are between 12 and 16 gpm. This water would require capture and treatment during the short-term operational and post-reclamation periods.

Downstream water quality for Alder Gulch under Alternative 4 is summarized on Table 4.2-1. Concentrations are expected to be similar to those observed today, although slight increases in TDS and sulfate concentrations are likely due to the increased area of disturbed rock and the increased volumes of impacted water bypassing the capture system. This projected increase in concentrations within surface water and alluvial groundwater is due primarily to the construction of the proposed Carter Gulch waste rock repository and would likely exceed the relevant significance criteria, making a significant impact on a local scale.

TABLE 4.2-6

ALTERNATIVE 4:
COMPANY PROPOSED PLAN (3 in. of clay underlying PVC liner)

1 At Zortman and Landusky, slopes >5% have reclamation cover C, slopes <5% would have reclamation cover B, if testing indicates not potentially acid draining, cover A used, reclamation slopes constructed at 3H:1V where possible

	Help Model Results Flat Surfaces	3H:1V Slopes	2H:1V Slopes
Surface Runoff (as % of precipitation)	10.05	10.16	10.19
Evapotranspiration (as percent of precip.)	71.27	71.34	71.31
Lateral Drainage (as percent of precip.)	17.64	8.07	8.48
Infiltration (as percent of precipitation)	0.94	10.35	9.93

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 5 yr. Water Quality (italics & shaded)				Comments
				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
ZORTMAN												
85/86 Leach Pad & Dike (removed)	Ruby Gulch	0.0						2.9	2760	1920	5.4	Z-37
89 Leach Pad & Dike	Ruby Gulch	1.6						3.0-5.0	2,000-3,000	1,000-2,000	3.0-5.0	Z-37
Ruby Gulch Waste Rock Rock Dump (removed)	Ruby Gulch	0.0										
OK Pit Waste Dump (removed)	Ruby Gulch	0.0										
82 Leach Pad (free draining)	Ruby Gulch	0.9										
79/80/81 Leach Pad (free draining)	Ruby Gulch	1.6						3	878	615	5.06	Z-1 (downstream)
	RUBY GULCH:	**4.1**	**69.3**	**30**	**40**	**34**	**44**	***3.0-5.0***	***500-900***	***300-700***	***3.0-5.0***	***Estimated water quality at Ruby Gulch capture system***
84 Leach Pad & Dike	Alder Spur	1.8										
83 Leach Pad & Dike	Alder Spur	1.7						4.1	2310	1460	1.98	Z-14 (downstream)
	ALDER SPUR:	**3.4**	**4.8**	**2**	**4**	**5**	**7**	***4.5-6.0***	***1,000-2,500***	***500-1,400***	***1.0-3.0***	***Estimated water quality at Alder Spur capture system***
Adler Gulch Waste Rock Dump (removed)	Carter Gulch	0.0						3.4	5450	3480	10.4	Z-13
Carter Gulch Waste Rock Repository	Carter Gulch	11.6										
	CARTER GULCH:	**11.6**	**0.3**	**0**	**4**	**12**	**16**	***3.0-5.0***	***3,000-6,000***	***2,500-4,000***	***4.0-8.0***	***Estimated water quality at Carter Gulch capture system***
Goslin Flat Leach Pad	Goslin Gulch	19.9						7.5-8.0	851-1,030	414-506	0.005-0.02	Z-35
	GOSLIN GULCH:	**19.9**	**8.0**	**0**	**8**	**28**	**28**	***6.5-7.0***	***400-1,500***	***400-800***	***0.005-0.02***	***Estimated water quality at Goslin Gulch***
LANDUSKY												
87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	21.0										
Mill Gulch Waste Rock Dump	Mill Gulch	5.4						4	2460	1620	8.43	
79 Leach Pad (free draining)	Mill Gulch	0.2										
80/81/82 Leach Pad (free draining)	Mill Gulch	0.2										
	MILL GULCH:	**26.8**	**1.9**	**0**	**4**	**27**	**31**	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Mill Gulch capture system***
87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	21.0										
Sullivan Park Waste Rock Dump	Sullivan Creek	2.3						2.8	14700	9960	25.4	L-20 (downstream, 1992)
	SULLIVAN CREEK:	**23.3**	**2.9**	**0**	**4**	**23**	**27**	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Sullivan Creek capture system***
Gold Bug Pit Waste Rock Repository	Montana Gulch	5.1										
Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	2.4										
84 Leach Pad & Dike	Montana Gulch	1.4										
85/86 Leach Pad & Dike	Montana Gulch	2.5						7.7	806	489	0.52	L-16
1983 Leach Pad & Dike	Montana Gulch	1.1						6.6	4670	2920	1.56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	**12.5**	**250.2**	**125**	**175**	**138**	**188**	***7.0-8.0***	***700-1,000***	***400-600***	***0.4-0.7***	***Estimated water quality at Montana Gulch capture system***
TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):						***259***	***333***					

Notes

1 "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions

2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc under each alternative

Goslin Flats consists of a flat prairie mantled with alluvium and underlain by over 200 feet of low permeability Thermopolis Shale. Below the shale lies the regionally extensive Madison Limestone. Water levels measured within the shale and limestone show both these units to have downward vertical potentials with potentiometric surfaces below the alluvium bedrock contact (see Section 3.2). The flat nature of the terrain and resultant gentle hydraulic gradient, combined with the low permeability of the shales underlying the proposed facilities, would significantly aid monitoring for and recovery of any released contaminant. Some minor water quality degradation -- in the form of increases in TDS, sulfate, etc. -- is expected to occur in surface water and alluvial groundwater surrounding the leach pad. These impacts would be primarily due to exposing a large area of bedrock to oxidation during construction.

The salvaging of the soil from the footprint of the proposed Goslin Flats leach pad (approximately 250 acres and the clearance of a corridor for the associated conveyor (12,000 feet long by 200 feet wide) is expected to result in significant amounts of suspended solids entering the upper and lower reaches of Goslin Creek. Although the solids would likely be only held in suspension for a short time the longer-term impact may be a significant build up of fines in the Goslin Flats/Ruby Creek drainage. If not controlled by efficient sediment traps this has the potential to be a significant local impact degrading macroinvertebrate and potential fish habitat in the short and long-term.

HELP model simulation of the proposed Goslin Flats leach pad is summarized on Table 4.2-6. Short-term drainage from the facility after perforation is estimated at an average seepage rate of 20 gpm.

Expansion proposed under Alternative 4 poses no additional potential for impacts to domestic water supplies at Zortman, Landusky, Hays, or Lodgepole.

The 7.6 million tons of ore proposed to be mined at Landusky would be placed on the existing 87/91 leach pad. Expansion of the pad would occur by increasing the vertical loading of ore on the pad by 50 feet. No adverse impact to water resources is expected from expansion of the 1987/1991 leach pad, as all ore would be placed on top of existing liners and there would be no increase in disturbance area.

Expected long-term water quality trends at capture systems are shown on the schematic summary figure in Section 4.2.8.6. Due to the effective water quality management attainable at the Goslin Flats leach pad, short and long-term water quality is expected to be better than that for the Carter Gulch waste repository. That is because Carter Gulch waste repository is in steep terrain which makes effective monitoring and capture of effluent much more problematic.

Estimated volumes of drainage requiring capture and treatment for each drainage are shown on Tables 4.2-2(a) and 4.2-2(b). The total volume of impacted water that would require capture and treatment in the short-term under Alternative 4 is estimated at between 260 and 330 gpm (Table 4.2-6).

Water Use

An average water appropriation of 190 gpm would be required for the expanded Zortman operation and an average of 260 gpm at Landusky. These figures include makeup water for the new process circuit, dust control, and ore wetting losses. The 190 gpm required at the Zortman Mine is already available from a permitted water supply well. At Landusky the current appropriation would be sufficient for the proposed operation. However, approximately 170 gpm is currently captured from the Gold Bug adit discharge. As discussed above, backfilling and capping of the Gold Bug pit is expected to decrease flow from the Gold Bug adit. Therefore, an additional groundwater source may be required. The additional 170 gpm is a worst case, and is attainable with no significant impact to groundwater resources available in the Little Rocky Mountains.

4.2.6.1 Cumulative Impacts

Cumulative impacts associated with past, current and foreseeable activities at the Zortman and Landusky mine sites under Alternative 4 include impacts to two currently undisturbed drainage areas and the potential for degradation of other currently unimpacted drainages due to reasonably foreseeable exploration and mining activities. More specifically, the cumulative impacts include:

- Construction of the Carter Gulch waste rock repository would likely result in additional degradation of downstream water quality at Alder Gulch and the loss of currently undisturbed drainage areas.

- Construction of the Goslin Flats leach pad would degrade water quality in the vicinity of the leach pad primarily due to disturbing the mineral rich shales.

- Enhanced reclamation covers are expected to be moderately successful in controlling infiltration although occasional 2H:1V slopes may be susceptible to erosion.
- Pit backfill and reclamation with a low permeability barrier would reduce the amount of base flow under facilities, and the overall volume of water requiring capture and treatment relative to Alternatives 1 and 2.
- Approval of the mine expansion and construction of the conveyor to Goslin Flats, would likely result in future exploration activities. Water resource impacts associated with reasonably foreseeable activity would involve increases in suspended solids and TDS concentrations. Road building would increase TSS and metal concentrations in drainage areas potentially unimpacted at present.
- The reasonably foreseeable development of the Pony Gulch ore body is less likely to generate acid rock drainage due to the buffering capacity of the limestone host rock. However excavation, road building, etc. would have an adverse impact on the present water quality in Pony Gulch. It is likely that these actions would cause adverse impacts including elevating TDS, TSS and sulfate concentrations, in the short- to mid-term.
- Short-term periods of surface water quality degradation would occur due to sediment runoff and due to the likely excavation of the Seaford and Williams clay pits and the King Creek and LS-1 limestone quarries.

Reclamation success is thought to be similar to that under Alternative 3. Cumulative impacts under Alternative 4 are rated as being high negative as implementation of Alternative 4 would establish a highly negative trend moving away from baseline conditions.

4.2.6.2 Unavoidable Adverse Impacts

ZMI defines NAG rock as having less than 0.2 percent sulfur. Geochemical testing shows that some of this waste with less than 0.2 percent sulfur has negative NNP values (see Section 3.2.2). Thus, some of this waste is expected to be acid generating. As such, use of low sulfur (<0.2%), negative NNP waste has the potential to degrade water quality relative to a situation where truly NAG waste was used. Water quality degradation may result in further depressed pHs, and increased TSS, TDS, sulfate and metals concentrations. The magnitude and duration of such water quality degradation cannot be predicted with any acceptable accuracy and precision given the state of the art. It is likely, that a cap composed of NAG material selected according to the modified criteria presented in Section 2 would result in better water quality than what would result from simply using the less than 0.2 percent total sulfur criteria in Alternative 4.

4.2.6.3 Short-term Use/Long-term Productivity

The Goslin Flats leach pad and Alder Gulch waste rock repository would be permanent features. Existing stream beds and ponds within the footprint of these facilities would be covered during operations, removing any long-term productivity. Other construction-related disturbances would be short-term (road construction, conveyor construction, land application, and similar activities) and the water resources associated with these areas should return to baseline conditions in the long-term.

4.2.6.4 Irreversible or Irretrievable Resource Commitments

A large waste rock repository would be constructed in Carter Gulch which is currently only partially disturbed. The Goslin Flats leach pad would be constructed in an area where the water resources are currently not impacted by past mining activity, but presently contain naturally high concentrations of TDS and sulfate (Section 3.2.5). Despite the best available source control and capture and treatment technology, some irreversible impacts to the present surface water quality are expected in the immediate vicinity of the Goslin Flats leach pad. These impacts are expected to be significant on a local scale.

As part of the Zortman pit expansion, an additional 41 acres of watershed would be lost from the Lodgepole Creek drainage and diverted to the south (Table 4.2.2(a)). The total 67 acres of disturbance represent only approximately 1.5% of the total Lodgepole drainage area, thus it is expected that impacts to flow within the Lodgepole drainage from expansion of the Zortman Pits would be minimal.

4.2.7 Impacts from Alternative 5

The major modification to the CPA (see Alternative 4, Section 2.9) would be relocation of the ore heap leach facility to Upper Alder Gulch, instead of Goslin Flats (see Alternative 5, Section 2.10). The agencies developed this alternative as a means of limiting the distribution of disturbance. Modified reclamation requirements for the Landusky Mine would require backfill of the pits to an elevation of approximately 4,800 feet so that surface water would drain freely to the northwest into King Creek rather than to Montana Gulch via the August drain adit (see Section 4.2-6).

This alternative also includes installation of water management systems including capture ponds and, a treatment plant in upper Montana Gulch to treat water discharging from the backfilled pits. The fill removal and pit backfilling would re-establish the approximate pre-mining King Creek catchment area by reconnecting surface runoff from the August/Queen Rose pit areas with King Creek.

Infiltration Modeling

Under Alternative 5, reclamation covers and slopes for pits, leach pads and waste rock piles would be the same as proposed for Alternative 3. Thus, drainage volumes and water quality from existing facilities would be similar to those estimated for Alternative 3.

HELP model simulations of the proposed Alder Gulch leach pad and existing facilities estimate that, after perforation and final reclamation on the side slopes, approximately 71% of available precipitation would go to evapotranspiration, 10% to surface runoff, 8% to lateral drainage, and 10% would infiltrate through the reclamation cover into the facility (Table 4.2-7). HELP modeling of slopes less than 5% suggest that approximately 71% of precipitation would evaporate, 10% would runoff the surface, 18% would drain laterally thoroughly the capillary break and only 0.12% would infiltrate (Table 4.2-7).

Post-Reclamation Water Quality

Development of the 80-million-ton leach facility in Upper Alder Gulch would create an additional 160 acres of disturbance. Disturbance to the soil, scree and bedrock during construction of the leach pad is likely to result in the generation of water quality similar to that observed at monitoring station Z-13 or L-28, exceeding aquatic life and human health criteria and therefore requiring capture and treatment.

Seepage from the reclaimed facility after perforation combined with baseflow is estimated at between 17 and 25 gpm, combined with the Carter Gulch waste rock repository seepage of 13 to 21 gpm, makes a total of between 30 and 46 gpm that would require capture and treatment. Estimated volumes of drainage requiring capture and treatment under Alternative 5 are summarized on Table 4.2-7.

As discussed in Section 4.2.6, effective water quality management is made difficult in this steep terrain due to the high degree of interaction between surface water and groundwater (see Section 3.2.6). This relationship makes it difficult to capture all the drainage from such a facility by use of a surface impoundment, thus increasing the risk of impacting surface and groundwater resources downstream. Conversely, the benefit of constructing two large facilities within the same already moderately-impacted drainage restricts the risk of future uncaptured acid rock drainage or process fluid spills to one drainage.

Downstream water quality in Alder Gulch is expected to be similar to that observed today (Table 4.2-1). However, due to the magnitude of earth moving associated with the Carter Gulch waste rock repository and the Alder Gulch leach pad, suspended solids concentrations in Alder Gulch are expected to increase during the initial construction phase. Longer-term minor increases in TDS and sulfate concentrations and loads are expected due to some impacted water bypassing the capture systems (Table 4.2-1). The total volume of water that would require capture and treatment in the short-term is estimated at between 232 and 318 gpm (Table 4.2-7).

Pit Reclamation

Agency mitigated reclamation for the Zortman pit complex includes the relocation of approximately 9 million tons of spent ore and tailing from the 85/86 leach pad and dikes and the Ruby Gulch drainage into the pit complex as backfill. This would concentrate the potentially acid generating materials in a more controlled environment and would significantly reduce the impacts at the materials existing location. Water quality expected to drain from the backfilled pit complexes would be discussed for Alternative 4 (see Section 4.2.6).

Diverting the Landusky pit runoff north towards King Creek would have the positive impact of augmenting surface water flows onto the Fort Belknap Reservation. The lack of any pre-1979 King Creek flow data makes it unclear what, if any, flow reductions have occurred in King Creek as a result of post-1979 mining activities.

TABLE 4.2-7

ALTERNATIVE 5:
AGENCY MITIGATED EXPANSION WITH ALDER GULCH LEACH PAD AND CARTER GULCH WASTE ROCK REPOSITORY

1 At Zortman and Landusky, slopes >5% have reclamation cover C, slopes <5% have modified reclamation cover B No testing required, all slopes at 3H:1V

Help Model Results

	Flat Surfaces	Side Slopes
Surface Runoff (as % of precipitation)	10 05	10 16
Evapotranspiration (as percent of precip.)	71 32	71 34
Lateral Drainage (as percent of precip)	18 42	8.07
Infiltration (as percent of precipitation)	0 12	10 35

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 5-yr. Water Quality (italics & shaded)				Comments
ZORTMAN				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
- 85/86 Leach Pad & Dike (removed)	Ruby Gulch	0 0						2 9	2760	1920	5 4	Z-37
- 89 Leach Pad & Dike	Ruby Gulch	1 6						3.0-5.0	2,000-3,000	1,000-2,000	3.0-5.0	Z-37
- Ruby Gulch Waste Rock Rock Dump (removed)	Ruby Gulch	0.0										
- OK Pit Waste Dump (removed)	Ruby Gulch	0.0										
- 82 Leach Pad (free draining)	Ruby Gulch	0.9										
- 79/80/81 Leach Pad (free draining)	Ruby Gulch	1 6						3	878	615	5.06	Z-1 (downstream)
- 79/80/81 Leach Pad (free draining)	***RUBY GULCH:***	**4.1**	**69.3**	**30.0**	**40.0**	**34.1**	**44.1**	***3.0-5.0***	***500-900***	***300-700***	***3.0-5.0***	***Estimated water quality at Ruby Gulch capture system***
- 84 Leach Pad & Dike	Alder Spur	1 8										
- 83 Leach Pad & Dike	Alder Spur	1 7						4 1	2310	1460	1.98	Z-14 (downstream)
	ALDER SPUR:	**3.4**	**4.8**	**2.0**	**4.0**	**5.4**	**7.4**	***4.5-6.0***	***1,000-2,500***	***500-2,600***	***1.0-3.0***	***Estimated water quality at Alder Spur capture system***
- Alder Gulch Waste Rock Dump (removed)	Carter Gulch	0.0						3 4	5450	3480	10.4	Z-13
- Carter Gulch Waste Rock Repository	Carter Gulch	11.3										
	CARTER GULCH:	**11.3**	**-0.3**	**2.0**	**10.0**	**13.3**	**21.3**	***3.0-5.0***	***3,000-6,000***	***2,500-4,000***	***4.0-9.0***	***Estimated water quality at Carter Gulch capture system***
- Alder Gulch Leach Pad	Alder Gulch	15 1										
	ALDER GULCH:	**15.1**		**2.0**	**10.0**	**17.1**	**25.1**	***4.0-7.0***	***1,000-2,000***	***1,000-2,000***	***1.0-5.0***	***Estimated water quality at Alder Gulch capture system***
LANDUSKY												
- 87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	21.0										
- Mill Gulch Waste Rock Dump	Mill Gulch	5 4						4	2460	1620	8 43	
- 79 Leach Pad (free draining)	Mill Gulch	0 1										
- 80/81/82 Leach Pad (free draining)	Mill Gulch	0.2										
	MILL GULCH:	**26.8**	**1.9**	**0.0**	**4.0**	**26.8**	**30.8**	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Mill Gulch capture system***
- 87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	21 0										
- Sullivan Park Waste Rock Dump	Sullivan Creek	2.3						2 8	14700	9960	25.4	L-28 (downstream; 1992)
	SULLIVAN CREEK:	**23.3**	**2.9**	**0.0**	**4.0**	**23.3**	**27.3**	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Sullivan Creek capture system***
- Gold Bug Pit Waste Rock Repository	Montana Gulch	4 9										
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	2.2										
- 84 Leach Pad & Dike	Montana Gulch	1.5										
- 85/86 Leach Pad & Dike	Montana Gulch	2 5						7.7	806	489	0.52	L-16
- 1983 Leach Pad & Dike	Montana Gulch	1.0						6.6	4670	2920	1.56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	**12.2**	**250.2**	**100.0**	**150.0**	**112.2**	**162.2**	***7.0-8.0***	***700-1,000***	***400-600***	***0.4-0.7***	***Estimated water quality at Montana Gulch capture system***
	TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):					***232***	***318***					

Notes
1. "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions
2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc under each alternative

Approximately 89 acres of potential drainage area have been disturbed, diverting flow into the Landusky Pit complex.

The reclamation plan for the Landusky pits under Alternative 5 also proposes a diversion drain at approximately 4,800 feet elevation to divert highwall runoff to the south before it comes into contact with the pit floor. This highwall runoff water may have a pH between 2 and 5, and elevated nitrate, sulfate, TDS, and metal concentrations (Schafer and Associates 1993 and 1994). As a result, this runoff would have to be captured and treated before being discharged.

The pit runoff to the north would be restricted to precipitation that falls directly onto the pit floor. This water is expected to be of good quality, although it may have elevated nitrate concentrations in the short-term due to the use of fertilizers for revegetation of the pit floor. The August Adit drainage would be at between 4,600 and 4,650 feet elevation (approximately 200 feet below King Creek) so acidic and elevated metal drainage from the backfill would drain preferentially through the August Adit rather than towards King Creek and be captured and treated in Montana Gulch as discussed in Section 4.2.6. However, present day water levels suggest the potential does exist for impacted waters to migrate from the pit backfill towards the northern tributaries.

Estimated downstream water quality for King Creek under Alternative 5 is summarized on Table 4.2-2. Water quality is expected to remain similar to that observed in King Creek and Peoples Creek today with slightly elevated nitrates due to fertilization of revegetated areas. Some short-term elevated suspended solids concentrations are also expected during earthwork to construct the breach between the pits and King Creek and subsequent reclamation of the pit floor. As a result of the installation of a capture system at King Creek no adverse impacts are expected to the beneficial uses downstream in Little Peoples Creek.

As a result of deepening the pits at Landusky and diverting surface drainage from the pits to the north, it is expected that flow from the August and Gold Bug adits would decrease. This reduction could have a proportional negative impact to downstream Montana Gulch (Montana Gulch campground) by potentially reducing flow to an intermittent level. Decreased flow volumes are not expected to have a significant effect below the confluence of Montana Gulch and Rock Creek.

Water Use

Water Appropriations required under Alternative 5 would be the same as Alternative 4, see discussion in Section 4.2.6.

4.2.7.1 Cumulative Impacts

Cumulative impacts associated with past, current and foreseeable activities at the Zortman and Landusky mine sites under Alternative 5 include construction of two large facilities in mountain valleys where water management is difficult. However, impacts are restricted to already disturbed drainages and treated and diverted runoff is proposed to be returned to its original drainage area at the Landusky mine.

Cumulative impacts associated with Alternative 5 would be as described for Alternative 4 in Section 4.2.6.1, with the following exceptions:

- Construction of the Alder Gulch leach pad rather than the Goslin Flats leach pad would result in further upstream degradation of water quality but would restrict additional impacts to one drainage system.
- Mining would no longer be foreseeable in Pony Gulch due to there being no conveyor; however, prospects close to the Alder Gulch leach pad may be developed. Impacts would be similar to those described in Section 4.2.6.1 with the exception that they may be restricted to an already impacted drainage area.
- A positive impact would result from the diversion of pit floor runoff flow into King Creek supplementing current flow conditions to something similar to baseline.

Cumulative impacts under Alternative 5 are rated as being moderately negative as implementation of Alternative 5 would establish a moderately negative trend moving away from baseline conditions.

4.2.7.2 Unavoidable Adverse Impacts

The diversion of surface water runoff from the Landusky pits into King Creek would likely reduce the amount of water discharging to Montana Gulch. This may compound the significant loss of flow from the August and Gold Bug adits to Montana Gulch and the impacts to recreation and to the aquatic habitat.

4.2.7.3 Short-term Use/Long-term Productivity

Construction of the proposed Carter Gulch waste rock repository and the Alder Gulch leach pad represents a loss of approximately 343 acres of natural watershed. On the local scale this means the removal of a proposed significant area of high quality recharge to Alder Gulch and the downstream section of Ruby Creek, and the loss of a water supply for wildlife. Although the facility has a short operating life it would likely inhibit the long-term productivity of these water resources.

4.2.7.4 Irreversible or Irretrievable Resource Commitments

Diversion of flow from the Zortman pits into Ruby Creek would alter the drainage that once flowed northward into Lodgepole Creek. As discussed under Alternative 4 (Section 4.2.6.4), this diversion of flow to represents a negligible impact on flow within Lodgepole Creek drainage.

4.2.8 Impacts from Alternative 6

Alternative 6 would approve expansion of both the Zortman and Landusky mines, but impose agency-developed mitigations on the expansion and reclamation activities. The major modification to the CPA (see Alternative 4, Section 2.8) would be the construction of a 60-million-ton waste rock repository on Ruby Flats just east of the Goslin Flats leach pad rather than in Carter Gulch as proposed for Alternatives 4 and 5. The agencies developed this alternative primarily because a repository on Ruby Flats would be easier to construct and maintain than would a facility in the steep Carter Gulch drainage. The alternative would route the Landusky mine pit drainage to Montana Gulch, as would surface runoff rather than to the north into King Creek as in Alternative 5 or through the August adit to groundwater as in Alternative 4.

Infiltration Modeling

Reclamation covers for pits, and sideslope angles for the existing pits, leach pads and waste rock piles would be described for Alternative 3. The proposed Goslin Flats leach pad would be reclaimed with side slopes no greater than 2.5H:1V and 3H:1V where topography follows. At the proposed Ruby Flats waste rock repository, post reclamation side slopes would be at 3H:1V. HELP modeling for this alternative uses a 3H:1V overall sideslope as the slight differences on the dikes and possibly at Goslin Flats have a negligible effect on the water budget calculations. HELP model simulation of the Ruby Flats waste rock repository estimates that 71% of precipitation would be lost to evapotranspiration, 10% to surface runoff. Lateral drainage as a percent of precipitation would be 18% on gentle slopes and 8% on steep slopes. On the gentle slopes it is estimated that infiltration would be approximately 1% and 10% on the side slopes. Any uncontrolled drainage from the facility has the potential to flow towards Ruby or Camp Creek.

Post-Reclamation Water Quality

Some minor increases in concentrations of TDS and sulfate are expected in the surface water surrounding the waste rock repository and leach pad, primarily due to the exposure of more bedrock area during construction. Although no waste rock sorting is proposed for this alternative, the placement of a liner under the waste rock repository and the leach pad (see Section 2.9.1.1.3) would control the acid-generating potential of these facilities. In the long-term, acid rock drainage is expected, but it is possible that only passive treatment techniques such as wetlands and anoxic limestone drains may be needed to maintain a level of acceptable water quality. Excess water is expected to drain from the facilities leaving them "high and dry," with little infiltration available to transport the sulfide oxidation products.

The proposed location of the Ruby Flats waste rock repository is within 300 feet of the well head of the Zortman community water supply well 2-8A. Little potential exists for any vertical infiltration of ARD contaminated waters to the production zone of the well as it is completed 728 feet below ground level and the permeable limestones are overlain by a significant thickness of lower permeability shales. However, monitoring wells would have to be placed in the surrounding alluvium and underlying shale to ensure that any leaked ARD did not have the opportunity to pond around the well casing. In the unlikely event of this occurring an alternative water supply well could be developed to avoid the risk of any contaminant entering the well by flowing down around the well casing.

The salvaging of the soil from the footprint of the proposed Ruby Flats waste rock repository (203 acres) and the Goslin Flats leach pad (approximately 250 acres), combined with the clearance of a corridor for the associated conveyor is expected to result in significant amounts of suspended solids entering the upper and lower reaches of Goslin Creek, and the lower reaches of Ruby Creek and Camp Creek. Although the solids would likely be held in suspension for a relatively short-time, the longer term impact would be a significant buildup of fines in the stream bottoms. If not controlled by efficient sediment traps this has the potential to be a significant local impact, degrading macroinvertebrate and potential fish habitat in the short and long-term. Long-term water quality trends expected for the Goslin Flats leach pad and Ruby Flats waste rock repository are shown schematically on the summary figure in Section 4.2.8.6. The total volume of water that will require capture and treatment in the short-term under Alternative 6 is estimated at between 266 and 339 gpm (Table 4.2-8).

Pit Reclamation
As a result of deepening the pits at Landusky to levels below the August and Gold Bug adits, discharge volumes are expected to decrease. Once the pits are backfilled, water discharges are expected to recover to some degree, but adit discharges are expected to remain depressed due to lack of recharge through the impermeable cover on the pH backfill. Under this alternative, pit drainage would be drained to Montana Gulch and treated if necessary. A slight improvement in downstream water quality is expected due to the reduction of flow from a known source of metals (Gold Bug Adit) and the return of good quality runoff water (Table 4.2-1).

Water Use
Water appropriations required under Alternative 6 would be the same as Alternative 4, see discussion in Section 4.2.6.

4.2.8.1 Cumulative Impacts

Cumulative impacts associated with past, current and foreseeable activities at the Zortman and Landusky mine sites under Alternative 6 include the construction of two large facilities on the flats to the south of the Little Rocky Mountains and the foreseeable development of a mine in Pony Gulch.

Cumulative impacts from Alternative 6 would be as described for Alternative 4 in Section 4.2.6.1, with the following exceptions:

- Construction of the Ruby Flats waste rock repository rather than the Carter Gulch waste rock repository puts both new facilities in an environment where water quality can be much more successfully managed, resulting in minimal impacts to water quality on the flats.

Cumulative Impacts under Alternative 6 are rated at low negative as implementation would establish a slightly negative trend away from baseline conditions.

4.2.8.2 Unavoidable Adverse Impacts

The diversion of the Zortman and Landusky Pit floor runoff to the south into Ruby and Montana Gulches leaves the adverse impact of decreased flow to the north unaddressed. This diversion of flow is considered to be more significant at King Creek than at Lodgepole Creek (see Section 4.2.3.4).

4.2.8.3 Short-term Use/Long-term Productivity

The presently undisturbed prairie at Goslin Flats and Ruby Flats acts as a water catchment area. The short-term productivity of this area would be lost due to the construction of the Goslin Flats leach pad and the Ruby Flats waste rock repository. The catchment area would be regained in the long-term following reclamation and resumption of previous runoff patterns.

4.2.8.4 Irreversible or Irretrievable Resource Commitments

Irretrievable resource commitments under this alternative would be similar to that described for Alternative 4 in Section 4.2.6.4. This commitment would be compounded by the additional disturbance at the currently unimpacted area of Ruby Flats by the construction of the Ruby Flats waste rock repository.

4.2.9 Impacts from Alternative 7

The major modification to the CPA would be at the Zortman Mine, where the proposed waste rock repository would be constructed on top of the existing facilities at the mine. Use of this area for waste rock storage confines disturbance to areas and facilities already disturbed by mining activity while providing the cap on top of the existing facilities that currently require reclamation. This alternative also uses "water balance reclamation covers" (see Section 2.11.2.1), as opposed to the barrier-type covers as described in Alternatives 2 through 6. At the Landusky Mine reclamation would include routing surface runoff from the pit complex into King Creek as described for Alternative 5.

Pit Reclamation
Mine pit reclamation would occur in a similar manner to that described for the CPA in section 2.8.2.3, with some modifications concerning backfilling of the pits. Backfill for the pits would be derived from existing mine facilities and historic tailing in the Ruby Gulch drainage. This material, in conjunction with that generated by the

TABLE 4.2-8

ALTERNATIVE 6
AGENCY MITIGATED EXPANSION WITH GOSLIN FLATS LEACH PAD AND RUBY FLATS WASTE REPOSITORY

1. At Zortman and Landusky, slopes >5% have reclamation cover C, slopes <5% have modified reclamation cover B No testing required, all slopes at 3H.1V.

Help Model Results

	Flat Surfaces	Side Slopes
Surface Runoff (as % of precipitation)	10 05	10 16
Evapotranspiration (as percent of precip).	71.32	71.34
Lateral Drainage (as percent of precip)	18 42	8 07

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 5-yr. Water Quality (italics & shaded)				Comments
				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
ZORTMAN												
- 85/86 Leach Pad & Dike (removed)	Ruby Gulch	0.0						2.9	2760	1920	5 4	Z-37
- 89 Leach Pad & Dike	Ruby Gulch	1 6						3.0-5.0	2,000-3,000	1,000-2,000	3.0-5.0	Z-37
- Ruby Gulch Waste Rock Rock Dump (removed)	Ruby Gulch	0 0										
- OK Pit Waste Dump (removed)	Ruby Gulch	0 0										
- 82 Leach Pad (free draining)	Ruby Gulch	0 9										
- 79/80/81 Leach Pad (free draining)	Ruby Gulch	1 6						3	878	615	5.06	Z-1 (downstream)
	RUBY GULCH:	**4.1**	**69.3**	**30.0**	**40.0**	**34**	**44**	***3.0-5.0***	***500-900***	***300-700***	***3.0-5.0***	***Estimated water quality at Ruby Gulch capture system***
- 84 Leach Pad & Dike	Alder Spur	1 79										
- 83 Leach Pad & Dike	Alder Spur	1 66						4 1	2310	1460	1 98	Z-14 (downstream)
	ALDER SPUR:	**3.4**	**4.8**	**3.0**	**4.0**	**6**	**7**	***4.5-6.0***	***1,000-2,500***	***500-1,600***	***1.0-3.0***	***Estimated water quality at Alder Spur capture system***
- Alder Gulch Waste Rock Dump (removed)	Carter Gulch	0 0						3 4	5450	3480	10 4	Z-13
	CARTER GULCH:	**0.0**	**-0.3**	**0.0**	**4.0**	**0**	**4**	***3.0-5.0***	***3,000-6,000***	***2,500-4,000***	***4.0-9.0***	***Estimated water quality at Carter Gulch capture system***
- Ruby Terrace Waste Repository	Ruby Flat/Camp Creek	18 7										
	RUBY FLAT/CAMP CRE	**18.7**		**0.0**	**0.0**	**19**	**19**	***6.5-7.0***	***800-1,500***	***400-800***	***0.02-0.05***	***Estimated water quality at Ruby Flat/Camp Creek capture system***
- Goslin Flat Leach Pad	Goslin Gulch	19 6						7 4-8 0	851-1,030	414-506	0 005-0 02	Z-35
	GOSLIN GULCH:	**19.6**		**0.0**	**0.0**	**20**	**20**	***6.5-7.0***	***600-1,500***	***400-800***	***0.005-0.02***	***Estimated water quality surrounding heap leach***
LANDUSKY												
- 87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	21 0										
- Mill Gulch Waste Rock Dump	Mill Gulch	5 4						4	2460	1620	8 43	
- 79 Leach Pad (free draining)	Mill Gulch	0.1										
- 80/81/82 Leach Pad (free draining)	Mill Gulch	0 2										
	MILL GULCH:	**26.8**	**1.9**	**0.0**	**4.0**	**27**	**31**	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Mill Gulch capture system***
- 87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	21 0										
- Sullivan Park Waste Rock Dump	Sullivan Creek	2 3						2 8	14700	9960	25 4	L-28 (downstream; 1992)
	SULLIVAN CREEK:	**23.3**	**2.9**	**0.0**	**4.0**	**23**	**27**	***4.0-5.0***	***2,000-3,000***	***1,500-2,000***	***5.0-9.0***	***Estimated water quality at Sullivan Creek capture system***
- Gold Bug Pit Waste Rock Repository	Montana Gulch	4 9										
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	2 2										
- 84 Leach Pad & Dike	Montana Gulch	1 5										
- 85/86 Leach Pad & Dike	Montana Gulch	2 5						7 7	806	489	0 52	L-16
- 1983 Leach Pad & Dike	Montana Gulch	1 0						6 6	4670	2920	1 56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	**12.2**	**250.2**	**125.0**	**175.0**	**137**	**187**	***7.0-8.0***	***700-1,000***	***400-600***	***0.4-0.7***	***Estimated water quality at Montana Gulch capture system***
	TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):					***266***	***339***					

Notes:
1 "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions
2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc under each alternative

proposed mining activities, would raise the pit to an elevation necessary to drain freely into Ruby Gulch and Alder Spur. Impacts associated with pit extension and reclamation at the Landusky mine would be as described for Alternative 5 in Section 4.2.7. Water quality impacts associated with backfilling of these pits with potentially acid generating material would be as discussed in Sections 4.2.6. and 4.2.7. At the Zortman Mine the majority of any acid rock drainage generated by the backfill would be captured at the Ruby Gulch capture system, due to the preferential flow paths expected along the fault zone between Ruby Gulch and the pits. At the Landusky Mine acid rock drainage is expected to daylight via the Gold Bug and August Adits and be captured at the Montana Gulch capture system. At both mine sites, the potential for some seepage of acid rock drainage from the pits to the northern drainages exists, although from reviewing available water monitoring data it is unclear if this has occurred in the past.

Infiltration Modeling

The "water balance caps" on the side slopes under this alternative use a thick profile of soil to increase the rooting depth of plants. This increases the amount of evapotranspiration and provides a large volume of storage during extreme precipitation events or when plant coverage is dormant. On the more gentle slopes (< 25 %), a Geosynthetic Clay Liner (GCL) would be used rather than a compacted clay layer because the GCL is less susceptible to desiccation from freeze thawing, dehydration etc. For Alternative 7, the same side slopes are proposed as would be used in Alternative 6, with between 2.5H:1V and 3H:1V on the Goslin Flats leach pad.

HELP model simulation of the Alternative 7 water balance reclamation cover for slopes greater than 25% shows that approximately 86% of precipitation would be lost to evapotranspiration, 7% to runoff and approximately 6% would remain to infiltrate into the facility (Table 4.2-9). On the slopes of <25% the use of the GCL results in approximately 82% of precipitation being lost to evapotranspiration, 7% to runoff 10% to lateral drainage and only 0.006% to infiltration.

Post Reclamation Water Quality

Only a small additional area of disturbance would be required for the Alternative 7 waste rock repository, as a result water quality degradation due to exposing potentially acid generating bedrock below the facility would be avoided. Additionally, the use of the GCL in the reclamation cover on slopes of less than 25 % may result in the majority of the pit backfill being covered with an effective barrier to infiltration, thereby reducing the volume of drainage requiring capture and treatment. Expected short-term water quality at the capture points is shown on Table 4.2-9.

Water quality impacts associated with the Goslin Flats leach pad and expansion and reclamation at Landusky are expected to be similar to those described in Section 4.2.7. However, it is expected that there would be less impacted water requiring treatment with the water balance and GCL caps further reducing infiltration. Short-term water quality at selected points of beneficial use are summarized on Table 4.2.1. The total volume of water that would require capture and treatment is estimated at between 200 and 270 gpm (Table 4.2-9). The water balance covers appear to intercept more precipitation than do the barrier type covers, this results in considerably less water requiring capture and treatment compared to the other alternatives.

Water Use

Water appropriations required under Alternative 7 would be the same as Alternative 4, see discussion in Section 4.2.6.

4.2.9.1 Cumulative Impacts

Cumulative impacts associated with past, current and foreseeable activities at the Zortman and Landusky mine sites under Alternative 7 are similar to those identified for Alternative 5. The exception is that considerable disturbance and resultant water degradation is avoided by placing the waste rock repository on top of existing areas of disturbance that already required a reclamation cover. Cumulative impacts resulting from Alternative 7 are rated low negative as implementation of Alternative 7 would establish a slightly negative trend away from baseline conditions.

4.2.9.2 Unavoidable Adverse Impacts

The diversion of surface water runoff from the Landusky pits into King Creek would likely reduce the amount of water discharging to Montana Gulch.

4.2.9.3 Short-Term Use/Long-Term Productivity

Trade-offs between long-term losses of productivity and short-term use under Alternative 7 are as discussed for

TABLE 4.2-9

ALTERNATIVE 7:
AGENCY MITIGATED EXPANSION WITH WASTE ROCK REPOSITORY ON EXISTING FACILITIES AT ZORTMAN AND GOSLIN FLATS LEACH PAD

1 At Zortman and Landusky, slopes >5% have reclamation cover C, slopes <5% have modified reclamation cover B No testing required, all slopes at 3H 1V

Help Model Results

	Flat Surfaces	Steep Surfaces
Surface Runoff (as % of precipitation)	7.44	7.26
Evapotranspiration (as percent of precip):	82.39	86.40
Lateral Drainage (as percent of precip)	10.02	
Infiltration (as percent of precipitation):	0.006	6.335

Facility	Drainage	Modeled Seepage through Facility (gpm)	Estimated Current Groundwater Seepage (1) (gpm)	Modified Groundwater Seepage (2) (gpm)		Estimated Combined Seepage Volumes Requiring Capture & Treatment (gpm)		1994 Existing Water Quality (plain text); Estimated 5-yr. Water Quality (italics & shaded)				Comments
				Low	High	Low	High	pH (su)	TDS (mg/L)	Sulfate (mg/L)	Zinc (mg/L)	
ZORTMAN												
- 85/86 Leach Pad & Dike (removed)	Ruby Gulch	0.0						2.9	2760	1920	5.4	Z-37
- 89 Leach Pad & Dike (50% covered)	Ruby Gulch	0.5						3.0-5.0	2,000-3,000	1,000-2,000	3.0-5.0	Z-37
- Ruby Gulch Waste Rock Rock Dump (removed)	Ruby Gulch	0.0										
- OK Pit Waste Dump (removed)	Ruby Gulch	0.0										
- 82 Leach Pad (free draining)	Ruby Gulch	0.6										
- 79/80/81 Leach Pad (free draining) (70% covered)	Ruby Gulch	0.7						3	878	615	5.06	Z-1 (downstream)
- Alt. 7 Waste Rock Repository	Ruby Gulch	7.9										
	RUBY GULCH:	9.6	69.3	25.0	35.0	35	45	*3.0-5.0*	*500-900*	*300-700*	*3.0-5.0*	***Estimated water quality at Ruby Gulch capture system***
- 84 Leach Pad & Dike	Alder Spur	1.1										
- 83 Leach Pad & Dike	Alder Spur	1.0						4.1	2310	1460	1.98	Z-14 (downstream)
- Alt 7 Waste Rock Repository	Alder Spur	4.6										
	ALDER SPUR:	6.7	4.8	2.0	4.0	9	11	*4.5-6.0*	*1,000-2,500*	*500-1,600*	*1.0-3.0*	***Estimated water quality at Alder Spur capture system***
- Alder Gulch Waste Rock Dump (removed)	Carter Gulch	0.0						3.4	5450	3480	10.4	Z-13
	CARTER GULCH:	0.0	-0.3	0.0	4.0	0	4	*3.0-5.0*	*3,000-6,000*	*2,500-4,000*	*4.0-9.0*	***Estimated water quality at Carter Gulch capture system***
- Goslin Flat Leach Pad	Goslin Gulch	*12.0*						d *5-7.5*	*800-1,500*	*400-800*	*0.005-0.05*	*Z-35*
	GOSLIN GULCH:	12.0	0.0	0.0	0.0	12	12	*6.5-7.5*	*800-1,500*	*400-800*	*0.005-0.05*	***Estimated water quality surrounding heap leach***
LANDUSKY												
- 87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	12.8										
- Mill Gulch Waste Rock Dump	Mill Gulch	5.4						4	2460	1620	8.43	
- 79 Leach Pad (free draining)	Mill Gulch	0.1										
- 80/81/82 Leach Pad (free draining)	Mill Gulch	0.1										
	MILL GULCH:	18.5	1.9	0.0	4.0	18	22	*4.0-5.0*	*2,000-3,000*	*1,500-2,000*	*5.0-9.0*	***Estimated water quality at Mill Gulch capture system***
- 87/91 Leach Pad & Dike 4-6	Mill Gulch/Sullivan Creek	12.8										
- Sullivan Park Waste Rock Dump	Sullivan Creek	2.3						2.8	14700	9960	25.4	L-28 (downstream, 1992)
	SULLIVAN CREEK:	15.2	2.9	0.0	4.0	15	19	*4.0-5.0*	*2,000-3,000*	*1,500-2,000*	*5.0-9.0*	***Estimated water quality at Sullivan Creek capture system***
- Gold Bug Pit Waste Rock Repository	Montana Gulch	3.0										
- Montana Gulch Waste Rock Dump	Mont Gulch/King Creek	1.4										
- 84 Leach Pad & Dike	Montana Gulch	0.9										
- 85/86 Leach Pad & Dike	Montana Gulch	1.6						7.7	806	489	0.52	L-16
- 1983 Leach Pad & Dike	Montana Gulch	0.6						6.6	4670	2920	1.56	ZL-114R data used because surface stations are generally dry
	MONTANA GULCH:	7.4	250.2	100.0	150.0	107	157	*7.0-8.0*	*700-1,000*	*400-600*	*0.4-0.7*	***Estimated water quality at Montana Gulch capture system***
	TOTAL ESTIMATED FLOW REQUIRING CAPTURE & TREATMENT (gpm):					*196*	*270*					

Notes
1. "Estimated Current Groundwater Seepage" is equal to "Measured Drainage Flow" less "Modeled Seepage through Facilities" computed for Current Non Reclaimed Non Perforated Conditions
2 "Modified Groundwater Seepage" is equal to "Estimated Current Groundwater Seepage" reduced to account for the Reduction in Recharge due to capping of pits, haul roads, etc. under each alternative

Alternative 4 (see Section 4.2.6.3), with the exception that no new irretrievable commitment would be required in Carter Gulch.

4.2.9.4 Irreversible or Irretrievable Resource Commitments

Irretrievable resource commitments under this alternative would be similar to those described for Alternative 4 with the exception that no new irreversible resource commitments would be required in Carter Gulch (see Section 4.2.6.3).

4.2.10.1 Non-Extension Alternatives Impact Summary

Infiltration modeling of the non-extension alternatives shows that Alternative 3 would provide the best barrier to infiltration. The following average percentages of available precipitation are predicted to infiltrate into facilities over the first 20 years of reclamation:

	Flat Area	Side Slopes
• Alternative 1	21%	19%
• Alternative 2	19%	17%
• Alternative 3	0.1%	10%

Total estimated annual average volumes of drainage that would require capture and treatment at the Zortman and Landusky mines in the short-term (approximately 20 years) are:

- Alternative 1, approximately 390 to 460 gpm
- Alternative 2, approximately 370 to 440 gpm
- Alternative 3, approximately 250 to 320 gpm

Figure 4.2-1 schematically summarizes the long-term trends in relative TDS (total water quality indicator) water concentrations and loads seeping from facilities. The major points to be noted regarding the three non-extension alternatives are:

- Under Alternative 1, water quality conditions are expected in the long-term to remain similar to what is presently observed.
- Alternative 2 is expected to provide a short-term barrier to infiltration where the 6 inch clay cap is applied, causing short-term increases in concentration and decreases in loads. However, because the long-term reliability of the clay cap is questionable, long-term water quality may return to conditions similar to those presently observed.
- As part of Alternative 3, two existing sources of acid rock drainage (85/86 leach pad and dike, Alder Gulch waste rock dump) would be removed from the southern drainages of the Zortman Mine.
- Alternative 3 provides low permeability barriers to infiltration and a capillary break which enhances lateral drainage, protects the clay or PVC cap, and provides water storage, helping the clay layer to remain saturated. Short-term concentrations are expected to increase and loads are expected to reduce rapidly. In the long-term, the facilities are expected to reach static hydraulic conditions (little discharge), which would inhibit the generation and transportation of acid rock drainage.

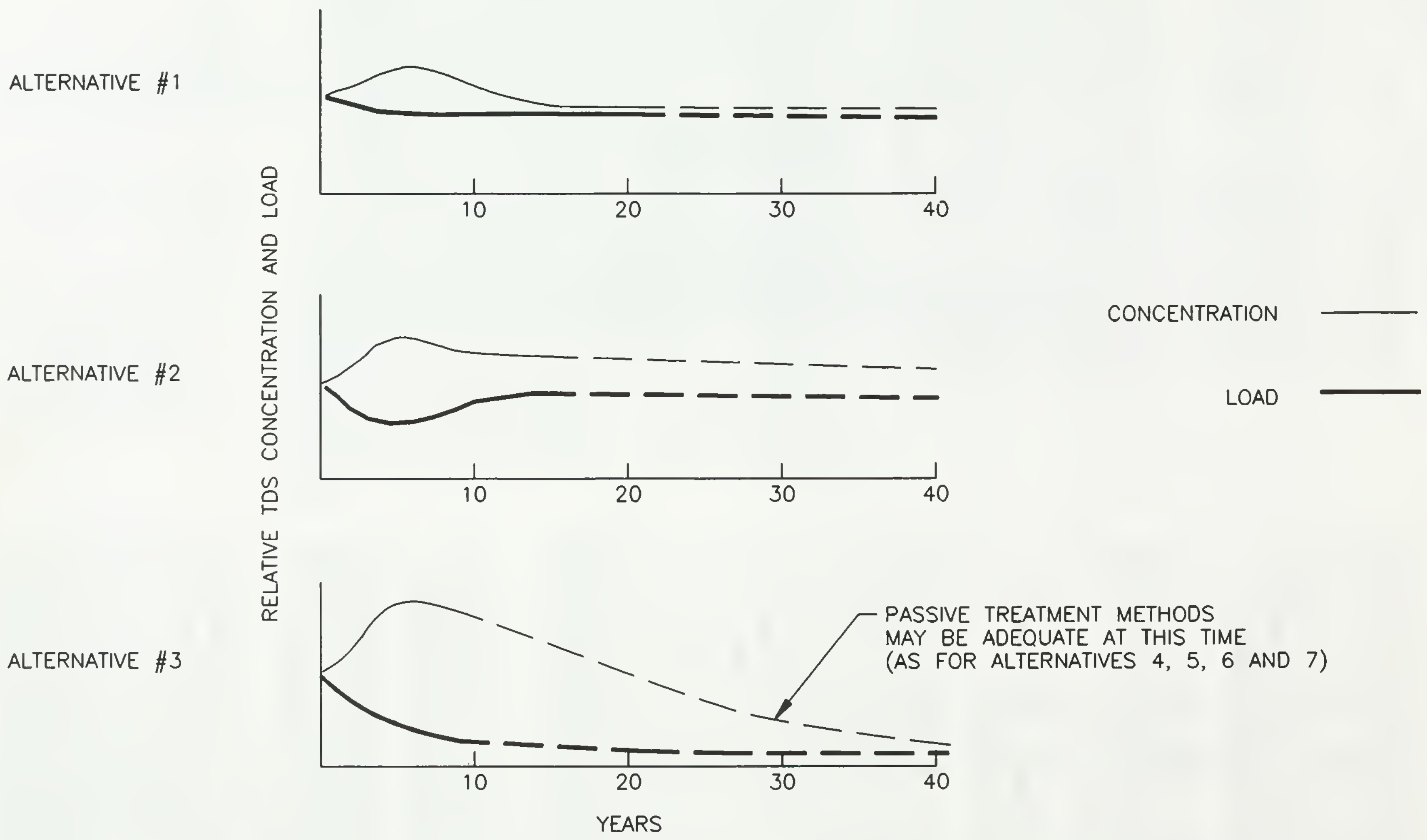
In summary, this analysis shows that only under Alternative 3 would there be the opportunity to shut down active treatment of seepage, and replace it with passive treatment systems. Even Alternative 3 has the potential to require long-term capture and treatment.

4.2.10.2 Extension (Action) Alternatives Impact Summary

Infiltration modeling of extension Alternatives, 4, 5, 6, and 7 shows all four to result in the similar percentage of infiltration. However, the water balance caps proposed in Alternative 7 appear to attain the best or smallest amount of infiltration into the facilities.

The following percentages of available precipitation are predicted to infiltrate into the facilities. Soil salvaging within the footprint of these facilities is expected to generate a considerable amount of suspended solids in the surrounding drainages.

		Side Slope	
	Flat Area	3:1	2:1
• Alternative 4	0.94	10.35	9.93
• Alternative 5	0.12	10.35	
• Alternative 6	0.12	10.35	
• Alternative 7	0.006	6.2	



PASSIVE TREATMENT METHODS MAY BE ADEQUATE AT THIS TIME (AS FOR ALTERNATIVES 4, 5, 6 AND 7)

NOTE:
TDS AS SHOWN IS MEANT TO BE REPRESENTATIVE OF TOTAL WATER QUALITY INCLUDING SULFATE, METALS ETC.

Job No. : 23173E
Prepared by : I.R.F
Date : 12/29/94

ESTIMATED LONG-TERM POST RECLAMATION WATER QUALITY FOR NON EXTENSION ALTERNATIVES 1, 2 AND 3

FIG. 4.2-1

Estimated total average volumes requiring capture and treatment in the short to mid-term (20 years) are:

- Alternative 4: approximately 260 to 330 gpm
- Alternative 5: approximately 230 to 320 gpm
- Alternative 6: approximately 270 to 340 gpm
- Alternative 7: approximately 200 to 270 gpm

Figure 4.2-2 schematically summarizes the expected long-term trends in relative TDS concentrations and loads seeping from facilities. The major points to be noted regarding the four extension alternatives are:

- In Alternative 4 the long-term reduction of acid rock drainage generation is expected to be more effective at the Goslin flats facility, as it would eventually drain, becoming "high and dry." In the case of Carter Gulch, underdrainage would provide an ongoing source of oxygen and water to transport acid rock drainage, thereby reducing the effectiveness of its enhanced reclamation cover in the long-term.

- Alternative 5 places both the leach pad and the waste rock repository within the Alder Gulch drainage. Although a significant reduction of infiltration and resultant acid rock drainage generation is expected, underdrainage would likely provide a source of some acid rock drainage in the long-term. Construction of both facilities in this steep terrain also increases the potential for downstream impacts to water quality, from seepage bypassing capture systems.

- Alternative 6 places both the leach pad and the waste rock repository on flats surrounding the Little Rocky Mountains. Construction on flat land above the water table, combined with the proposed enhanced reclamation covers, is expected to allow both facilities to drain, essentially becoming "high and dry." The flat topography and resultant flat hydraulic gradient underlying these facilities would also allow effective monitoring and recovery of any unforeseen seepage from the facilities. Soil salvaging within the footprint of these facilities is expected to generate a considerable amount of suspended solids in the surrounding drainages.

- Alternative 7 places the leach pad on the flats above the water table in an environment suited for effective, water quality management. It also places the waste rock repository on top of existing waste rock piles, leach pads and pits. This location creates little additional disturbance, concentrates the impact in drainage systems with existing mitigation measures and provides the reclamation cover required for the majority of the existing Zortman mine facilities. The water budget type-reclamation covers proposed with this alternative further reduce infiltration and volumes requiring treatment, but do not preclude the possible need for long-term capture and treatment of impacted waters.

In summary, under all four extension (action) alternatives, there would potentially be the opportunity to scale down treatment of seepage. The long-term effectiveness of the enhanced reclamation covers is, however, better on the flat terrain surrounding the Little Rocky Mountains where the facilities would eventually drain in a controlled manner becoming "high and dry".

4.2.10.3 Comparison of Impacts - Water Resources and Geochemistry

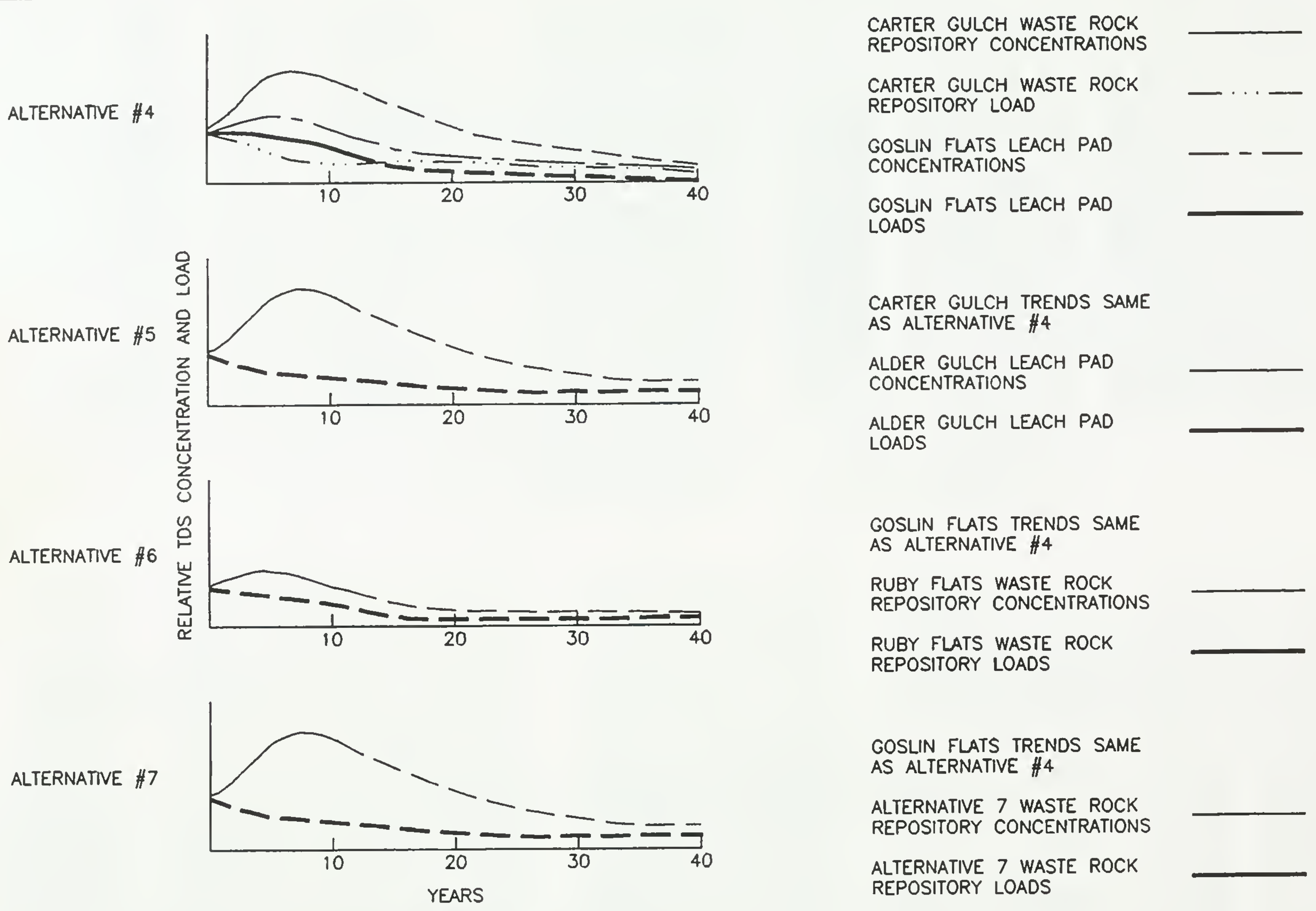
Table 4.2-10 summarizes the positive and negative impacts to water resources for each of the alternatives and the assigned overall impact rankings. This comparison provides an indication of the relative impacts for each mining and reclamation option. Rankings have been assigned based on professional opinion and the projected ability of the alternatives to attain and maintain acceptable water quality conditions over the long-term.

The following major conclusions are also pertinent:

- Accurate predictions of water quality concentrations or loads are not attainable for a mining environment as complex as that at Zortman/Landusky. Predictions of relative water quality are most realistic in such settings.

- The water quality of all major southern drainages has been impacted to some degree by recent mining activity.

- The HELP model is a useful tool for making comparisons of the ability of different capping alternatives to reduce infiltration.



NOTES:

1. TDS AS SHOWN IS MEANT TO BE REPRESENTATIVE OF TOTAL WATER QUALITY INCLUDING SULFATE, METALS, ETC.
2. EXISTING FACILITIES WOULD HAVE SOME LONG-TERM WATER QUALITY TRENDS AS SHOWN IN ALTERNATIVE #3 (FIGURE 4.2-1)

ESTIMATED POST RECLAMATION
WATER QUALITY FOR
EXTENSION ALTERNATIVES
4, 5, 6, AND 7

73002A

FIG. 4.2-

TABLE 4.2-10
IMPACTS SUMMARY FOR WATER RESOURCES

Positive Impact	Negative Impact	Impact Ranking
<u>Alternative #1</u> • No further exposure of potentially acid generating material • 8" of soil for revegetation • 21.4% infiltration on flats, 18.8% on slopes • Minor impacts downstream	• Inadequate reclamation covers • Capture and treat in perpetuity • Risk of overtopping existing capture systems • Irretrievable loss of drainage area to northern tributaries (total of 115 acres)	High negative (-/H)
<u>Alternative #2</u> • No further exposure of potentially acid generating material • NAG capillary break for pit floors • 6" of compacted clay on area found to be acid generating • 19.7% infiltration on flats, 17.7% on slopes • Minor impacts downstream	• Unsatisfactory assessment of acid generating potential of facilities • Unsatisfactory reclamation coverage • Capture and treatment in perpetuity is likely • Risk of overtopping existing capture systems • Internal drainage of pits • Irretrievable loss of drainage area to northern tributaries (total of 115 acres)	High negative (-/H)
<u>Alternative #3</u> • Use of PVC liner on slopes <5% • Use of a capillary break, lateral drainage, long-term stability for all facilities • Removal of known sources of ARD including 1985/1986 pad and buttress, and Alder Gulch waste rock pile • Backfilling of pits to free drain to the south • PVC liner on slopes <5% • 0.12% infiltration on flats, 10.35% on slopes • Eventual source control of ARD is likely, [potential to stop active treatment] • Thorough procedure for recognition of NAG rock • Minor impacts downstream (short-term)	• More disturbance required for NAG rock source (quarries) • Irretrievable loss of drainage area to northern tributaries (total of 115 acres)	Low positive (+/L)

TABLE 4.2-10 - IMPACTS SUMMARY FOR WATER RESOURCES
(Continued)

Positive Impact	Negative Impact	Impact Ranking
Alternative #4		
• Source of NAG material for caps results from planned mining • Waste rock facility placed in drainage with existing partial impacts to water quality - Alder Gulch • Backfilled pits, free draining to the south • Eventual source control of ARD is likely • Reduction of flow in Gold Bug adit, August adit, reducing known source of metals to Montana Gulch • 0.94% infiltration on flats, 10.35% on slopes	• Exposure of more potentially acid generating rock • Unsatisfactory procedure for classifying NAG rock • Leach pad placed in non-impacted drainage area • New facilities in 2 separate drainage areas • Irretrievable loss of drainage area to northern tributaries (total of 156 acres)	Low negative (-/L)
Alternative #5		
• Both facilities (leach pad, waste repository) restricted to an already impacted drainage - Alder Gulch • Enhancing flow in King Creek from free draining pit to the north • Eventual source control of ARD is likely • Reduction of flow in Gold Bug adit, August adit, reducing known source of metals to Montana Gulch • 0.12% infiltration on flats, 10.35% on slopes	• Exposure of more potentially acid generating rock • Both facilities in steep terrain, where water monitoring and capture is difficult • Probable decrease in flow to Montana Gulch • Irretrievable loss of drainage area to the northern tributaries (total of 47 acres)	Moderate negative (-/M)
Alternative #6		
• Both facilities in Goslin Flats area, where water monitoring and successful management is more likely • Reduction of flow in Gold Bug adit, August adit, reducing known source of metals to Montana Gulch • Eventual source control of ARD is likely • 0.12% infiltration on flats, 10.35% on slopes	• Both facilities in a presently non-impacted drainage area • Minor water quality degradation associated with both facilities • Exposure of more potentially acid generating rock • Irretrievable loss of drainage area to northern tributaries (total of 156 acres) • Probable loss of flow to Montana Gulch	Low negative (-/L)

TABLE 4.2-10 - IMPACTS SUMMARY FOR WATER RESOURCES
(Concluded)

Positive Impact	Negative Impact	Impact Ranking
<u>Alternative #7</u>		
• Little or no additional disturbance required for waste rock repository • Eventual source control of ARD likely • 0.006% infiltration on flats, 6.2% on slopes • Waste rock stored above existing capture facility • Leach pad constructed at location suitable for effective water quality management	• Leach pad constructed in presently non-impacted drainage area • Irretrievable loss of drainage area to the northern tributaries (total of 47 acres) • Probable decrease in flow to Montana Gulch	Low negative to neutral (-/L to N)

- The best caps, with thick soil profiles, GCL liners and capillary breaks would quickly improve downgradient loads; down gradient concentrations may take many years to improve.

- Capture and treatment as required by the Water Quality Improvement Plan would improve all downstream water quality regardless of cap success.

- Seepage from reclaimed spent ore piles should not be released untreated into the environment.

- Capture and treatment if implemented as planned would reduce flows in drainages such as Alder Spur, Carter Gulch, and Mill Gulch.

- Long-term treatment may be necessary regardless of which alternative is implemented.

- Regional aquifers such as the Madison Limestone would not be degraded beyond the perimeter of the Little Rocky Mountains by any of the alternatives analyzed.

- To make the monitoring of water quality impacts more quantitative, and to better evaluate the effectiveness of any reclamation alternative, accurate flow measurements in the streams of the Little Rocky Mountains are needed.

4.3 SOIL AND RECLAMATION EFFECTIVENESS

4.3.1 Methodology

Issues and concerns raised for soil during the scoping process are summarized in Section 1.6 and focus on the following:

- Adequacy of soil quantity and quality - volume of suitable cover soil for salvage and/or redistribution to an adequate thickness which will sustain a protective vegetative cover and the post-mining land use
- Stability of disturbed/reclaimed soil as measured primarily in terms of erosion potential and soil loss estimates
- Adequacy of post-closure/reclamation monitoring for rapid identification and remediation of localized failures

In response to these concerns, the following two significance criteria have been developed to aid in focusing the impact analyses on the key issues and in providing points of reference about which the analysis of impacts severity will be completed:

- Restoration of less than 48 inches of suitable material, including at least 16 inches of cover soil, on final reclamation grades/surfaces to serve as an effective long-term plant growth medium.
- Soil loss as predicted by the Revised Universal Soil Loss Equation (RUSLE) (Renard et al. 1991, Journal of Soil and Water Conservation) in excess of 2 tons/acre/year for reclaimed slopes and surfaces (EPA 1991, Richardson 1995).

Key background points and assumptions pertinent to the less than 16-inch cover soil and 48-inch growth medium-depth significance criterion are:

- A loss of 2 tons of soil per acre per year approximates a standard tolerance factor for soil loss based on a standard for new soil development of 2 tons per acre per year.
- Montana Department of Environmental Quality (DEQ, formerly Montana Department of State Lands) policy has been to achieve 48 inches over acid producing materials based on OSM guidelines for acid generating wastes. associated with coal mining.
- Mountain soil occupying slopes ranging from nearly level to greater than 65% (1.5H:1V) slopes average (unweighted) 30 inches of suitable (effective root zone) soil growth medium (A and B horizon materials) (Noel and Houlton 1991).
- The minimum thickness of suitable cover soil for mountain soil in the Little Rocky Mountains is approximately 16 inches (Noel and Houlton 1991).
- The less than 16-inch thickness criterion for replaced cover soil also applies to reclamation of facilities and disturbed areas in the Goslin Flats and Ruby Flats areas - both steeper sloped areas (side slopes) and more level to gently sloping areas (tops of reclaimed facilities and surrounding and roaded areas adjacent to major facilities).
- Results of previous research on minimum and optimum replaced suitable soil thicknesses, supporting successful long-term establishment of a vegetative cover, indicate that replacement depths of 9 to 33 inches of topsoil/cover soil material promote the highest rates of plant establishment and greatest productivity on reclaimed areas in semi-arid environments (Barth and Martin 1982, Halversen et al. 1986, Pinchak 1983, Schuman and Taylor 1975, and USFS 1979).
- Categorization of impact for soil quantity and quality relative to pre-1979 disturbance conditions are based on the following criteria:

- Negative

Short-term (1-5 years)	- Low: New disturbance with salvage of cover soil materials
Long-term (5+ years)	- Low: Replacement of >16 inches of cover soil; 48 inches of total non-acid generating materials.
	Medium: 9-16 inches of cover soil; 30-48 inches of total non-acid generating materials.

<u>High</u>: <9 inches of cover soil; <30 inches of total non-acid generating materials.

Key background points and/or assumptions pertinent to estimation of soil loss due to erosion in excess of the significance criteria of 2 tons/acre/year for reclaimed slopes and surfaces are:

- Potential soil losses by water erosion from reclaimed disturbances located in the Zortman and Landusky mine areas have been estimated using the revised universal soil loss equation (RUSLE) (Renard et al. 1991), which is an update of the USLE (USDA 1978). Values for the variables in the RUSLE/USLE, A = R K L S C P, are listed below. Each value is supported by a brief explanation. Calculations of soil loss by reclaimed facility for each alternative are presented in Table 4.3-1.

A	The soil loss per unit area, expressed in units selected for a soil erodibility factor (K) and for the period selected for precipitation and runoff value (R). In practice, A is usually selected so to compute A in tons/acre/year.
R = 15	The precipitation and runoff value was provided by the data base for RUSLE and represents the value for Havre, Montana.
K = .21	The soil erodibility value selected as representative of the higher coarse fragment content soil (currently stockpiled and yet to be disturbed) to be placed on steeper slopes.
K = .40	The soil erodibility value selected as representative of the lower coarse fragment content, finer textured soil yet undisturbed in the Goslin Flats area to be placed on less steep (<5 percent slopes) facilities tops.
L	The length of slope value - estimated slope lengths (distances between slope break benches) are presented by facility for each alternative in Table 4.3-1. Slope lengths of 200 feet are considered excessive by the agencies.
S	Slope gradient in percent - slopes for facilities by alternative are presented in Table 4.3-1 - side slopes are 50 percent (2H:1V) to 33 percent (3H:1V) depending on alternative and site; slopes of facilities tops are 5 percent of all alternatives.
C	Cover and management values - values used for this factor varied with (1) period of vegetation establishment, short-term equal to less than 3 years, long-term equal to period of 3 years and beyond; (2) slope as represented by side slopes for each facility by alternative and the tops for all facilities, all alternatives (5 percent slopes). Values for C are presented in Table 4.3-1.
P	Supportive practice value - This value represents the natural topographic features or range conservation practices that slow runoff to varying degrees. The value of 1.0 was used in all calculations presented in Table 4.3-1; a value of 1.0 represents conditions of uniform slopes and smooth surface water flow.

- A detailed presentation of the RUSLE calculations for the major Zortman and Landusky mine facilities was prepared and submitted to the agencies' project file to serve as a reference document.

- Categorization of impacts for soil loss are based on the following criteria:

  - <u>Negative</u>

    Estimated soil loss (both short- and long-term) greater than 2 tons/acre/year - <u>high</u>, significant impact

    Estimated soil loss (both short- and long-term) between 1 and 2 tons/acre/year - <u>medium</u> impact

    Estimated soil loss (both short- and long-term) less than 1 ton/acre/year - <u>low</u>

TABLE 4.3-1

SUMMARY OF SOIL LOSS RATE FOR EACH ALTERNATIVE AND MAJOR FACILITIES AT ZORTMAN AND LANDUSKY MINES[1]

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6		Alternative 7	
Facility	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)
<u>Zortman</u>														
• 79/80/81 Pad													N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40	3.13	1.04	3.13	1.04	3.13	1.04	3.13	1.04		
- Top Areas	0.15	0.06	0.15	0.06	0.10	0.03	0.10	0.03	0.10	0.03	0.10	0.03		
• 82 Pad													N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40	3.13	1.04	3.13	1.04	3.13	1.04	3.13	1.04		
- Top Areas	0.19	0.08	0.19	0.08	0.13	0.03	0.13	0.03	0.13	0.03	0.13	0.03		
• 83 Pad													N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40	3.13	1.04	3.13	1.04	3.13	1.04	3.13	1.04		
- Top Areas	0.21	0.09	0.21	0.09	0.14	0.04	0.14	0.04	0.14	0.04	0.14	0.04		
• 84 Pad													N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40	3.13	1.04	3.13	1.04	3.13	1.04	3.13	1.04		
- Top Areas	0.23	0.10	0.23	0.10	0.16	0.04	0.16	0.04	0.16	0.04	0.16	0.04		
• 85/86 Pad					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40										
- Top Areas	0.22	0.09	0.22	0.09										
• 89 Pad													N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40	3.13	1.04	3.13	1.04	3.13	1.04	3.13	1.04		
- Top Areas	0.19	0.08	0.19	0.08	0.13	0.03	0.13	0.03	0.13	0.03	0.13	0.03		
• Alder Gulch WRD					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
- Sideslopes	6.06	2.37	6.06	2.37										
- Top Areas	0.22	0.09	0.22	0.09										
• OK WRD					N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
- Sideslopes	6.12	2.40	6.12	2.40										
- Top Areas	0.19	0.08	0.19	0.08										
• Goslin Flats Pad	N/A	N/A	N/A	N/A	N/A	N/A			N/A	N/A				
- Sideslopes							3.74	1.25			3.74	1.25	2.70	0.90
- Top Areas							0.24	0.06			0.24	0.06	0.19	0.05

TABLE 4.3-1 - SUMMARY OF SOIL LOSS RATE FOR EACH ALTERNATIVE
(Continued)

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6		Alternative 7	
Facility	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)
• Carter Gulch WRR - Sideslopes - Top Areas	N/A	N/A	N/A	N/A	N/A	N/A	4.48 0.23	1.50 0.06	3.13 0.23	1.04 0.06	N/A	N/A	N/A	N/A
• Upper Alder Gulch Pad - Sideslopes - Top Areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.13 0.31	1.04 0.08	N/A	N/A	N/A	N/A
• Ruby Flats WRR - Sideslopes - Top Areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.13 0.24	1.04 0.06	N/A	N/A
• Alt. #7 WRC - Sideslopes - Top Areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.59 0.19	0.86 0.05
COMBINED SOIL LOSS	4.9	1.9	4.9	1.9	2.5	0.8	2.6	0.8	2.2	0.7	2.4	0.8	2.1	0.7
Landusky														
• 79 Pad - Sideslopes - Top Areas	6.12 0.15	2.40 0.06	6.12 0.14	2.40 0.05	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	2.41 0.06	0.72 0.01
• 80/82 Pad - Sideslopes - Top Areas	6.12 0.17	2.40 0.07	6.12 0.15	2.40 0.06	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	2.41 0.07	0.72 0.01
• 83 Pad - Sideslopes - Top Areas	6.12 0.15	2.40 0.06	6.12 0.14	2.40 0.05	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	2.41 0.06	0.72 0.01
• 84 Pad - Sideslopes - Top Areas	6.12 0.16	2.40 0.07	6.12 0.14	2.40 0.05	3.13 0.11	1.04 0.03	3.13 0.11	1.04 0.03	3.13 0.11	1.04 0.03	3.13 0.11	1.04 0.03	2.41 0.07	0.72 0.01
• 85/86 Pad - Sideslopes - Top Areas	6.12 0.18	2.40 0.08	6.12 0.16	2.40 0.06	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	2.41 0.08	0.72 0.01

TABLE 4.3-1 - SUMMARY OF SOIL LOSS RATE FOR EACH ALTERNATIVE
(Concluded)

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6		Alternative 7	
Facility	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)	Short Term (Tons/ Ac/Yr)	Long Term (Tons/ Ac/Yr)
• 87/91 Pad - Sideslopes - Top Areas	3.89 0.18	1.52 0.07	3.89 0.16	1.52 0.06	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	3.13 0.12	1.04 0.03	2.41 0.07	0.72 0.01
• Gold Bug WRD - Sideslopes - Top Areas	5.92 0.15	2.32 0.06	5.92 0.14	2.32 0.05	4.76 0.10	1.59 0.03	4.76 0.10	1.59 0.03	4.76 0.10	1.59 0.03	4.76 0.10	1.59 0.03	3.66 0.06	1.10 0.01
• Mill Gulch WRD - Sideslopes - Top Areas	5.75 0.17	2.25 0.07	5.75 0.15	2.25 0.06	4.63 0.12	1.54 0.03	4.63 0.12	1.54 0.03	4.63 0.12	1.54 0.03	4.63 0.12	1.54 0.03	3.56 0.07	1.07 0.01
• Montana Gulch WRD - Sideslopes - Top Areas	6.12 0.15	2.40 0.06	6.12 0.14	2.40 0.05	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	3.13 0.10	1.04 0.03	2.41 0.06	0.72 0.01
• Sullivan Park WRD - Sideslopes - Top Areas	6.12 0.16	2.40 0.07	6.12 0.14	2.40 0.05	4.92 0.11	1.64 0.03	4.92 0.11	1.64 0.03	4.92 0.11	1.64 0.03	4.92 0.11	1.64 0.03	3.79 0.07	1.14 0.01
• August #1, #2 WRD - Sideslopes - Top Areas	N/A	N/A	N/A	N/A	4.92 0.10	1.64 0.03	4.92 0.10	1.64 0.03	4.92 0.10	1.64 0.03	4.92 0.10	1.64 0.03	N/A	N/A
COMBINED SOIL LOSS	3.8	1.5	3.8	1.5	2.8	0.9	2.8	0.9	2.8	0.9	2.8	0.9	2.1	0.6

*(1) A detailed presentation of the RUSLE calculations for the major Zortman and Landusky Mine Facilities was prepared and submitted to the Agencies' project file dated 7/21/95.

4.3.2 Impacts from Mining, 1979 to Present

Past implementation of exploration and mining-related activities has resulted in the disturbance and alteration of in-place, natural soil in both the Zortman and Landusky mine areas.

Prior to 1979, mining activities resulted in the disturbance of approximately 54 acres in the Zortman and Landusky mine areas. Soil were affected by excavations of adits and burial beneath waste rock dumps. With the onset of modern and more extensive mining efforts in 1979, negative impacts to native soil have resulted from the clearing of protective vegetation, the excavation and storage of cover soil materials (including topsoil and suitable subsoil), the exposure and subsequent loss of disturbed soil materials to wind and water erosion, and the loss of soil productivity (vegetative) in areas replaced by exploration roads and mining facilities, including open pits, heap leach facilities, waste rock storage areas, roads, processing areas, cover soil stockpiles, land application areas, and shop and storage areas. Probable direct negative effects on soil that have resulted from exploration, and the construction and operation of mine-related facilities/ activities include the following:

- Loss/interruption of pedogenic (soil) development, including breakdown of soil structure and some mixing of distinct soil horizons
- Loss of soil material to erosion due to disturbance and exposure to forces of erosion
- Alteration of biological and nutrient conditions in soil materials stored in piles for extended periods
- Compaction of soil materials beneath facilities and in areas of natural soil crossed by vehicular traffic
- Loss or reduction of soil productivity

Excavation, transportation, and construction of cover soil material stockpiles have affected the breakdown of soil aggregates into loose soil particles, and increased the potential for wind and water erosion on the stockpiles. Storage of cover soil materials can further aggravate the breakdown of natural aggregates and alter the favorable nutrient and microbiotic condition commonly present in soil. Measures to stabilize and protect soil stockpiles are described in reclamation plans attached as appendixes to the separate permitted plans of operation, which address committed mitigation for Zortman and Landusky mines (ZMI 1994a and 1993). These measures have been or would be implemented to control soil loss and prevent additional disturbance to stockpiled cover soil.

Direct impacts to soil, as described above for mining activities during the 1979-to-present period, separately, and certainly collectively, can be classified as negative, high. Although no significance criteria have been defined for these impacts on the soil resource if the soil was not salvaged, the effects would be negative and significant, particularly as the soil disturbance affects the loss of productivity of the land (the removal of vegetation), the loss of wildlife habitat, the change in visual aesthetics, and the alteration of watershed characteristics. However, the stockpiling of cover soil has provided a basis for mitigating much of these effects when the soil is subsequently replaced.

Upon reclamation and replacement of stockpiled cover soil to a depth of 8 inches, direct impacts would be negative, low for at least the short-term (1-5 years) as soil are returned to a similar position in the landscape and recovery of productivity (reclaimed area and soil) is allowed to begin. Long-term (beyond 5 years) impacts are anticipated to be negative, and low to high depending on local conditions affecting cover soil quality and the protective, stabilizing vegetation it supports. If the growth medium is less than 30 inches thick, negative, medium to high impacts would result when:

- Soil loss exceeds new soil development on steep long slopes and acid producing materials are exposed and washed down the slope onto other areas;
- Roots are confined by the underlying, acid-producing materials and plant growth and cover may be limited by the lack of suitable soil depth; lack of protective vegetative cover may result in accelerated soil erosion, particularly on steep, long slopes;
- Lateral, acidic seeps exiting ore and waste rock facilities on lower slopes contaminate local and/or downslope soil;
- Acidifying moisture moves by capillary action up into the cover soil from acid generating waste, ore, or in-place rock below; and

- Indirect impacts of increased flows off of reclaimed facilities on to soil in downstream drainages.

Direct impacts of soil contamination by acidifying moisture from substrates or lateral seeps would be toxic to protective vegetation on reclaimed facilities. Vegetative cover would be reduced which would result in increased run-off and accelerated erosion. Increased flows of potentially acidic moisture would result in the indirect effect of soil contamination from the acidic runoff and deposition of eroded, contaminated soil.

Current (permitted) areas of disturbance by mining activities total 401 acres for the Zortman Mine and 814 acres for the Landusky Mine (DSL/BLM 1993a,b). Stockpiled cover soil volumes available for use in reclamation of existing disturbance at the Zortman Mine and Landusky Mine are estimated to be 183,000 yd^3 and 2,172,000 yd^3, respectively (Section 3.3). If stockpiled cover soil were to be used only for their respective mine area, cover soil volumes are sufficient to cover 375 surface acres (assumes 334 acres at 2H:1V slope) of remaining unreclaimed area (401 acres of total current disturbance minus 67 acres currently reclaimed) at Zortman Mine with approximately 4.0 inches of cover soil, and the 747 surface acres (assumes 667 acres at 2H:1V slope) of remaining unreclaimed area (814 acres of total current minus 147 acres currently reclaimed) at the Landusky Mine with approximately 24 inches of cover soil.

Replacement of only 4 inches of cover soil over Zortman Mine areas would result in significant negative high impacts in the long-term as a 4-inch thickness of cover soil is insufficient for long-term support of a stabilizing cover of vegetation, especially on steep slopes over acid generating materials. Reduced vegetative cover would result in accelerated erosion and soil loss. Replacement of 24 inches of cover soil over Landusky Mine areas would result in direct negative medium impacts. Cover soil loss would remain a potential, but the likelihood would be reduced due to increased thickness of cover soil layer.

4.3.3 Impacts from Alternative 1

Redevelopment of a soil profile on reclaimed areas is accelerated by redistribution of stockpiled cover soil as a soil cover over final graded surfaces. (For the purposes of this analysis, it has been assumed that cover soil would be distributed over all disturbed areas/facilities.)

Cover Soil Quality

With the passage of time, inherent fertility levels originally present in salvaged cover soil are decreased due to reductions in organic matter content and microbial activity. The return of the cover soil material to the surface would restore the material to its pre-disturbance position and increase the potential for the reestablishment of vegetation, erosion control, and soil development.

Limitations to successful vegetation reestablishment would be overcome by the supplemental addition of fertilizers and organic amendments as outlined in the reclamation programs presented in Section 2.6. Salvaged, currently stockpiled cover soil at Zortman and Landusky generally have high coarse fragment (larger than sand-sized) contents of 35 to 50 percent and greater. High coarse fragment contents in cover soil have been classified as less desirable plant growth media under some conditions. In this case, the stockpiled cover soil materials are native topsoil and some subsoil. By replacing these soil materials, the native soil system that took up to 10,000 years to develop would at least be partially salvaged.

Cover Soil Quantity and Thickness

A minimum of 8 inches of cover soil over 233 acres of Zortman disturbances would require approximately 250,600 yd^3, which is 67,600 yd^3 more than the 183,000 yd^3 currently available in cover stockpiles in the Zortman Mine area. The importation of 67,600 yd^3 of cover soil from Landusky cover soil stockpiles would leave approximately 2,104,400 yd^3 for the reclamation of the Landusky Mine area. To achieve an 8-inch cover of soil over 650 acres of Landusky disturbances, approximately 699,100 yd^3 of cover soil would be required. Use of Landusky's stockpiled cover soil at both Zortman and Landusky for an 8-inch cover would leave approximately 1,405,300 yd^3 of cover soil in stockpiles in the Landusky Mine area. Equal distribution of the remaining 1,405,300 yd^3 of stockpiled cover soil over the Landusky facilities alone or the combined 883 acres of Zortman and Landusky facilities would result in the placement of an additional 16 inches (24 inches total) at Landusky and approximately 12 inches (20 inches total) at both mines, respectively.

The 8 inches of cover soil would provide a minimal growth medium for plants on the disturbances at closure. Mixed fill materials, exposed rock, waste rock, and leached ore are inferior growth media for plants due to their sterility, potential to produce acid, lack of organic matter, fertility, and suitable physical characteristics such as sufficient soil fines to hold moisture and nutrients. Due to the similarity in parent materials and soil development conditions, the importation of cover soil material to Zortman from Landusky would not effect vegetation response. The 8-inch thickness of cover soil should support the establishment of vegetation in the short-term (1-5 years). Direct impacts would be negative, medium for the short-term (1-5 years).

Previous research indicates that replacement depths of 9 to 33 inches of soil promote the highest rates of plant establishment and greatest productivity on reclaimed areas in semi-arid environments (Barth and Martin 1982, Halversen et al. 1986, Pinchak 1983, Schuman and Taylor 1978, and USFS 1979). The proposed cover soil thickness falls at the low end of the range of effective soil thicknesses even if 12 inches were used as discussed in Section 2.6.. In addition, the high coarse fragment content of the cover soil would reduce moisture and nutrient holding capacity. Less moisture would be available particularly during dry periods. Reduced availability of nutrients, particularly nitrogen, would occur due to leaching. As a result, the vegetation would be limited due to stressful soil moisture and nutrient conditions. Optimum cover soil/topsoil depth is defined as the depth or thickness at which the rate of increase of plant establishment or productivity, as a function of cover soil thickness, becomes small or static (Coppinger et al. 1993). The optimum replacement thickness is dependent on numerous factors including cover soil and overburden/substrate quality, precipitation, and topographic position.

On acid generating materials, long-term (greater than 5 years) direct impacts for placement of 8 inches of cover soil would be negative, high as previously described. In areas where 9 to 12 inches would be placed, long-term direct impacts would likely be negative, medium due to the greater cover soil thickness and improved soil moisture and nutrient retention capacities. Under favorable local conditions, 9 to 12 inches of cover soil may support a productive vegetation cover for the long-term if the substrate is not acid generating. With less than 30 inches of total non-acid generating growth media, impacts from 9-12 inches of soil replacement are assumed to be negative high.

Topsoil depths/thicknesses of 9 to 24 inches promote optimum establishment of perennial grasses over neutral overburden (Coppinger, et al 1993).The soil range noted above assumes that plants would eventually root into the overburden; thus, becoming part of the growth media. However, the development of acidic conditions in substrate materials, including exposed rock, waste rock, and leached ore, beneath the 8 inches of replaced cover soil would either preclude or restrict rooting. In addition, there is the potential that the cover soil layer could be lost by erosion and acidification due to the movement of acidic moisture from:

- The acidified substrate up into the cover soil by soil absorption and capillary rise (driven by the evaporation of moisture from the soil surface)
- Lateral, acidic seeps exiting ore and waste rock facilities on lower slopes

Should acidic conditions develop in the cover soil, the affected area would have a much reduced cover of vegetation due to intolerance for acidic soil conditions. Under this condition, the susceptibility of the cover soil to accelerated erosion would increase. Given the shallow nature of the cover soil, soil losses could expose the underlying acid generating substrate, which could exacerbate soil losses above and below the affected area. In addition, cover soil placed in pit bottoms and on benches could become acidified by acidic runoff from exposed acid-generating surfaces on pit highwalls. Long-term impacts would remain negative high for 8-12 inch soil covers.

Indirect negative effects would include potential increased seepage levels within the substrate materials which could surface downslope affecting vegetation. Stressed plants and subsequent reduced cover provided by plant canopies and litter provide less resistance to the forces of water erosion and increased potential for accelerated soil loss.

Cover Soil Erosion

Zortman Mine Facilities - Potential soil losses from reclaimed areas/facilities at the Zortman and Landusky mines have been estimated using the RUSLE (A=R K L S C P) (see Section 4.3.1). For Zortman Mine leach pads and waste dump facilities to be reclaimed under this alternative, estimated short-term soil losses (1-5 years) from side slopes (2H:1V) would be approximately 6.1 tons/acre/year for all facilities (Table 4.3-1). Lengths of side slopes between benches would be 224 feet for all facilities with the exception of the 250 foot slope lengths for the Alder Gulch waste dump. The 6.1 tons/acre/year rate of soil loss equals a rate of approximately 0.034 inches/year of soil loss from each facilities' side slopes. A loss of one inch of soil from these surfaces would take approximately 29 years. Direct negative short-term impacts due to soil loss and the reduction in thickness and volume of plant growth medium would be significant high for all facilities.

Estimated long-term soil losses (beyond 5 years) from side slopes of Zortman Mine facilities would be approximately 2.4 tons/acre/year. The 2.4 tons/acre/year rate of soil loss equals a rate of approximately 0.013 inch/year of soil loss from each facilities' side slopes. The loss of one inch of soil would require approximately 77 years. Direct negative long-term impacts would be high.

Soil loss from flatter top areas of the leach pads and waste dumps and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term (Table 4.3-1). Direct negative short- and long-term impacts on flatter areas would be low for all facilities and areas.

Combined soil loss from the major Zortman Mine facilities would be approximately 4.9 tons/acre/year in the short-term and 1.9 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 75 percent of reclaimed areas due to loss of the limited soil cover and soil acidification, soil loss would likely increase and impacts would be negative high for all reclaimed surfaces.

Landusky Mine Facilities - Short- and long-term rates of soil loss and levels of impact for side slopes of most Landusky Mine facilities would be the same as those described above for the Zortman Facilities as proposed slope angles (2H:1V) and lengths (224 feet) for the Landusky Mine facilities are similar to those for the Zortman Mine. Exceptions are the Gold Bug waste repository (2.5H:1V and 269 feet long slopes), Mill Gulch waste repository (assumed 2.75H:1V and 293 feet long slopes), and the 87/91 leach pad (3H:1V and 200 feet long slopes). Again in the short-term, the 6.1 tons/acre/year rate of soil loss equals a rate of 0.034 inch/year and would require approximately 29 years for a one inch soil loss. The rate of soil loss from side slopes of the Gold Bug waste repository of 5.9 tons/acre/year equals a rate of 0.033 inch/year (30 years per inch of soil loss). The rate of soil loss from side slopes of the Mill Gulch waste repository of 5.8 tons/acre/year equals a rate of 0.032 inch/year (31 years per inch of soil loss). The rate of soil loss from side slopes of the 87/91 leach pad of 3.9 tons/acre/year equals a rate of 0.021 inch/year (48 years per inch of soil loss). Direct negative short-term impacts on most steeper side slopes would be significant high.

Estimated long-term soil losses (beyond 5 years) from side slopes of Landusky Mine facilities would exceed 2 tons/acre/year (approximately 2.3 to 2.4 tons/acre/year) for all facilities with the exception of the 87/91 leach pad (1.5 tons/acre/year). The rate of soil loss from side slopes of the 87/91 leach pad equals a rate of 0.008 inch/year (125 years per inch of soil loss); the remaining facilities' rates of soil loss equal 0.012 to 0.013 inch/year (83 to 77 years per inch of soil loss). Direct negative long-term impacts on most steeper side slopes would be significant high with the exception of side slopes of the 87/91 leach pad.

Direct negative short- and long-term impacts would for the flatter tops would be low for all facilities.

Combined soil loss from all Landusky Mine facilities would be approximately 3.8 tons/acre/year in the short-term and 1.5 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 75 percent of reclaimed areas due to loss of the limited soil cover and soil acidification, soil loss would likely increase and impacts would be negative high for all reclaimed surfaces.

Additional Actions

Reclamation of the Seaford and Williams clay pits and the King Creek limestone quarry under the specifications of this alternative would effectively restore the disturbed lands to comparable stability and utility. Grading to maximums of 3H:1V slopes and limited slope lengths would limit excessive soil loss due to erosion and 12 inches of cover soil over non-acid generating substrate may provide a growth medium comparable to adjacent undisturbed areas. However, replacement of 12 inches of cover soil may be a limiting factor for long-term vegetation establishment under adverse precipitation conditions.

Soil of the approximately 285 acres in the Goslin Flats area to be used for the treatment and disposal of excess mining solutions would be affected by minor disturbances of limited compaction/rutting and loss of vegetative cover due to vehicular traffic associated with the construction and ultimate demolition of the spray system. The dilute nature of the barren solution to be sprayed onto the soil and the adequate adsorption capacity would result in the effective capture of most metals and other deleterious substances in the waste stream (Schafer and Associates 1993). Accumulations of most trace elements would not concentrate in levels that pose a threat to vegetation, human health, or any waters of the state. Possible exceptions would be some metals, such as cadmium and arsenic which could desorb from some soil and be leached deeper into the soil profile.

4.3.3.1 Cumulative Impacts

Further mining at the Zortman and Landusky mines beyond that already permitted would not be allowed under this alternative. It is assumed that 75 percent of reclaimed areas would fail (934 acres out of 1,245 acres). Additional reclamation and remediation measures would be required. Such measures would require the redisturbance and/or new disturbance of areas to access reclamation materials for use in improved cover systems and to remove and dispose of ineffective cover materials and contaminated materials. Past disturbance of soil total 1,245 acres including:

- 54 acres of historic mining disturbance from activities occurring prior to 1978;
- 1,161 acres of recent mining disturbance (both mines) between 1979 and the present;
- 33 acres of past disturbance from activities at the Seaford and Williams clay pits and the King Creek Quarry (limestone); and

During recent mining activities (post 1978), soil materials have been salvaged and stockpiled for use in reclamation of the disturbed areas.

4.3.3.2 Unavoidable Adverse Impacts

It is assumed that 75 percent of the reclaimed areas would eventually fail from erosion of the cover soil on steep, long slopes. In addition, some migration of acidic moisture from underlying acid forming waste or parent rock would occur. On 934 acres, over 10,000 years of soil development would be lost. Soil parent materials would have to oxidize over time and soil development would take centuries to recover.

4.3.3.3 Short-term Use/Long-term Productivity

Assuming 25 percent of disturbed acres are successfully reclaimed, soil development would occur in a relatively short time. On 75 percent of reclaimed acres, soil would be lost and long-term productivity of the soil system would be delayed for centuries. Comparable stability and utility would not be achieved in the post-mine landscape.

4.3.3.4 Irreversible or Irretrievable Resources Commitments

The removal of vegetation and the excavation, storage and subsequent replacement of soil as part of mine construction, operations and reclamation has resulted in the irreversible loss of thousands of years of soil development.

Replacement of soil materials during reclamation enhances the restoration of soil development and soil productivity. Unused stockpiled cover soil materials left in stockpiles is a valuable resource which would be wasted if not used in reclamation as surface cover.

On 75 percent of reclaimed acres (934 acres), replaced soil is assumed to be lost from erosion and contamination from acid producing mine wastes and water. The complete loss of over 10,000 years of soil development would occur. Over 1,000,000 yd^3 would be lost.

4.3.4 Impacts from Alternative 2

Effects from the redistribution of stockpiled cover soil over final graded surfaces in Alternative 1 are enhanced in Alternative 2 from the placement of Reclamation Cover A, a compacted, low hydraulic conductivity 6-inch clay layer beneath the 8-inch cover soil layer (Section 2.7.2.2) over all mine disturbance areas tested to be acid producing. (For the purposes of this analysis, it has been assumed that 6 inches of compacted clay and 8 inches of cover soil would be distributed over all mine waste units.) Clay could only be applied to slopes 2.5H:1V or less.

Cover Soil Quality

Impacts and limitations posed by stockpiled cover soil for both Zortman and Landusky would be as described for Alternative 1. The compacted clay layer is a physical barrier to plant roots and soil moisture. The bentonite clay is essentially neutral and would provide soil moisture storage and rooting depth as it weathers.

Cover Soil Quantity and Thickness

A minimum of 8 inches of cover soil over 300 acres of Zortman facilities would require approximately 322,600 yd^3, which is 139,600 yd^3 more than the 183,000 yd^3 currently available in cover stockpiles in the Zortman Mine area. The importation of 139,600 yd^3 of cover soil from Landusky cover soil stockpiles would leave approximately 2,032,400 yd^3 for the reclamation of the

Landusky Mine area. To achieve an 8-inch cover of soil over 650 acres of Landusky facilities, approximately 699,100 yd^3 of cover soil would be required. Use of Landusky's stockpiled cover soil at both Zortman and Landusky for an 8-inch cover would leave approximately 1,333,300 yd^3 of cover soil in stockpiles in the Landusky Mine area. Equal distribution of the remaining 1,333,300 yd^3 of stockpiled cover soil over the Landusky facilities alone or the combined 950 acres of Zortman and Landusky facilities would result in the placement of an additional 15 inches (23 inches total) at Landusky or approximately 10 inches (18 inches total) at both mines, respectively.

The presence of a low hydraulic conductivity clay layer beneath the cover soil layer would in the short-term:

- Improve moisture retention in the 8 inches of cover soil by limiting moisture loss from the cover soil layer to the substrate below - more water would be available to sustain plants

- Delay any migration of acidic moisture from acid generating substrate into the cover soil layer

These effects on soil benefit vegetation productivity and cover, and erosion control. However, the 14-inch clay/cover soil system has several potential problems:

- The cover soil layer could acidify and erode leaving the clay layer exposed on steep, long slopes. The clay layer would then erode away.

- Saturated soil moisture conditions at the cover soil - clay layer interface could result in slippage of the cover soil layer, particularly on steeper slopes (2.5H:1V). The clay layer would then erode away.

- The shallow depth to the clay layer places the layer within the frost zone. Freeze/thaw cycles would compromise the integrity of the compacted clay layer. In addition, drying and subsequent cracking of the bentonitic clay layer would destroy the compacted clay layer and increase the hydraulic conductivity.

Should the soil/clay cover be compromised, indirect adverse effects of increased seepage would likely result as described in Alternative 1. It would not take longer for effects to show in a 14-inch layer rather than an 8-inch layer.

Cover Soil Erosion

Impacts to Zortman and Landusky mines areas are the same as described for Alternative 1, even though the clay would delay exposure of the acid-producing substrate. It is assumed that 65 percent of the reclaimed acres would eventually fail from erosion and soil acidification over the long-term.

Additional Actions

In response to needs for clay to be used in reclamation covers at the Zortman Mine, an additional 3 acres of disturbance involving soil salvage and stockpiling would occur at the Seaford clay pit. An additional 6 acres of disturbance including topsoil salvage would occur at the Williams clay pit as a result of clay mining for cover materials. Impacts to soil from new disturbance would be as described in Section 4.3.2. Both facilities would be reclaimed using on-site, stockpiled cover soil and revegetation measures presented in Section 2.6.2.9.

Impacts to soil as a result of land application of waste mining solutions would be as described above for Alternative 1. Completion of reclamation measures proposed under this alternative would be effective in restoring stability and utility as described in Section 4.3. Direct short-term negative impacts would be low for all pits and quarry as cover soil would be salvaged, stockpiled, and replaced at reclamation. Long-term negative impacts would be low to medium due to potential limitations associated with 12 inches of cover soil.

4.3.4.1 Cumulative Impacts

Cumulative impacts for activities under Alternative 2 are essentially similar to Alternative 1 except that 9 additional acres would be disturbed from activities at the clay pits and limestone quarries. It is assumed that 65 percent (815 acres) would fail. Total disturbance is 1,254 acres of disturbance.

4.3.4.2 Unavoidable Adverse Impacts

It is assumed that 65 percent of the reclaimed areas would eventually fail from erosion of the cover soil and subsequent erosion of the clay layer on long, steep slopes.

On 815 acres, over 10,000 years of soil development would be lost. Soil would have to oxidize over time and soil development would take centuries to recover. In addition, new disturbances of soil at the Seaford and Williams clay pits would be unavoidable long-term negative actions necessary for the improved reclamation potential for the Zortman and Landusky mines.

4.3.4.3 Short-term Use/Long-term Productivity

Assuming 35 percent of disturbed areas are successfully reclaimed, soil development would occur in a relatively short time. On 65 percent of reclaimed areas, soil would be lost and long-term productivity of the soil system would be delayed for centuries. Comparable stability and utility would not be achieved in the post-mine landscape.

4.3.4.4 Irreversible or Irretrievable Resources Commitments

Commitments of soil resources for Alternative 2 would be similar to those described for Alternative 1 except that 65 percent or 815 acres of soil loss occurs, and 900,000 yd^3 of soil would be lost and over 650,000 yd^3 of clay are wasted.

4.3.5 Impacts from Alternative 3

Effects from the redistribution of stockpiled cover soil over final graded surfaces in Alternative 2 are enhanced in Alternative 3 by:

- Reduction of slopes from approximately 2H:1V to 3H:1V (2.5H:1V for dikes) and placement of Reclamation Covers B (slopes greater than 5 percent) and Modified C (slopes less than 5 percent) on all heap leach facilities within the Zortman Mine complex including those previously reclaimed with approximately 8 inches of cover soil over unclassified mine wastes

- Reduction of slopes from approximately 2H:1V to 3H:1V and placement of Reclamation Covers B and Modified C on all heap leach waste rock dumps (Mill Gulch dump already covered by a cover system similar to B), and pit bottoms/fill surfaces within the Landusky Mine complex

(For the purposes of this analysis, it has been assumed that 6 inches of compacted clay and 8 inches of cover soil would be distributed over all remaining disturbed areas/facilities not covered by the Reclamation Covers B or Modified C).

Cover Soil Quality

Impacts and limitations posed by stockpiled cover soil for both Zortman and Landusky mines would be as described for Alternative 2.

Cover Soil Quantity and Thickness

Soil volumes, thicknesses, and limitations would be the same as Alternative 2 except the presence of a 36-inch thick capillary break layer underlain by either a compacted clay layer (Cover B) or a combination of synthetic liner and clay layer would:

- Improve moisture availability to plants by providing additional material below the 8 inches of cover soil for moisture retention and increased rooting depths

- Prevent acidification of the cover soil layer by migration of moisture from the acid generating substrates. The potential for lateral movement of acidic seepage into soil downslope remains a possibility.

- Minimize potential failures of the covers by providing: 1) an erosion resistant layer (capillary break); 2) a drainage layer to channel excess water away at the capillary break or liner shield and clay layer or synthetic liner interface, respectively; and 3) an increased depth to the clay layer so that it is protected from desiccation and freeze/thaw effects.

Impacts regarding cover soil thickness would be negative, medium in both the short- and long-term. The impacts associated with soil loss and acidification of the cover soil would be reduced to an assumed loss of only 5 percent of reclaimed acres by the addition of the capillary break and clay layers to the cover system. Placement of 8 inches of cover soil would limit development of vegetative cover and productivity for an extended period of time but is adequate to set the stage for soil succession to begin again.

Cover Soil Erosion

Zortman Mine Facilities - For Zortman Mine facilities to be reclaimed under this alternative, estimated short-term soil losses (1-5 years) from side slopes (slopes of 3H:1V and slope lengths of 200 feet) would be 3.1 tons/acre/year for all facilities (Table 4.3-1). The 3.1 tons/acre/year rate of soil loss equals a rate of approximately 0.017 inches/year of soil loss from each facilities' side slopes. A loss of one inch of soil from these surfaces would take approximately 59 years.

Direct negative short-term impacts would be significant, high for soil loss from all facilities.

Estimated long-term soil losses (beyond 5 years) from side slopes of Zortman Mine facilities would be approximately 0.10 tons/acre/year (Table 4.3-1). The 0.98 tons/acre/year rate of soil loss equals a rate of approximately 0.006 inches/year of soil loss from each facilities' side slopes. The loss of one inch of soil would require approximately 162 years. Direct negative long-term impacts would be medium.

Soil loss from the flatter top areas of the Zortman Mine facilities and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term. Direct negative short- and long-term impacts on the flatter tops and other areas would be low.

Combined soil loss from all Zortman Mine facilities would be approximately 2.5 tons/acre/year in the short-term and 0.8 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 5 percent of reclaimed areas due to loss of the limited soil cover and soil acidification, soil loss would likely increase and impacts would be negative high for those limited areas and low for most others.

For Landusky Mine leach pads and waste dump facilities to be reclaimed under this alternative, estimated short-term soil losses (1-5 years) from side slopes range from 3.2 to 4.9 tons/acre/year (Table 4.3-1); slopes for most facilities would be reduced to 3H:1V slopes and slope lengths of 200 feet. Exceptions are the Gold Bug waste repository (2.5H:1V and 269 feet long slopes), Mill Gulch waste repository (assumed 2.75H:1V and 293 feet long slopes), the Sullivan Park waste repository (2H:1V and 224 feet long slopes), and the August Nos. 1 and 2 waste dumps (2H:1V and 224 feet long slopes). Soil loss from facility side slopes would range from 0.017 to 0.027 inch/year (59 to 37 years per inch of soil loss, respectively). Direct negative short-term impacts due to soil loss and the reduction in thickness and volume of plant growth medium would be significant, high for all facilities.

Estimated long-term soil losses (beyond 5 years) from side slopes of Zortman Mine facilities would range from 1.0 to 1.6 tons/acre/year (Table 4.3-1). The 1.0 and 1.6 tons/acre/year rate of soil loss equal rates of approximately 0.006 and 0.009 inches/year of soil loss from facilities' side slopes. The loss of one inch of soil would require approximately 166 and 111 years, respectively. Direct negative long-term impacts would be medium.

Soil loss from flatter top areas of the leach pads and waste dumps and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term. Direct negative short- and long-term impacts on flatter top and areas would be low.

Combined soil loss from all Landusky Mine facilities would be approximately 2.7 tons/acre/year in the short-term and 0.9 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 5 percent of reclaimed areas due to loss of soil cover and soil acidification, soil loss would likely increase and impacts would be negative, high for those limited areas while remaining mostly low for unaffected areas.

Additional Actions

In response to needs for clay and limestone to be used in reclamation of the Zortman Mine, an additional 3.5 acres of the Seaford clay pit and 13 acres of a new limestone quarry located near Shell Butte would be disturbed including soil salvage, slopes permitting. An additional 9 acres of the Williams clay pit would be disturbed, including soil salvage, to provide reclamation materials for the Landusky Mine. Approximately 19 acres would be disturbed to remove limestone from the King Creek quarry. Impacts to soil from new disturbance would be as described in Section 4.3.2. These reclamation material source areas would be reclaimed as described in Section 2.8.2.6 (Zortman Mine) and Section 2.8.4.6 (Landusky Mine). Completion of reclamation measures proposed under this alternative would be effective in restoring stability and utility as described in Section 4.3.3. Direct short-term negative impacts would be low for all pits and quarry as cover soil would be salvaged, stockpiled, and replaced at reclamation. Long-term negative impacts would be low to medium due to potential limitations associated with 12 inches of cover soil.

Impacts to soil as a result of land application of heap rinsate would be as described above for Alternatives 1 and .

4.3.5.1 Cumulative Impacts

Cumulative impacts from Alternative 3 include 44.5 more acres of new disturbance over Alternative 1 and 35.5 more acres than Alternative 2 for reclamation materials. It is assumed that only 5 percent of reclaimed acres would fail (65 acres out of a total 1,290 acres).

4.3.5.2 Unavoidable Adverse Impacts

It is assumed that 5 percent of the reclaimed areas would eventually fail from erosion of the cover soil on long, steep slopes.

On 65 acres, over 10,000 years of soil development would be wasted. Soil would have to oxidize over time and soil development would take centuries to recover.

New disturbances of soil at the Seaford and Williams clay pits, the King Creek quarry, and the new Zortman Mine limestone quarry (LS-1) would be unavoidable actions necessary for the improved reclamation potential for the Zortman and Landusky mines.

4.3.5.3 Short-term Use/Long-term Productivity

The relatively short-term use and replacement of soil materials previously salvaged during mine development would result in improved long-term productivity of the affected lands as compared to Alternatives 1 and 2. Limited soil are protected by 36 inches of limestone. Only 5 percent of the reclaimed area is assumed to fail, soil development would occur in a relatively short time on 1,225 acres out of 1,290 acres. Comparable stability and utility in the long-term would be achieved in the post-mine landscape.

4.3.5.4 Irreversible or Irretrievable Resources Commitments

Commitments of soil resources for Alternative 3 would be similar to those for Alternatives 1 and 2 except that 5 percent or 65 acres of soil loss occurs and only 70,000 yd^3 of soil and clay would be wasted. Unreclaimed acres would approximately equal acres disturbed in 1979.

4.3.6 Impacts from Alternative 4

Effects from redistribution of stockpiled cover soil over final graded surfaces would be similar to those of Alternative 3 where Reclamation Covers B and C would be used to cover disturbed areas at closure. Direct negative impacts to soil would result from mine expansion of 964 acres including the Goslin Flats heap leach facility and associated conveyor, ore crushing/handling facility, process facility, waste rock dump, and cover soil stockpile. Impacts to the soil resource located within the footprint of the above facilities would be similar to those described in Section 4.3.2 for mine development.

Cover Soil Quality

Effects and limitations posed by currently stockpiled and new soil salvaged in advance of mine expansion areas in the Little Rocky Mountains would be the same as those described in Section 4.3.3. Cover soil materials for use in the reclamation of both the Zortman and Landusky mines would be the same as Alternatives 1-3.

In contrast, soil in the Goslin Flats area have more potential uses in reclamation cover systems. Approximately 589,000 yd^3 of cover soil material (organic matter content greater than 0.5 percent) would be salvaged from approximately 250 acres beneath the heap leach pad, ore crushing/handling facility, and process facility. About 280,000 yd^3 are resistant to erosion based on soil characteristics including texture and coarse fragment content. These cover soil materials would be better suited for placement on steeper slopes (2.5H:1V-3H:1V). The remaining 309,000 yd^3 of finer soil would be generally less resistant to erosion and better suited for placement on more level areas. Other important quality considerations of Goslin Flats soil include:

1) none are acid producing; many contain $CaCo_3$ and would provide a net neutralizing effect;

2) textures vary and include some loams to clay loams which have large available water holding capacities; and

3) many subsoil are suitable at depth and would provide large volumes of quality soil materials as compared to the mountain soil.

Soil within the conveyor right-of-way would be bladed/windrowed into a berm on the edge of the right-of-way, revegetated, and subsequently bladed back over the cleared right-of-way and revegetated at closure as described in Section 2.9.2.6. Impacts would be mostly negative low to medium for soil erosion and ability to re-establish vegetation.

Soil beneath the proposed cover soil stockpile adjacent to the Goslin Flats heap leach pad would be buried beneath the stockpile for the life of the pile and subsequently ripped to break up any compaction and revegetated after cover soil redistribution at mine closure.

The above direct impacts to soil in the expansion area would be negative high resulting from 964 acres of disturbance in the short-term. Replacement of stockpiled cover soil would reduce impacts to low to medium.

Cover Soil Quantity and Thickness

Cover soil volume requirements for reclaiming existing disturbed areas within the Zortman and Landusky mine areas in the mountains are described in Alternative 1. Cover soil volume requirements for reclaiming approximately 568 and 30 surface acres of new disturbance associated with expansion of the Zortman Mine and miscellaneous disturbances within the Landusky Mine, respectively, are approximately 610,900 yd^3 and 78,500 yd^3. Assuming the remaining 1,333,300 yd^3 of cover soil stored in stockpiles at the Landusky Mine would meet the needs with approximately 690,400 yd^3 remaining in stockpiles.

A minimum of 8 inches of cover soil over 230 surface acres of the Goslin Flats heap leach would require approximately 247,500 yd^3 of cover soil material. Assuming approximately 80 acres for the nearly level top of the heap leach, approximately 86,000 yd^3 of the 309,000 yd^3 of soil suitable for placement on reduced slopes would be required. Approximately 220,000 yd^3 of material suitable for reduced slopes would remain. Assuming 150 surface acres for the 2.5H:1V slopes of the heap leach pile, approximately 162,000 of the 280,000 yd^3 of soil suitable for placement on steeper, 2.5H:1V slopes would be required. Approximately 118,000 yd^3 of material suitable for 2H:1V slopes would remain.

The effectiveness of the cover soil as a growth medium as part of Reclamation Covers B and C on the Goslin Flats heap leach pile would be similar to those effects described in Alternative 3 and impacts would be negative, medium in both the short- and long-term.

Cover Soil Erosion

Zortman Mine Facilities - For Zortman Mine facilities to be reclaimed under Alternative 4, estimated short-term soil losses (1-5 years) from side slopes (3H:1V and 200 feet long) would be 3.1 tons/acre/year for all facilities, with the exception of the Goslin Flats heap leach facility - 3.8 tons/acre/year from 2.5H:1V and 200 feet long slopes (Table 4.3-1). The 3.1 tons/acre/year rate of soil loss equals a rate of approximately 0.017 inches/year of soil loss from each facilities' side slopes; 3.8 tons/acre/year and 4.5 tons/acre/year equal rates of 0.021 and 0.025 inch/year of soil loss. A loss of one inch of soil from these surfaces of the Goslin Flats heap leach facility, Carter Gulch waste repository, and the other facilities would take approximately 48, 40, and 59 years, respectively. Direct negative short-term impacts would be significant, high for soil loss from all facilities. Estimated long-term soil losses (beyond 5 <years) from side slopes of the Goslin Flats heap leach facility, Carter Gulch waste repository, and the other Zortman Mine facilities would range from approximately 1.0 to 1.5 tons/acre/year (Table 4.3-1). The 1.0 and 1.5 tons/acre/year rates of soil loss equal a rate of approximately 0.006 to 0.008 inches/year of soil loss, respectively. The loss of one inch of soil would require approximately 166 and 125 years, respectively. Direct negative long-term impacts would be medium for all facilities.

Soil loss from the flatter top areas of the Zortman Mine facilities and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term. Direct negative short- and long-term impacts on the flatter tops/areas would be low.

Combined soil loss from all Zortman Mine facilities would be approximately 2.6 tons/acre/year in the short-term and 0.9 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 5 percent of reclaimed areas due to loss of soil cover and soil acidification, soil loss would likely increase and impacts would be negative high for those limited areas and low to medium for other areas.

Landusky Mine Facilities - Short- and long-term and combined direct negative impacts for Landusky Mine facilities would be the same as those described under Alternative 3. Five percent (110 acres) of reclaimed acres are assumed to fail from erosion on long, steep slopes and soil acidification over time.

Additional Actions

In response to needs for clay and limestone to be used in reclamation of the Zortman Mine area, and construction and reclamation of the Goslin Flats heap leach pile, an additional 10 acres of the Seaford clay pit and 13 acres of a new limestone quarry (LS-1) located near Shell Butte would be disturbed including soil salvage, slopes permitting. An additional 7 acres of the Williams clay pit and 36 acres of the King Creek limestone quarry would be disturbed, including soil salvage, to provide reclamation materials for the Landusky Mine. These reclamation material source areas would be reclaimed as described in Section 2.9.2.6 (Zortman Mine) and Section 2.9.4.6 (Landusky Mine).

Direct short-term negative impacts would be low for all pits and quarry as cover soil would be salvaged, stockpiled, and replaced at reclamation. Long-term negative impacts would be low to medium due to potential limitations associated with 12 inches of cover soil.

Impacts to soil as a result of land application of heap rinsate would be as described above for Alternatives 1-3.

4.3.6.1 Cumulative Impacts

Cumulative impacts for activities under Alternative 4 would come from disturbances to 964 acres of soil by proposed mine expansion at both Zortman and Landusky mines, assumed development of a mine in the Pony Gulch area in the reasonably foreseeable future, and from the expansion of reclamation materials source pits and quarries. Past and proposed new disturbance of soil include:

- 54 acres of historic mining disturbance from activities occurring prior to 1978
- 1,161 acres of recent mining disturbance (both mines) between 1979 and the present
- 964 acres of proposed new disturbance for both mines including 33 acres of proposed disturbance from activities at the clay pits and limestone quarries.
- 33 acres of past disturbance from activities at the Seaford and Williams clay pits and the King Creek Quarry (limestone)
- 155 acres of potential exploration

4.3.6.2 Unavoidable Adverse Impacts

It is assumed that 5 percent of the reclaimed acres would eventually fail from erosion on long, steep slopes and soil acidification. In addition, some migration of acidic moisture from underlying acid forming waste or parent rock would occur. On 110 acres, over 10,000 years of soil development would be wasted. Soil would have to oxidize over time and soil development would take centuries to recover.

New disturbances of soil in the Goslin Flats and mine areas and at the Seaford and Williams clay pits and the new Zortman Mine limestone quarry and King Creek limestone quarry would be unavoidable actions necessary for the effective mineral extraction and improved reclamation potential for the Zortman and Landusky mines.

4.3.6.3 Short-term Use/Long-term Productivity

The relatively short-term use and replacement of soil materials previously salvaged during mine development would result in improved long-term productivity of the affected lands as compared to Alternatives 1 and 2. Limited soil are protected by 36 inches of limestone. Only 5 percent of the reclaimed area is assumed to fail, and soil development would occur in a relatively short time on 2,099 acres out of 2,209 acres. Comparable stability and utility in the long-term would be achieved in the post-mine landscape.

4.3.6.4 Irreversible or Irretrievable Resources Commitments

Commitments of soil resources for Alternative 4 would be similar to those in Alternative 3 except that 5 percent of 110 acres of soil loss would occur. Only 120,000 yd^3 of soil and no clay would be wasted. Unreclaimed acres would be twice as much as existed in 1979. Unused stockpiled cover soil materials is a valuable resource which would be wasted if not used in reclamation as surface cover.

4.3.7 Impacts from Alternative 5

Effects from redistribution of stockpiled cover soil over final graded surfaces would be similar to those of Alternative 3 where Reclamation Covers B and Modified C would be used to cover disturbed areas at closure. Direct negative impacts to those few soil present would result from the proposed mine expansion of 1,025 acres including the Carter Gulch waste rock repository and Alder Gulch heap leach facility and associated ore crushing/handling facility, and process facility. Impacts to soil located within the footprints of the above facilities would be similar to those described in Section 4.3.2 for mine development.

Cover Soil Quality

Effects and limitations posed by currently stockpiled and new soil salvaged in advance of mine expansion areas in the Little Rocky Mountains would be the same as described in Section 4.3-3. Cover soil materials for use in the reclamation of both the Zortman and Landusky mines would be the same as Alternatives 1-3.

No soil salvage is planned for either the Upper Alder Gulch leach pad or the Carter Gulch waste rock depository due to steep slopes and lack of salvageable soil materials. Additional cover soil to reclaim these facilities would be obtained from the surplus of cover soil stockpiled at the Landusky Mine.

Direct impacts to soil in the expansion area would be negative high due to the disturbance of 1,025 acres in the short-term. Replacement of stockpiled cover soil would reduce impacts to negative low to medium.

Cover Soil Quantity and Thickness

Reclamation of facilities would be the same as Alternative 4.

Cover soil volume requirements for reclaiming existing disturbed areas within the Zortman and Landusky mine areas in the mountains are described in Alternative 1. Cover soil volume requirements for reclaiming approximately 405 and 30 surface acres of new disturbance associated with expansion of the Zortman Mine and miscellaneous disturbances within the Landusky Mine, respectively, are approximately 435,600 yd^3 and 32,200 yd^3. Assuming no soil salvage ahead of disturbance, the remaining 1,333,300 yd^3 of cover soil stored in stockpiles at the Landusky Mine would meet the needs with approximately 865,600 yd^3 remaining in stockpiles.

The effects of the cover soil as a growth medium as part of Reclamation Covers B and Modified C on the new disturbances would be similar to those effects described in Alternative 3. Impacts would be negative medium in both the short- and long-term.

Cover Soil Erosion

For both Zortman and Landusky mine facilities, short- and long-term soil losses and impact levels for both side slopes and tops would be as described for Alternative 4 (Zortman) for the facilities (not Goslin Flats or Carter Gulch facilities) and Alternative 3 (Landusky).

Combined soil loss from all Zortman Mine facilities would be approximately 2.2 tons/acre/year in the short-term and 0.7 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 5 percent of reclaimed areas due to loss of soil cover and soil acidification, soil loss would likely increase and impacts would be negative high for those limited areas, while remaining low for other areas.

Additional Actions

In response to needs for clay and limestone to be used for construction and in reclamation of the Zortman Mine area, an additional 11.5 acres of the Seaford clay pit and 13 acres of a new limestone quarry (LS-1) located near Shell Butte would be disturbed including soil salvage, slopes permitting. An additional 9 acres of the Williams clay pit and 3 acres of the King Creek limestone quarry would be disturbed, including soil salvage, to provide reclamation materials for the Landusky Mine. These reclamation material source areas would be reclaimed as described in Section 2.10.2.6 (Zortman Mine) and Section 2.10.4.6 (Landusky Mine).

Direct short-term negative impacts would be low for all pits and quarry as cover soil would be salvaged, stockpiled, and replaced at reclamation. Long-term negative impacts would be low to medium due to potential limitations associated with 12 inches of cover soil.

Impacts to soil as a result of land application of waste mining solutions would be as described above for Alternatives 1-4.

4.3.7.1 Cumulative Impacts

Cumulative impacts to 1,025 acres of soil by proposed mine expansion at both Zortman and Landusky and from the expansion of reclamation materials source pits and quarries include:

- 54 acres of historic mining disturbance from activities occurring prior to 1978;
- 1,161 acres of recent mining disturbance (both mines) between 1979 and the present;
- 1,025 acres of proposed new disturbance for both mines including 36.5 acres of proposed disturbance from activities at the clay pits and limestone quarries;
- 33 acres of past disturbance from activities at the Seaford and Williams clay pits and the King Creek Quarry (limestone); and
- 155 acres of potential exploration.

4.3.7.2 Unavoidable Adverse Impacts

It is assumed that 5 percent of the reclaimed acres would eventually fail from erosion on long, steep slopes and soil acidification. In addition, some migration of acidic moisture from underlying acid forming waste or parent rock would occur. On 110 acres, over 10,000 years of soil development would be lost. Soil would have to oxidize over time and soil development would take centuries to recover.

New disturbances of those few soil present in the Upper Alder Gulch heap leach pad and at the Seaford and Williams clay pits and the new Zortman Mine limestone quarry and King Creek limestone quarry would be unavoidable actions necessary for the effective mineral extraction and improved reclamation potential for the Zortman and Landusky mines.

4.3.7.3 Short-term Use/Long-term Productivity

The relatively short-term use and replacement of soil materials previously salvaged during mine development would result in improved long-term productivity of the affected lands as compared to Alternatives 1 and 2. Limited soil are protected by 36 inches of limestone. Only 5 percent of the reclaimed area is assumed to fail, and soil development would occur in a relatively short time on 2,146 acres out of 2,270 acres. Comparable stability and utility in the long-term would be achieved in the post-mine landscape.

4.3.7.4 Irreversible or Irretrievable Resources Commitments

Commitments of soil resources for Alternative 5 would be similar to those in Alternative 4 except that 5 percent or 114 acres of soil loss would occur. Only 123,000 yd^3 of soil and no clay would be wasted. Unreclaimed acres would be twice as much as existed in 1979. Unused stockpile cover soil materials (volume) is a valuable resource which would be wasted if not used in reclamation as surface cover.

4.3.8 Impacts from Alternative 6

Effects from redistribution of stockpiled cover soil over final graded surfaces would be similar to those of Alternative 3 where Reclamation Covers B and Modified C would be used to cover disturbed areas at closure. Direct negative impacts to soil would result from mine expansion of 1,174 acres including construction of the Goslin Flats heap leach facility and associated conveyor, ore crushing/handling facility, process facility, cover soil stockpile, and Ruby Flats waste rock repository. Impacts to the soil resource located within the footprint of the above facilities would be similar to those described in Section 4.3.2 for mine development.

Cover Soil Quality

Effects and limitations posed by currently stockpiled and new soil salvaged in advance of mine expansion areas in the Little Rocky Mountains would be the same as described in Section 4.3-3. Cover soil materials for use in the reclamation of both the Zortman and Landusky mines would be the same as Alternatives 1-3.

In contrast, soil in the Goslin Flats and Ruby Flats area have more potential uses in reclamation cover systems. Approximately 589,000 yd^3 of cover soil material (organic matter content greater than 0.5 percent) would be salvaged from 250 acres beneath the heap leach pad, ore crushing/handling facility, and process facility. Approximately 271,500 yd^3 of cover soil material would be salvaged from 203 acres beneath the Ruby Flats waste rock repository.

Impacts associated with the conveyor would be as described in Section 4.3.6

Soil beneath the proposed cover soil stockpile adjacent to the Goslin Flats heap leach pad would be buried beneath the stockpile for the life of the pile and subsequently ripped to break up any compaction and revegetated after cover soil redistribution at mine closure.

The above direct impacts would be negative, high resulting from disturbance of 1,174 acres in the expansion area in the short-term. Replacement of stockpiled cover soil would reduce impacts to low to medium. About 451,500 yd^3 are resistant to erosion based on soil characteristics including texture and coarse fragment content. These cover soil materials would be better suited for placement on steeper slopes (2.5H:1V-3H:1V). The remaining 409,000 yd^3 would be generally less resistant to erosion and better suited for placement on more level areas.

Direct impacts to soil in the expansion area would be negative high due to the disturbance of 1,025 acres in the short-term. Replacement of stockpiled cover soil would reduce impacts to negative low to medium.

Cover Soil Quantity and Thickness

Reclamation of facilities would be the same as described in Alternative 4.

Cover soil volume requirements for reclaiming existing disturbed areas within the Zortman and Landusky mine areas in the mountains are described in Alternative 1. Cover soil volume requirements for reclaiming approximately 488 and 30 surface acres of new disturbance associated with expansion of the Zortman Mine and miscellaneous disturbances within the Landusky Mine, respectively, are approximately 524,800 yd^3 and 32,200 yd^3. Assuming no soil salvage ahead of disturbance, including the Goslin and Ruby Flats facilities, the remaining approximately 1,333,300 yd^3 of cover soil stored in stockpiles at the Landusky Mine would be short approximately 245,400 yd^3 to meet the need for soil material to achieve an 8-inch soil cover over all disturbed areas for both Zortman and Landusky mines.

Salvage of 8 inches of cover soil material from beneath the proposed Goslin and Ruby Flats facilities would yield approximately 487,200 yd^3 of material. Salvage and use of this material would leave approximately 241,800 yd^3 of cover soil material in stockpiles at the Landusky Mine.

The effectiveness of the cover soil as a growth medium as part of Reclamation Covers B and C on the Goslin Flats heap leach pile and Ruby Flats waste rock repository would be similar to those effects described in Alternative 3 and impacts would be negative medium in both the short- and long-term.

Cover Soil Erosion

For Zortman Mine facilities to be reclaimed under this alternatives, estimated short-term soil losses (1-5 years) from side slopes (3H:1V and 200 feet long) would be 3.1 tons/acre/year for all facilities with the exception of the Goslin Flats heap leach facility - 3.7 tons/acre/year from 2.5H:1V slopes (Table 4.3-1). The 3.1 tons/acre/year rate of soil loss equals a rate of approximately 0.017 inches/year of soil loss from each facilities' side slopes; 3.7 tons/acre/year equals a rate of 0.021 inches of soil loss. A loss of one inch of soil from these surfaces of the Goslin Flats heap leach facility and the other facilities would take approximately 59 and 48 years, respectively. Direct negative short-term impacts would be significant, high for soil loss from major facilities.

Estimated long-term soil losses (beyond 5 years) from side slopes of the Goslin Flats heap leach facility and the other Zortman Mine facilities would be approximately 1.2 and 1.0 tons/acre/year) (Table 4.3-1). The 1.2 and 1.0 tons/acre/year rates of soil loss equal a rate of approximately 0.007 and 0.006 inches/year of soil loss, respectively. The loss of one inch of soil would require approximately 143 and 166 years, respectively. Direct negative long-term impacts would be medium for all Zortman facilities.

Soil loss from the flatter top areas of the Zortman Mine facilities and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term. Direct negative short- and long-term impacts on the flatter tops and other areas would be low for all facilities.

Combined soil loss from all Zortman Mine facilities would be approximately 2.5 tons/acre/year in the short-term and 0.8 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on 5 percent of reclaimed areas due to loss of soil cover and soil acidification, soil loss would likely increase and impacts would be negative, high for those limited areas, while remaining low for unaffected areas.

Short- and long-term direct negative impacts, and impact levels, for Landusky Mine facilities would be the same as those described under Alternative 3.

Combined soil loss from all Landusky Mine facilities would be the same as described for Alternative 3 (Table 4.3-1).

Additional Actions

In response to needs for clay and limestone to be used in reclamation of the Zortman Mine area, and construction and reclamation of the Goslin Flats heap leach pile, an additional 12 acres of the Seaford clay pit and 13 acres of the new limestone quarry (LS-1) located near Shell Butte would be disturbed including soil salvage, slopes permitting. An additional 9 acres of the Williams clay pit and 3 acres of the King Creek limestone quarry would be disturbed, including soil salvage, to provide reclamation materials for the Landusky Mine. These reclamation material source areas would be reclaimed as described in Section 2.11.2.6 (Zortman Mine) and Section 2.11.4.6 (Landusky Mine).

Direct short-term negative impacts would be low for all pits and quarry as cover soil would be salvaged, stockpiled, and replaced at reclamation. Long-term negative impacts would be medium due to potential limitations associated with 12 inches of cover soil.

Impacts to soil as a result of land application of waste mining solutions would be as described above for Alternatives 1-5.

4.3.8.1 Cumulative Impacts

Cumulative impacts for activities under Alternative 6 would come from historic and recent soil disturbances, disturbances to 1,174 acres of soil by proposed mine expansion at both Zortman and Landusky mines, assumed development of the mine in the Pony Gulch area in the reasonably foreseeable future, and from the expansion of reclamation materials source pits and quarries. Past and proposed new disturbance of soil include:

- 54 acres of historic mining disturbance from activities occurring prior to 1978;
- 1,161 acres of recent mining disturbance (both mines) between 1979 and the present;
- 1,174 acres of proposed new disturbance for both mines including 37 acres of proposed disturbance from activities at the clay pits and limestone quarries;
- 33 acres of past disturbance from activities at the Seaford and Williams clay pits and the King Creek Quarry (limestone); and
- 155 acres of potential disturbance due to exploration.

4.3.8.2 Unavoidable Adverse Impacts

It is assumed that 5 percent of the reclaimed acres would eventually fail from erosion on long, steep slopes and soil acidification. In addition, some migration of acidic moisture from underlying acid forming waste or parent rock would occur. On 110 acres, over 10,000 years of soil development would be wasted. Soil would have to oxidize over time and soil development would take centuries to recover.

New disturbances of soil in the Goslin Flats and Ruby Flats areas and at the Seaford and Williams clay pits and the new Zortman Mine limestone quarry and King Creek limestone quarry would be unavoidable actions necessary for the effective mineral extraction and improved reclamation potential for the Zortman and Landusky mines.

4.3.8.3 Short-term Use/Long-term Productivity

The relatively short-term use and replacement of soil materials previously salvaged during mine development would result in improved long-term productivity of the affected lands as compared to Alternatives 1 and 2. Limited soil are protected by 36 inches of limestone. Only 5 percent of the reclaimed area assumed to fail, soil development would occur in a relatively short time on 2,298 acres out of 2,419 acres. Comparable stability and utility in the long-term would be achieved in the post-mine landscape.

4.3.8.4 Irreversible or Irretrievable Resources Commitments

Commitments of soil resources for Alternative 6 would be similar to those in Alternative 4 except that 5 percent or 121 acres of soil loss would occur. Only 131,000 yd^3 of soil and no clay would be wasted. Unreclaimed acres would be twice as much as existed in 1979. Unused stockpile cover soil material is a valuable resource which would be wasted if not used in reclamation as a surface cover.

4.3.9 Impacts from Alternative 7

Effects from redistribution of existing stockpiled cover soil over final graded surfaces would be similar to those of Alternative 3 where Reclamation Covers B and C would be used to cover disturbed areas at closure. Direct negative impacts to soil present would result from mine expansion of 835 acres including construction of the waste rock repository near the Zortman pit complex and the Goslin Flats heap leach facility and associated conveyor, ore crushing/handling facility, process facility, and cover soil stockpile. Impacts to soil located within the footprints of the above facilities would be similar to those described in Section 4.3.2 for mine development.

Cover Soil Quality

Effects and limitations posed by currently stockpiled and new soil salvaged in advance of mine expansion areas in the Little Rocky Mountains. Cover soil materials for use in the reclamation of both the Zortman and Landusky mines would be the same as Alternatives 1-3.

No soil salvage is planned for the waste rock repository due to previous disturbance, steep slopes, and lack of salvageable soil materials. Additional cover soil to reclaim these facilities would be obtained from the surplus of cover soil stockpiled at the Landusky Mine, or soil materials salvaged ahead of construction of the Goslin Flats heap leach facility or soil salvaged from a borrow site in Ruby Flats. Resalvage of soil placed previously on existing facilities would occur and conserve soil reserves.

In contrast, soil in the Goslin Flats and Ruby Flats area have more potential uses in reclamation cover systems. Approximately 589,000 yd^3 of cover soil material would be salvaged from 250 acres beneath the heap leach pad, ore crushing/handling facility, and process facility. Approximately 271,500 yd^3 of suitable cover soil material would be available for salvage from approximately 203 acres beneath the Ruby Flats waste rock repository.

Direct impacts would be negative, high resulting from 835 acres of disturbance in the short-term. Replacement of stockpiled cover soil would reduce impacts to low to medium.

Cover Soil Quantity and Thickness

Soil material (cover soil/topsoil and subsoil) volume requirements for reclaiming past and proposed disturbed areas within the Zortman Mine area (including facilities in Goslin Flats) are approximately 3,254,900 yd^3 (555 acres covered with 3.5 feet of soil and 75 acres covered with 12 inches of cover soil). Soil material volume requirements for reclaiming past and proposed disturbed areas within the Landusky Mine area are approximately 3,839,700 yd^3 (680 acres covered with 3.5 feet of soil). Cover soil/topsoil volumes available in the Zortman Mine area (including the Goslin Flats facilities area) and the Landusky Mine area (cover soil stockpiles) are 852,000 yd^3 and 2,172,000 yd^3, respectively; the total for both mine areas would be 3,024,000 yd^3. Distribution of approximately one foot of cover soil over the combined disturbance acreage of 1310 acres for both mine areas would require approximately 2,113,500 yd^3, which would leave approximately 910,500 yd^3 for use in creating the additional 2.5 feet of soil cover over both mines' disturbed areas. Approximately 4,981,300 yd^3 of soil material would be required to provide a coverage of 2.5 feet of soil/subsoil beneath the one foot of cover soil/topsoil. The 910,500 yd^3 of remaining/available cover soil/topsoil, the 1,448,000 yd^3 of subsoil beneath the Goslin Flats facilities, and the 1,637,000 yd^3 beneath the previously investigated Ruby Flats waste rock repository site would total approximately 3,995,500 yd^3. The need for the remaining 985,800 yd^3 of subsoil material could be met with the salvage of an additional 2.5 feet of subsoil across the area beneath the Goslin Flats facilities (250 acres) or Ruby Flats waste rock repository. Previous calculations allowed for salvage of soil materials to a depth of only 60 inches. An average depth of an additional 2.5 feet of suitable subsoil material is anticipated for the Goslin Flats facilities area and/or Ruby Flats.

The effectiveness of the cover soil as a growth medium in a Water Balance Cover would be improved over the effects described in Section 4.3.5 for Reclamation Covers B and C. Increased moisture retention and availability in the 3.5 feet of soil material would provide a better growth medium and support higher plant cover and productivity; increased effectiveness of the evapotranspiration process would result. Impacts regarding cover soil thickness would be negative, low in both the short- and long-term, as potential negative high impacts associated with erosion and soil acidification of the cover soil would be reduced to virtually no impact by the addition of the thicker soil cover.

Cover Soil Erosion

Zortman Mine Facilities - For Zortman Mine leach pads and waste dump facilities to be reclaimed under this alternative, estimated short-term soil losses (1-5 years) from side slopes of facilities (3H:1V and 200 feet long slopes) would be 3.1 tons/acre/year for all facilities with the two exceptions of the waste rock repository (3H:1V and 158 feet long slopes) and the Goslin Flats heap leach pad (2.5H:1V and 134 feet long slopes) (Table 4.3-1). The 3.1 tons/acre/year rate of soil loss equals a rate of approximately 0.017 inches/year of soil loss from facilities' side slopes. A loss of one inch of soil from these surfaces would take approximately 59 years. Short-term soil loss rates for the waste rock repository of 2.6 tons/acre/year equal a rate of 0.014 inch/year (71 years per inch of soil loss). Short-term soil loss for the Goslin Flats heap leach pad of 2.7 tons/acre/year equal a rate of 0.015 inch/year (67 years per inch of soil loss). Direct negative short-term impacts due to soil loss and the reduction in thickness and volume of plant growth medium would be significant high for all facilities.

Estimated long-term soil losses (beyond 5 years) from side slopes of Zortman Mine facilities would range from approximately 0.86 to 1.0 tons/acre/year (Table 4.3-1). The 0.86 tons/acre/year and 1.0 tons/acre/year rates of soil loss equal a loss of approximately 0.005 and 0.006 inch/year of soil loss from each facilities' side slopes. The loss of one inch of soil would require approximately 200 and 166 years, respectively. Direct negative long-term impacts would be low to medium.

Soil loss from flatter top areas of the leach pads and waste dumps and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term. Direct negative short- and long-term impacts on flatter areas would be low.

Combined soil loss from all Zortman Mine facilities would be approximately 2.1 tons/acre/year in the short-term and 0.7 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on less than 5 percent of reclaimed areas due to loss of the limited soil cover and soil acidification, soil loss would likely increase and impacts would be negative high for those limited areas and low for remaining areas.

Landusky Mine Facilities - Slopes and slope lengths are the same as those described for Alternatives 3-6; however, the cover soil's improved ability to support a higher percentage cover of vegetation results in a range in soil loss rates from 2.4 to 3.8 tons/acre/year for the short-term. The 2.4 and 3.8 tons/acre/year rates of soil loss equal a loss of approximately 0.013 to 0.020 inch/year. A loss of one inch of soil from these surfaces would take approximately 77 and 50 years, respectively. Direct negative short-term impacts would be significant high for all facilities.

Estimated long-term soil losses (beyond 5 years) from side slopes of Landusky Mine facilities would range from approximately 0.72 to 1.1 tons/acre/year. The 0.72 tons/acre/year and 1.1 tons/acre/year rates of soil loss equal a loss of approximately 0.004 and 0.006 inch/year of soil loss from each facilities' side slopes. The loss of one inch of soil would require approximately 250 and 166 years, respectively. Direct negative long-term impacts would be low to medium.

Soil loss from flatter top areas of the leach pads and waste dumps and other disturbed areas would be less than 1 ton/acre/year for both the short- and long-term. Direct negative short- and long-term impacts on flatter areas would be low.

Combined soil loss from all Landusky Mine facilities would be approximately 3.8 tons/acre/year in the short-term and 1.5 tons/acre/year in the long-term (Table 4.3-1). Assuming long-term revegetation failure on less than 5 percent of reclaimed areas due to loss of the limited soil cover and soil acidification, soil loss would likely increase and impacts would be negative, high for those limited areas and low to medium for remaining areas.

Additional Actions

In response to needs for clay and limestone to be used for construction and in reclamation of the Zortman Mine area, an additional 4 acres of the Seaford clay pit and 13 acres of a new limestone quarry (LS-1) located near Shell Butte would be disturbed including soil salvage, slopes permitting. An additional 3 acres of the King Creek limestone quarry would be disturbed, including soil salvage, to provide reclamation materials for the Landusky Mine. These reclamation material source areas would be reclaimed as described in Section 2.10.2.6 (Zortman Mine) and Section 2.10.4.6 (Landusky Mine).

Direct short-term negative impacts would be low for all pits and quarry as cover soil would be salvaged, stockpiled, and replaced at reclamation. Long-term negative impacts would be medium due to potential limitations associated with 12 inches of cover soil.

Impacts to soil as a result of land application of waste mining solutions would be as described above for Alternatives 1-6.

4.3.9.1 Cumulative Impacts

Cumulative impacts for activities under Alternative 7 would come from historic and recent soil disturbances, disturbances to 835 acres of soil by proposed mine expansion for both Zortman and Landusky, assumed development of the proposed mine in the Pony Gulch area, and from the expansion of reclamation materials source pits and quarries. Expansion of the Seaford and Williams clay pits, and the Zortman limestone quarry and King Creek limestone quarry would result in increased soil disturbance and redistribution of salvaged cover soil.

Past and proposed new disturbance of soil include:

- 54 acres of historic mining disturbance from activities occurring prior to 1978;
- 1,161 acres of recent mining disturbance (both mines) between 1979 and the present;
- 835 acres of proposed new disturbance for both mines including 20 acres of proposed disturbance from activities at the clay pits and limestone quarries. It is assumed that 1 percent (21 acres)of reclaimed acres would fail. This is half as many acres as existed disturbed in 1979;
- 33 acres of past disturbance from activities at the Seaford and Williams clay pits and the King Creek Quarry (limestone); and
- 155 acres of potential disturbance due to exploration.

4.3.9.2 Unavoidable Adverse Impacts

It is assumed that 1 percent of the reclaimed acres would fail from erosion on moderately long, steep slopes, and limited soil acidification. In addition, some migration of acidic moisture from underlying acid forming waste or parent rock would occur. On 21 acres, over 10,000 years of soil development would be wasted. Soil would have to oxidize over time and soil development would take centuries to recover.

New disturbances of those few soil present in the area of the new waste rock repository, Goslin Flats heap leach facility, and at the Seaford clay pit, the new Zortman Mine limestone quarry, King Creek limestone quarry, and the Ruby Flats borrow area would be unavoidable actions necessary for the effective mineral extraction and improved reclamation potential for the Zortman and Landusky mines.

4.3.9.3 Short-term Use/Long-term Productivity

The relatively short-term use and replacement of soil materials previously salvaged during mine development would result in improved long-term productivity of the affected lands as compared to Alternatives 1 and 2. Limited soil are protected by 36 inches of limestone. Only 5 percent of the reclaimed area assumed to fail, soil development would occur in a relatively short time on 2,059 acres out of 2,270 acres. Comparable stability and utility in the long-term would be achieved in the post-mine landscape.

4.3.9.4 Irreversible or Irretrievable Resources Commitments

Commitment of soil resources for Alternative 7 if only 1 percent of reclaimed acres fail equal 23,000 yd^3 or 21 acres. No clay would be wasted. Unreclaimed acres would be less than the 54 acres that existed in the area in 1979.

4.4 VEGETATION AND WETLANDS

4.4.1 Methodology

Public Scoping Issues. The public scoping process for the expansion of the Zortman and Landusky mines identified several issues and concerns regarding potential impacts to vegetation resources in the project area related to expansion of existing facilities, construction of new facilities, and implementation of a reclamation program. The comments (not already addressed in Section 3.4) are summarized below.

1. The quantity of species (diversity) on reclaimed acres lost by disturbance.

2. Disturbance of threatened, endangered, or sensitive plant species/communities.

3. Impacts to vegetation used by Native Americans for ceremonies, medicine and food.

4. The long-term loss of trees and forestry resources.

5. Impacts to riparian vegetation and wetlands.

6. Impacts to wetlands and non-wetland waters of the U.S.

7. Adequacy of the proposed reclamation programs to achieve an adequate environment for natural plant succession over acid producing materials and a return to premining levels of canopy cover, productivity, and utility in both the short- and long-term.

Significance Criteria. In response to these issues the following significance criteria have been developed to guide and focus the analysis of potential impacts to the vegetation resources.

1. Restoration of 50 percent of total species quantity (diversity) in reclaimed communities as compared to pre-mine inventories in the study area.

2. Less than 1 percent habitat loss of listed threatened or endangered plant species, and less than 10 percent habitat loss of species of special concern in vegetation study area.

3. Impacts to less than 10 percent of habitats providing sole sources of vegetation used by the Native Americans in vegetation study area.

4. Disturbance of forested habitat equal to less than 25 percent of the total disturbance area, or less than 10 percent of the forest habitat in the study area.

5. Disturbance of riparian habitat less than 5 percent in the vegetation study area.

6. Significant loss or negative change in the functions and values of waters of the U.S.

7. Development of a comprehensive reclamation program capable of achieving and sustaining an environment over acid producing materials conducive to supporting at least 95 percent of the vegetation on the reclaimed acres in the long term (as compared to adjacent undisturbed sites).

Impact Ratings. To complete the analysis, the magnitude of impacts to vegetation resulting from implementation of each respective alternative and the effectiveness of the proposed reclamation plan were ranked high, medium, or low. Impacts are rated relative to baseline conditions, that is, pre-1979, with the premise that mitigation efforts, while they may come close, will never achieve the less disturbed conditions present prior to disturbance from modern mining activities which commenced in 1979.

1. In the short-term, the loss of plant diversity on reclaimed acres for all alternatives would be considered a high, significant, negative impact to vegetation resources; however, over the long-term most species could be expected to re-invade the disturbed sites and thus reduce long-term effects.

   Reclamation research studies over 20 years in the Northern Rocky Mountains and Great Plains area (Munshower and Fisher 1993), have shown that, even with the best reclamation plans, the total number of species (diversity) is substantially reduced for long periods of time; it can be centuries before the original diversity of a site is returned to predisturbance levels. However, even when diversity is lost, reclaimed communities can achieve comparable cover and productivity in 3-5 years for grasses and forbs, and in 70 to 80 years for shrubs and trees (Plantenberg p.c. 1995).

It should be noted the ultimate goal of revegetation at the Zortman and Landusky mines is to quickly reestablish grasses and forbs to control erosion, reduce seepage and subsequent acid rock drainage, maximize productivity and canopy cover, and create a suitable environment for natural plant succession. Reclamation to obtain a predisturbance level of diversity is not the main goal of the revegetation program. Plant species used in revegetation are selected for their ability to become quickly established, provide a stable surface, and support a self-perpetuating community. It should also be noted that none of the native plant species would be removed completely from any of the Little Rocky Mountain plant communities in the disturbance area.

1. Short- and Long-term (0-70 years) — Greater than 50 percent loss of species quantity in reclaimed areas as compared to undisturbed communities in the vegetation study area - high

2. Short- and Long-term (0-70 years) — Loss of greater than 1 percent of habitat in the vegetation study area supporting listed threatened or endangered plant species, and greater than 10 percent habitat loss supporting species of special concern - high

3. Short- and Long-term (0-70 years) — Greater than 10 percent loss of habitat in vegetation study area providing sole sources of vegetation used by Native Americans - high

4. The removal of forested habitat (as compared to grassland communities) would be considered a significant, negative high impact due to the amount of time (70-80 years) necessary to regenerate stands of comparable utility (merchantable timber, wildlife cover, visual screening of disturbances).

   Short- and Long-term (0-70 years)
   - Removal of greater than 75 percent of the forest habitat that existed in the disturbance area or greater than 25 percent of the forest habitat that existed in the vegetation study area- high
   - Removal of 25-75 percent forest habitat in disturbance area and 10-25 percent of forest habitat in study area- medium
   - Removal of less than 25 percent forest habitat in disturbance area and less than 10 percent of forest habitat in vegetation study area- low
   - After 70-80 years - no significant difference

5. Short- and Long-term (0-70 years)
   - Loss of greater than 10 percent riparian habitat in the vegetation study area- high
   - Loss of 5-10 percent riparian habitat in the vegetation study area- medium
   - Loss of less than 5 percent riparian habitat in the vegetation study area- low

6. Short- and Long-term (0-70 years)
   - The relative change in the majority of the wetland functions and values is considered a major change - high
   - The relative change is considered moderate - medium
   - The relative change is considered minor, negligible, or no change is anticipated - low

7. While implementation of any or all of the reclamation plans (as detailed in Section 2 and highlighted in the following sections) would likely reduce impacts to the vegetation resources, not all of the beneficial effects could be sustained over the long-term; therefore, it is the long-term effectiveness that will drive the final impact assessment of reclamation activities. Included in the evaluation of the effectiveness of a proposed reclamation plan are such factors as predicted effectiveness of reclamation covers, slope angles, and depth of replaced cover soil.

Long-term (5+ years)	• Growth media over acid producing materials, following reclamation, expected to support a vegetative community less than 95 percent of reclaimed acres - <u>high</u> • Growth media over acid producing materials , following reclamation, expected to support a vegetative community on 95-99 percent of reclaimed area - <u>medium</u> • Growth media over acid producing materials , following reclamation, expected to support a vegetative community on greater than 99 percent of reclaimed area - <u>low</u>

<u>Assumptions</u>. To analyze the significance of the above criteria, the following assumptions or estimations were used when specific information was incomplete or not available.

- Based on interviews and ethnographic studies by Deaver and Kooistra (1992) and Culwell et. al (1990) a list was developed identifying specific plant species used by the Native Americans for food, medicinal and ceremonial purposes (see Section 3.12). The list may or may not be complete; however, for this analysis, it is assumed to be a complete listing of relevant species.

  Interviews with the Native Americans did not reveal locations where plants are collected, but based on the above noted list and vegetation surveys of the project area, vegetation used by the Native Americans either does not occur within the study area, or the plant species are fairly common throughout the Little Rocky Mountains. Since no unique plants or habitats would be eliminated, it is assumed no sole sources of vegetation will be impacted especially if less than 10 percent of habitat are disturbed.

- Acreages of disturbance by community type were calculated using a planimeter and overlaying the figures of existing and proposed facilities (see Section 2 for figures of each alternative) onto vegetation maps (WESTECH 1990). However, for some disturbances such as new roads, the power line corridor and the conveyor corridor, and some existing disturbance at Landusky, acreages were estimated based on the percentage of habitat in the disturbance area. Additionally, total acres, by community type, covered in the baseline study area were estimated based on the WESTECH (1990) maps.

<u>Definitions</u>. Direct Impacts - Activities resulting in 1) the removal of the vegetative cover or disturbance of sensitive habitats or, 2) revegetation of grasses, forbs, shrubs, and trees.

Indirect Impacts - Activities that, though vegetative cover is not physically removed, may have a detrimental effect on vegetation through impacts to soil or water, e.g. erosion and acid rock drainage, or loss of forestry resources and wildlife habitat. Alternatively, mitigation measures such as reduction of slope angle to reduce erosion potential, replacement of cover soil, and installation of reclamation covers to minimize potential impacts of acid rock drainage would have an indirect beneficial effect.

4.4.2 Impacts from Mining, 1979 to Present

Direct impacts to vegetation resulting from currently permitted activities include the removal of primarily lodgepole pine community types as well as grasslands, and some shrub and ponderosa pine community types in the vicinity of both the Zortman and the Landusky mines. Approximately 401 acres of grasses, shrubs, forbs, trees, and previously disturbed land at Zortman and 814 acres at Landusky have been impacted by the construction of the mine pits, waste rock piles, leach pads, access roads, and construction of the operations facilities, and 33 acres at the Williams and Seaford clay pits and the King Creek Quarry. Approximately 13 acres of riparian vegetation in the vicinity of the

Zortman Mine and approximately 3 acres near the Landusky Mine were impacted between 1979 and the present. Table 4.4-1 lists the approximate number of acres of each community type impacted by ZMI mining activities between 1979 and 1994. The total includes approximately 54 acres of disturbance from other mining activities prior to 1978 and areas of rock outcrop and scree not previously vegetated.

Wetlands - During 1977 to present, it is estimated that approximately 1.24 acres of potentially jurisdictional non-wetland waters of the U.S. (incised drainages) were directly impacted by mining activities at the Zortman Mine. The disturbances occurred in six drainages: Carter Gulch; Alder Gulch and tributaries; Alder Spur and tributaries; Ruby Gulch and tributaries; Goslin Flats and tributaries; and tributaries to Lodgepole Creek (Gallagher 1995). Included in the 1.24 acres of disturbance is 0.4 acres which would be affected by compliance structures required by the Water Quality Improvement Plan. No vegetated wetlands are believed to have been impacted. At the Landusky Mine, existing facilities are currently directly impacting 2.9 acres of non-wetland waters of the U.S. in six drainages: Montana Gulch with tributaries, King Creek, South End drainages, North End drainages, Rock Creek tributaries, and Mill Gulch with tributaries (Gallagher 1995). A preliminary assessment of the potential change in wetland functions and values was conducted comparing pre-1979 conditions to conditions between 1979 to present. Refer to Appendix B for a summary.

In addition to directly affected areas, waters of the U.S. have been indirectly disturbed by mining-related activities such as increased erosion and sediment in surface runoff, acid rock drainage, leach pad leakage, constriction of diversion ditches and noise. Indirect impacts from 1979 to present have not been quantified.

Under Alternatives 3, 5, 6, and 7, ZMI will be required to remove historic mine tailings from Ruby Gulch drainage above the town of Zortman, and restore the streambed channel to compensate for past impacts to waters of the U.S. The access road will be relocated out of the Ruby Gulch streambed to an existing historic county roadway.

Direct Impacts. Previously permitted mining activities have resulted in direct, high negative impacts through the removal of 1,194 acres of vegetation. It will take up to 70-80 years for forested habitats to establish a tree canopy that would appear similar to pre-disturbed communities.

There have been no known impacts to threatened, endangered, or sensitive plant communities, nor to any sole sources of vegetation used by Native Americans.

Direct impacts to vegetation include:

- 120 acres out of 2700 acres, or 4 percent of grasslands in the study area
- 12 acres out of 800 acres, or about 2 percent of shrubland in the study area
- 889 acres out of 7300 acres or, 12 percent of lodgepole forests in the study area
- 124 acres out of 3700 acres, or about 3 percent of ponderosa pine forests in the study area
- 16 acres out of 1300 acres or, 1 percent of the deciduous forests (riparian)
- No impacts to vegetated wetlands.
- 1.24 acres at Zortman and 2.9 acres at Landusky of non-wetland waters of the U.S.

Impacts to forested areas equal about 11 percent of forested land in the study area and about 82 percent of the total disturbance; impacts are rated negative high.

Impacts to wetlands are rated neutral.

Impacts to riparian areas are rated negative low.

Impacts to species diversity are rated negative high.

Indirect Impacts. Assuming all 454 acres of BLM land disturbed between 1979 and the present consisted of merchantable timber resources, approximately 3 percent of forestry resources were lost due to previous mining activities at both Zortman and Landusky. This is likely an overestimation since much of the area was covered with "dog-hair" lodgepole pine that has limited use. Wildlife forage and habitat was also lost across the project area (see Section 4.5).

Review of ZMI Revegetation Efforts. In a study on reclamation success, Michael Spry (1986) conducted a revegetation program on disturbed sites at the Zortman Mine including waste rock dumps, abandoned tailing, and clay pits. The purpose of the study was to develop a reclamation program that would meet the requirements mandated under the Montana Metal Mine Reclamation Act of 1972. Based upon environmental conditions (physical and chemical), and environmental factors limiting revegetation potential (moisture, wind, and soil nutrients), Spry was able to develop some recommendations for the revegetation of several disturbed areas near the Zortman Mine.

TABLE 4.4-1

ACRES OF DISTURBANCE BY COMMUNITY TYPE

Community[1]	Alternative 1 Zortman	Alternative 1 Landusky	Alternative 2 Zortman	Alternative 2 Landusky	Alternative 3 Zortman	Alternative 3 Landusky	Alternative 4 Zortman	Alternative 4 Landusky	Alternative 5 Zortman	Alternative 5 Landusky	Alternative 6 Zortman	Alternative 6 Landusky	Alternative 7 Zortman	Alternative 7 Landusky
Grassland	21	99	21	99	21	99	411	7	328	7	684	7	411	7
Shrubland	12	--	12	--	12	--	121	--	72	--	178	--	121	--
Forested:														
Lodgepole pine	300	589	300	589	300	589	256	35	397	35	124	35	164	35
Ponderosa pine	8	116	8	116	8	116	34	13	37	13	33	13	34	13
Douglas fir	--	--	--	--	--	--	9	1	11	1	--	1	--	1
Deciduous	13	3	13	3	13	3	10	--	27	--	10	--	9	--
Unvegetated	47	7	47	7	47	7	29	7	53	7	44	7	13	7
Wetlands[2]	--	--	--	--	--	--	1.06	--	0.02	--	1.06	--	1.06	--
Clay Pits	4	26	7	32	7.5	35	7	7	11.5	9	12	9	3	--
Limestone Quarry	--	3	--	3	13	22	13	3	13	3	13	3	13	3
Total New Disturbance	--	--	3	6	16.5	28	891.06	73	949.52	75	1099.06	75	769.06	66
Total Disturbance: Previous plus Proposed	405	843	408	840	421.5	871	1296	916	1354.52	918	1504.06	918	1174.06	909
Total Forested	1,029		1,029		1,029		1,387		1,550		1,245		1,285	
Total Disturbed	1,248		1,257		1,292.50		2,212		2,272		2,422		2,083	
Total Study Area	11%		11%		11%		15%		17%		14%		14%	

Shaded area - disturbance from 1979 to the present.

[1] Source -Vegetation Maps - WESTECH 1992

[2] Source - Gallagher 1995

Results of the study indicated low water availability (due to a drought in 1984) was the main limiting factor at all sites indicating an enhanced water supply may be necessary for successful revegetation. In addition, applications of fertilizer and mulch may substantially enhance revegetation; however, further studies were necessary to determine appropriate application rates.

Spry used several grass species to quickly revegetate the disturbed areas. The results varied from site to site, e.g. bluebunch wheatgrass and sheep fescue provided satisfactory revegetation of the dumps, but showed poor to moderate germination at the tailing site. Tree and shrub species were successful when planted as seedlings, but germination was poor when the same species were seeded.

Spry concluded that further research would be needed to identify appropriate seed and fertilizer rates, timing, and seeding methods, to maximize plant establishment.

Reclamation Activities. Interim and final reclamation activities and revegetation trials have been ongoing since 1988 at both the Zortman and Landusky mines. A total of 214.18 acres on 27 sites had been reclaimed by the end of 1993, using a variety of grass and forb seed mixtures. Fifteen of the sites were also planted with trees and shrubs (ZMI 1993). Reclamation has been redisturbed on 72.07 acres at Gold Bug Pit and the Mill Gulch waste rock dump.

Revegetation efforts included using a variety of seed mixtures, seeding rates and methods, mulch types and rates, tackifier rates, seedbed preparation and shrub and tree planting to identify the optimal combination of species and methods to achieve post-operation land use objectives. Monitoring of the reclaimed sites is conducted annually.

Grass species used for revegetation include a variety of wheatgrasses, brome, fescue, blue grass, little bluestem, ricegrass and needle grass. Forb mixtures include milkvetch, arrowleaf balsam root, Lewis flax, clover, coneflower, yarrow, and birdsfoot trefoil. Shrub and tree species include chokecherry, rose, kinnickinnick, western snowberry, raspberry, lodgepole pine, ponderosa pine, and Douglas-fir. A complete list of species can be found in the 1993 WESTECH Revegetation Monitoring Report.

ZMI has made substantial improvements in the reclamation program, particularly in the revegetation efforts, since the mid-1980's. The company has hired a Montana nursery to collect locally adapted seed from native trees and shrubs. This seed is used to grow trees and shrubs that are replanted on the reclaimed areas.

Revegetation Monitoring. In general, reclamation efforts appear to be relatively successful. Total vegetative cover and plant density increased between 1990 and 1992 on most sites, particularly perennial grasses, and litter increased on 80 percent of the sites. Tree and shrub survival has been variable. Limited success of shrubs and trees due to plant mortality appears to be the result of competition by herbaceous plant species, an inhospitable growth medium, (compacted soil), wildlife depredation, or burying or pasting down woody plants during hydromulching. Countermeasures to these deterrents to shrub and tree survival could be developed to decrease mortality.

The reclamation and revegetation conducted to date indicates trends similar to other research in the Northern Great Plains. These trends include; 1) achievement of premining cover and productivity for grasses and forbs in 3-5 years, assuming the growth medium remains neutral and erosion is controlled; 2) limited success with tree and shrub establishment because of short time frames; and 3) substantially reduced total number of species in reclaimed communities. Full vegetation re-establishment will take several decades. The current revegetation program is dynamic and would be essentially the same for all alternatives.

It is generally reported that maximum vegetative stability cannot be attained on slopes steeper than 3H:1V (Gray and Leiser 1982; Law 1984; BLM 1992a). Slope angles of 3H:1V or less have a moderate to moderately low potential for erosion while 2.5H:1V slopes have a moderately high to high potential for erosion. The velocity of surface water runoff increases with increasing steepness, thus increasing erosion and reducing the potential for successful revegetation.

Impact Rating. Due to the large area of disturbance and limited revegetation efforts, impacts from mining activities between 1979 and the present are rated negative high.

4.4.3 Impacts from Alternative 1

Alternative Background. Under this No Action Alternative, ZMI would continue activities already permitted at both the Zortman and Landusky mines. No further surface disturbance would occur and previously permitted reclamation schedules for both mines would be implemented. In addition, a 205-acre land application area has been proposed for emergency land application disposal in the Goslin Flats area. This disposal area would replace the Carter Butte land application area where soil have been loaded to maximum metal attenuation capacity from previous emergency land application disposal.

Proposed Reclamation. Under Alternative 1, reclamation plans consist of placing a layer of cover soil approximately 8 inches thick on disturbed sites prior to reseeding and planting. Most slopes in the leach pad and waste rock areas would remain at approximately a 2H:1V angle and would be over 200 feet long. No geochemical testing is required of disturbed areas prior to reclamation to determine suitability of waste rock and ore for reclamation growth medium.

Direct Impacts. Under this alternative there would be no further surface disturbance at either mine, and no new direct impacts are anticipated to wetlands; endangered, threatened, or sensitive species; riparian vegetation; sole sources of vegetation used by the Native Americans; nor forestry resources and wildlife habitat.

No additional impacts to waters of the U.S. will occur either at the Zortman or Landusky mines (Tables 4.4-2 and 4.4-3).

Indirect Impacts. Indirect impacts to vegetation, under Alternative 1, result from an inadequate reclamation plan that, over the long-term, is unlikely to maintain a suitable environment for most vegetation. Impacts include erosion and soil loss, particularly on steep slopes, increased sedimentation of waters of the U.S., and a high potential for acidification of soil in areas such as the waste rock piles, leach pads, and the pit bottoms and walls.

- Soil - In the short-term, a replacement of 8 inches of cover soil would allow revegetation of grasses, forbs, shrubs and trees to become established relatively quickly in most areas, including the steep slopes in the leach pad area and waste rock piles. The pit walls would not revegetate. Wildlife forage would be increased as would the visual quality of the project area.

  It is over the long-term that significant, negative impacts could be expected. The erosion potential at Zortman is 1.9 tons/acre/year, and at Landusky 1.5 tons/acre/year (Section 4.3.3). As a result, high negative impacts would occur due to the loss of cover soil and the moisture and nutrients it provides, resulting in a loss of vegetative productivity and ecological stability.

- Slope Angle - Additionally, erosion of the waste rock piles with steep, long (>200 feet) slopes left at the 2H:1V angle have the potential to become acidic as the relatively shallow layer of cover soil is eroded and the sulfur-bearing material underneath is exposed to air and water and subsequent erosion. There is some potential for capillary rise and lateral seepage of acid rock drainage and acidification of soil in the root zone. High negative impacts are assumed on the older waste rock piles where, due to less selective handling, there is more sulfur-bearing material. With continued erosion, acid rock drainage would daylight on the surface further impacting the soil and vegetation as acidic water seeps out on lower slopes and runs downhill.

  Should the soil become acidic, potential impacts to vegetation include phytotoxic effects such as reduced seed germination rates, reduced growth of roots and shoots, reduced vegetative cover, and death of some species (Lipton et al. 1993). In the event current revegetation plans failed, especially on the steep, long slopes of the waste rock dumps and leach pads, impacts would occur on an increasingly expanding area further downhill. Impacts would include loss of cover soil, increased exposure of acidic material, and loss of vegetative cover.

Impact Rating. Over 75 percent of the revegetation efforts are assumed to fail as a result of erosion and acidification of soil in the long-term (Good, et al. 1995). Under Alternative 1, negative impacts to vegetation are rated medium high because the reclamation program limits the ability of plant succession in the area to proceed at an acceptable rate; therefore, the site would not return to comparable stability and utility as required in the Metal Mine Reclamation Act in a reasonable time frame.

4.4.3.1 Cumulative Impacts

Cumulative impacts from Alternative 1 include:

- 54 acres of disturbance from historical mining activities prior to 1978, rock outcrops, and scree
- 33 acres of vegetation removed by disturbance at the Williams and Seaford Clay pits and the King Creek Quarry
- 1,161 acres of vegetation removed due to mining activities between 1979 and the present
- No new disturbance

TABLE 4.4-2

WETLAND AND DRAINAGE DISTURBANCE AT ZORTMAN MINE[a]

Alternatives 1, 2, and 3 - No Action and existing facilities with various reclamation plans

Drainage	Alternatives 1, 2, and 3[b]			
	Waters of the U.S.			
	Non-Wetland		Wetland	
	Length (feet)	Area (acres)	Length (feet)	Area (acres)
Carter Gulch	2,926	0.19	-	-
Alder Gulch and tributaries	-	-	-	-
Alder Spur with tributaries	4,899	0.13	-	-
Ruby Gulch with tributaries	9,978	0.89	-	-
Goslin Gulch and tributaries	-	-	-	-
Tributaries to Lodgepole Creek	1,061	0.03	-	-
TOTAL	18,864	1.24	-	-

NOTES:

[a] Source: Kathy Gallagher, Consulting Hydrogeologist, Memorandum to Paula Daukas, June 2, 1995

[b] Based on values presented in the 2/17/95 WESTECH memo to Rolin Erickson regarding "Potential Jurisdictional Waters of the U.S. Impacted at the Zortman and Landusky Mines." Values include all site disturbances.
Compliance structure acreages included in the above table are as follows:

Carter Gulch	300 ft	0.07 acre
Alder Spur	300 ft	0.02 acre
Ruby Gulch	970 ft	0.31 acre

TABLE 4.4-3

WETLAND AND DRAINAGE DISTURBANCE AT LANDUSKY MINE

Landusky - Existing facilities and compliance structures[a]

Alternatives 1, 2, 3, 4, 5, 6 & 7				
Drainage	Waters of the U.S.			
	Non-Wetland		Wetland	
	Length (feet)	Area (acres)	Length (feet)	Area (acres)
Montana Gulch with tributaries	12,910	0.76	-	-
King Creek	3,113	0.35	-	-
South End Drainages	2,511	0.06	-	-
North End Drainages	2,116	0.21	-	-
Rock Creek Tributaries	4,922	0.34	-	-
Mill Gulch with tributaries	10,562	1.18	-	-
TOTAL	36,134	2.90		

NOTES:

[a] Based on values presented in the 2/17/95 WESTECH memo to Rolin Erickson regarding "Potential Jurisdictional Waters of the U.S. Impacted at the Zortman and Landusky Mines". Values include all site disturbances.

- Approximately 1.24 acres and 2.90 acres of non-wetland waters of the U.S. have been disturbed at the Zortman and Landusky mines, respectively, from past mining activities.
- No new disturbance to waters of the U.S.
- No foreseeable future actions

Past mining activities have directly impacted a total of 1,248 acres. Impacts include the removal of vegetation, loss of over 80 percent of forested habitat in the disturbance area and wildlife forage and habitat that will take up to 70 to 80 years to return to premining conditions. Assuming reclamation would fail on 75 percent or more of the reclaimed area (930+ acres), left untouched, impacts would take centuries to recover. Cumulative impacts under Alternative 1 are rated negative high.

4.4.3.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would occur under Alternative 1 when:

- Soils become acidic resulting in phytotoxic impacts on vegetation, and acid drainage starts moving downslope. Eventually over 75 percent of reclaimed acreage is assumed to fail.
- Regardless of reclamation strategy, the total number of species in reclaimed communities will take centuries to recover.

4.4.3.3 Short-term Use/Long-term Productivity

Assuming 25 percent of the reclaimed acres are successfully reclaimed, total plant cover and productivity would return to premining levels in these limited grassland communities within 3-5 years and forested communities within 70-80 years. Some wildlife forage use by sheep and deer on reclaimed communities has already been documented. Assuming at least 75 percent failure of reclamation, cover and productivity and subsequent use by wildlife and man would not return to premining levels for centuries. Some acid tolerant species would develop dominance in the area. Comparable stability and utility would not be achieved in the post-mine landscape.

Over the long-term, species diversity will slowly increase but it may be centuries before it is returned to premining levels.

4.4.3.4 Irreversible or Irretrievable Resource Commitments

No irreversible or irretrievable vegetation resource commitments are anticipated under Alternative 1 because no impacts are anticipated to threatened, endangered, or sensitive species, and no known sole sources of vegetation used by the Native Americans would be impacted.

4.4.4 Impacts from Alternative 2

Alternative Background. This alternative is similar to Alternative 1 in that expansion of the Zortman and Landusky mines would not be approved, but it includes ZMI proposed improvements in reclamation procedures. These procedures would be the same for both Zortman and Landusky. Under this alternative, without expansion, there would be a shortage of suitable reclamation material, and additional material would have to be obtained from off-site sources. An additional 9 acres would be disturbed at the clay pits to obtain clay for capping material.

Proposed Reclamation. The focus of the revised reclamation plan is on control and treatment of acid rock drainage. The revegetation program under the revised plan is generally unchanged. However, the activities benefit reclaimed area vegetation. These actions include:

- Access and haul roads would be ripped to alleviate surface compaction, and then graded and revegetated;
- Steep slopes would be reduced to a 3H:1V angle where feasible and slope lengths would remain >200 feet in length; and
- The potential for damage to vegetation from acidification of soil due to acid rock drainage would be reduced by the placement of a 6-inch clay cap over areas where sampling shows the potential for acid production before soil (8-inch) replacement.

Direct Impacts. Under Alternative 2, no further surface disturbance would occur at either mine site and there would be no further direct impacts to existing vegetation communities. Nine vegetated acres would be disturbed at the clay pits to provide clay for the reclamation cover. No impacts to threatened, endangered, or sensitive plant species, wetlands, riparian areas, nor to any known sole sources of plant species used by the Native Americans are expected. Finally, no additional impacts to forested resources are expected.

No additional impacts to waters of the U.S. will occur at either the Zortman or Landusky mines or clay pits (Table 4.4-2 and 4.4-3).

Indirect Impacts. Better reclamation procedures under Alternative 2 - reduction of soil compaction, reduction of some slope angles, and reduction of potential acid rock drainage impacts - would increase the potential for successful revegetation as compared to Alternative 1. In the long-term, though, this reclamation plan is also unlikely to provide a sustainable, suitable environment for successful revegetation on a large portion of the reclaimed disturbances.

- Soil - Impacts from soil erosion at Zortman and Landusky would be the same as described in Alternative 1 resulting in high negative impacts.

  Alleviating surface soil compaction on access and haul roads would result in an improved, more hospitable seed bed and enhance the potential for successful revegetation for these areas in non-acid generating bedrock materials.

- Slope Angle - Reducing long slopes (>200 feet) to a 3H:1V angle would reduce water runoff and erosion, provide a more stable seed bed and increase the potential for successful revegetation on those slopes. For long slopes left at a 2H:1V angle impacts would be the same as described in Alternative 1.

- Reclamation Cover - Modified reclamation plans include the placement of a 6-inch clay cap over areas where sampling shows the potential for acid production before soil replacement. The potential for acidification of soil due to acid rock drainage from capillary rise and lateral seepage of acidic moisture from waste rock, spent ore or rock substrata would be reduced. The 6-inch clay layer would also improve moisture retention in the 14-inch cover system (see Section 4.3.4) and enhance revegetation success. In the short-term, the 14-inch cover would have a beneficial effect on vegetation re-establishment as compared to the 8-inch cover in Alternative 1.

  In the long-term, as discussed in 4.3.3, the 14-inch cover is not expected to withstand weathering and erosion on a large portion of the reclaimed acreage. The clay would freeze, thaw, and desiccate and not provide the protection needed over acid producing materials. Additionally, due to the shallow depth of the clay layer, tree, shrub, grass, and forb roots, would penetrate the clay and expose vegetation to the acidic conditions underneath. Should the cover subsequently fail from acidification and lateral seepage, high negative impacts from erosion and acidification of soil would be the same as discussed in Alternative 1.

Impact Rating. A 65 percent revegetation failure is assumed as an indirect result of erosion, clay desiccation, and acidification of replaced soil and access and haul roads on acid-generating materials (Good, et al. 1995). Under Alternative 2, impacts are rated negative medium-high because the reclamation cover is not adequate to eliminate long-term problems of acidification of the soil and erosion. Under this reclamation program plant succession would be hindered and a level of comparable stability and utility would not be achieved on a large portion of the reclaimed areas.

4.4.4.1 Cumulative Impacts

Cumulative impacts from Alternative 2 would be the same as those described above in Section 4.4.3.1 but would include an additional 9 acres of disturbance at the clay pits for a total of 1,257 acres of disturbance. Impacts are the same as described for Alternative 1 except that 65 percent of the reclamation would fail (over 815 acres). Cumulative impacts are rated negative-high.

4.4.4.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as discussed in Alternative 1 except if soil become acidic 65 percent of reclaimed acreage would fail.

4.4.4.3 Short-term Use/Long-term Productivity

Assuming successful reclamation on 35 percent of the disturbed acres, total plant cover and productivity would return to premining levels in these limited grassland communities within 3-5 years and forested communities within 70-80 years. Some wildlife forage use by sheep and deer on reclaimed communities has already been documented. Assuming at least 65 percent failure of revegetation, cover and productivity and subsequent use by wildlife and humans would not return to premining levels for centuries. Some acid tolerant species would develop dominance in the area. Comparable stability and utility could not be achieved in the post-mine landscape. Over the long-term, species diversity will slowly increase but it may be centuries before it is returned to premining levels.

4.4.4.4 Irreversible or Irretrievable Resource Commitments

No irreversible or irretrievable vegetation resource commitments are anticipated under Alternative 2, because no impacts are anticipated to threatened, endangered, or sensitive species, and no known sole sources of vegetation used by the Native Americans would be impacted.

4.4.5 Impacts from Alternative 3

Alternative Background. This alternative is similar to the No Action Alternative 1, in that there would be no further expansion of the Zortman and Landusky mines. Alternative 3 incorporates agency-developed mitigation and modifications to the current reclamation plan that are designed to promote revegetation success, prevent water contamination, and reduce acid rock drainage.

Proposed Reclamation. Under Alternative 3, all potentially acid areas would be capped with 6 inches of clay. In addition, a 36-inch limestone capillary break would be placed on top of the clay cap and covered with 12 inches of soil (as compared to 8 inches for Alternatives 1 and 2) prior to revegetation. The revised surface reclamation plan includes reducing long (>200') slopes to a 3H:1V angle (2.5H:1V for dikes). Access and haul roads would be ripped to reduce compaction prior to revegetation efforts. Roads would be covered with clay if it is determined they contain acid producing material. Material from the Alder Gulch waste rock repository, the 85/86 leach pad and dike, the OK waste rock dump, tailing in Ruby Gulch, the sulfide storage area and Montana Gulch waste rock dump would be used to backfill the pit complexes at Zortman and Landusky. This measure would also reduce potential acid rock drainage problems at these facilities. These additional reclamation measures would significantly reduce desiccation of the clay liner, and potential acidification of soil and the resulting phytotoxic effects to vegetation. Again, as with Alternative 2, reclamation materials would have to be obtained from off-site sources. An additional 44.5 (35.5 more than Alternative 2) acres would be disturbed at the clay pits and limestone quarries to provide material for the clay caps and limestone capillary breaks.

To compensate for past impacts to waters of the U.S., ZMI will be requires to remove historic mine tailing from Ruby Gulch drainage above the town of Zortman, and restore the streambed channel. The access road will be relocated out of the Ruby Gulch streambed.

Direct Impacts. Direct impacts would be the same as those described for Alternative 1 and 2, but a total of 44.5 acres would be disturbed at the clay pits and limestone quarries (3.5 acres at the Seaford clay pit, 13 acres at a new limestone quarry, 9 acres at the Williams clay pit, and 19 acres at the King Creek quarry) to provide additional reclamation materials.

No additional impacts to waters of the U.S. will occur either at the Zortman or Landusky mines (Table 4.4-2 and 4.4-3). Impacts to forested areas equal 11 percent of forest in study area and 80 percent of forested acres in the disturbance area.

Indirect Impacts. Enhanced reclamation activities proposed with Alternative 3 would significantly increase the potential for successful revegetation and provide an environment capable of promoting natural plant succession and sustaining productivity into the future.

- Soil - Potential long-term cover soil loss at Zortman is 0.8 tons/acre/year and 0.9 at Landusky (Section 4.3.5). As a result, moderate negative impacts to vegetation would occur due to the loss of some cover soil.

  Increasing the cover soil thickness from 8 to 12 inches and increasing the potential rooting zone with 36-inch of limestone would decrease the potential of acidification of soils in the root zone and phytotoxic impacts to vegetation.

- Slope Angle - Slope reduction to a 3H:1V angle would reduce soil erosion, rilling, and offsite sedimentation. In addition, it would provide a more stable seedbed and significantly enhance the potential for successful revegetation.

- Reclamation Cover - The addition of a 36-inch limestone capillary break between the clay cap and the 12 inches of cover soil would decrease potential acidification of the cover soil. This 54-inch cover system would prevent the capillary rise and lateral seepage of acidic moisture and subsequent impacts to vegetation. Additionally, the 48-inch of material over the clay cap would provide an effective thermal barrier and decrease effects from weathering and potential failure of the reclamation cover.

- Relocation of Acid Producing Material - The Alder Gulch waste rock dump, the entire 85/86 leach pad and dike, the OK waste rock dump, old mill tailing in Ruby Gulch, and the sulfide stockpile at Zortman would be removed and used to backfill the pit complex to a free-draining configuration. This reclamation measure would relocate potentially acid generating material from these sites and reduce potential acidification of soil in these reclaimed areas, and increase the likelihood for successful revegetation. The sulfide area in the pit could then be reclaimed as well.

Impact Rating. The enhanced reclamation plan would significantly reduce impacts to vegetation on reclaimed areas. Revegetation failure is assumed to be less than 5 percent overall (Good et al. 1995). Natural plant succession, productivity, stability and utility is expected to return to conditions comparable to premining disturbance. Impacts to vegetation from Alternative 3 are rated negative low-medium, but not significant.

4.4.5.1 Cumulative Impacts

Cumulative impacts from Alternative 3 would be the same as those described above in Section 4.4.4, but would include a total of 44.5 acres of disturbance at the clay pits and the limestone quarry for a total of 1,292.5 acres. However, successful revegetation in the long-term would reduce impacts to vegetation on reclaimed acres including the pit floor and walls in the sulfide zone. In the long-term, less than 5 percent of the 1,289.5 (<65 acres) would be lost because of erosion and seepage of steep, long slopes and in drainage ways. Impacts to forest resources are the same as in Alternatives 1 and 2. Cumulative impacts are rated negative medium.

Restoration activities to be performed on Ruby Gulch, as described in Section 4.4.2, will offset cumulative impacts to waters of the U.S.

4.4.5.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as discussed in Alternative 1 and 2 except that only 5 percent of revegetated acres would subsequently fail (65 acres).

4.4.5.3 Short-term Use/Long-term Productivity

Assuming successful reclamation on 95 percent of the disturbed acres, total plant cover and productivity would return to premining levels in grassland communities within 3-5 years and forested communities within 70-80 years. Over the long-term, species diversity will slowly increase but it may be centuries before it is returned to premining levels. Comparable stability and utility would be achieved in the post-mine landscape.

4.4.5.4 Irreversible or Irretrievable Resource Commitments

No irreversible or irretrievable vegetation resource commitments are anticipated under Alternative 3, because no impacts are anticipated to threatened, endangered, or sensitive species, and no known sole sources of vegetation used by the Native Americans will be impacted.

4.4.6 Impacts from Alternative 4

This alternative consists of the company-proposed actions for mine life extension, and corrective measures. Major actions at Zortman would include expansion of the pit complex, construction of a heap leach facility at Goslin Flats, and construction of an ore conveyor system through Alder Gulch to Goslin Flats. At Landusky, major actions include the expansion of the Queen Rose and August Pits, development of the South Gold Bug pit, and development of a quarry in the King Creek drainage to obtain limestone for use in reclamation.

Proposed Reclamation. ZMI would implement enhanced reclamation practices for new facilities and those facilities already disturbed at Zortman and Landusky. Concurrent reclamation is proposed for some of the facilities such as pits, waste rock dumps, leach pads, dikes, and soil stockpiles (for stabilization). At cessation of mining, final reclamation would occur at additional facilities, including the limestone quarry, clay pit, processing facilities and structures, haul and access roads, process ponds, soil stockpile areas, the Goslin Flats heap leach pad, and the conveyor corridor.

Enhanced reclamation procedures proposed for this alternative include:

- A 6 inch clay cap and 8 inches of cover soil on haul roads and pit benches where testing shows a sulfur content greater than 0.2% (Cover A).

- A 12 inch clay cap, 36-inch non-acid generating (NAG) waste capillary break and 8 to 12 inches of cover soil on all facilities with greater than 0.2% sulfur and slopes 5% or greater (Cover B).

- A synthetic liner, a 3 inch clay cap, and 36 inch NAG waste capillary break and 8 to 12 inches of cover soil on all facilities with greater than 0.2% sulfur and slopes less than 3% (Cover C).

- Reduction of steep, long slopes, where feasible, to a 3H:1V angle, are the same as stated in Alternatives 2 and 3.

- The mine pits would be partially backfilled with spent ore and waste rock from the Carter Gulch waste rock repository, the 85/86 leach pad, and the Mill Gulch waste rock repository thus reducing potential acid rock drainage problems in these areas.

Wetlands Replacement. Approximately 1.8 acres of replacement wetlands are proposed by ZMI under this alternative to mitigate for impacts associated with the Goslin Flats leach pad (ZMI 1995). Wetlands would be created in a tributary to Ruby Creek to the east of the disturbed wetlands on Goslin Flats. A series of seven seasonal impoundments ranging in size from 0.09 to 0.38 acres will be created along the tributary to provide "in-kind" replacement of similar functions and values as the impacted wetland. A long-term monitoring program is proposed to assess wetland hydrology, soil stability and vegetation establishment, and to evaluate the overall success of the mitigation. The mitigation program will be developed and implemented in cooperation with the COE under Section 404 and other involved regulatory agencies to provide for continued protection of the mitigation sites. For more details on the wetland mitigation plan, refer to Appendix B and ZMI 1995.

Direct Impacts. Alternative 4 would result in direct removal of vegetation on up to 891 acres in the vicinity of the Zortman complex for extension of the mine facilities, including the pit extension, expansion of the Alder Gulch waste rock facility, construction of a heap leach pad at Goslin Flats, expansion of a limestone quarry, construction of a conveyor between the Zortman Mine and the Goslin Flats area, a power line corridor between Landusky and Zortman, process and handling facilities, and access and haul roads.

In the Landusky area, approximately 73 acres of vegetation would be removed for an LAD support area, reclamation access, drainage construction, and quarry areas and access. Total acres of disturbance include approximately 36 acres of previously disturbed land (pre-1979), rock outcrops, and scree where vegetation does not currently exist.

With respect to waters of the U.S., mining and reclamation activities at the Zortman Mine associated with Alternative 4 would impact approximately 3.01 acres of non-wetland waters of the U.S. and 1.06 acres of vegetated wetlands. (Refer to Table 4.4-4.) The proposed waste rock facility in Carter Gulch, and developments in Alder Spur and Alder Gulch (conveyor system, pipeline, construction and maintenance road) would impact the Alder Gulch drainage. Reclamation activities, such as removal of the sulfide stockpile, could impact non-wetland waters in the Ruby Gulch drainage. The Ruby Creek drainage would also be impacted by development of the Goslin Flats leach pad and associated facilities. The Goslin Flats leach pad and Alder Gulch facilities would impact drainages of Goslin Flats as well designated wetlands. Tributaries to Lodgepole Creek would be impacted by expanded mining operations. The type and quantity of fill materials that may be placed in the jurisdictional areas are described in Table A-1 of the draft Predischarge Notification (PDN) permit application (ZMI 1995).

The existing wetland functions and values were assessed, and are summarized in Table 3.4-2. For the impact assessment, the potential change to each function and value as a result of the proposed actions was evaluated using knowledge of the on-site conditions and best professional judgment. Appendix B provides a summary of the potential changes for each project component. The existing wetland functions and values would not substantially change by Alternative 4 activities, as shown in Appendix B.

No wetlands or drainages would be directly disturbed by proposed activities at the Landusky Mine (Table 4.4-3). Corrective measures at the Zortman and Landusky mines, required by the Water Quality Improvement Plan, could have additional direct and indirect impacts on waters of the U.S. Compliance structures could directly affect 0.4 acres of non-wetland waters of the U.S., as shown in Table 4.4-2. Indirect disturbances could result from erosion and sedimentation from unstabilized and unrevegetated areas.

Direct impacts to vegetation include:

- 418 acres out of 2700 acres, or 16 percent of grasslands in the study area
- 121 acres out of 800 acres, or about 15 percent of shrubland in the study area

TABLE 4.4-4

WETLAND AND DRAINAGE DISTURBANCE AT ZORTMAN MINE

Alternative 4 - Pit Expansion, Carter Gulch Waste Rock Repository, Goslin Flat Leach Pad[a]

Zortman - Alternative 4								
Drainage	Waters of the U.S.							
	Non-Wetland				Wetland			
	Length (feet)		Area (acres)		Length (feet)		Area (acres)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
Carter Gulch	2,926	1,468	0.19	0.07	-	-	-	-
Alder Gulch and tributaries	-	11,756	-	1.05	-	-	-	-
Alder Spur with tributaries	4,899	709	0.13	0.02	-	-	-	-
Ruby Gulch with tributaries	9,978	2,417	0.89	0.17	-	-	-	-
Goslin Gulch and tributaries	-	13,410	-	1.63	-	3,176	-	1.06
Tributaries to Lodgepole Creek	1,061	2,313	0.03	0.07	-	-	-	-
TOTAL	18,864	32,073	1.24	3.01	-	3,176	-	1.06
TOTAL EXISTING AND PROPOSED	50,937		4.25		3,176		1.06	

NOTES:

[a] Source: Kathy Gallagher, Consulting Hydrogeologist, Memorandum to Paula Daukas, June 2, 1995
Based on Waters of the U.S. Delineation Maps in Draft Predischarge Notification (PDN) Nationwide Permit No. 26, Zortman Mining, Inc. May 1995

- 291 acres out of 7300 acres or, 4 percent of lodgepole forests in the study area
- 47 acres out of 3700 acres, or about 1 percent of ponderosa pine forests in the study area
- 10 acres out of 300 acres or, about 3 percent of Douglas-fir forests in the study area
- 10 acres out of 1300 acres or, less than 1 percent of the deciduous forests (riparian) habitat (primarily in the drainages of the Goslin Flats area and the drainages crossed by the conveyor).
- 1.06 acres out of 21.8 acres, or less than 1 percent of wetlands in the study area
- 3.01 acres of non-wetland waters

Note: This includes 285 acres of grassland/shrubland in the land application area where vegetation will not be physically removed.

Total forested acres impacted equal about 1,387 acres or 15 percent of forested land in the study area and about 63 percent of the total disturbance; impacts are rated negative high (over 10 percent of forest in study area).

Impacts to wetlands are rated negative low since the majority of the functions and values provided will have either no change or a minor negative change due to Alternative 4 actions.

Impacts to riparian areas are rated negative low.

The reclamation plan includes revegetation with the following seed mix:

- 14 species of grasses; a 84 percent loss of diversity
- 6 species of forbs; a 98 percent loss of diversity
- 10 species of shrubs; a 77 percent loss of diversity
- 3 species of trees; a 58 percent loss of diversity

Invasion of native species on reclaimed areas would be slow (Munshower and Fisher 1993), and impacts to species diversity are rated negative high.

There are no known listed threatened, endangered, or sensitive plant species in the areas proposed for disturbance, and no known sole sources of plant species used for various purposes by Native Americans are in the project area.

Indirect Impacts.

- Soil - Moderate negative impacts to vegetation would occur due to the loss of some cover soil material as in Alternative 3.

  Cover soil thickness would range from 8 to 12 inches, with 10 inches average providing slightly better protection from acid rock drainage in the vegetation root zone than Alternatives 1 and 2, but not as good as Alternative 3.

- Slope Angle - Slopes would be reduced to a 3H:1V angle where feasible and as topography allows as in Alternatives 2 and 3. Slope lengths would be over 200 feet. Erosion, stability and potential for successful revegetation would be as discussed in Alternatives 2-3, with slope angles reduced to 3:1 providing a significantly improved potential for reclamation success.

- Reclamation Covers - Benefits, impacts and predicted success would be the same as discussed in Alternative 2 for Cover A (3- to 12-inch clay, 8-inch soil), and as discussed in Alternative 3 for Covers B and C (6 inches clay, 36-inch limestone, and 8-12 inches soil). Covers B and C would significantly reduce potential acid conditions in soil and the resulting phytotoxic effects to vegetation. In all, less than 5 percent of reclaimed acres are assumed to fail (Good et al 1995).

- Waters of the U.S. - Approximately 4.4 acres of wetlands may be indirectly disturbed (0.8 acres in Goslin Flats associated with the Goslin Flats leach pad, and 0.59 acres in Ruby Gulch and 3.0 acres in Camp Creek associated with the Land Application Disposal System). The types of indirect impacts that could occur are listed in Appendix B.

Proposed Monitoring for Revegetation. During the first season following seeding or planting, revegetated areas would be evaluated for initial revegetation success. During the second season, monitoring would include quantitative and qualitative evaluations of canopy cover, species composition and tree planting success. Areas with poor germination and/or growth would be evaluated to determine causes of any unsuccessful revegetation. The agencies would be consulted and reclamation techniques would be modified to address any identified problems. Attempts to revegetate problem areas would be made until successful. Monitoring would be conducted biannually until vegetation composition is stable.

Impact Rating. The enhanced reclamation plan would reduce impacts to vegetation on reclaimed areas. Revegetation failure is assumed to be less than 5 percent (110 acres). Natural plant succession, productivity, stability and utility is expected to almost return to conditions comparable to premining disturbance (54 acres disturbed). The overall rating for Alternative 4 would be negative medium due to the total disturbance of forested acres (1,387 acres or 63 percent of total disturbance area and 15 percent of forested habitat in study area and the assumed 5 percent failure of the revegetation efforts).

4.4.6.1 Cumulative Impacts

Cumulative impacts under Alternative 4 would include the 1,248 acres of existing disturbance from previous activities plus the proposed 964 acres of new disturbance for a total of approximately 2,212 acres of disturbance. This total includes approximately 90 acres of rock outcrop, scree, or areas that were previously disturbed and not covered with vegetation, plus 60 acres at the clay pits and limestone quarry.

An additional 3.01 acres of non-wetland U.S. waters and 1.06 acres of vegetated wetlands would be disturbed under this alternative at the Zortman Mine and no additional acres at the Landusky Mine. The cumulative disturbance to waters of the U.S. from past, present, and proposed activities under this Alternative would be 5.31 acres and 2.90 acres at the Zortman and Landusky mines, respectively.

Additional direct and indirect impacts to vegetation would occur if any of the reasonably foreseeable developments take place. Potential impacts would include the loss of vegetation, forestry resources, and wildlife habitat of primarily lodgepole pine type communities on up to 155 acres associated with exploration activities. Should the Pony Gulch ore body be developed, an additional 14 acres of lodgepole pine and grasslands would be impacted for a total of approximately 2,381 acres of disturbance. Cumulative impacts are rated negative medium although comparable stability and utility would be achieved on 95 percent of disturbed areas.

4.4.6.2 Unavoidable Adverse Impacts

Unavoidable impacts would be the same as described in Alternatives 1-3, except only 5 percent of revegetated acres would subsequently fail. Although this is similar to the failure percentage assumed in Alternative 3, almost twice as many acres (110 versus 62) would fail to revegetate in Alternative 4.

Other unavoidable impacts would be the same as described in Alternative 1.

4.4.6.3 Short-term Use/Long-term Productivity

Short-term Use and Long-term Productivity would be the same as described in Alternative 3 except that almost twice as many acres are assumed not to revegetate (110 vs. 62.

4.4.6.4 Irreversible or Irretrievable Resource Commitments

As in Alternatives 1-3 even with the additional disturbance, no irreversible or irretrievable vegetation resource commitments are anticipated under Alternative 4, because no impacts are anticipated to endangered, threatened, or sensitive species, and no known sole sources of vegetation used by the Native Americans will be impacted. No habitat for plant communities would be reduced in the study area by more than 15 percent.

4.4.7 Impacts from Alternative 5

Alternative Background. Alternative 5 is similar to Alternative 4 in that expansion of both the Zortman and Landusky mines would be allowed, but agency-developed mitigations on the expansion and reclamation plans would be imposed. The major modification, relative to vegetation resources, is the relocation of the heap leach facility from Goslin Flats to Upper Alder Gulch which would also eliminate the need for the conveyor system. Impacts to vegetation would be shifted from grasslands, shrublands, and wetlands in Goslin Flats, to the primarily lodgepole pine community in Alder Gulch. Impacts to vegetation at Landusky would be similar to Alternative 4.

Proposed Reclamation. Reclamation activities would be carried out as described for Alternative 4 except that the Alder Gulch waste rock dump would not be removed and used for backfill. However, at Landusky, material from the 85/86 leach pad and Montana Gulch waste rock dump may be used to help fill the pits as needed to meet reclamation and drainage requirements.

Other agency-developed mitigations, as discussed in Alternative 3, would be incorporated into this Alternative.

Direct Impacts. This alternative presents a shift of impacts from about 205 acres of grasslands and shrublands in Goslin Flats to about 180 acres in the primarily lodgepole pine forest of Upper Alder Gulch.

In other words, short-term impacts to grasslands and wildlife forage are shifted to long-term impacts to forests and forestry resources.

Beneficial effects of Alternative 5 include substantially less impacts to wildlife forage and habitat, and minimal impacts to wetlands as described below. All other direct impacts would be as described for Alternative 4.

Mining and reclamation activities at the Zortman Mine associated with Alternative 5 would impact approximately 2.08 acres of non-wetland waters of the U.S. and 0.02 acres of vegetated wetlands (Table 4.4-5). The proposed waste rock facility in Carter Gulch and heap leach pad in Upper Alder Gulch would impact the Alder Gulch drainage and limited jurisdictional wetlands. Reclamation activities, such as removal of the sulfide stockpile and tailing above the town of Zortman, could impact the Ruby Gulch drainage. No impacts would occur to the Goslin Flats drainage. Approximately 0.06 acres of the Lodgepole Creek drainage would be impacted by expanded mining operations. Refer to Appendix B for a summary of the effects on wetland functions and values.

Construction of the drainage notch from the August/ Little Ben pit to King Creek would restore some surface water flow to the King Creek drainage. Corrective measures at the Zortman and Landusky mines, required by the Water Quality Improvement Plan, could have additional direct and indirect impact on waters of the U.S. Compliance structures could directly affect 0.4 acres of non-wetland waters of the U.S., as shown in Table 4.4-2. Indirect disturbances could result from erosion and sedimentation from unstabilized and unrevegetated areas.

Direct impacts to vegetation include:

- 335 acres out of 2700 acres, or about 12 percent of grasslands in the study area
- 72 acres out of 800 acres, or about 9 percent of shrublands in the study area
- 432 acres out of 7300 acres or, 6 percent of lodgepole pine forests in the study area
- 50 acres out of 3700 acres or, about 1 percent of ponderosa pine forests in the study area
- 12 acres out of 300 acres or, about 4 percent of Douglas-fir forest in the study area
- 27 acres out of 1300 acres or, 2 percent of deciduous woodland (riparian) in the study area
- 0.02 acres of wetlands out of 21.8, or less than 1 percent of the study area
- 3.32 acres of non-wetland waters

Note: This includes 285 acres of grassland/shrubland in the land application area where vegetation will not be physically removed.

Impacts to forested areas equal about 17 percent of forested land in the study area and about 68 percent of the total disturbance; impacts are rated negative high.

Impacts to wetlands are rated negative low since the majority of the functions and values provided will have either no change or a minor negative change.

Impacts to riparian vegetation are rated negative low.

Impacts to species diversity are rated negative high, the same as those discussed for all other alternatives.

Indirect Impacts. Agency-developed mitigation measures would be as described in Alternative 3. As previously discussed, the enhanced reclamation plan would significantly increase the potential for successful revegetation and in the long-term, the utility and productivity of the vegetation resources would return to conditions similar to those prior to mining activity on 95 percent of the disturbed area.

Indirect impacts to waters of the U.S. are associated with the Land Application Disposal and Alder Gulch alternative leach pad. Approximately 3.8 acres of wetlands may be indirectly disturbed. The types of potential indirect impacts are summarized in Appendix B. The potential change in wetland functions and values resulting from Alternative 5 activities are considered minor or to have no change (Appendix B).

Monitoring for Revegetation. ZMI would be required to submit a surface reclamation monitoring plan to the Agencies that evaluates the continued performance of such features as; 1) reclamation covers, 2) revegetation success and performance, and 3) erosion control measures, and continue monitoring until such time as the Agencies release the reclamation bond.

Impact Rating. The enhanced reclamation plan would reduce expected revegetation failure to less than 5 percent (Good, et al. 1995) as in Alternative 3. In Alternative 5, 114 acres are assumed to fail compared to 62 acres in Alternative 3. Natural plant succession, productivity, stability, and utility is expected to almost return to conditions comparable to premining disturbance (54 acres disturbed). The overall rating for Alternative 5 would be negative medium due to the total disturbance of forested acres (1,550 acres or 68 percent

TABLE 4.4-5

WETLAND AND DRAINAGE DISTURBANCE AT ZORTMAN MINE

Alternative 5 - Pit Expansion, Carter Gulch Waste Rock Repository, Alder Gulch Leach Pad[a]

Zortman - Alternative 5								
Drainage	Waters of the U.S.							
	Non-Wetland				Wetland			
	Length (feet)		Area (acres)		Length (feet)		Area (acres)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
Carter Gulch	2,926	1,468	0.19	0.07	-	-	-	-
Alder Gulch and tributaries	-	26,836	-	1.93	-	100	-	0.02
Alder Spur with tributaries	4,899	709	0.13	0.02	-	-	-	-
Ruby Gulch with tributaries	9,978	-	0.89	-	-	-	-	-
Goslin Gulch and tributaries	-	-	-	-	-	-	-	-
Tributaries to Lodgepole Creek	1,061	2,164	0.03	0.06	-	-	-	-
TOTAL	18,864	31,177	1.24	2.08	-	100	-	0.02
TOTAL EXISTING AND PROPOSED	50,041		3.32		100		0.02	

NOTES:

[a] Source: Kathy Gallagher, Consulting Hydrogeologist, Memorandum to Paula Daukas, June 2, 1995

Based on Waters of the U.S. Delineation Maps in Draft Predischarge Notification (PDN) Nationwide Permit No. 26, Zortman Mining, Inc. May 1995

of total disturbance area and 12 percent of forested habitat in study area and the assumed 5 percent failure of revegetation efforts).

4.4.7.1 Cumulative Impacts

Cumulative impacts under Alternative 5 would include the 1,248 acres of existing disturbance from current activities, and approximately 1,025 acres of new disturbance, for a total of about 2,273 acres of disturbance. This total includes approximately 114 acres of rock outcrop, scree, or areas that were previously disturbed and not covered with vegetation, plus 66.5 acres at the clay pits and limestone quarries.

An additional 2.08 acres of non-wetland U.S. waters and 0.02 acres of vegetated wetlands would be disturbed under this alternative at the Zortman Mine and no additional acres at the Landusky Mine. The cumulative disturbance to waters of the U.S. from past, present, and proposed activities under this Alternative would be 3.34 acres and 2.90 acres at the Zortman and Landusky mines, respectively.

Additional direct and indirect impacts to vegetation would occur to 155 acres of primarily lodgepole pine communities that could be disturbed during exploration activities for a total of 2,428 acres of disturbance. Cumulative impacts are rated negative medium although comparable stability and utility would be achieved on 95 percent of disturbed areas.

To compensate for past impacts to waters of the U.S., ZMI will be requires to remove historic mine tailing from Ruby Gulch drainage above the town of Zortman, and restore the streambed channel. The access road will be relocated out of the Ruby Gulch streambed.

4.4.7.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would essentially be the same as discussed in Alternative 4.

4.4.7.3 Short-term Use/Long-term Productivity

Short-term Use and Long-term Productivity would be the same as described in Alternative 3 except that almost twice as many acres are assumed not to revegetate (114 vs. 62.

4.4.7.4 Irreversible or Irretrievable Resource Commitments

As in Alternatives 1-3 even with the additional disturbance, no irreversible or irretrievable vegetation resource commitments are anticipated under Alternative 5, because no impacts are anticipated to endangered, threatened, or sensitive species, and no known sole sources of vegetation used by the Native Americans would be impacted. No habitat for plant communities would be reduced in the study area by more than 15 percent.

4.4.8 Impacts from Alternative 6

Alternative Background. Alternative 6 is similar to Alternative 4 in that expansion of both the Zortman and Landusky mines would be allowed, but agency-developed mitigations on the expansion and reclamation plans would be imposed. The major modification, relative to vegetation resources, is the Alder Gulch waste rock repository would be relocated to the Ruby Flats, just east of the Goslin Flats leach pad. Impacts to vegetation at Landusky would be similar to Alternative 4.

Proposed Reclamation. Reclamation activities would be carried out as described in Alternative 4.

Direct Impacts. This alternative presents a shift of impacts from 180 acres of lodgepole pine forest to 203 acres of grasslands and shrublands in Goslin Flats. In other words, long-term impacts to forests and forestry resources are shifted to short-term impacts to grasslands and wildlife habitat and forage. Impacts to species diversity would be as described for all other alternatives.

Mining and reclamation activities associated with Alternative 6 would impact approximately 2.21 acres of non-wetland waters of the U.S. and 1.06 acres of vegetated wetland (Table 4.4-6). The proposed developments in Alder Spur and Alder Gulch (conveyor system, pipeline, construction and maintenance road) would impact the Alder Gulch drainage. No additional impacts would occur to the Carter Gulch tributary of Alder Gulch. Reclamation activities, such as removal of the sulfide stockpile and old mill tailing above the town of Zortman, could impact non-wetland waters in Ruby Gulch drainage. The Ruby Creek drainage would also be impacted by development of the Goslin Flats leach pad and associated facilities, and be development of the Ruby Flats waste rock repository. The Goslin Flats leach pad and Alder Gulch facilities would impact drainages of Goslin Flats as well designated wetland.

TABLE 4.4-6

WETLAND AND DRAINAGE DISTURBANCE AT ZORTMAN MINE

Alternative 6 - Pit Expansion, Ruby Terrace Waste Rock Repository, Goslin Flat Leach Pad[a]

Zortman - Alternative 6								
Drainage	Waters of the U.S.							
	Non-Wetland				Wetland			
	Length (feet)		Area (acres)		Length (feet)		Area (acres)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
Carter Gulch	2,926	-	0.19	-	-	-	-	-
Alder Gulch and tributaries	-	2,101	-	0.20	-	-	-	-
Alder Spur with tributaries	4,899	709	0.13	0.02	-	-	-	-
Ruby Gulch with tributaries	9,978	4,235	0.89	0.30	-	-	-	-
Goslin Gulch and tributaries	-	13,410	-	1.63	-	3,176	-	1.06
Tributaries to Lodgepole Creek	1,061	2,164	0.03	0.06	-	-	-	-
TOTAL	18,864	22,619	1.24	2.21	-	3,176	-	1.06
TOTAL EXISTING AND PROPOSED	41,483		3.45		3,176		1.06	

NOTES:

[a] Source: Kathy Gallagher, Consulting Hydrogeologist, Memorandum to Paula Daukas, June 2, 1995
Based on Waters of the U.S. Delineation Maps in Draft Predischarge Notification (PDN) Nationwide Permit No. 26, Zortman Mining, Inc. May 1995

Approximately 0.06 acres of Lodgepole Creek drainage would be impacted by expanded mining operations. Refer to Appendix B for a summary of potential changes in the wetlands functions and values as a result of Alternative 6 activities.

No wetlands or drainages would be directly disturbed by proposed activities at the Landusky Mine (Table 4.4-3). Corrective measures required by the Water Quality Improvement Plan could have additional direct and indirect impact on waters of the U.S. Compliance structures could directly affect 0.4 acres of non-wetland waters of the U.S., as shown in Table 4.4-2. Indirect disturbances could result from erosion and sedimentation from unstabilized and unrevegetated areas.

Direct impacts to vegetation include:

- 691 acres out of 2700 acres, or 26 percent of grassland in the study area
- 178 acres out of 800 acres, or about 22 percent of shrubland in the study area
- 159 acres out of 7300 acres or, 2 percent of lodgepole pine forest in the study area
- 46 acres out of 3700 acres or, about 1 percent ponderosa pine forest in the study area
- 1 acre out of 300 acres or, less than 1 percent of Douglas-fir forest in the study area
- 10 acres out of 1300 acres or, less than 1 percent of deciduous woodland (riparian) habitat in the study area (primarily in the drainages of the Goslin Flats area and the drainages crossed by the conveyor).
- 1.06 acres out of 21.8 acres, or less than 1 percent of wetlands in the study area
- 3.45 acres of non-wetland waters

Note: This includes 285 acres of grassland/shrubland in the land application area where vegetation will not be physically removed.

Impacts to forested areas equal about 14 percent of forested land in the study area and about 51 percent of the total disturbance; impacts are rated negative high.

Impacts to wetlands are rated negative low since the majority of the functions and values provided will have either no change or a minor negative change.

Impacts to riparian areas are rated negative low.

Impacts to species diversity are rated negative high, the same as discussed for all other alternatives.

Indirect Impacts. Indirect impacts would be as discussed in Alternatives 4 and 5.

Monitoring for Revegetation. ZMI would be required to submit a surface reclamation monitoring plan to the Agencies that evaluates the continued performance of such features as; 1) reclamation covers, 2) revegetation success and performance, and 3) erosion control measures, and continue monitoring until such time as the Agencies release the reclamation bond.

Impact Rating The enhanced reclamation plan would reduce expected revegetation failure to less than 5 percent (Good, et al. 1995) as in Alternative 3. In Alternatives 4, 5, and 6, 110 acres, 114 acres, and 121 acres, respectively, would be left unvegetated. Natural plant succession, productivity, stability, and utility is expected to almost return to conditions comparable to premining disturbance (54 acres disturbed). The overall rating for Alternative 6 would be negative low-medium due to the total disturbance of forested acres (1,245 acres or 51 percent of total disturbance area and 14 percent of forested habitat in study area and the assumed 5 percent failure of revegetation efforts).

4.4.8.1 Cumulative Impacts

Cumulative impacts under Alternative 6 would include the 1,248 acres of existing disturbance from current activities, and 1,174 acres of proposed disturbance, for a total of approximately 2,422 acres of disturbance. This total includes approximately 105 acres of rock outcrop, scree, or areas previously disturbed and not currently covered with vegetation, and 67 acres at the clay pits and quarries.

An additional 2.21 acres of non-wetland U.S. waters and 1.06 acres of vegetated wetlands would be disturbed under this alternative at the Zortman Mine and no additional acres at the Landusky Mine. The cumulative disturbance to waters of the U.S. from past, present, and proposed activities under this Alternative would be 4.51 acres and 2.90 acres at the Zortman and Landusky mines, respectively.

Additional direct and indirect impacts to vegetation would occur if any of the reasonably foreseeable developments take place. Impacts would include the loss of vegetation on up to 155 acres of primarily lodgepole pine type communities associated with exploration activities. Should the Pony Gulch ore body be developed, an additional 14 acres of lodgepole pine and grasslands would be impacted for a total of 2,591 acres of disturbance. Cumulative impacts are rated negative

To compensate for past impacts to waters of the U.S., ZMI will be required to remove historic mine tailing from, Ruby Gulch drainage above the town of Zortman, and restore the streambed channel. The access road will be relocated out of the Ruby Gulch streambed.

4.4.8.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be essentially as discussed in Alternatives 4 and 5.

4.4.8.3 Short-term Use/Long-term Productivity

Short-term Use and Long-term Productivity would essentially be the same as described in Alternative 3 except that almost twice as many acres are assumed not to revegetate (121 vs. 62.

4.4.8.4 Irreversible or Irretrievable Resource Commitments

The impacts are essentially the same as in Alternatives 4 and 5 except that grassland/shrubland in the study area would be reduced 22 percent. This is an important reduction but not an irreversible or irretrievable resource commitment in the long run.

4.4.9 Impacts from Alternative 7

Alternative Background. Alternative 7 is similar to Alternative 4 in that expansion of both the Zortman and Landusky mines would be allowed, but agency-developed mitigations on the expansion and reclamation plans would be imposed. The major modification, relative to vegetation resources, is elimination of the Alder Gulch waste rock repository and placement of most of the waste rock on top of existing facilities. Impacts to vegetation at Landusky would be similar to Alternative 4.

Proposed Reclamation. Activities would be carried out as described in Alternative 4 with the following additional modifications relative to vegetation resources.

- in the design of the reclamation covers as discussed in Section 4.1.
- ZMI would be required to remove more waste rock fill from the head of King Creek to backfill the Landusky pit complex.
- Nine million tons of spent ore and tailing from the 85/86 leach pad and dike and Ruby Gulch drainage would be used as backfill in the pit complex at Zortman.
- Post-closure, the site would be managed for limited wildlife habitat.Tree species would be in the revegetation plan. Grasses, forbs and shrubs would be used to enhance wildlife habitat. Lack of open parks and meadows is the limiting factor for wildlife. Scattered clumps of trees may be planted to provide cover and improve aesthetics, particularly in the drainages. The location and numbers of trees will be negotiated between the agencies' wildlife biologist and ZMI at the time of final reclamation.
- Crested wheatgrass will be removed from the seed mix due to low palatability for wildlife and a tendency for it to crowd out other more suitable species.
- Reclamation Cover A (8 inches of soil and 6 inches of clay) would not be used for this alternative.

Direct Impacts. This alternative presents reduction of impacts to 180 acres of lodgepole pine forest. In other words, long-term impacts to forests and forestry resources would be reduced by placing the waste rock on previously disturbed sites currently rather than clearing a forested site to create a new waste rock repository.

Impacts to species diversity would be as described for all other alternatives. The revised plan would significantly benefit wildlife forage and habitat but would be a negative impact to reestablishment of trees.

Mining and reclamation activities associated with Alternative 7 would impact approximately 2.51 acres of non-wetland waters of the U.S. and 1.06 acres of vegetated wetlands (Table 4.4-7). The proposed development in Alder Spur and Alder Gulch (conveyor system, pipeline, construction and maintenance road) would impact the Alder Gulch drainage. The new waste rock repository near the mine site would extend into the upper part of Ruby Gulch. Reclamation activities, such as removal of the sulfide stockpile and old mill tailing above the town of Zortman, could also impact the Ruby Creek drainage, as could development of the Goslin Flats leach pad and associated facilities. The Goslin Flats leach pad and Alder Gulch facilities would impact drainages of Goslin Flats as well designated wetlands. Approximately 0.06 acres of the Lodgepole Creek drainage would be impacted by expanded mining operations. Refer to Appendix B for a summary of

TABLE 4.4-7

WETLAND AND DRAINAGE DISTURBANCE AT ZORTMAN MINE

Alternative 7 - Pit Expansion, Zortman Waste Rock Cap, Goslin Flat Leach Pad[a]

Zortman - Alternative 7								
Drainage	Waters of the U.S.							
	Non-Wetland				Wetland			
	Length (feet)		Area (acres)		Length (feet)		Area (acres)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
Carter Gulch	2,926	-	0.19	-	-	-	-	-
Alder Gulch and tributaries	-	2,101	-	0.20	-	-	-	-
Alder Spur with tributaries	4,899	4,752	0.13	0.12	-	-	-	-
Ruby Gulch with tributaries	9,978	7,218	0.89	0.50	-	-	-	-
Goslin Gulch and tributaries	-	13,410	-	1.63	-	3,176	-	1.06
Tributaries to Lodgepole Creek	1,061	2,164	0.03	0.06	-	-	-	-
TOTAL	18,864	29,645	1.24	2.51	-	3,176	-	1.06
TOTAL EXISTING AND PROPOSED	48,509		3.75		3,176		1.06	

NOTES:

[a] Source: Kathy Gallagher, Consulting Hydrogeologist, Memorandum to Paula Daukas, June 2, 1995

Based on Waters of the U.S. Delineation Maps in Draft Predischarge Notification (PDN) Nationwide Permit No. 26, Zortman Mining, Inc. May 1995

potential changes in the wetland functions and values as a result of Alternative 7 actions.

Construction of the drainage notch from the August/ Little Ben pit to King Creek would restore some surface water flow to the King Creek drainage. Corrective measures at the Zortman and Landusky mines, required by the Water Quality Improvement Plan, could have additional direct and indirect impact of waters of the U.S. Compliance structures could directly affect 0.4 acres of non-wetland waters of the U.S., as shown in Table 4.4-2. Indirect disturbances could result from erosion and sedimentation from unstabilized and unrevegetated areas.

Direct impacts to vegetation include:

- 418 acres out of 2700 acres, or 16 percent of grassland in the study area
- 121 acres out of 800 acres, or about 15 percent of shrubland in the study area
- 199 acres out of 7300 acres or, 3 percent of lodgepole pine forest in the study area
- 34 acres out of 3700 acres or, less than 1 percent ponderosa pine forest in the study area
- 9 acres out of 1300 acres or, less than 1 percent of deciduous woodland (riparian) habitat in the study area (in the drainages of the Goslin Flats area and the drainages crossed by the conveyor).
- 1.06 acres out of 21.8 acres, or less than 1 percent of wetlands in the study area
- 3.75 acres of non-wetland waters

Note: This includes 285 acres of grassland/shrubland in the land application area where vegetation will not be physically removed.

Impacts to forested areas equal about 14 percent of forested land in the study area and about 62 percent of the total disturbance; impacts are rated negative high.

Impacts to wetlands are rated negative low since the majority of the functions and values provided will have no change or a minor negative change.

Impacts to riparian areas are rated negative low.

Impacts to species diversity are rated negative high as discussed for all other alternatives.

Indirect Impacts.

- Slopes - With the exception of leach pad dikes (at 2.5H:1V), existing facilities would be reclaimed to a 3:1 slope, with constructed benches for erosion control every 50 feet. This would reduce slope length to 158 feet (<200 feet). The long-term potential for erosion at Zortman would drop to 0.7 tons/acre/year and 0.6 tons/acre/year at Landusky (Section 4.3.9) resulting in low negative impacts to vegetation.

- Reclamation Cover - Improvements in the design of the reclamation cover, as discussed in Section 4.1, reduce the potential for failure of the cap to less than 1 percent with failures occurring only through limited erosion in drainage ways.The enhanced reclamation plan would significantly reduce the potential failure of revegetation in the long-term to less than 1 percent. The disturbed acres would provide comparable stability and utility as required by the Metal Mine Reclamation Act.

- Waters of the U.S. - Indirect impacts would be as discussed in Alternative 4.

Monitoring for Revegetation. ZMI would be required to submit a surface reclamation monitoring plan to the Agencies that evaluates the continued performance of such features as; 1) reclamation covers, 2) revegetation success and performance, and 3) erosion control measures, and continue monitoring until such time as the Agencies release the reclamation bond.

Impact Rating. The improved reclamation cover system, increased erosion control measures, additional pit backfilling, and selective placement of waste rock over predisturbed acres reduce the potential for reclamation failure to less than 1 percent (21 acres). Natural plant succession productivity, stability and utility are expected to return to conditions comparable to premining disturbance (54 acres). The overall rating for Alternative 7 would be negative low.

4.4.9.1 Cumulative Impacts

Cumulative impacts under Alternative 7 would include the 1,248 acres of existing disturbance from current activities, and 835 acres of proposed disturbance for a total of 2,083 acres. This total includes 74 acres of rock outcrop, scree, or areas previously disturbed and not currently covered with vegetation, and 49 acres at the clay pits and quarries.

An additional 2.51 acres of non-wetland U.S. waters and 1.06 acres of vegetated wetlands would be disturbed under this alternative at the Zortman Mine and no additional acres at the Landusky Mine. The cumulative disturbance to waters of the U.S. from past, present, and under this alternative at the Zortman Mine and no additional acres at the Landusky Mine. The cumulative disturbance to waters of the U.S. from past, present, and proposed activities under this Alternative would be 4.81 acres and 2.90 acres at the Zortman and Landusky mines, respectively.

Additional direct and indirect impacts to vegetation would occur if any of the reasonably foreseeable developments take place. Impacts would be as described in Alternative 4, for a total disturbance of 2,252 acres. Cumulative impacts are rated negative low although comparable stability and utility would be achieved on 99 percent of the disturbed area. With 1 percent failure, 21 acres would remain unvegetated. This is 33 acres less than the 54 acres of premining unvegetated acres that existed before mining commenced in 1979.

To compensate for past impacts to waters of the U.S., ZMI will be required to remove historic mine tailing from Ruby Gulch drainage above the town of Zortman, and restore the streambed channel. The access road will be relocated out of the Ruby Gulch streambed.

4.4.9.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be reduced to less than premining disturbance levels (21 acres compared to 54 acres). Other impacts to species diversity would stay the same.

4.4.9.3 Short-term Use/Long-term Productivity

It is expected that on 99 percent of the reclaimed acres, total plant cover and productivity would return to premining levels within 3 to 5 years providing significant benefits for wildlife. Over the long-term, species diversity will slowly increase but it may be centuries before it is returned to premining levels. Eventually, forested habitat would return to suitable sites which were reclaimed to grasslands in the short-term. In the long-term, only 21 acres rather than 54 would remain unvegetated.

4.4.9.4 Irreversible or Irretrievable Resource Commitments

The impacts are essentially the same as in Alternatives 4 and 5.

4.4.10 Impacts Summary

A summary of impacts from each alternative is presented in Table 4.4-8.

TABLE 4.4-8

IMPACTS SUMMARY

Resource	Units	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7
Vegetation and Wetlands								
Threatened, endangered, sensitive species habitat	Acres	NI	NI	NI	NI	NI	NI	NI
Sole source of vegetation used by Native Americans	Acres	NI	NI	NI	NI	NI	NI	NI
Non-wetland waters of the U.S.	Acres	4.14	4.14	4.14	3.01	2.08	2.21	2.51
Wetland	Acres	NI	NI	NI	1.06	0.02	1.06	1.06
Riparian vegetation[*]	Acres	--/16	--/16	--/16	10/26	27/43	10/26	9/25
Forest[*]	Acres	--/1029	--/1029	--/1029	358/1387	521/1550	216/1245	256/1285
Species diversity	% loss	92	92	92	92	92	92	93
Reclamation Plan	% Effective	25	35	95	95	95	95	99
Impact Rating/Alternative		-M/H	-M/H	L/-M	-M	-M	-L/M	-L
Cumulative Impact Rating		-H	-H	-M	-M	-M	-M	-L

[*] X/Y
X - Acres disturbed as a result of implementing the alternative
Y - Cumulative acres disturbed - previous and proposed

N1 - No Impact

4.5 WILDLIFE AND AQUATICS

4.5.1 Methodology

Issues concerning wildlife potentially impacted by potential mine expansion, operations, and closure/ reclamation activities were developed from the public scoping process and consultation with local, state and federal agencies. These issues and concerns are summarized in Section 1.6 and listed below:

- Loss or disturbance to federal threatened or endangered wildlife species and their habitats.
- Loss or disturbance to federal Category 2 candidate species.
- Degraded water quality and adverse impacts on fish and aquatic organisms.
- Increased wildlife mortality from mining activities.
- Adverse impacts to bats occupying or hibernating at Azure Cave.

Based on these issues a series of significance criteria was developed to evaluate impacts to fisheries and wildlife from the seven alternatives. Significance criteria used in the evaluation of impacts include:

- Disturbed area contains habitat officially designated as critical habitat for federal threatened or endangered species by the USFWS (No areas designated as critical habitat for any threatened or endangered species occurs within the study area).
- Disturbed area contains habitat or known use areas for federal candidate species.
- Mine activities disturbs known populations or individuals of federal and state sensitive species, particularly bats and nesting raptors.
- Noise (decibels) of mine activities at Azure Cave exceed levels considered potentially detrimental to hibernating bats.
- Potential wildlife mortality from mining related activity (cyanide ponds, vehicle collision) experiences an increase above pre-mine levels that is detrimental to wildlife populations in the Little Rocky Mountains.
- Effectiveness of reclamation for wildlife.
- Acres of habitat lost exceeding 5, 10, and 15 percent of the approximately 20,500 acres of wildlife habitat available in the Little Rocky Mountains as examined by Scow (1978) are considered low, medium, and high negative impacts, respectively.
- Residual water quality exceeds baseline water quality levels shown in Table 3.2-9, or exceeds maximum freshwater continuous criterion presented on Table 4.2-1 for selected locations downgradient from the mine. These criterion are adjusted for site-specific water hardness.
- Increases in suspended solids and stream bottom sediments in receiving streams that could be detrimental to aquatic macroinvertebrates and fish as described in Section 4.2.

Evaluations and comparisons of impacts of alternatives based on the above significance criteria were separated into seven subsections. These subsections include, habitat loss, wildlife mortality, noise, nesting raptors, special status species, residual water quality, and reclamation. Special status species included federally listed threatened, endangered, Category 2 candidate species, and state sensitive species. Several special status species described in Section 3.5 either do not occur within the proposed mine area or occupy habitats not likely to be impacted by any alternatives and thus are not further evaluated. These species include:

- Bald Eagle
- Peregrine Falcon
- Piping Plover
- Black-footed Ferret
- Burrowing Owl
- Ferruginous Hawk
- Mountain Plover
- Northern Goshawk
- Loggerhead Shrike
- Baird's Sparrow
- Long-billed Curlew

Impacts to big game and upland game species are generally evaluated collectively under habitat loss and wildlife mortality sections.

Methods used in this evaluation involved a review of existing information including baseline reports, previous environmental impact statements, Applications for Amendment to Operating Permits, scientific journals, and consultation with local, state and federal agency personnel.

Several analyses, based on existing information, were conducted that develop a relative index of impacts by the different alternatives. Although these calculations may not have produced absolute numbers for potential impact, they did provide a consistent estimate of the relative impacts by alternative. The precision of the estimates were dependent on the quality of the available data. When baseline or specific information was lacking, basic assumptions were made during the analyses. These assumptions are explained in the text.

Specific methods included: (1) obtaining information on the occurrence of federal threatened and endangered species and their potential habitat from baseline studies, the USFWS, BLM, MDFWP and the Montana Natural Heritage Program (MNHP); (2) calculating wildlife mortality based on the scientific literature, baseline and wildlife monitoring reports, and estimates of increased traffic by alternative; (3) evaluating noise impacts to hibernating bats based on calculations presented in Section 4.9, and consulting with experts from Bat Conservation International (BCI); (4) evaluating residual water quality based on calculations presented in Section 4.2; (5) evaluating impacts to nesting raptors based on baseline reports and element occurrence searches conducted by the MNHP; and (6) estimating habitat loss by comparing total acreage of disturbance reported by alternative to a baseline evaluation of the Little Rocky Mountains south of the Fort Belknap Indian Reservation, conducted by Scow (1979). The baseline evaluation by Scow (1979) did not encompass the entire Little Rocky Mountains, therefore estimates of habitat loss provided in this report are extremely conservative.

The duration of impacts to fishery and wildlife resources are defined as: short-term-impacts of less than 10 years (approximately the life-of-mine for most alternatives); and long-term impacts greater than 10 years.

Categorization of impact direction and levels for fisheries and wildlife are based on the following criteria:

- NS - No Significant Impacts, i.e., impacts do not exceed significance criteria
- Low - Slightly exceeds significance criteria
- Moderate - Moderately exceeds significance criteria
- High - Greatly exceeds significance criteria
- Beneficial - Impacts that improve the resource beyond 1979 baseline conditions
- Negative - Impacts that further reduce the value of the resource below 1979 baseline conditions or maintain conditions at less than baseline conditions

4.5.2 Impacts from Mining, 1979 to Present

The Zortman and Landusky mining sites in the Little Rocky Mountains contain seasonal and year long habitats for a number of wildlife species, particularly bighorn sheep, mule deer, various bats and upland game birds. Negative impacts to wildlife have occurred from habitat loss, human and mechanical harassment and wildlife mortality. The primary impact to wildlife from mining at the Zortman and Landusky Mines has been a loss of habitat. Total disturbance at the Zortman and Landusky Mines has been approximately 401 and 814 acres, respectively and 30 acres at clay pits for a total of 1,245 acres.

Approximately 18,500 acres of crucial year-round bighorn sheep habitat is contained in the Little Rocky Mountains. Current mining activities in the Little Rocky Mountains have been estimated to have decreased year long crucial habitat for bighorn sheep by 4 percent (BLM 1992b), and overall wildlife habitat has been reduced 6 percent (Table 4.5-1). This habitat reduction is considered to be a low negative impact.

No federally listed threatened or endangered wildlife species have been documented on the project site prior to, or subsequent to 1979. Additionally, no critical habitat for threatened or endangered species has been designated to occur within the Little Rocky Mountains by the USFWS. Thus, no threatened or endangered species have occurred or are expected to occur within the immediate vicinity of mining operations within the Little Rocky Mountains and adverse impacts have not occurred.

Prior to mining at the Zortman and Landusky mines, the only fisheries in the vicinity of the project occurred in Lodgepole, Beaver, and King Creeks and Rock Creek below the town of Landusky (DSL 1979b). Little Peoples Creek was a major fishery prior to cyanide poisoning caused by historical mining prior to 1979. Beaver Creek is outside the area of influence of the Zortman and Landusky mines and has not been impacted by current mining, but some mine exploration has occurred. Lodgepole Creek has been impacted by

TABLE 4.5-1
SUMMARY AND COMPARISON OF IMPACTS
WILDLIFE AND FISHERIES

		IMPACTS								
		Special Status spp.	Nesting Raptors	Habitat lost or Disturbed	Residual Water Quality	Sedimentation	Wildlife Mortality		Noise	Reclamation Effectiveness
							Solution	Collisions		
Alternative[2]										
1979 to Present		NS	NS	1245 acres	Mod. -	Mod -	Low -	NS	NS	High -
1	S-T	NS	NS	1245 acres	Mod. -	Mod -	NS	NS	NS	Low +
	L-T	NS	NS		Mod. -	Low -	NS	NS	NS	High -
2	S-T	NS	NS	1254 acres	Mod. -	Mod -	NS	Low -	NS	Low +
	L-T	NS	NS		Mod. -	Low -	NS	NS	NS	Mod -
3	S-T	NS	NS	1290 acres	Low -	Mod/High -	NS	Mod -	NS	Mod +
	L-T	NS	NS		Low -	Low -	NS	NS	NS	Low -
4	S-T	NS	NS	2209 acres	Low -	High -	NS	Mod -	NS	Mod +
	L-T	NS	NS		Mod -	Mod -	NS	NS	NS	Low -
5	S-T	NS	NS	2270 acres	Low -	Mod -	NS	Mod -	NS	Mod +
	L-T	NS	NS		Low/Mod -	NS/Low -	NS	NS	NS	Low -
6	S-T	NS	NS	2419 acres	Low -	High -	NS	Mod -	NS	Mod +
	L-T	NS	NS		Low -	Med -	NS	NS	NS	Low -
7	S-T	NS	NS	2080 acres	Low +	High -	NS	Mod -	NS	Mod +
	L-T	NS	NS		Low +	Mod -	NS	NS	NS	NS

[1] Threatened, endangered, federal candidate and special status species are combined into special status species for this summary table.

[2] S-T = Short-term; L-T = Long-term

NS = No Significant Impact (Adverse or Beneficial); Impacts do not Exceed Significance Criteria

Low = Slightly Exceeds Significance Criteria

Mod. = Moderate, Moderately Exceeds Significance Criteria

High = Greatly Exceeds Significance Criteria

\+ = Beneficial Impact

\- = Adverse Impact

the diversion of the recharge area since 1979; however, the resultant decrease in flow has been negligible (see Section 4.2.2). King Creek has also experienced a negligible amount of flow diversion since 1979. Rock Creek has been impacted at surface water station L-2 and has experienced a slight increase in sulfates and cyanide; however arsenic has decreased from pre-mine levels (Table 3.2-18). These chemical concentrations are not elevated above acute or chronic levels detrimental to aquatic life. Mining activity in general and acid rock drainage in particular can result in high sediment loads which can smother bottom dwelling aquatic macroinvertebrates and destroy their habitat. As described in Section 3.5.9, overall low total macroinvertebrate numbers, low diversity of taxa, and an abundance of pollution-tolerant organisms are reflective at natural perturbation and previous mining activity. Montana Gulch, which flows into Rock Creek, was heavily impacted prior to 1979. Changes in water flows, degraded water quality, and reduced availability of water sources within mined areas has impacted water supplies for terrestrial wildlife both within and downstream of existing mine operations.

Wildlife mortality from all mine-related activities (vehicle collision, cyanide poisoning) recorded by ZMI since 1979 have been relatively minor; however, concerted efforts to document mortality were not initiated until 1990. Wildlife mortality records from mine process ponds are summarized below:

YEAR	NUMBER	SPECIES
1982	1	Bighorn Sheep
1991	1	Mule Deer
	30	Sea Gulls
	4	Mallards
1992	2	Mule Deer
1993	0	
1994	6	Eared Grebe

Mortality of migratory birds in process ponds and cyanide solutions can be a violation of the Migratory Bird Treaty Act and result in significant fines and legal action. Bats often die ¼-½ mile from poisoning source, so data is lacking.

As a result of the loss of 30 sea gulls in a barren solution pond at the Zortman plant site, bird netting was installed above all process ponds at both the Zortman and Landusky mines. Prior to 1991, avian mortality is reported to have not been a problem at either mine (Miller 1991).

Wildlife mortality from mine-related traffic has not been recorded at either the Zortman or Landusky mines; however, collisions with wildlife often go unreported. Wildlife may be fatally injured and crawl away from the road, large carnivores may drag carcasses away from roadsides, and roadkills may simply be tossed to the roadside without documentation.

A 1978 survey of Azure Cave found 530 hibernating bats (Chester et al. 1979). A survey of the cave in March 1993 found approximately 250-300 hibernating bats (Butts 1993). This apparent decline in bat numbers could be related to discrepancies in counting methods, the extent of the cave area surveyed, or other factors; however, habitat loss or disturbance may be contributing to the actual decline (Taylor 1994). Similar declines in bat populations have been documented in a number of bat species nation-wide. The most common reasons cited are loss of secure roosting sites through cave destruction, unplanned recreational use of caves, abandoned mine closures, loss of late seral stage forest as roosting sites, and loss of foraging habitat (Tuttle and Taylor in press).

4.5.3 Impacts from Alternative 1

Under the No Action Alternative, ZMI would continue activities already permitted at both the Zortman and Landusky mines. Over the short-term (i.e., over the life of the mine under this alternative), adverse impacts to fisheries and wildlife would be direct habitat loss and indirect impacts from increased traffic and noise. Evaluations of impacts for each alternative are presented in Table 4.5-1.

Habitat Loss

No direct loss of wildlife habitat beyond the existing permitted acreage at the Zortman Mine would occur under Alternative 1.

Soil at the current Carter Butte land application area have been loaded to nearly maximum metal contents from past emergency land application disposal. Under Alternative 1, a 205 acre emergency land application area (LAD) has been proposed for the Goslin Flats. Thus, Alternative 1 has the potential to temporarily disturb an additional 205 acres of wildlife habitat (primarily grassland) beyond the 401 acres previously disturbed by the existing Zortman mining operations. Disturbance at the LAD will be of only short duration during emergency disposal operations and will not preclude wildlife use or result in any significant short-term or long-term habitat loss. Thus, short-term loss of habitat availability would remain 1,245 acres or 6 percent from pre-1979 conditions (Table 4.5-2) This would result in a low negative impact. Long-term impacts based on the success of reclamation at re-establishing wildlife habitat are discussed under reclamation. Long-term habitat loss would not be significant.

No habitat disturbance beyond currently permitted activities would occur at the Landusky Mine.

Wildlife Mortality

Wildlife mortality from process ponds would be minimal under Alternative 1. All process ponds at the Zortman and Landusky mines have been covered with bird netting and are enclosed by fencing, effectively eliminating wildlife mortality. Water catchment ponds at Ruby, Alder and Carter Gulches currently catch seepage and capture water and pump it to the Zortman water treatment plant. Capture ponds at the Landusky Mine include Sullivan Park, Mill Gulch, and the 85/86 contingency pond. Water temporarily stored in these ponds contain acid rock drainage with high metals concentrations that could adversely effect wildlife drinking from these ponds. Capture ponds would remain unfenced under Alternative 1 and potentially attract wildlife.

Collisions with haul trucks and employee vehicles would be a potential source of wildlife mortality. Current levels of wildlife mortality from vehicle collisions are minimal and considered non-significant. Only a few minor haul trips would occur at the Zortman Mine under Alternative 1; however, between 400 and 1,500 round trip commuter and haul trips per year would occur at the Landusky Mine. Based on these estimates of traffic, wildlife mortality would initially remain at current non-significant levels then decrease below current levels through 2000. Haul traffic would occur 24 hours a day for approximately 5 years resulting in short-term non-significant impacts.

Long-term impacts from wildlife-vehicle collisions would decrease to pre-mine levels because haul truck and employee vehicle traffic would diminish and virtually cease after completion of final reclamation and no mining would occur in the foreseeable future.

Noise

No haul trucks would be needed to haul clay from the Seaford clay pit to the Zortman Mine under Alternative 1 and noise impacts to bats hibernating in Azure Cave would not occur. Mine and reclamation activities under this alternative (including Goslin Flats land application) would be more than one mile from Azure Cave and noise would be 55 dBA or roughly the noise produced in an older urban residential area (Table 4.9-3). Considering that the bats are inside a cave which further attenuates sound, this level of noise would not likely impact bats at Azure Cave (Taylor 1994).

Nesting Raptors

Raptor surveys were conducted in all permitted areas prior to initiation of mining activity in 1978 and prior to subsequent amendments to mining permits (Farmer 1994). The most recent survey for nesting raptors was conducted in spring 1990. No breeding raptors or potential habitat have been located in or near existing permitted areas and no significant short- or long- term impacts to raptors would occur as a result of Alternative 1.

Special Status Species

There are no known occurrences of, or potential habitat for bald eagle, peregrine falcon, piping plover, or black-footed ferret in the project vicinity under Alternative 1. Most federal candidate species and state species of special interest or concern would not be impacted by the No Action Alternative because many of these species inhabit open grassland prairie and would not be expected to occur at the mine sites.

The northern goshawk could occur in forested areas in the Little Rocky Mountains; however, nesting raptor surveys conducted prior to mining found no raptor nests of any kind. One adult goshawk was observed in Mill Gulch in October 1985, but the observer postulated that the bird was probably a non-resident or migrant because surveys in the same vicinity during the breeding season did not locate any nests or breeding goshawks (Farmer 1994).

Several candidate bat species (western big-eared bat, long-eared myotis, western small-footed myotis, and the long-legged myotis) are known to hibernate in Azure Cave. Hibernating bats would not be impacted by Alterative 1; however, some or all of these species would likely occur in the Little Rocky Mountains during summer breeding or migration. Important known habitats for bats include caves, cliffs, crevasses, riparian areas, late seral forest, and abandoned mines. This alternative would not impact any important bat habitat

TABLE 4.5-2

WILDLIFE HABITAT LOSS BY ALTERNATIVE

Short-Term (Life of Mine) Habitat Loss in Acres

	Zortman			Landusky			Total			Acres	% Habitat Loss		
Alternative	Existing	New	Total	Existing	New	Total	Existing	New	Total	Available *	Existing	New	Total
1	405	0	405	840	0	840	1245	0	1245	20480	6%	0%	6%
2	405	3	408	840	6	846	1245	9	1254	20480	6%	0%	6%
3	405	16	421	840	28	868	1245	44	1289	20480	6%	0%	6%
4	405	891	1296	840	73	913	1245	964	2209	20480	6%	5%	11%
5	405	950	1355	840	75	915	1245	1025	2270	20480	6%	5%	11%
6	405	1099	1504	840	75	915	1245	1174	2419	20480	6%	6%	12%
7	405	769	1174	840	66	906	1245	835	2080	20480	6%	4%	10%

* = Total Acres of Habitat in the Little Rocky Mountains Evaluated by Scow (1979)

and would have no adverse impacts to bats.

Residual Water Quality

Most streams in the vicinity of the Zortman and Landusky mines are ephemeral and do not support fisheries. Estimates of short-term water quality in streams that support fish show that no significant change would occur in Rock, Lodgepole or King Creeks; Beaver Creek is outside the area of influence of both mines (Table 4.2-2). Thus, no significant impacts (adverse or beneficial) to fishery resources from residual water quality would occur under Alternative 1. However, current efforts to control acid rock drainage have not been effective and it would be likely that acid rock drainage would drain into streams supporting fish, particularly Rock Creek.

Downstream water quality impacting macroinvertebrate habitat would be little changed from existing conditions under Alternative 1. Metals concentrations in most streams would be about the same as baseline conditions (Table 4.2-1). However, some metals would still be elevated above federal standards for chronic effects to aquatic life (see Table 4.2-1) in Montana Gulch.

Ongoing degradation of macroinvertebrate habitat and wildlife drinking water supplies would continue in the upper reaches of Ruby Gulch, Alder Spur, and Carter Gulch at the Zortman Mine and in Upper Sullivan Creek, Mill Gulch, Montana Gulch, and King Creek at the Landusky Mine. Reclamation would likely cause periods of elevated suspended solids in surface water, particularly near Williams clay pit. It is anticipated that ongoing sediment runoff would be controlled by construction of sediment traps and settling ponds.

Reclamation

Based on analysis of vegetation impacts presented in Section 4.4.3, no direct impacts to vegetation or wildlife habitat would occur under Alternative 1. However, indirect impacts to vegetation and subsequently wildlife habitat result from inadequate reclamation of existing disturbance. Over the short-term, wildlife forage would become established and habitat would improve in most areas particularly as pre-mine lodgepole pine forests are replaced with reclamation seed mixes containing preferred wildlife forage species. Additional wildlife habitat could be improved by creating breeding and roosting or hacking areas on exposed highwalls for special status species such as peregrine falcons and breeding and hibernating bats. Over the long-term, approximately 75 percent of the revegetation efforts are expected to fail because of steep slopes, erosion, inadequate plant growth media, and acid rock drainage. This failed revegetation would result in high negative impacts on the re-establishment of wildlife habitat.

Bats potentially occurring in the area could ingest large quantities of water and acid rock drainage containing elevated metals. Bats must drink every night during the breeding season and may drink up to a third of their weight in water. Reclamation under Alternative 1 would not adequately control acid rock drainage, and this alternative would continue to produce water in seepage and catchment ponds that could be detrimental to bats and other wildlife.

4.5.3.1 Cumulative Impacts

Cumulative impacts from Alternative 1 include:

- 54 acres of disturbance from historical mining activities prior to 1978
- 1,245 acres of habitat removed due to mining activities between 1979 and the present
- Continued acid rock drainage and degraded water quality
- No new disturbance
- No foreseeable future actions

Past and present mining activities have directly impacted approximately 1,300 acres of wildlife foraging, breeding, resting and hiding areas resulting in a 6 percent loss in overall wildlife habitat in the Little Rocky Mountains. Assuming complete success of revegetation efforts, short term positive impacts would be realized as wildlife forage becomes established above pre-1979 conditions. However, assuming reclamation would fail on 75 percent of the reclaimed area, cumulative impacts to wildlife, fisheries and aquatic macroinvertebrates would continue from acid rock drainage. Long-term cumulative impacts to fisheries and wildlife are rated high negative because of reclamation failure and continued acid rock drainage impacts to wildlife, fisheries and aquatic macroinvertebrates.

4.5.3.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts to fisheries and wildlife under Alternative 1 would be long-term and consist of habitat lost from existing mining plus acres of failed reclamation over time. Continued acid rock drainage seepage and contaminated catchment ponds could be detrimental to bats and other wildlife that drink from these ponds.

4.5.3.3 Short-term Use/Long-term Productivity

Long-term productivity of fish and wildlife would be impacted under this alternative. Establishment of vegetation would be less effective because of shallow soil depths and steep, long slopes. Degradation of vegetation and habitat from acid rock drainage would likely continue into the foreseeable future. Current reclamation has not been effective at controlling acid rock drainage. Reclamation under this alternative would not be protective of the environment and would not be effective at controlling acid rock drainage and subsequent significant impacts to fisheries and wildlife. Comparable stability and utility in the reclaimed landscape would not be achieved.

4.5.3.4 Irreversible or Irretrievable Resource Commitments

The more than 1,245 aces of wildlife habitat that has been lost from pre-1979 conditions would be in jeopardy of not being reclaimed adequately under this alternative. This would result in a permanent loss of habitat and is considered irretrievable and irreversible on 75 percent or 934 acres.

4.5.4 Impacts from Alternative 2

Under this alternative, ZMI would continue already permitted activities at both the Zortman and Landusky mines. The reclamation plans would be revised, as proposed by ZMI, to effect source control and treatment of acid rock drainage. The result of implementation of this alternative would be increased source control measures and a greater reliance on long-term corrective action for capture and treatment of seepage water and acid rock drainage.

4.5.4.1 Impacts

Impacts to fisheries and wildlife under Alternative 2 would generally be similar to impacts under Alternative 1. Impacts to wildlife habitat, noise, nesting raptors and special status species would be the same as Alternative 1. Major differences in impacts between Alternatives 1 and 2 would be associated with the increased level of reclamation activities, and increased truck traffic hauling reclamation materials. Evaluation of impacts for each alternative is presented in Table 4.5-1.

Negative impacts to fish and wildlife related to Alternative 2 would include:

- Increased wildlife disturbance and mortality from traffic associated with the Williams and Seaford clay pits.
- Improved capture and treatment of seepage and acid rock drainage would result in improved water quality and fisheries habitat below capture and treatment facilities. This would reduce the negative impacts of existing operations; impacts from process ponds would be the same as Alternative 1.

Wildlife Mortality

Based on traffic estimates presented in Section 4.11, between 1,500-2,100 round trip commuter and haul (both reclamation and hazardous materials) round trips per year would be needed at the Zortman Mine, and between 1,400 and 5,600 trips per year would be needed at the Landusky Mine. Clay would be hauled approximately 7 miles through grassland and disturbed habitat along Ruby Gulch. The haul routes would travel through summer and year-round habitat for mule deer. Clay would be hauled to the Landusky Mine approximately 2 miles from Williams clay pit and travel through grassland and forest habitats that support mule deer and bighorn sheep. Increased traffic also increases the potential of wildlife mortality caused by vehicle collision. Traffic and associated wildlife mortality would increase during the first 5 years then decrease in the final 3 years of implementation of Alternative 2. Haul traffic would occur 24 hours a day for approximately 3 years at the Zortman Mine and 8 years at the Landusky Mine. Considering the low levels of existing wildlife mortality a potential short-term increase in mortality would be a low negative impact.

Wildlife mortality from vehicle collisions under this alternative would decrease over the long-term as mine operations and closure activities end, eventually reaching levels comparable to pre-mining conditions. No future mining is foreseeable under this alterative.

Residual Water Quality

Ongoing degradation of macroinvertebrate habitat and wildlife drinking water supplies would continue as described for Alternative 1. Most streams in the vicinity of the Zortman and Landusky mines are ephemeral and do not support a fishery. Estimates of short-term water quality in streams that support fish show that no significant change would occur in Rock, Lodgepole or King Creeks; Beaver Creek is outside the area of influence of both mines (Table 4.2-2). No significant impacts (adverse or beneficial) to fishery resources from residual water quality would occur under Alternative 2. Improved capture and treatment facilities would improve downstream water quality, but some metals (e.g., zinc) would still be elevated above federal standards for chronic effects to aquatic life (see Table 4.2-1) in Montana Gulch.

As described for Alternative 1, reclamation would likely cause periods of elevated suspended solids in surface water over the short-term and longer-term build-up of fine sediments in streambeds that could impact aquatic macroinvertebrate habitat. It is anticipated that ongoing sediment runoff would be controlled by construction of sediment traps and settling ponds.

Reclamation

Based on analysis of vegetation impacts presented in Section 4.4.4, no direct impacts to vegetation or wildlife habitat would occur.

Indirect impacts to fisheries and wildlife associated with reclamation would be similar under Alternatives 1 and 2. Reclamation slopes would continue to be 1H:1V at mine pits; however, other facilities (i.e. heap leach pads) would be graded to 2.5H:1V or 3H:1V where possible, resulting in improved potential for establishment of vegetation cover over the short-term. However, over the long-term, as discussed in Section 4.3.3, the clay cover is not expected to withstand weathering and erosion and vegetation would likely penetrate the clay and be exposed to acid rock drainage. A 65 percent revegetation failure (see Section 4.4.4) would result in limited success of re-establishing bighorn sheep and other wildlife habitat. Reclamation under Alternative 2 would not adequately control acid rock drainage, particularly at the various sources and this alternative would continue to produce water in seepage and catchment ponds that could be detrimental to bats and other wildlife. Because of long-term continued acid rock drainage and reclamation failure, long-term impact to fisheries and wildlife associated with reclamation success is rated moderate negative.

4.5.4.2 Cumulative Impacts

Cumulative impacts under Alternative 2 from past and present mining and RFDs would be the same as those described for Alternative 1 in Section 4.5.3.1, but would include increased mine-related traffic and potential wildlife-vehicle collisions and an increased level of reclamation. Potential wildlife mortality while increased would not result in significant impacts; and 65 percent of reclamation would fail over the long-term, resulting in moderate negative cumulative impacts to fisheries and wildlife. Nine additional acres would be disturbed at the clay pits for a total of 1,254 acres.

4.5.4.3 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as discussed in Alternative 1 with slightly less potential impacts from wildlife using downstream contaminated water sources.

4.5.4.4 Short-term Use/Long-term Productivity

Long-term productivity of fish and wildlife under this alternative would be greater than under Alternative 1. Potential impacts to fish and wildlife from acid rock drainage and contaminated water would be controlled by active water treatment; however, productivity upgradient (i.e., mine pits, leach pads, waste rock) would be less productive than Alternatives 3 through 7 because source control would be less stringent and acid rock drainage would likely continue indefinitely.

4.5.4.5 Irreversible or Irretrievable Resource Commitments

The more than 1,254 acres of wildlife habitat that has been disturbed from pre-1979 conditions would be in jeopardy of not being reclaimed adequately under this alternative. This would result in a permanent loss of habitat and is considered irretrievable and irreversible on 65 percent or 815 acres. The potential for wildlife mortality from vehicle collisions would increase over the short-term but populations would recover and even increase after mine closure and final reclamation.

4.5.5 Impacts from Alternative 3

Under this alternative, ZMI would continue already permitted activities at both the Zortman and Landusky mines. The revised reclamation plans proposed by ZMI would be modified with additional measures to effect source control and treatment of acid rock drainage. The emphasis of this alternative, as opposed to the previous "No Expansion" alternatives is on source control. All facilities would be assumed to be potentially acid generating and will require reclamation covers B or C which will include compacted clay, possibly a PVC liner, 36-inch non-acid forming capillary break, and 8-12 inches of topsoil. It is anticipated that supplemental reclamation materials would need to be imported for this alternative. Sources of supplemental reclamation material include the King Creek and Beaver Creek limestone quarries, and the Seaford and Williams clay pits. Existing facilities would also be reclaimed to a 3H:1V slope, with constructed benches for erosion control. Slope lengths between benches would extend 200 feet in length.

4.5.5.1 Impacts

Impacts to wildlife habitat, noise, nesting raptors and special status species would generally be the same as Alternative 1. Major difference in impacts from Alternative 3 would be associated with the increased level of reclamation and increased haul traffic. Adverse impacts to fisheries and wildlife habitat would be reduced under Alternative 3. Evaluation of impacts for each alternative is presented in Table 4.5-1. These reduced impacts result from a further reduction in the potential for damage to fish and wildlife resources from acid rock drainage and would include:

- Clay and topsoil covers on all disturbed areas that would inhibit acidic materials from contacting the cover soil, impacting vegetative growth, and damaging wildlife forage and habitat.
- Improved potential for the establishment of vegetation and wildlife forage on reduced slopes.
- Expanded water catchment facilities to further reduce the potential of acid rock drainage release.

Potential negative impacts could result from:

- Direct loss of habitat as a result of an increased need for limestone and clay as cover material.
- Indirect wildlife mortality from increased haul traffic to clay and limestone sources.
- Expanded water catchment facilities containing high metals and acid rock drainage concentrations could attract and potentially contaminate wildlife.

Wildlife Mortality

Based on traffic estimates provided in Section 4.11, between 4,500 and 5,350 round trips commuter and haul trips per year would be needed to haul reclamation and hazardous materials to the Zortman Mine.

Reclamation at the Landusky Mine would require an estimated 4,400 to 16,000 round trip commuter and haul trips per year. This amount of traffic would increase the potential of wildlife mortality caused by vehicle collision during the first 6 years of reclamation and would be a short-term moderately negative impact. Long-term wildlife mortality would return to pre-mine, non-significant levels following completion of final reclamation.

Residual Water Quality

Most streams in the vicinity of the Zortman and Landusky mines are ephemeral and do not support a fishery. Estimates of short-term water quality in streams that support fish show that no significant change would occur in Lodgepole or King Creeks; Rock Creek would experience a minor degradation over the short -term due to a reduced amount of water available for diluting; Beaver Creek is outside the area of influence of both mines (Table 4.2-2). Thus, minor adverse impacts to fishery resources from residual water quality would occur in Rock Creek under Alternative 3; however, chemical levels would be below acute or chronic levels detrimental to aquatic life. Capture and treatment facilities under this alternative would reduce or maintain downstream metals concentrations in surface water at or below federal standards for effects on aquatic macroinvertebrates. However, estimated facility drainage above capture systems would exceed aquatic life criteria over the short-term. These concentrations, as in Alternatives 1 and 2, result in a negative impact to wildlife drinking water supplies and aquatic macroinvertebrate habitat on a local (mined area) scale.

Reclamation and the operation of limestone and clay quarries would result in short-term increases in suspended solids concentrations and long-term increases in stream bottom sediments detrimental to aquatic macroinvertebrates.

Reclamation

Based on analysis of vegetation impacts presented in Section 4.4.5, direct impacts to vegetation and wildlife habitat would consist of 44.5 acres of new disturbance at clay pits and limestone quarries to provide additional reclamation materials. Indirect impacts would consist of reduced averse impacts to fisheries and wildlife habitat over the short-term as a result of reclamation activities. As described in Section 4.4.5, the enhanced reclamation plan would reduce adverse impacts to vegetation and wildlife habitat. Reclamation slopes would be 3H:1V resulting in improved vegetation cover and greater success in re-establishing bighorn sheep and other wildlife habitat. This would result in a short-term moderate positive impact. Over the long-term, vegetation failure is expected to be less than 5 percent due to weathering and erosion. However, failure of the clay cap is possible and infiltration and eventual acid rock drainage would continue to create low negative long-term impacts to fishery and wildlife resources. Seepage and catchment ponds under this alternative would continue to be unfenced and could be detrimental to bats and other wildlife.

4.5.5.2 Cumulative Impacts

Cumulative impacts from Alternative 3 would be the same as those described for Alternative 1 in Section 4.5.3.1, but would include an additional non-significant loss of 44.5 acres of wildlife habitat and enhanced reclamation that reduces adverse impacts to wildlife habitat from past mining. Wildlife habitat will not be restored to pre-mine conditions, however, and cumulative impacts are rated low negative.

4.5.5.3 Unavoidable Adverse Impacts

The potential for wildlife mortality from vehicle collisions would increase over the life of the mine. Over the long-term, wildlife populations would recover and big game would likely increase after mine closure and final reclamation assuming 95 percent success and depending on management of wildlife populations. Impacts to wildlife from ponds full of contaminated water would be reduced over Alternative 2 as less seepage would be expected.

4.5.5.4 Short-term Use/Long-term Productivity

Long-term productivity of fish and wildlife under this alternative would be greater than under Alternatives 1 and 2. Potential impacts to fish and wildlife from acid rock drainage and contaminated water would be reduced at the source and by active water treatment. This provides a greater level of environmental protection and significantly reduces potential damage to wildlife forage and habitat from acid rock drainage at the mine sties and below active treatment facilities in both the short- and long-term. Comparable stability and utility would be achieved in the post-mine landscape.

4.5.5.5 Irreversible or Irretrievable Resource Commitments

There are limited irreversible or irretrievable wildlife or fisheries resource commitments under Alternative 3. Habitat loss resulting from 5 percent long-term reclamation failure would equal 65 acres.

4.5.6 Impacts from Alternative 4

This alternative consists of the Company Proposed Alternative (CPA) for mine expansion at both the Zortman and Landusky mines including corrective reclamation measures of existing disturbance. Major activities that impact wildlife and fisheries include: construction of a heap leach pad at Goslin Flats; use of a conveyor for ore transport; removal of acid generating waste rock dumps and heap leach pads; construction of a waste rock repository in Carter Gulch; and developing a limestone source south of Green Mountain.

4.5.6.1 Impacts

direct and indirect impacts to fishery and wildlife resources could occur including direct loss of habitat, increased wildlife mortality, noise disturbance to hibernating bats, disturbance to nesting raptors and special status species, restricted wildlife movement as a result of the construction of the conveyor, altering surface water quality, and limited restoration of wildlife habitat. Impacts for each alternative is presented in Table 4.5-1.

Habitat Loss

Alternative 4 would result in loss of wildlife habitat from 1979 conditions of 1,296 acres at the Zortman Mine and 913 acres at the Landusky Mine (Table 4.5-2). Total new disturbance to wildlife habitat would be approximately 891 acres at the Zortman Mine and 73 acres at the Landusky Mine (Table 4.5-2). Total direct removal of vegetation and wildlife habitat from previously undisturbed areas under Alternative 4 would be 964 acres and account for an additional 5 percent decrease in overall wildlife habitat. Total loss of wildlife habitat from 1979 baseline conditions would be 2,209 acres or approximately 11 percent of overall habitat. This level exceeds the significance criteria established at 10 percent habitat loss and would be a moderate negative impact.

Except for Goslin Flats, most of the vegetation removed would be in Lodgepole pine forest with minor disturbance occurring in ponderosa pine and douglas fir forest. Forested areas provide thermal and escape cover for big game species, and potential habitat for northern goshawk but contain little understory or food for foraging wildlife. At Goslin Flats, vegetation that would be removed includes shrub and grassland habitats occasionally used by pronghorn antelope, and 0.97 acres of wetlands. Some riparian habitat would also be disturbed where roads, conveyor and power corridors, and other facilities cross or are constructed in riparian areas along drainages. Riparian areas with open water is important summer bat habitat especially within 1 mile of roost sites. This would be an adverse impact to bats.

Construction of the conveyor belt would cause increased short-term disturbance to big game and upland game bird habitats, particularly along Alder Gulch. Use of Carter Gulch as a waste rock repository would disturb high-value white-tailed deer habitat.

Restricted Access

Construction of the conveyor from the Zortman Mine to Goslin Flats would result in restricted wildlife access along Goslin Flats. Overhead spans of Pony and Alder Gulches by the conveyor would not restrict wildlife access in these two major drainages. However, the constant noise and psychological barrier of crossing open areas would likely restrict movement and access of some individual animals. This would result in a high negative impact in that big game home ranges could become restricted, the effective habitat of the area reduced, and the overall carrying capacity within and near the study site decreased.

Wildlife Mortality

Wildlife mortality from process ponds would be minimal under Alternative 4. All process ponds at the Zortman and Landusky mines would be covered with bird netting and enclosed by fencing. This netting (mesh size 1" or less) would effectively preclude all bird and mammal (including bat) mortality at process ponds.

Collisions with haul trucks and employee vehicles would be a potential source of wildlife mortality. Wildlife mortality from mine-related traffic has not been recorded at either the Zortman or Landusky mines; however, collisions with wildlife often go unreported. Between 9,000 and 33,000 round trip commuter and haul trips per year would be made at the Zortman and Landusky mines under Alternative 4. These haul trips would traverse year-round mule deer and bighorn sheep habitat. Based on traffic projections provided in Section 4.11, haul traffic would increase significantly through year 2004, then decrease to around current levels in years 2005 and 2006. Haul traffic would occur 24 hours a day for approximately 12 years.

Wildlife mortality from vehicle collisions have not been a problem at the Zortman/Landusky mines and big game and other wildlife seem to have acclimated to traffic and mining operations. Potential wildlife mortality rates under this alternative would be for mine life of 12 years and based on the minimal vehicle-wildlife collisions from existing operations, is rated a moderate negative impact.

Long-term impacts would be non-significant as final reclamation is completed as traffic returns to pre-mine levels.

Noise

The conveyor belt proposed under Alternative 4 would not be expected to directly disturb hibernating bats (Taylor 1994). There may be some indirect effects during sustaining, foraging, or fall arrival of bats. Attenuation with distance at Azure Cave yields noise levels from the conveyor well below background levels effectively eliminating audible sound from the conveyor at the cave. Noise impacts at Azure Cave from mining and reclamation activities (including blasting) would be 66 dBA, or roughly the noise produced in an older urban residential area (Table 4.9-3). Noise from mining and reclamation would be constant and short-term in nature (i.e., life of mine) and is rated as a non-significant impact to hibernating bats. No long-term impacts would occur because noise would virtually cease upon final reclamation.

Nesting Raptors

Based on the results of nesting raptor surveys and element occurrence searches conducted by Montana National Heritage Program, Alternative 4 would not significantly impact nesting raptors.

Special Status Species

There are no known federally listed threatened or endangered wildlife species in the areas proposed for disturbance; however, potential nesting habitat for peregrine falcons exists approximately two miles west of the proposed Goslin Flats leach pad.

There are no known occurrences of, or potential habitat for bald eagle, peregrine falcon, piping plover, or black-footed ferret in the project vicinity under Alternative 4.

The northern goshawk could occur in forested areas in the Little Rocky Mountains; however, nesting raptor surveys conducted prior to mining found no raptor nests of any kind. One adult goshawk was observed in Mill Gulch in October 1985, but the observer postulated that the bird was probably a non-resident or migrant because surveys in the same vicinity during the breeding season did not locate any nests or breeding goshawks (Farmer 1994). A single goshawk nest has been recorded approximately 1.5 miles north of the project site. No northern goshawks would be impacted by Alternative 4.

Several candidate bat species (western big-eared bat, long-eared myotis, western small-footed myotis, and the long-legged myotis) are known to hibernate in Azure Cave. Hibernating bats would not be directly impacted by Altcrative 4 through either habitat disturbance or noise from crushing and conveyor activities. Little specific information is known regarding the summer ranges and foraging habitat of the bat species hibernating in Azure Cave. However, some or all of these bat species would likely occur in the Little Rocky Mountains during summer breeding or migration. Important habitats for bats include riparian areas, late seral forest, and abandoned mines (Taylor 1994). This alternative would impact approximately 10 acres of aspen riparian habitat along the conveyor route that likely supports bats. (Because of the small area of disturbance, few bats would likely be significantly impacted by disturbance to riparian habitat under Alternative 4.) However, it should be noted that one aspen snag can house 75 or more bats in summer.

This alternative places a large number of lights along the conveyor belt and near the ore processing facilities that would attract insects and subsequently breeding bats. Short-term positive impacts would be realized assuming process ponds are adequately netted to prevent bats from drinking contaminated water.

The two bodies of standing water closest to Azure Cave would be removed under Alternative 4. Considering the importance of drinking water to summer resident bats, the loss of these open water bodies could have a considerable adverse impact on breeding or summer resident bats, causing them to abandon current breeding areas or seek water from other sources such as process and catchment ponds. Replacement of these ponds could be mitigated by constructing water bodies closer to Azure Cave. This would result in low positive impact as bats would be attracted away from mining operations and process ponds. Currently the wetland replacement plan locates new ponds in Ruby Flats which is further from Azure Cave

The overall impact rating of Alternative 4 on special status species is non-significant.

Residual Water Quality

Most streams in the vicinity of the Zortman and Landusky mines are ephemeral and do not support a fishery. Estimates of short-term water quality in streams that support fish show that no significant change would occur in Lodgepole or King Creeks; Rock Creek would experience an improvement in residual water quality due to the reduction of Gold Bug Adit flow. Beaver Creek is outside the area of influence of both mines (Table 4.2-2). Thus, moderate beneficial impacts to aquatic life and fishery resources from improved residual water quality would occur in Rock Creek under Alternative 4.

Metals concentrations in Alder Gulch would increase above pre-1979 conditions and reach levels exceeding federal standards for chronic effects to aquatic life. However, Alder Gulch was historically impacted by mining and contains a highly variable and impoverished macroinvertebrate population (WESTECH 1991).

Metals concentrations in Montana Gulch above the confluence with Rock Creek would be greatly reduced from existing conditions. This would result in a highly positive impact for aquatic macroinvertebrate habitat. However, significant flow reductions are expected in Montana Gulch due to short-term pit dewatering and long-term reduction in recharge to Gold Bug and August Adits. Montana Gulch could become intermittent limiting its potential as aquatic habitat.

Salvaging of soil from Goslin Flats leach pad and the clearance of a conveyor corridor is expected to result in significant amounts of suspended solids entering Goslin Creek over the short-term and longer-term buildup of fines in the Goslin Gulch/Ruby Creek drainage. These sediment fines would negatively impact existing macroinvertebrate habitat and impede the recovery of already low abundance and diversity of taxa. Overall impacts rating of residual water quality on fisheries and aquatic macroinvertebrates is low negative.

Reclamation

Fisheries and wildlife habitat associated with reclamation would improve over the short-term. Reclamation slopes of 2H:1V would be reduced to 3H:1V where topography will allow. This would result in improved vegetation cover and greater success in re-establishing bighorn sheep and other wildlife habitat.

Limiting habitat for bighorn sheep in the Little Rocky Mountains is open grassy areas on south facing slopes. Removal of lodgepole pine forest through mining and reclamation of mine facilities and conveyor corridors to produce open grassy areas would be a positive impact for wildlife. Short-term impacts of the reclamation effectiveness of Alternative 4 are rated low positive because of the increased forage provided by successful revegetation. Eventually planted trees would dominate again producing an overall low negative effect.

As discussed in the analysis of vegetation impacts presented in Section 4.4.6, over the long-term vegetation failure is expected to be 5 percent due to weathering and erosion. Slope angles of 3H:1V would reduce erosion, but areas with 2H:1V or 2.5H:1V would experience continued erosion. Additionally, failure of long, steep slopes is assumed on 5 percent of reclaimed areas infiltration and eventual acid rock drainage would continue to create low negative long-term impacts to fishery and wildlife resources. Additionally, succession and forest regeneration would revert to the original habitat. Seepage and catchment ponds under this alternative would continue to be unfenced and could be detrimental to bats and other wildlife.

4.5.6.2 Cumulative Impacts

Cumulative impacts from Alternative 4 include:

- 54 acres of disturbance from historical mining activities prior to 1978;
- 1,245 acres of habitat removed due to mining activities between 1979 and the present;
- 964 acres of new disturbance to wildlife habitat;
- Restricted access and reduced effective wildlife habitat caused by the conveyor;
- Continued acid rock drainage due to long-term reclamation failure of 5 percent of area (110 acres);
- Degradation of water in Alder Gulch quality due to water bypassing capture systems and concentrations of some metals exceeding federal chronic freshwater criteria and adversely impacting aquatic macroinvertebrates;
- Improvement of water quality and macroinvertebrate habitat in Montana Gulch; and
- Reasonably foreseeable Mining in Pony Gulch in the future.

Additional direct and indirect disturbance of fisheries, aquatic macroinvertebrates, and wildlife would occur from reasonably feasible developments under Alternative 4. Potential impacts would be greatest from future mining in Pony Gulch (no expansion needed for 2 million tons). Impacts associated with exploration, such as additional roads, would likely be minor; however, loss of habitat and short-term disturbance would occur, primarily from the roads. Primary impacts of exploration may be disturbance to hibernating bats at Azure Cave and aspen riparian habitats along Pony and Alder Gulches.

The 2 million ton, Pony Gulch deposit is located approximately ½ mile from Azure Cave. Mining activity that includes blasting, large machinery and ore crushing operations within ½ mile could create a noise impact on bats hibernating in Azure Cave (Taylor 1994). However, analysis of noise impacts estimate a level of 64 dBA at Azure Cave from mining operations in Pony Gulch not accounting for screening and attenuation by vegetation and topography. Literature reviews and consultation with BCI found no available information on noise impacts to bats. The 64 dBA compares to noise levels of an urban residential area where bats are commonly found and no significant impact is anticipated. Noise would be further attenuated by an intervening hill and Lodgepole pine forest. This deposit in Pony Gulch would be mined and reclaimed within an approximately 2 year time frame, further reducing the chances of long-term impacts to bats in Azure Cave.

Past and present mining activities have directly impacted 1,245 acres of wildlife foraging, breeding, resting and hiding areas. Proposed disturbance under Alternative 4 would impact 964 acres of wildlife habitat for a total disturbance of about 2,209 acres or 11 percent of available habitat in the Little Rocky Mountains. Assuming 95 percent success of reclamation and the establishment of grassland areas beneficial to wildlife, cumulative impacts to wildlife habitat are rated low negative.

Cumulative impacts of residual water quality on aquatic macroinvertebrates, post reclamation, is rated non-significant based on average metals concentrations in downstream waters remaining at baseline levels in most drainages. Alder Gulch would experience some degradation in water quality and contain zinc levels exceeding federal standards for chronic effects to aquatic life. Metals concentrations in Montana Gulch would be greatly reduced from existing conditions. This would result in a highly positive impact for aquatic macroinvertebrate habitat and create conditions conducive to the recovery of populations of macroinvertebrates in Montana Gulch which is currently nearly devoid of organisms (WESTECH 1991).

The cumulative effects of noise, vibration, and habitat loss, particularly in riparian and mature Douglas fir along Alder, Carter, and Pony Gulches combined with habitat previously lost due to historic and existing mining could adversely impact summer breeding bats by directly removing breeding and foraging habitat or causing bats to avoid the area.

Cumulative impacts of past and present mining and reasonably feasible developments on increased mortality to wildlife would be short-term and considered low negative. Mortality from process facilities and vehicle collisions have been minor in the past and are expected to remain minor or have been mitigated with netting and fencing of process ponds (BLM 1995), poaching appeared to increase at the start of mining in 1979, but currently is not a problem.

Overall cumulative impacts rating for Alternative 4 is moderate negative because of restricted access due to the conveyor; 5 percent reclamation failure; increased sedimentation; and mining in Pony Gulch in the future.

4.5.6.3 Unavoidable Adverse Impacts

The potential for wildlife mortality from vehicle collisions would increase 3-4 fold over the life of the mine. Over the long-term wildlife populations would recover and big game populations would increase after mine closure and final reclamation. Assuming 95 percent success and dependent on management of wildlife populations, 110 acres would not be reclaimed in the long-term. The loss of standing water bodies near Azure Cave could reduce summer bat populations in the area. Construction of the conveyor belt would disrupt home ranges and travel corridors for big game during mine life.

4.5.6.4 Short-term Use/Long-term Productivity

The short-term extraction of mineral resources would not impact the long-term productivity of the disturbed area to support healthy and productive populations of endemic wildlife. One of the limiting factors for bighorn sheep in the Little Rocky Mountains is open, grassy, south facing slopes interspersed with forest. Almost all of the south facing slopes in the Little Rocky Mountains are covered with lodgepole pine. Through mining and proper reclamation, many of the currently wooded, south facing slopes would be changed into grassy slopes planted with trees that would benefit bighorn sheep and other wildlife (BLM 1992a). Impact from Alternative 4 would be greater than impacts from Alternatives 1-3 because of 864 acres of disturbance. But assuming only 5 percent reclamation failure, comparable stability and utility would be achieved in the post-mine landscape.

4.5.6.5 Irreversible or Irretrievable Resource Commitments

There are limited irreversible or irretrievable wildlife or fisheries resource commitments under Alternative 4. Habitat lost during mining activities can be reclaimed and replaced during reclamation activities. Displaced wildlife populations would recolonize reclaimed areas and creation of open grassy habitats would benefit big game, grouse and other wildlife that may be limited by the lack of open meadows and grassland forage in the Little Rocky Mountains in the short-term. As planted trees grow, habitat would return to forested canopy in 70-80 years.

4.5.7 Impacts from Alternative 5

Alternative 5 would approve expansion of both the Zortman and Landusky mines but imposes agency developed mitigation on expansion and reclamation activities. The major modification under this alternative is the relocation of the Goslin Flats heap leach facility within upper Alder Gulch.

4.5.7.1 Impacts

Impacts to fisheries and wildlife under this alternative would be similar to that described for Alternative 4, although somewhat less in magnitude since no disturbance would occur at Goslin Flats. Impacts would be the same under Alternatives 4 and 5 for nesting raptors, special status species, and wildlife mortality from process ponds. Evaluation of impacts for each alternative is presented in Table 4.5-1.

Habitat Loss

Alternative 5 would result in loss of wildlife habitat from 1979 conditions of approximately 1,355 acres at the Zortman Mine and 915 acres at the Landusky Mine. Total new disturbance to wildlife habitat would be approximately 950 acres at the Zortman Mine and 75 acres at the Landusky Mine. Total direct removal of vegetation and wildlife habitat from previously undisturbed areas under Alternative 5 would be approximately 1,025 acres.

Habitat loss at the Zortman Mine would occur primarily in forested areas and some riparian habitat in Alder and Carter Gulches. The 1,025 acres occur in year-round deer habitat and accounts for an additional wildlife habitat loss of 5 percent of available habitat in the Little Rocky Mountains. Total habitat loss from both mines since 1979 would be approximately 2,270 acres and would account for a 11 percent decrease from 1979 conditions. This loss of habitat acreage would be a moderate negative impact to wildlife.

Because no facilities would be located on Goslin Flats, the wetlands and grassland and shrub habitats located there would not be directly disturbed; however, emergency land application could periodically disturb 285 acres at Goslin Flats resulting in a short-term loss of available habitat. Under Alternative 5, disturbance associated with the conveyor would not occur. However, impacts to high-value white-tailed deer habitat would occur in Alder Gulch from the leach pad and waste rock repository.

Wildlife Mortality

Based on traffic projections provided in Section 4.11, the number of round trip commuter and haul trips per year would be about the same under alternatives 4 and 5. These haul trips would traverse year-round mule deer and bighorn sheep habitat. Wildlife mortality from vehicle collisions would be short-term and would increase slightly through year 2006. Haul traffic would decrease to current levels in year 2007 and essentially cease thereafter. Haul traffic would occur 24 hours a day for approximately 12 years. Short-term impacts from wildlife-vehicle collisions is rated moderate negative. Wildlife mortality rates under this alternative would not be a significant long-term impact.

Noise

Noise impacts to Azure Cave from mining and reclamation activities under Alternative 5 would be 58 dBA (Table 4.9-3). This noise level is less than an urban residential area and 13 dBA above background levels of 45 dBA, not accounting for screening and attenuation by vegetation and topography. Literature reviews and consultation with BCI found no available information on noise impacts to bats. The 57 dBA compares to noise levels of an urban residential area where bats are commonly found. Therefore, no significant impact is anticipated.

Residual Water Quality

Most streams in the vicinity of the Zortman and Landusky mines are ephemeral and do not support a fishery. Estimates of short-term water quality in streams that support fish show that no significant change would occur in Lodgepole Creek; King Creek would experience a slight decrease in water quality due to the bypass of a capture system; and Rock Creek would experience an improvement in residual water quality due to the reduction of Gold Bug Adit flow. Beaver Creek is outside the area of influence of both mines (Table 4.2-2). Thus, reduced negative impacts from past and present mining to aquatic life and fishery resources from improved residual water quality would occur in Rock Creek and slight adverse impacts would occur in King Creek under Alternative 5.

Metals concentrations in Alder Gulch would increase above pre-1979 conditions and reach levels exceeding federal standards for chronic effects to aquatic life. However, Alder Gulch was historically impacted by mining and contains a highly variable and impoverished macroinvertebrate population (WESTECH 1991).

Metals concentrations in Montana Gulch above the confluence with Rock Creek would be greatly reduced from existing conditions. This would result in a highly positive impact for aquatic macroinvertebrate habitat.

The magnitude of earth moving associated with the Carter Gulch waste rock repository and Alder Gulch lead pad would increase suspended solids in Alder Creek. However, these sediments would settle in capture and treatment facilities and would have negligible impacts on downstream macroinvertebrates.

Overall impacts rating of residual water quality on fisheries and aquatic macroinvertebrates is low/moderate negative and degraded water quality in Alder Gulch.

Reclamation

Impacts of reclamation effectiveness on wildlife habitat would be similar to Alternative 4 with improved short term success of revegetation. Reclamation under Alternative 5 would provide more favorable wildlife habitat. Reduced slopes would increase vegetation cover and reduce potential erosion problems. Almost all of the south facing slopes in the Little Rocky Mountains are covered with lodgepole pine. Through mining and proper reclamation, many of the currently wooded, south facing slopes would be changed into open grassy slopes with small planted trees that would benefit bighorn sheep and other wildlife (BLM 1992a). Over 70-80 years the trees would mature and forested habitat would return.

As discussed in the analysis of vegetation impacts presented in Section 4.4.7, over the long-term vegetation failure is expected to be less than 5 percent due to weathering and erosion of long steep slopes over 200 feet in length. This loss of 114 acres would create low negative long-term impacts to fishery and wildlife resources.

4.5.7.2 Cumulative Impacts

Cumulative impacts for wildlife and fisheries would be similar to Alternative 4. Major differences under Alternative 5 include:

- 1,025 acres of new disturbance to wildlife habitat.
- Wildlife access and effective habitat not restricted by the conveyor.
- Past and present mining activities have directly impacted 1,245 acres of wildlife foraging, breeding, resting and hiding areas. Proposed disturbance under Alternative 5 would impact 1,025 acres of wildlife habitat for a total disturbance of about 2,270 acres or 11 percent of available habitat in the Little Rocky Mountains. Assuming 95 percent success of reclamation and the establishment of grassland areas beneficial to wildlife for 70-80 years, cumulative impacts to wildlife habitat are rated low negative.
- Exploration activities would target mineralized areas near the upper Alder Gulch leach pad impacting primarily Lodgepole pine habitats.
- Overall cumulative impacts rating for Alternative 5 is low/moderate negative because of water quality impacts to fisheries and macroinvertebrates and 5 percent reclamation failure (114 acres) and mining in Pony Gulch.

4.5.7.3 Unavoidable Adverse Impacts

The potential for wildlife mortality from vehicle collisions would increase 3-4 fold over the life of the mine. Over the long-term wildlife populations would recover and big game populations would increase after mine closure and final reclamation. Assuming 95 percent success of reclamation and revegetation, 114 acres of wildlife habitat, or about double the amount of habitat disturbed prior to 1979, would not be reclaimed. The loss of standing water bodies near Azure Cave could reduce summer bat populations in the area.

4.5.7.4 Short-term Use/Long-term Productivity

The short-term use/long-term productivity of Alternative 5 would be similar to Alterative 4 except 1,025 acres rather than 964 acres are to be disturbed.

4.5.7.5 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable resource commitments under Alternative 5 would be the same as Alternative 4.

4.5.8 Impacts from Alternative 6

Alternative 6 would approve expansion of both the Zortman and Landusky mines but would impose agency-developed mitigations on expansion and reclamation activities. The major modification to the company proposed mine expansion would relocate the waste rock repository to Ruby Flats, instead of in Carter Gulch. The conveyor used for waste rock and ore transport would be enclosed.

4.5.8.1 Impacts

Impacts to fisheries and wildlife under Alternative 6 would be similar to impacts described for Alternative 4. Impacts would be the same under Alternatives 4 and 6 for nesting raptors, special status species and wildlife mortality from process ponds. Impacts for each alternative are presented in Table 4.5-1.

Habitat Loss

Alternative 6 would result in loss of wildlife habitat from 1979 conditions of approximately 1,504 acres at the Zortman Mine and 915 acres at the Landusky Mine. Total new disturbance to wildlife habitat would be approximately 1,099 acres at the Zortman Mine and 75 acres at the Landusky Mine. Total direct removal of vegetation and wildlife habitat from previously undisturbed areas under Alternative 6 would be approximately 1,174 acres.

Habitat loss at the Zortman Mine would occur primarily in grassland habitat at Goslin Flats and Ruby Flats. The 1,174 acres occur in year-round mule deer/pronghorn habitat and account for an additional wildlife habitat loss of 6 percent of available habitat in the Little Rocky Mountains. Total habitat loss from both mines since 1979 would be approximately 2,419 acres and would account for a 12 percent decrease from 1979 conditions. This loss of habitat exceeds the significant criteria of 10 percent loss of habitat and would be a moderate negative impact to wildlife. The level of impact from Alternative 6 is approximately the same as Alternative 4; however impacts to deer habitat in Carter Gulch would be less and impacts to grassland species such as pronghorn would be greater under Alternative 6.

Wildlife Mortality
Based on traffic projections provided in Section 4.11, approximately 7,900 to 33,700 total round trip commuter and haul trips per year would be made at the Zortman and Landusky mines under Alternative 6. These haul trips would traverse year-round mule deer and bighorn sheep habitat. Wildlife mortality from vehicle collisions would be short-term and would increase through 2008. Haul traffic would occur 24 hours a day for approximately 14 years then essentially cease thereafter. Wildlife mortality under this alternative would not be a significant long-term impact.

Noise
Noise impacts from the conveyor would be similar to Alternative 4. Duration of use of the conveyor would increase because ore and waste rock would be conveyed from the Zortman Mine to Goslin Flats. Enclosing the conveyor would reduce overall noise, but would have little impact on noise levels at Azure Cave.

Noise impacts to Azure Cave from mining and reclamation activities would be 66 dBA, or roughly the noise produced in an older urban residential area (Table 4.9-3). This noise level would not present a significant adverse impact to hibernating bats (Taylor 1994).

Residual Water Quality
Most streams in the vicinity of the Zortman and Landusky mines are ephemeral and do not support a fishery. Estimates of short-term water quality in streams that support fish show that no significant change would occur in Lodgepole or King Creeks; Rock Creek would experience an improvement in residual water quality due to the reduction of Gold Bug Adit flow; Beaver Creek is outside the area of influence of both mines (Table 4.2-2). Thus, moderate beneficial impacts to aquatic life and fishery resources from improved residual water quality would occur in Rock Creek under Alternative 6.

Metals concentrations in Montana Gulch above the confluence with Rock Creek would be greatly reduced from existing conditions. This would result in a highly positive impact for aquatic macroinvertebrate habitat. The salvaging of soil from the Ruby Flats waste rock repository and the Goslin Flats leach pad, combined with the clearance of the conveyor corridor is expected to result in significant amounts of suspended solids entering Goslin Creek and the lower reaches of Ruby and Camp Creeks over the short-term. Longer-term buildup of sediment fines would negatively impact macroinvertebrate habitat.

Overall impacts rating of residual water quality on fisheries and aquatic macroinvertebrates is low negative.

Reclamation
Impacts of the effectiveness of reclamation on fisheries and wildlife habitat would be similar for Alternatives 4 and 6. Indirect impacts would consist of reduced adverse impacts over the short-term from reduced slopes and reclamation activities. Short-term impacts are rated moderate positive. Over the long-term, vegetation failure is expected to be less than 5 percent due to weathering and erosion on steep, long slopes over 200 feet in length. This failure and continued acid rock drainage results in long-term low negative impacts to fishery and wildlife resources.

4.5.8.2 Cumulative Impacts

Cumulative impacts for wildlife and fisheries would be the same as Alternative 4, including construction of the conveyor and development of reasonably foreseeable ore deposits in Pony Gulch. Major differences would include:

- 1,174 acres of new disturbance to wildlife habitat.
- No degradation of water quality in Alder Gulch.
- Past and present mining activities have directly impacted 1,245 acres of wildlife foraging, breeding, resting and hiding areas. Proposed disturbance under Alternative 6 would impact 1,174 acres of wildlife habitat for a total disturbance of about 2,465 acres or 12 percent of available habitat in the Little Rocky Mountains. Assuming 95 percent success of reclamation and the establishment of grassland areas beneficial to wildlife, cumulative impacts to wildlife habitat are rated low negative.
- Overall cumulative impact rating for Alternative 6 is low/moderate negative because of mining in Pony Gulch, restricted wildlife access due to the conveyor, increased sedimentation, and 5 percent reclamation failure (121 acres).

4.5.8.3 Unavoidable Adverse Impacts

The potential for wildlife mortality from vehicle collisions would increase 3-4 fold over the life of the mine. Over the long-term wildlife populations would recover and big game populations would increase after mine closure and final reclamation. Assuming 95 percent success and dependent on management of wildlife populations, 121 acres would not be reclaimed in the long-term which is twice as many acres as was disturbed in 1979. The loss of standing water bodies near Azure Cave could reduce summer bat populations in the area.

4.5.8.4 Short-term Use/Long-term Productivity

Short-term Use/Long-term Productivity would be similar to Alternative 4 except 1,174 acres rather than 964 acres are to be disturbed.

4.5.8.5 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable wildlife or fisheries resource commitments under Alternative 6 would be similar to Alternative 4.

4.5.9 Impacts from Alternative 7

Alternative 7 would allow expansion of both the Zortman and Landusky mines but impose agency-developed mitigations on the expansion and reclamation activities. The major modifications to ZMI's expansion plans would be to locate the proposed waste rock repository on top of existing facilities at the Zortman Mine and to remove tree planting from reclamation plans. This alternative was developed by the agencies as a way to reduce the amount of land disturbance, reduce impacts to water resources, and enhance reclamation; all of which have an effect on impacts to wildlife and fisheries.

4.5.9.1 Impacts

Impacts to fisheries and wildlife under Alternative 7 are similar to impacts described for Alternative 4, with major differences consisting of the amount of wildlife habitat lost, water quality impacts on fisheries and aquatic macroinvertebrates and the success of reclamation at establishing wildlife habitat. Impacts would be the same under Alternatives 4 and 7 for nesting raptors, special status species, restricted access and wildlife movement, and wildlife mortality from process ponds. Impacts for each alternative are presented in Table 4.5-1.

Habitat Loss

Alternative 7 would result in a total loss of wildlife habitat of approximately 1,170 acres at the Zortman Mine and 906 acres at Landusky Mine. Total new disturbance to wildlife habitat would be approximately 769 acres at Zortman Mine and 66 acres at Landusky Mine. Total direct removal of vegetation and wildlife habitat from previously undisturbed areas under Alternative 7 would be 835 acres. This results in an additional 4 percent loss of available wildlife habitat and a total loss of 10 percent of available habitat from pre-1979 conditions. This loss of habitat exceeds the 10 percent significance criteria and would be a moderate negative impact.

Wildlife Mortality

Based on traffic projections provided in Section 4.11, between 4,700 and 30,000 total round trip commuter and haul trips per year would be made at the Zortman and Landusky mines under Alternative 7. These haul trips would traverse year-round mule deer and bighorn sheep habitat.

Haul traffic would occur 24 hours a day for approximately 14 years. Over the short-term, mortality from vehicle collisions would likely increase through year 2008. Over the long-term, wildlife collisions with mine-related vehicles would cease as mine closure and final reclamation is completed and wildlife mortality would return to pre-mine levels.

Noise

Noise impacts from the conveyor would be the same as Alternative 6.

Noise levels at Azure Cave from mining and reclamation activities would be 66 dBA, or roughly the noise produced in an older urban residential area (Table 4.9-3) not accounting for screening and attenuation by vegetation and topography. Literature reviews and consultation with BCI found no available information on noise impacts to bats. The 66 dBA compares to noise levels of an urban residential area where bats are commonly found and would not present a significant adverse impact to hibernating bats (Taylor 1994). These noise levels would be further reduced and attenuated by vegetation, topography and the physical structure of the cave.

Residual Water Quality

Most streams in the vicinity of Zortman and Landusky mines are ephemeral and do not support a fishery. Estimates of short-term water quality in streams that support fish show that no change is expected to fish habitat would occur in Lodgepole Creek. King Creek would essentially remain unchanged because of the removal of rock fill at the head of the creek and free surface drainage from the backfilled mine pits. Metals concentrations in Rock Creek would be greatly reduced below baseline conditions resulting in a high positive impact to fisheries and aquatic macroinvertebrates.

Metals concentrations in Montana Gulch above the confluence with Rock Creek would be greatly reduced from existing conditions. This would result in a highly positive impact for aquatic macroinvertebrate habitat. Suspended solids entering surface water and long-term sedimentation in Goslin Gulch/Ruby Creek would be similar to Alternative 4 due to soil salvaging from Goslin Flats and clearance of a conveyor corridor. The long-term buildup of sediment fines would negatively impact macroinvertebrate habitat.

Overall impacts rating of residual water quality on fisheries and aquatic macroinvertebrates is low positive.

Reclamation

Impacts of the effectiveness of reclamation on fisheries and wildlife habitat would be similar to Alternatives 4 and 6 but with improved success of revegetation from increased soil depths reduced slope lengths by reducing distance between erosion control benches.. Additionally, improvements in the design of the reclamation cover effectively controls acid rock drainage over the long term. Based on improved revegetation success, elimination of acid rock drainage and the establishment of forbs and grasslands as wildlife forage would result in long-term establishment of wildlife and aquatic macroinvertebrate habitat similar to or slightly improved from pre-mine conditions in terms of productivity and biomass. Species diversity, particularly aquatic macroinvertebrates, may take decades to recover. Impacts of reclamation effectiveness on fishery and wildlife resources is rated as non-significant to pre-1979 baseline. Assuming 1 percent vegetation failure over time, 21 acres out of 2,080 would not be reclaimed. This is less than the 54 acres disturbed in 1979.

4.5.9.2 Cumulative Impacts

Cumulative impacts for wildlife and aquatic macroinvertebrates would be similar to Alternative 4.

Major differences would include:

- 835 acres of new disturbance to wildlife habitat.
- Increased disturbance to grassland habitat on Ruby Flats.
- Improved reclamation and establishment of wildlife habitat.
- Improved water quality and macroinvertebrate habitat due to removal of Alder Gulch waste rock repository and Ruby tailing.
- Improved water quality in Montana Gulch.
- Past and present mining activities have directly impacted 1,245 acres of wildlife foraging, breeding, resting and hiding areas. Proposed disturbance under Alternative 7 would impact 835 acres of wildlife habitat for a total disturbance of about 2,080 acres of available wildlife habitat in the Little Rocky Mountains. Assuming 99 percent success of reclamation and the establishment of grassland areas beneficial to wildlife, cumulative impacts to wildlife habitat are rated low negative.

- Overall rating of cumulative impacts of Alternative 7 to fishery and wildlife resources is non-significant/low based on less than 1 percent vegetation failure or 21 acres, increased sedimentation, controlled acid rock drainage, conveyor impacts, mining in Pony Gulch and improved water quality and macroinvertebrate habitat.

4.5.9.3 Unavoidable Adverse Impacts

The potential for wildlife mortality from vehicle collisions would increase 3-4 fold over the life of the mine. Over the long-term wildlife populations would recover and big game populations would increase after mine closure and final reclamation. The loss of standing water bodies near Azure Cave could reduce summer bat populations in the area.

4.5.9.4 Short-term Use/Long-Term Productivity

Short-term use/long-term productivity would be similar to Alternative 4, but would increase under Alternative 7 due to improved reclamation and water quality except 835 acres rather than 964 are to be disturbed.

4.5.9.5 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable wildlife or fisheries resource commitments under Alternative 7 would be similar to Alternative 4.

4.6 AIR QUALITY

4.6.1 Methodology

Air quality impacts were assessed for each alternative by comparing expected emission levels of air pollutants resulting from mining activities with (a) National Ambient Air Quality Standards (NAAQS) and (b) Prevention of Significant Deterioration (PSD) Increments. NAAQS and PSD Increments were selected as criteria for these assessments because they represent enforceable standards and criteria under State of Montana and federal regulations. The impacts evaluations are compared to the Average 24-Hour (150 $\mu g/m^3$) and Average Annual (50 $\mu g/m^3$)standards for respirable particulate matter less than 10 microns in size (known as "PM-10"), the pollutant of most concern from the Zortman and Landusky mining activities.

Air quality impacts associated with the alternative actions were estimated using data collected during on-site measurements, as reported in the Air Quality Permit Applications for the two mines submitted to the Air Quality Division of the Montana Department of Environmental Quality (Permit No. 1825-04 for Landusky, MDHES AQD 1993; and Permit No. 1823-04 for Zortman, MDHES AQD 1983). Section 3.6.1.1 summarized the PM_{10} data for the various monitoring stations. Tables 3.6-1 through 3.6-3 list the maximum and average PM_{10} concentrations at these stations for select monitoring periods during the years 1990 through 1993.

4.6.1.1 Emissions Models

Two different emissions models were used in this impact analysis. A relatively unsophisticated model called SCREEN was used to calculate impacts associated with the no action alternatives at both mines. SCREEN was also used to calculate emissions for the Landusky Mine extension alternatives, since emissions rates for Alternatives 4 through 7 would be very similar. A more sophisticated model known as Fugitive Dust Model (FDM) was used to calculate emissions for the Zortman Mine extension alternatives. This model is designed to specifically evaluate emissions from fugitive dust, the air pollutant of specific concern to this project. In addition, FDM has the capability to model the emissions from haul trucks as a separate line source, which more truly represents the impacts stemming from road traffic. A brief description of each model follows.

SCREEN is an EPA-approved screening-level model. SCREEN uses the distance between the source and receptor, the emission rate from the source in pounds per hour, and worst-case meteorological conditions (stable atmosphere and light winds blowing directly from the source to the receptor) to estimate the ambient concentrations of the pollutant. The model incorporates a relatively large degree of conservatism to provide reasonable assurance that maximum concentrations are not underestimated. In other words, the model would be expected to overestimate impacts. Emission rates used in the SCREEN modeling assumed that water was used as a mitigation measure to reduce dust.

The Fugitive Dust Model (FDM) was used to estimate PM_{10} impacts resulting from mining and reclamation activities associated with the Zortman Mine alternatives 4 through 7. FDM is an hourly, steady-state model designed for estimation of concentration and deposition impacts from fugitive dust sources (EPA 1980). The sources may be point, line, or area sources. Area sources were used to model impacts from mining activities, and line sources were used to model impacts from haul road emissions.

FDM has been designed to eliminate hours with wind speeds less than 1.0 meters per second from the analysis and the averaging computations, as suggested in EPA's Air Quality Modeling Guideline (EPA 1993). The most conservative, "worst case" meteorological data were incorporated into the model. FDM accounts for deposition through two parameters: the gravitational settling velocity and the deposition velocity. Three particle sizes of 10, 5, and 2.5 were distributed as 65, 27, and 8 percent of the emissions, respectively. Additional key inputs to the model are the roughness height and friction velocity. Friction velocities are calculated internally in the FDM from the wind speed and the reference height of the meteorological data. A roughness height of 15 cm, was used in this analysis as suggested by EPA's FDM User's Guide (EPA 1992).

The reader is cautioned that the models are limited by the amount and quality of data used as input; where estimates and assumptions are made they are conservative, so that errors or variance would result in overestimation of impacts. Model results indicating an exceedance of standards suggest that an exceedance is possible, but a refined modeling analysis would be necessary for a more precise air quality impact assessment.

4.6.1.2 Sources of Air Emissions

Six emissions source types were used to estimate emissions rates for the alternatives. These emissions sources were selected because they would be responsible for almost the entire contribution of PM_{10} emissions resulting from mining and reclamation activities. Five of these sources (mine pit, waste rock repository, primary crusher, ore transfer operation, and the heap leach pad) were modeled as Zortman Mine area sources using the FDM, while clay and topsoil hauling were modeled as a line source. The SCREEN model combines all sources into one point source, but as stated previously does not account for emissions from reclamation haul trucks in transit through the towns. The emissions estimates for the FDM by source at the Zortman Mine include:

- Mine Pits Emissions as a result of drilling, blasting, ore/waste removal and hauling activities were incorporated into a total mine pit emission rate which varied by alternative. Hauling activities were grouped as ore, non-acid waste rock, and one half of the waste hauling.

- Waste Rock Emissions from the waste rock repository consisted of one half the waste rock hauling, waste rock dumping, and topsoil dumping. Emissions varied by alternative.

- Primary Crusher The total emissions (318 lbs/day) at the primary crusher included emissions from ore dumping, non-acid waste rock dumping, primary crushing, and primary screening.

- Transfer Operations Five transfer points along the conveyor line from the mine pit to the Goslin Flats leach pad were modeled using ore and non-acid waste rock emissions. Emission varied by alternative.

- Heap Leach Pad: Emissions (302 lbs/day) from the heap leach pad consists of secondary and tertiary crushing, ore dumping from the conveyor, and non-acid dumping. These were assumed to be the same for the two heap leach pad sites.

- Reclamation Hauling Clay hauling from the Seaford Clay Pit to the leach pads for liner material and various facilities for reclamation covers, and topsoil hauling from the topsoil area to the various facilities for reclamation covers, were modeled as two separate line sources. Emissions rates depended on the alternative considered.

4.6.1.3 Sensitive Receptors

Known or estimated emissions rates for the various sources are supplied as input parameters to the emissions models. The models are used to calculate the projected PM_{10} emissions at the receptor locations. The towns of Zortman and Landusky were selected as the sensitive receptor locations for this analysis. They were chosen because of their proximity to the mining activities, population potentially affected, and location on routes used by haul trucks to deliver reclamation and construction materials.

4.6.1.4 Impact Significance

The air emissions levels estimated for each alternative have been compared against baseline air quality in the study area to determine whether impacts are positive or negative. In other words, the determination is based on whether air quality would be better than baseline conditions (positive impact) or worse than baseline conditions (negative impact). Tables 3.6-1 through 3.6-3 provided average PM_{10} concentrations for the study area, including the sensitive receptor locations in Zortman and Landusky. At these two sites, average concentrations were between 9 and 13 $\mu g/m^3$ for the three monitoring durations. Baseline air quality in the study area would be expected to be at or less than those values, since the baseline condition is represented by average air quality prior to the beginning of large-scale mining in the Little Rocky Mountains. All emissions levels projected under this analysis, for all alternatives, would cause negative impacts since baseline air quality could only be reached when all mine activity ceases.

The estimated impacts have been rated as low, medium, or high magnitude, using the Annual and 24-Hour PM_{10} Primary standards for rating criteria (See Table 4.6-1). Low air quality impacts are those that are less than the standards. Medium air quality impacts are those that are equal to or near the standards, and a high air quality impact rating was assigned to alternatives for which substantial exceedances of the standards were estimated. Impacts are considered to be significant if they exceed one or both of the air quality standards.

The frequency and duration of impacts are also evaluated. Air emissions caused by mining activities could be of a short-term duration, in that the air quality would degrade for short, possibly intense periods then clear up; or long-term, such as the relatively constant emissions from mining and reclamation which would

TABLE 4.6-1

SUMMARY OF AMBIENT AIR QUALITY STANDARDS AND PSD INCREMENTS FOR CRITERIA POLLUTANTS

(micrograms per cubic meter, $\mu g/m^3$)

Pollutant[1]	Averaging Period	State and Federal Standards[2]		PSD Increments	
		Primary	Secondary	Class I	Class II
Particulate Matter (PM_{10})	Annual	50	NA	NA	NA
	24-Hour	150	NA	NA	NA
Total Suspended Particulates (TSP)	Annual	NA	NA	5	19
	24-Hour	NA	NA	10	37
Sulfur Dioxide (SO_2)	Annual	80	NA	2	20
	24-Hour	365	NA	5	91
	3-Hour	1,300	NA	25	512
Carbon Monoxide (CO)	8-Hour	10,000	10,000	NA	NA
	1-Hour	40,000	40,000	NA	NA
Nitrogen Dioxide (NO_2)	Annual	100	NA	2.5	25
Lead (Pb)	3-Month	1.5	NA	1.5	1.5
Ozone (O_3)	1-Hour	235	NA	235	235

[1] Gaseous concentrations are corrected to a reference temperature of 25°C and to a reference pressure of 760 millimeters of mercury.

[2] All maximum values are not to be exceeded more than one time per year and the ozone standard is not to be exceeded during more than one day per year.

NA Not applicable

Source: Montana Air Quality Regulations, December 1993.

extend until closure is approved. The frequency of air emissions also varies. In particular, air emissions from most mining and reclamation activities would be constant. The air emissions resulting from haul trucks passing through Zortman and Landusky would occur on a frequent but intermittent, and short-duration basis.

The importance of duration and frequency of emissions is particularly evident in the fugitive dust models conducted for Zortman Mine activities, especially the impacts resulting from haul truck traffic through the town of Zortman. Significance criteria are exceeded in Zortman for alternatives 2 through 7 as a result of the truck traffic raising dust in town. However, the truck convoys would typically pass through town in a matter of minutes and the air would usually clear relatively soon after. Therefore, the duration of the impact would be very short term, and occur only when the convoys pass through town.

4.6.1.5 Cumulative Impacts

Air emissions resulting from historic and recent mine activities is not relevant to a cumulative impacts analysis, since air quality would usually improve very quickly after emissions cease. Therefore, the cumulative impacts analysis for this resource relies on air emissions from existing sources (say, average PM_{10} concentrations in Zortman) combined with ongoing and/or projected mine activities, plus reasonably foreseeable developments if the applicable emissions would occur concurrent with the other air emissions sources.

4.6.2 Impacts from Mining, 1979 to Present

Air quality impacts from mining for the years 1979 to present, based on the limited data available and summarized in Section 3.6.1, have not exceeded applicable air quality standards. No air quality monitoring data were available to determine baseline (pre-1979) conditions.

Other air quality sources and emissions exist in the vicinity of the mines. These include: (1) lead emissions from the assay lab located in Zortman; (2) emissions from the refinery at the Zortman mine process plant; and (3) hydrogen cyanide gas emissions from the various Zortman and Landusky leach pads. Each of these sources and their nature were discussed in Section 3.6 A summary of emissions from each is repeated below.

Lead air emissions from the assay lab have been estimated by the Montana Air Quality Division at approximately 504 pounds per year (0.25 tons per year) based on the current lab operating schedule of 8 hours per day. The maximum lead concentration measured at a nearby monitoring location was 0.03 $\mu g/m^3$. Based on these emission estimates and ambient air monitoring results, the assay lab is in compliance with applicable lead ambient air quality standards. Lead emissions from the assay lab would be expected to drop to zero under a non-expansion alternative (Alternatives 1 through 3). Current emission rates would be expected to continue for the action alternatives. Under either scenario, the emissions would not constitute a significant impact. Because the emissions would cease for the no-action alternatives and remain constant for the mine extension alternatives, lead emissions are not discussed under each alternative's impact analysis.

Stack testing of emissions from the refinery indicate a total particulate emission rate of 2.42 tons per year (MDHES AQD 1994a). Modeling results indicate a 24-hour and annual PM_{10} concentration of 1.4 $\mu g/m^3$ and 0.3 $\mu g/m^3$, respectively. These concentrations are well below applicable Montana and federal ambient PM_{10} standards. Emissions from the refinery would cease under a no-action alternative and be expected to continue at similar rates for the mine extension alternatives. Under either scenario, the emissions would not constitute a significant impact. Refinery emissions are not discussed under each Alternative's impact analysis.

Emissions of hydrogen cyanide from the leach pads at the Zortman and Landusky mines have been measured by ZMI personnel in the early 1990s (DSL/BLM 1993). Hydrogen cyanide concentrations did not exceed 1 ppm. The Threshold Limit Value (a concentration established for the protection of human health, particularly worker safety) for hydrogen cyanide is 10 ppm (ACGIH 1993). When compared to the TLV, hydrogen cyanide concentrations emanating from the leach pads do not represent a significant impact.

4.6.3 Impacts from Alternative 1

This no action alternative limits activities at the Zortman and Landusky Mines to already permitted actions. Air emissions would originate from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and reclamation at both mines.

4.6.3.1 Impacts

PM_{10} concentrations were measured at a number of monitoring stations at various times during the years 1990 through 1993. Arithmetic average PM_{10} concentrations at Zortman ranged from 9 to 13 $\mu g/m^3$. Arithmetic average PM_{10} concentrations at Landusky ranged from 10 to 12 $\mu g/m^3$.

Projected air quality concentrations for mining and reclamation activities at both mines were estimated using the SCREEN model and the appropriate emissions sources for the activities. No operational calculations were conducted for the Zortman Mine since there is no additional permitted mining. The 24-hour and annual PM_{10} impacts resulting from Landusky Mine operations are estimated to be 85 $\mu g/m^3$ and 1 $\mu g/m^3$, respectively, at Landusky Mine. Table 4.6-2 summarizes the estimated PM_{10} concentrations for each alternative. Impacts are not significant from either mine.

The reclamation activities for which impacts were assessed included material handling, such as truck loading and dumping, grading and dozer activities, and material transport, which involves emissions from haul roads. The 24-hour and annual PM_{10} impacts associated with reclamation activities at the Zortman mine were estimated at 32 $\mu g/m^3$ and 8 $\mu g/m^3$, respectively, at Zortman. The 24-hour and annual PM_{10} impacts for Landusky mine were estimated at 14 $\mu g/m^3$ and 4 $\mu g/m^3$, respectively, at Landusky. These concentrations are well below the applicable federal and state ambient air quality standards (see Table 4.6-1). These concentrations reflect a low level of impact at both receptor locations which is not significant. The frequency of these air emissions is considered to be continuous and would occur until mining and reclamation activities are completed.

For this alternative, no clay or cover soil would be hauled through either Zortman or Landusky for reclamation covers. There would be no impact at the sensitive receptor locations associated with reclamation materials transport.

4.6.3.2 Cumulative Impacts

Although mine exploration and development is a reasonably foreseeable development under this alternative, there is no projection of the extent of such development (see Section 2.5.6). Therefore, cumulative air quality impacts are estimated by adding the modeled impacts at the mine sites to representative background, measured PM_{10} concentrations. The maximum 24-hour and annual average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively (see Table 3.6-1). Adding these background concentrations to the estimated impacts results in 24-hour and annual PM_{10} impacts of 64 $\mu g/m^3$ and 18 $\mu g/m^3$, respectively, for the Zortman Mine and 46 $\mu g/m^3$ and 14 $\mu g/m^3$, respectively, for the Landusky mine. These concentrations are below the applicable federal and state ambient air quality standards and not significant.

The maximum 24-hour average concentrations measured at the Zortman and Landusky townsites are 102 $\mu g/m^3$ and 96 $\mu g/m^3$, respectively. Adding these maximum background concentrations to the estimated impacts results in 24-hour PM10 impacts of 134 $\mu g/m^3$ for Zortman and 110 $\mu g/m^3$ for Landusky. These concentrations are below the applicable standards for the 24-hour average PM10 concentration and not significant.

4.6.3.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse, but not significant. Therefore, additional mitigation should not be needed to reduce the magnitude of impacts further.

4.6.3.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts under this alternative would last until 2000 (see Table 4.11-2). After reclamation is completed, air quality concentrations would improve to background levels.

4.6.3.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this alternative. Air quality would return to background levels after reclamation is completed.

TABLE 4.6-2

SUMMARY OF 24-HOUR AND ANNUAL PM_{10} IMPACTS $(\mu g/m^3)$ FOR EACH ALTERNATIVE[1]

	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5		Alt 6		Alt. 7	
	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual	24-hr	Annual
Zortman Mine														
Mining[3]	NA	NA	NA	NA	NA	NA	348	87	373	93	241	60	440	110
Reclamation[3]	32	8	57	14	68	17	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]	N/A[4]
Cumulative[3]	134	N/A	159	N/A	170	N/A	402	48	405	103	273	70	472	120
Landusky Mine														
Mining[2]	85	1	85	1	85	1	85	1	85	1	85	1	85	1
Reclamation[3]	14	4	25	6	31	8	31	8	32	8	32	8	32	8
Cumulative[3]	110	N/A	121	N/A	127	N/A	115	11	115	11	115	10	115	10

NA - not applicable.

[1] Values shown are for the maximum impact from any facility modeled.

[2] Values shown are as measured at the mine facility.

[3] Values shown are as estimated for the applicable townsite, Zortman or Landusky

[4] Reclamation estimates for the Zortman Mine, Alternative 4 through 7, are incorporated in the values presented for Mining

4.6.4 Impacts from Alternative 2

This no action alternative limits activities at the Zortman and Landusky Mines to already permitted actions, with some enhanced reclamation as proposed by ZMI. Air emissions would originate from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and reclamation at both mines.

4.6.4.1 Impacts

Projected air quality concentrations for mining and reclamation activities at both mines were estimated using the SCREEN model, and the appropriate emissions sources for the activities. No operational calculations were conducted for the Zortman Mine since there is no additional permitted mining. The 24-hour and annual PM10 impacts resulting from Landusky Mine operations are estimated to be 85 $\mu g/m^3$ and 1 $\mu g/m^3$, respectively, at the Landusky Mine. Impacts are not significant from either mine.

Clay would be hauled through Zortman and Landusky for use in reclamation covers. Topsoil would come from existing facilities and not require transport through either town. The 24-hour and annual PM10 impacts from reclamation activities at the Zortman mine were estimated at 57 $\mu g/m^3$ and 14 $\mu g/m^3$, respectively, at Zortman. The 24-hour and annual PM_{10} impacts for the Landusky mine were estimated at 25 $\mu g/m^3$ and 6 $\mu g/m^3$, respectively, at Landusky. These concentrations reflect a low level of impact at both receptor locations which is not significant. The frequency of these emissions is considered to be continuous and would occur until mining and reclamation activities are completed.

4.6.4.2 Cumulative Impacts

Cumulative air quality impacts were estimated by adding the modeled impacts to representative background, measured PM_{10} concentrations. The maximum 24-hour and annual average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively (see Table 3.6-1). Adding these background concentrations to the estimated impacts results in 24-hour and annual PM_{10} impacts of 89 $\mu g/m^3$ and 24 $\mu g/m^3$, respectively, for the Zortman mine and 57 $\mu g/m^3$ and 16 $\mu g/m^3$, respectively, for the Landusky mine. These concentrations are below the applicable federal and state ambient air quality standards and not significant.

The maximum 24-hour concentrations measured at the Zortman and Landusky townsites are 102 $\mu g/m^3$ and 96 $\mu g/m^3$, respectively. Adding these maximum background concentrations to the estimated impacts results in 24-hour PM10 impacts of 159 $\mu g/m^3$ for Zortman and 121 $\mu g/m^3$ for Landusky. All cumulative concentrations are above standards and represent a significant impact, except for the cumulative 24-hour average at Landusky.

4.6.4.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse. It is possible additional mitigation could be applied to help reduce the magnitude of the significant impacts.

4.6.4.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts under this alternative would last until 1998 for the Zortman mine; and until 2000 for the Landusky mine. After reclamation is completed, air quality concentrations would improve to background levels.

4.6.4.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this alternative. Air quality would return to background levels after reclamation is completed.

4.6.5 Impacts from Alternative 3

This non-expansion alternative limits activities at the Zortman and Landusky Mines to already permitted actions, with agency-mitigated reclamation imposed. Impacts to air quality would result from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and enhanced reclamation at both mines.

4.6.5.1 Impacts

Projected air quality concentrations for mining and reclamation activities at both mines were estimated using the SCREEN model, and the appropriate emissions sources for the activities. No operational calculations were conducted for the Zortman Mine site there is no additional permitted mining. The 24-hour and annual PM10 impacts resulting from Landusky Mine operations are estimated to be 85 $\mu g/m^3$ and 1 $\mu g/m^3$, respectively, at the Landusky Mine.

Clay would be hauled through Zortman and Landusky for use in reclamation covers. Topsoil would come from existing facilities and not require transport through either town. Limestone would also be used in reclamation covers but would not require transport through either town.

The 24-hour and annual PM10 impacts from reclamation activities at the Zortman mine were estimated at 68 $\mu g/m^3$ and 17 $\mu g/m^3$, respectively, at Zortman. The 24-hour and annual PM_{10} impacts for the Landusky mine were estimated at 31 $\mu g/m^3$ and 8 $\mu g/m^3$, respectively, at Landusky. These concentrations represent a low level of impact at both receptor locations which is not significant. The frequency of these emissions is considered to be continuous and would occur until mining and reclamation activities are completed.

4.6.5.2 Cumulative Impacts

Cumulative air quality impacts were estimated by adding the modeled impacts to representative background, measured PM_{10} concentrations. The maximum 24-hour and annual average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively (see Table 3.6-1). Adding these background concentrations to the estimated impacts results in 24-hour and annual PM_{10} impacts of 100 $\mu g/m^3$ and 27 $\mu g/m^3$, respectively, for the Zortman mine and 63 $\mu g/m^3$ and 18 $\mu g/m^3$, respectively, for the Landusky mine. These concentrations are below the applicable federal and state ambient air quality standards and not significant.

The maximum 24-hour concentrations measured at the Zortman and Landusky townsites are 102 $\mu g/m^3$ and 96 $\mu g/m^3$, respectively. Adding these maximum background concentrations to the estimated impacts results in 24-hour PM10 impacts of 170 $\mu g/m^3$ for Zortman and 127 $\mu g/m^3$ for Landusky. All cumulative concentrations are above standards and represent a significant impact, except for the cumulative 24-hour average at Landusky.

4.6.5.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse. It is possible additional mitigation could be applied to help reduce the magnitude of significant impacts.

4.6.5.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts under this alternative would last until 1999 for the Zortman mine and until 2001 for the Landusky mine. After reclamation is completed, air quality concentrations would return to background levels.

4.6.5.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this Alternative. Air quality impacts would return to background levels after reclamation is completed.

4.6.6 Impacts from Alternative 4

The Company Proposed Action includes extension of mine activities at both the Zortman and Landusky Mines. Increased reclamation would be implemented at both mines as well. Air emissions would emanate from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development actions are reasonably foreseeable.

4.6.6.1 Impacts

Projected air quality concentrations for mining and reclamation activities were estimated using the FDM model at the Zortman Mine, and the SCREEN model for the Landusky Mine. In addition, air quality impacts were estimated in ZMI's air permit application for the Zortman Mine (MDHES AQD 1994) and the Landusky Mine (MDHES AQD 1993). The maximum predicted 24-hour and annual PM_{10} impacts at the Zortman mine were 107 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively. The maximum predicted 24-hour and annual PM_{10} impacts at the Landusky mine were 85 $\mu g/m^3$ and 1 $\mu g/m^3$, respectively. Using the FDM model, the maximum predicted 24-hour and annual PM_{10} impacts at the Zortman mine were 348 $\mu g/m^3$ and 87 $\mu g/m^3$, respectively. This estimate includes impacts from reclamation activities and haul trucks carrying reclamation materials. So that comparison can be made between alternatives, the estimates derived using the FDM model are applied to the assessment of cumulative impacts.

Other air pollutants predicted to be generated by the mining activities at Zortman include carbon monoxide (335 tons per year), nitrogen oxides (430 tons per year), sulfur dioxide (47 tons per year), and volatile organic compounds (28 tons per year). Ambient air quality impacts from these pollutants were modeled using SCREEN. SCREEN predicted ambient air quality impacts for each of the pollutants listed above at Zortman (the nearest sensitive receptor) as follows. Carbon monoxide 1-hour and 8-hour impacts were estimated at 274 $\mu g/m^3$ and 192 $\mu g/m^3$, respectively. Nitrogen oxides annual impacts were estimated at 35 $\mu g/m^3$. Sulfur dioxide 3-hour, 24-hour and annual impacts were estimated at 35 $\mu g/m^3$, 15 $\mu g/m^3$, and 4 $\mu g/m^3$, respectively. Volatile organic compounds annual impacts were estimated at 23 $\mu g/m^3$. (The volatile organic compounds impacts can be compared to the federal and state ozone standard, since volatile organic compounds are a precursor to the formation of ozone.) These impacts are all well below the corresponding federal and state ambient air quality standards (see Table 4.6-1), and would result in no significant impact. These calculations would apply to the air quality impacts analyses for the remaining mine extension alternatives.

Air pollutants generated by the mining activities at Landusky include PM_{10} (872 tons per year), carbon monoxide (264 tons per year), nitrogen oxides (404 tons per year), sulfur dioxide (44 tons per year), and volatile organic compounds (28 tons per year). Ambient air quality impacts from the other pollutants listed above were modeled using SCREEN. SCREEN predicted ambient air quality impacts for the pollutants listed above at Landusky (the nearest sensitive receptor) as follows. Carbon monoxide 1-hour and 8-hour impacts were estimated at 263 $\mu g/m^3$ and 184 $\mu g/m^3$, respectively. Nitrogen oxides annual impacts were estimated at 40 $\mu g/m^3$. Sulfur dioxide 3-hour, 24-hour and annual impacts were estimated at 44 $\mu g/m^3$, 40 $\mu g/m^3$, and 4 $\mu g/m^3$, respectively. Volatile organic compounds annual impacts were estimated at 28 $\mu g/m^3$. These impacts are all well below the corresponding federal and state ambient air quality standards (see Table 4.6-1), and would result in no significant impact.

The 24-hour and annual PM_{10} impacts for Landusky mine were estimated at 31 $\mu g/m^3$ and 8 $\mu g/m^3$, respectively, at Landusky. These concentrations are below the applicable federal and state ambient air quality standards and would result in no significant impact. The impacts for Zortman were estimated using FDM and described earlier. These impacts are in exceedance of the 24-hour and annual average PM_{10} concentration and would be significant. The frequency of the Zortman emissions is variable; mining and reclamation activities would be continuous until complete. Impacts from hauling reclamation materials through town would be frequent but not continuous. The frequency of impact can be related to the schedule for haul truck traffic, as shown on Table 4.11-2, which lists projected annual haul trips for reclamation materials for each alternative.

4.6.6.2 Cumulative Impacts

Cumulative air quality impacts were estimated by adding the impacts to representative background, measured, PM_{10} concentrations. The maximum 24-hour average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively. Adding these background concentrations to the SCREEN estimated Landusky mining impacts results in 24-hour and annual PM_{10} impacts of 115 $\mu g/m^3$ and 11 $\mu g/m^3$, respectively. Adding the background concentrations to the estimated reclamation impacts for the Landusky Mine results in 24-hour and annual PM_{10} impacts of 63 $\mu g/m^3$ and 18 $\mu g/m^3$, respectively. These concentrations are below the applicable federal and state ambient air quality standards and not significant.

Addition of background concentrations to the FDM estimated emissions for the Zortman Mine results in 24-hour PM_{10} impacts of 380 $\mu g/m^3$. These concentrations are well above the applicable standards and result in a high, significant impact.

The reasonably foreseeable developments under Alternative 4 include mining extension into Pony Gulch. The Pony Gulch area is approximately 4000 feet from Zortman. Air emissions would result from haul roads traffic and be a function of the amount of ore and waste rock handled per day. The SCREEN model predicts 24-hour and annual PM10 impacts of 189 $\mu g/m^3$ and 48 $\mu g/m^3$, respectively. If this development occurs, an air quality permit modification would be required. These impacts added to the totals presented above would result in cumulative emissions of 402 $\mu g/m^3$ and 125 $\mu g/m^3$, respectively, emissions which represent a high, significant impact.

4.6.6.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse. It is likely additional mitigation could be applied to help reduce the magnitude of significant impacts.

4.6.6.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts under this alternative would last until 2007, for the Zortman mine and until 2002 for the Landusky mine. After reclamation is completed, air quality concentrations would improve to pre-mining levels.

4.6.6.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this Alternative. Air quality impacts would return to pre-mining levels after reclamation is completed.

4.6.7 Impacts from Alternative 5

This alternative includes extension of mine activities at both the Zortman and Landusky Mines. A major operational modification affecting air quality impacts would place the Zortman Mine heap leach pad in Upper Alder Gulch. Agency mitigated reclamation would be implemented at both mines. Air quality impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities.

4.6.7.1 Impacts

Air quality impacts under this alternative would be similar to those in Alternative 4. The differences in air quality impacts from Alternative 4 would result from the relocation of the proposed Goslin Flats Leach Pad relocated to Upper Alder Gulch. The ore would be transported to the leach pad using haul trucks. Other air pollutants associated with the mining activities would be estimated to have similar emissions as described in Section 4.6.6.1.

Using the FDM model, the maximum predicted 24-hour and annual PM10 impacts at Zortman from Zortman mine operations were 373 $\mu g/m^3$ and 93 $\mu g/m^3$, respectively. This estimate includes impacts from reclamation activities and haul trucks carrying reclamation materials. These impacts are in exceedance of the 24-hour average PM10 concentrations and would be significant. As described in Section 4.6.6.1, the frequency of these impacts would be variable, but the impacts would continue for the duration of the mining and reclamation activities.

Air quality impacts from mining activities would be the same as described for Alternative 4 (Section 4.6.6.1); some additional blasting and construction would occur to develop a drainage passage into King Creek, but these impacts would be short-term and similar to emission sources already incorporated into the SCREEN model. This alternative would probably result in reclamation activities at the Landusky mine occurring for 1 year longer than Alternative 4. The 24-hour and annual PM10 impacts for Landusky mine were estimated at 32 $\mu g/m^3$ and 8 $\mu g/m^3$, respectively, at Landusky, slightly higher than for Alternative 4. These concentrations are below the applicable federal and state standards and would result in no significant impact.

4.6.7.2 Cumulative Impacts

The only reasonably foreseeable development would be expanded mining activities at the Landusky Mine. This action would not affect emissions levels but would extend the duration of the impacts.

Cumulative air quality impacts were assessed by adding the impacts to representative background, measured PM_{10} concentrations. The maximum 24-hour average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively. Adding these background concentrations to the SCREEN estimated Landusky mining impacts results in 24-hour and annual PM_{10} impacts of 115 $\mu g/m^3$ and 11 $\mu g/m^3$, respectively, for the Landusky mine. Adding the background concentrations to the estimated reclamation impacts results in 24-hour and annual PM_{10} impacts of 64 $\mu g/m^3$ and 18 $\mu g/m^3$, respectively, for the Landusky mine. These concentrations are below the applicable federal and state standards and not significant.

Addition of background concentrations to the FDM estimated emissions for the Zortman Mine results in 24-hour and annual average PM_{10} impacts of 405 $\mu g/m^3$ and 103 $\mu g/m^3$, respectively. These concentrations are well above the applicable standards and result in a high, significant impact.

4.6.7.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse. It is possible that additional mitigation could be applied to help reduce the magnitude of significant impacts.

4.6.7.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts would last until 2007 for the Zortman mine and until 2002 for the Landusky mine. After reclamation is completed, air quality impacts would return to background levels.

4.6.7.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this Alternative. Air quality impacts would return to background levels after reclamation is completed.

4.6.8 Impacts from Alternative 6

This alternative includes extension of mine activities at both the Zortman and Landusky Mines. A major operational modification affecting the air impacts analysis would place the Zortman Mine waste rock repository on Ruby Flats. Agency mitigated reclamation would be implemented at both mines. Air emissions would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development activities are reasonably foreseeable.

4.6.8.1 Impacts

Air quality impacts under this alternative would be similar to Alternative 4. The differences in air quality impacts from Alternative 4 would result from the relocation of the Carter Gulch waste rock repository to Ruby Flats just east of the Goslin Flats leach lad. A conveyor system would be used to transport the ore and waste rock from the Zortman Mine to the Goslin Flats area. A haul road would be needed to transport the waste rock from the conveyor terminus to Ruby Flats. Other air pollutants associated with the mining activities would be estimated to have similar emissions as described in Section 4.6.6.1.

Using the FDM model, the maximum predicted 24-hour and annual PM10 impacts at Zortman from Zortman mine operations were estimated to be 241 $\mu g/m^3$ and 60 $\mu g/m^3$, respectively. This estimate includes impacts from reclamation activities and haul trucks carrying reclamation materials. These emissions exceed the 24-hour average PM10 standards and would be significant. As described in Section 4.6.6.1, the frequency of these impacts would be variable, but the impacts would continue for the duration of mining and reclamation.

Air quality impacts from mining activities would be the same as described for Alternative 4 (Section 4.6.6.1); some additional blasting and construction would occur to develop a drainage passage into Montana Gulch, but these impacts would be short-term and similar to emission sources already incorporated into the SCREEN model. The 24-hour and annual PM10 impacts for the Landusky mine were estimated at 32 $\mu g/m^3$ and 8 $\mu g/m^3$, respectively, at Landusky, slightly higher than for Alternative 4. These concentrations are below the applicable federal and state standards and would result in no significant impact.

4.6.8.2 Cumulative Impacts

Reasonably foreseeable developments under Alternative 6 would be as described for Alternative 4 in Section 4.6.6.2. Air emissions from a Pony Gulch mine would results from blasting, crushing, loading, hauling, and processing of ore. The SCREEN model was used to predict 24-hour and annual PM_{10} impacts of 189 $\mu g/m^3$ and 48 $\mu g/m^3$, respectively. An air quality permit modification would be required for such a development.

Cumulative air quality impacts were assessed by adding the impacts to representative background, measured PM10 concentrations and the emissions from the Pony Gulch reasonably foreseeable development. (The reasonable foreseeable development of additional, deeper mining at the Landusky Mine would not increase the cumulative impacts, merely extent the duration of the impacts.) The maximum 24-hour average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively. Adding these background concentrations to the SCREEN estimated Landusky mining impacts results in 24-hour and annual PM_{10} impacts of 115 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively, for the Landusky mine. Adding the background concentrations to the estimated reclamation impacts for the Landusky Mine results in 24-hour and annual PM_{10} impacts of 63 $\mu g/m^3$ and 18 $\mu g/m3^3$, respectively, for the Landusky mine.

Addition of background concentrations and emissions from the Pony Gulch reasonably foreseeable development to the FDM estimated emissions for the Zortman Mine results in 24-hour and annual PM_{10} emission concentrations of 273 $\mu g/m^3$ and 70 $\mu g/m^3$, respectively. These concentrations are well above the applicable standards and result in a high, significant impact.

4.6.8.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse. It is likely additional mitigation could be applied to help reduce the magnitude of significant impacts.

4.6.8.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts would last until 2006 for the Zortman mine and until 2002 for the Landusky mine. After reclamation is completed, air quality impacts would return to baseline levels.

4.6.8.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this Alternative. Air quality impacts would return to background levels after reclamation is completed.

4.6.9 Impacts from Alternative 7

This alternative includes extension of mine activities at both the Zortman and Landusky Mines. A major operational modification which would affect air emissions would place the Zortman Mine waste rock repository on top of existing disturbances and undisturbed areas around the mine site. Agency mitigated reclamation would be implemented at both mines. Air quality impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development activities are reasonably foreseeable.

4.6.9.1 Impacts

The air emissions levels for this Alternative would be expected to be similar, since the new waste rock repository would be within the mine source area, as was the Carter Gulch waste rock repository under Alternative 4. Air quality impact analyses for this Alternative are also based on a worst-case scenario that all mining equipment listed in Table 4.9-1 would be operating at the same time. Other air pollutants associated with the mining activities would be estimated to have similar emissions as described in Section 4.6.6.1.

Using the FDM model, the maximum predicted 24-hour and annual PM10 impacts at Zortman from Zortman mine operations were estimated to be 440 and 110 $\mu g/m^3$, respectively. This estimate includes impacts from reclamation activities and haul trucks carrying reclamation materials. These emissions are in exceedance of the 24-hour average PM10 standards and would be significant. As described in Section 4.6.6.1, the frequency of these impacts would be variable, but the impacts would continue for the duration of mining and reclamation.

Air quality impacts from mining activities would be the same as described for Alternative 4 (Section 4.6.6.1); some additional blasting and construction would occur to develop a drainage passage into King Creek, but these impacts would be short-term and similar to emission sources already incorporated into the SCREEN model. The 24-hour and annual PM10 impacts for the Landusky mine were estimated at 32 $\mu g/m^3$ and 8 $\mu g/m^3$, respectively, at Landusky, slightly higher than for Alternative 4. These concentrations are below the applicable federal and state standards and would result in no significant impact.

4.6.9.2 Cumulative Impacts

Reasonably foreseeable developments under Alternative 7 would be as described for Alternative 4 in Section 4.6.6.2. Air emissions from a Pony Gulch mine would result from blasting, crushing, loading, hauling, and processing of ore. The SCREEN model was used to predict 24-hour and annual PM_{10} impacts of 189 $\mu g/m^3$ and 48 $\mu g/m^3$, respectively. An air quality permit modification would be required for such a development.

Cumulative air quality impacts were assessed by adding the impacts to representative background, measured PM10 concentrations and the emissions from the Pony Gulch reasonably foreseeable development. (The reasonable foreseeable development of additional, deeper mining at the Landusky Mine would not increase the cumulative impacts, merely extent the duration of the impacts.) The maximum 24-hour average concentrations measured upwind of the Zortman and Landusky mines are 32 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively. Adding these background concentrations to the SCREEN estimated Landusky mining impacts results in 24-hour and annual PM_{10} impacts of 115 $\mu g/m^3$ and 10 $\mu g/m^3$, respectively, for the Landusky mine. Adding the background concentrations to the estimated reclamation impacts for the Landusky Mine results in 24-hour and annual PM_{10} impacts of 63 $\mu g/m^3$ and 18 $\mu g/m^3$, respectively, for the Landusky mine.

Addition of background concentrations and emissions from the Pony Gulch reasonably foreseeable development to the FDM estimated emissions for the Zortman Mine results in 24-hour and annual PM_{10} emission concentrations of 472 $\mu g/m^3$ and 120 $\mu g/m^3$, respectively. These concentrations are well above the applicable standards and result in a high, significant impact.

4.6.9.3 Unavoidable Adverse Impacts

The impacts described are considered unavoidable and adverse. It is likely additional mitigation could be applied to help reduce the magnitude of significant impacts.

4.6.9.4 Short-term Use/Long-term Productivity

Mining and reclamation air quality impacts would last until 2007 for the Zortman mine and until 2002 for the Landusky mine. After reclamation is completed, air quality impacts would return to baseline levels.

4.6.9.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible of irretrievable resource commitments for air quality for this Alternative. Air quality impacts would return to background levels after reclamation is completed.

4.7 RECREATION AND LAND USE

4.7.1 Methodology

Mining activities could effect recreation and land use resources both directly and indirectly by exerting a physical and/or a visual influence. Direct impacts to recreational or land use resources would occur if construction or operation of the project resulted in the termination of use or modification of the resources within the study area. Indirect impacts would occur if construction or operation activities altered recreation use patterns, recreation demand, access, or the quality of the recreational experience.

Impacts to recreation and land use were considered significant if: (1) project-related changes would alter or otherwise physically affect established, designated, or planned recreation areas or activities; (2) project-related changes would conflict with officially adopted polices or goals for land management; (3) project-related changes would effect accessibility to areas established, designated or planned for recreational use; (4) project-related changes would terminate or have a major affect on existing land uses; (5) project-related changes would have a major effect on the duration or quality of recreational environments and experiences.

Impacts may be locally or regionally significant. For the recreation and land use resources, local is defined as those areas within 0-5 miles of current or proposed mine activities. The regional area includes recreation and land use resources in north central Montana, including the many recreational opportunities and facilities found along the Missouri River. Short term impacts are defined as those occurring during the life of mine operations. Long term impacts are defined as those occurring after reclamation and revegetation.

4.7.2 Impacts from Mining, 1979 to Present

As described in the affected environment chapter (Section 3.7), recreation activities in 1979 centered around the two campgrounds (Montana Gulch campground near Landusky and the Camp Creek campground near Zortman), picnicking in Mission Canyon, and the hiking, hunting, picnicking, and sightseeing opportunities available throughout the Little Rocky Mountains. Prior to 1979, recreationists could drive the Zortman/Landusky county road and use that road to access hunting and hiking areas, and for sightseeing (including viewing historic mining structures). BLM lands were managed for multiple use including wildlife habitat, forestry, mining and recreation. Agriculture was the dominant use on private lands surrounding the Little Rocky Mountains.

Impacts to recreation resources due to mining activities can be generally characterized as a loss of access to dispersed use areas that were previously accessed by the Zortman/Landusky county road over Antoine Butte; a reduction in the aesthetic quality of surrounding recreational use areas due to an increase in the amount of visible land disturbances; and noise from mining operations.

The recreation environment today still includes the two campgrounds, picnic spots and Pow Wow grounds in Mission Canyon, and the dispersed activities available in 1979. However, the Zortman/Landusky county road over Antoine Butte is closed to non-mine business which has caused some loss of access to hunting areas and sightseeing opportunities. ZMI does offer mine tours of their operations.

Although visitor use data for the campgrounds is not available for 1979, overall recreational visits to the Little Rocky Mountain Recreation Management Area has been declining in the last decade (Whitehead 1995). The water well at the Montana Gulch campground, found to be producing arsenic contaminated water prior to 1979 and which was capped soon after drilling, was plugged and abandoned in 1991. Since 1979 there have been periods of surface water degradation at the campground due to overtopping of upstream capture systems at the Landusky Mine. Noise from blasting can occasionally be heard at the Pow Wow grounds in Mission Canyon on the Fort Belknap Indian Reservation.

There has been a substantial increase in the amount of visible land disturbance since 1979. Recreationists hiking up several of the peaks and buttes near the Zortman and Landusky mines now have extensive views of mine disturbance which can reduce the quality of the recreational environment and reduce scenic viewing opportunities. Portions of the Landusky Mine have now become visible to recreation areas as far south as the Missouri Breaks Backcountry Byway, located over 20 miles south of the mines, as well as to viewers at the Pow Wow grounds in Mission Canyon. Light sources at the mines are particularly visible at night, from both nearby and distant viewpoints. (Visual impacts are further evaluated in Section 4.8.)

Lands used for mine operations have precluded other land uses in the immediate area of mine operations.

BLM lands in the surrounding area still provide for other uses such as wildlife habitat and recreation. Native Americans use many of the areas in the Little Rocky Mountains for cultural purposes, including vision quests. Since 1979 there have been indirect impacts to several of these sites from the visual and noise impacts caused by mine operations.

4.7.3 Impacts From Alternative 1

Under Alternative 1, mine expansion plans would not be approved. Mining activities previously permitted would continue, and reclamation procedures would proceed as approved. Previously permitted activities at the Zortman mine include continued leaching at the 89 pad and reclamation and closure activities. At the Landusky mine ore is still being removed at the Gold Bug pit and leaching operations are active at the 87/91 and 91 heap leach pads. These activities would have no appreciable effect on recreation resources. Existing impacts to recreation, as described in the previous section, would remain the same until reclamation and revegetation activities reduced the indirect visual impacts caused by land disturbance, and the Zortman/Landusky road is available for use by the public.

Reclamation generally includes regrading of facilities to slopes no steeper than 2:1 and a soil cover of eight inches. Reclamation specialists predict that the existing reclamation plan under Alternative 1 would not be successful in many areas because of problems with steep slopes and potential acidification of soils in those areas where the cover soil is overlain on acid producing material (Plantenberg 1994). In those areas of reclamation failure, there would be long-term significant impacts to land use and recreation. Water quality may remain poor in some drainages where the 8 inches of cover soil is not adequate to prevent acid rock drainage. If this occurs, water quality at the Montana Gulch campground may remain poor. However, a water quality compliance plan may be implemented by ZMI to address water quality issues, and would likely be required in all alternatives. With implementation of the compliance plan, both surface and groundwater quality should be improved in all drainages affected by mining operations, including Montana Gulch.

Mining is an approved use of BLM lands in the Little Rocky Mountains (BLM 1994). Denial of mine extension plans would end this land use after the currently permitted operations have ended, having a significant impact on mining within the Little Rocky Mountains.

4.7.3.1 Cumulative Impacts

Under Alternative 1, future mining activities would be limited. Further reclamation and remediation measures may be required in the future to correct problems with acid rock drainage. Exploration activities are not anticipated with Alternative 1, however, it is foreseeable that some exploration may occur at some point in the future which would involve road building and exploratory drilling. Long-term impacts to recreation and land use would be reduced by any improvement in reclamation success, however, continued building of exploration roads would add to the visible disturbance in the area, and lower the scenic quality of the landscape. This would continue the impacts to recreationists expecting to view natural appearing mountain scenery while recreating in areas within the viewshed of mining activities.

In summary, mining operations at both the Zortman and Landusky mines have created significant short-term impacts to the recreational environment in the local area. These impacts are caused by access restrictions and the degradation of the scenic quality of the area, which can affect the quality of the recreational experience. The reclamation plan may not be adequate to return the land to productive uses which would continue the impacts to recreation, and create long-term impacts to land use resources.

4.7.3.2 Unavoidable Adverse Impacts

Indirect visual impacts will occur to recreationists who may view the mine area until the disturbed areas are reclaimed. Reclamation will not entirely remove visual impacts as the reclaimed surfaces still be noticeable because of their unnatural topography and differences in vegetation pattern. Reclamation failure would cause long-term impacts to both recreation and land use. Access to lands currently within the mine operational areas continue to be restricted until reclamation activities are complete.

4.7.3.3 Short Term Use/Long-Term Productivity

With successful reclamation and revegetation, the land could return to other productive uses such as wildlife habitat and hunting. Reclamation specialists predict that the reclamation plan under Alternative 1 will not be successful in some areas, which would cause significant long-term impacts to future productive uses of the affected lands.

4.7.3.4 Irreversible or Irretrievable Resource Commitments

Mining in the Little Rocky Mountains has permanently altered the topography in some locations. Even with successful reclamation, the scenic quality of some lands will not return to their original condition. For land uses that are affected by the scenic quality and natural appearance of the landscape, such as scenic viewing by recreationists and cultural uses (vision quests) by Native Americans, there has been an irretrievable loss in the quality of their experiences. This impact has already occurred as a result of past and ongoing mining activities.

If reclamation fails in areas because of slope instability and soil acidification problems, impacts to both recreation and land use resources would remain at high levels into the foreseeable future.

4.7.4 Impacts from Alternative 2

Under this alternative, already permitted activities would continue, but plans for mine expansion would not be approved. Impacts from the already permitted mine activities would be as described for Alternative 1. Reclamation plans would be revised as proposed by ZMI. The Seaford Clay Pit, located approximately 7 miles south of Zortman and the Williams Clay Pit, located approximately 2 miles west of Landusky, would be used for reclamation material. Disturbance at those sites would not impact recreational facilities or activities. Improvement in the success of reclamation measures to control water quality problems would have a positive effect on water quality conditions at the Montana Gulch campground. Successful revegetation on reclaimed areas would reduce long-term, indirect visual impacts to recreationists to non-significant levels.

Reclamation measures would improve the probability of successful revegetation and control of water quality problems. Successful reclamation is critical for: disturbed areas to return to other land uses such as wildlife habitat; improvement in the visual appearance of disturbed lands; and the general improvement in the ecological condition of mined areas.

4.7.4.1 Cumulative Impacts

As in Alternative 1, future mining activities are not reasonably foreseeable with implementation of Alternative 2. It is possible that a few exploration roads may be built, but exploration activities are also predicted to be limited since this alternative does not allow for mining of already delineated ore reserves. Existing impacts from past and current mining activities have had a significant short-term effect on the recreational environment in the local area. Alternative 2 improves the probability of successful reclamation, and reduces long-term impacts to recreation and land use resources. However, reclamation measures still may not correct water quality problems that exist in some drainages. Where those impacts continue, there would be significant long-term impacts to recreation, and to the ability of the land to support other land uses such as wildlife habitat.

4.7.4.2 Unavoidable Adverse Impacts

The reclamation plan under Alternative 2 improves the probability of successful revegetation and correction of existing water quality problems. However, their still may be some areas where reclamation efforts are not completely successful, and water quality may still be an issue in some locations. In those areas of continuing water quality degradation, and in any areas where revegetation was not successful, there would continue to be long-term impacts to the recreational environment caused by indirect visual impacts, and long-term impacts to returning the land to other land uses.

4.7.4.3 Short Term Use/Long-Term Productivity

There have been significant short-term impacts to recreation resources surrounding the Zortman and Landusky mines. With successful reclamation, lands could return to other productive land uses and effects to recreational opportunities would be reduced to non-significant levels.

4.7.4.4 Irreversible or Irretrievable Resource Commitments

Mining in the Little Rocky Mountains has permanently altered the topography in some locations. Even with successful reclamation, the scenic quality of some lands will not return to their original condition. For land uses that are affected by the scenic quality and natural appearance of the landscape, such as scenic viewing by recreationists and cultural uses (vision quests) by Native Americans, there has been an irretrievable loss in the quality of their experiences. This impact has already occurred as a result of past and ongoing mining activities. Alternative 2, as well as alternatives 1 and 3, would not approve additional mining other than that already permitted and would limit additional irretrievable resources commitments.

4.7.5 Impacts from Alternative 3

Under this alternative, already permitted activities would continue, but plans for mine expansion would not be approved. Reclamation plans would be revised using agency modified corrective measures. Effects to land use and recreation resources would generally be the same as described in Alternative 2, except that the probability of reclamation producing the desired post-mine land use is increased. Long-term impacts to recreation sites and activities, and land use would be further reduced by an increase in the revegetation success rate and cleaner water.

4.7.5.1 Cumulative Impacts

Past and present impacts, and reasonably foreseeable developments would be the same as described for Alternative 2. Improvement in reclamation success, which is predicted with implementation of the measures outlined for Alternative 3, would reduce long-term impacts to non-significant levels. With successful reclamation lands could return to productive use, including wildlife habitat and hunting.

4.7.5.2 Unavoidable Adverse Impacts

Impacts would generally be as described for Alternative 2. However, reclamation specialists predict that the reclamation measures recommended by the agencies in this alternative would improve the potential for reclamation success. Any improvement in water quality and the general success of reclamation would further reduce long-term impacts to the recreational environment, and increase the availability and productivity of the land for other land uses.

4.7.5.3 Short-Term Use/ Long-Term Productivity

Short-term use and long-term productivity would generally be the same as described for Alternative 2. Any increase in the effectiveness of reclamation would cause a corresponding increase in the long-term productivity of the affected area for other land uses.

4.7.5.4 Irreversible or Irretrievable Resource Commitments

Irretrievable resources commitments would be the same as described for Alternative 2.

4.7.6 Impacts from Alternative 4

Alternative 4 is the company proposed action (CPA). Activities at the Zortman mine would include: expansion of existing pits; a waste rock repository in Carter Gulch; an overland conveyor for ore transport; a heap leach pad and other processing facilities in Goslin Flats; rerouting of the Zortman to Landusky access road, power line and pipeline; upgrading of haul roads; and development of a limestone quarry south of Green Mountain. No direct impacts to recreation facilities or activities would occur to areas in, or immediately adjacent to, existing mining operations. However, the overland conveyor, which would carry ore from the mine to the heap leach pad in Goslin Gulch; and the Goslin Flats heap leach pad, would restrict access to Goslin Gulch, which is occasionally used by recreationists and biologists to access Saddle Butte and the Azure Cave. Access would be maintained into Pony Gulch. Hunters may encounter access restrictions along the length of the conveyor. The Camp Creek Campground and Buffington day use area would not be directly impacted by the proposed mine expansion.

Indirect impacts would be significant, primarily as a result of an increase in visual, noise and traffic impacts. Sightseeing, which includes walking, biking, horseback riding or driving along roads and trails, is a high use activity in the Little Rocky Mountains. Recreationists driving up the county road (7-mile Road) to the Town of Zortman would drive by the heap leach pad and processing facilities in Goslin Flats. Facilities at Goslin Flats would require night lighting, creating a noticeable light source for miles around. Trail users on Old Scraggy Peak and Saddle Butte would also be exposed to the new facilities in Goslin Flats as well as expansion of facilities at the mine site (mine pits and the waste rock dump). The increase in industrial activity in the area would affect the natural appearance of the landscape and decrease the quality of the recreational environment. This would cause significant short-term impacts until the area is reclaimed. Mine life would be extended by approximately five to eight years after project startup.

Proposed activities at the Landusky mine include expansion of the existing pits and heap leach pads, and development of a limestone quarry at Kings Creek.

None of these proposed facilities would directly impact developed recreation facilities. The Montana Gulch campground is not within view of mining areas. Assuming that a water compliance plan will be implemented, water quality at the campground should improve. Indirect impacts would be the same as those caused by expansion of the Zortman Mine - primarily visual impacts caused by an increase in the amount of visible mine disturbance. The expanded mine pits and/or heap leach pads would be seen from several of the higher peaks in the area including Mission, Indian and Silver Peaks, Thornhill Butte, and from sections of U.S. Highway 191 and State Highway 66. Expansion of the heap leach pads would be visible from the Pow Wow grounds in Mission Canyon. This would cause a small incremental increase in visual impacts to the Power Wow grounds, but would not be expected to cause any reduction in the recreational use of the area.

Continued disturbance at the Landusky mine will increase the area of visible contrast to viewers on both the auto tour route on the Charles M. Russell National Wildlife Refuge (CMR) and the Missouri Backcountry Byway south of the Missouri River. Recreation facilities or activities within the CMR would not be directly impacted by the proposed mine expansion.

Continued mining in the Little Rocky Mountains would not be inconsistent with federal land use plans. Private land in Goslin Gulch, used for the heap leach pad and ancillary facilities, would no longer be used for livestock grazing. This would have a minor effect on the total amount of grazing land in the region. Phillips County would require the rezoning of the Goslin Gulch land from agriculture to industrial. After reclamation, grazing could be an appropriate use on reclaimed lands.

4.7.6.1 Cumulative Impacts

Possible future developments at the Zortman mine include mining in the Pony Gulch area, expansion of the Goslin Gulch leach pad and additional limestone quarry development. At the Landusky mine foreseeable future actions include continued mining of ore and waste rock at existing pits and the South Gold Bug pit, additional heap leach capacity, and additional limestone mining at the King Creek quarry and a proposed quarry in Montana Gulch. Exploration activities could occur over a ten year period and disturb an additional 128 acres throughout that portion of the Little Rocky Mountains outside of the Fort Belknap Indian Reservation. This additional disturbance would be from road and trench construction and drill sites.

Mine development in the Pony Gulch area would have a significant, direct impact on recreationists who may use the area for hiking, hunting or christmas tree cutting. Disturbance from additional ore and waste rock mining and exploration activities would increase the amount of industrial activity occurring in the area and decrease the amount of land in the Little Rocky Mountains that provide undisturbed, intact landscapes and environments. Future mine development would prolong the use of facilities in Goslin Flats, increasing the duration of visual impacts in that area. Operation of a limestone quarry at the Montana Gulch site would cause substantial visual and noise impacts to recreationists at the Montana Gulch campground. The quarry may be partially visible from the campground and the access road to the quarry, which would be used by haul trucks, would be in close proximity to the campground.

In summary, there has been significant short-term impacts to the local recreational environment caused primarily by indirect visual impacts from existing mine developments, and from access restrictions. On a more regional level, impacts are not considered significant. Recreation activities outside of the Little Rocky Mountains, including prairie dog hunting and developed recreation sites along the Missouri River are unaffected. Visible contrasts in the landscape caused by mine disturbance are noticeable from very long distances, including viewers on the Missouri Breaks Backcountry Byway, but these impacts are not significant enough at those distances to cause a substantial reduction in the enjoyment of their activities.

The CPA would extend the mine life for approximately eight years, and create new areas of visible ground disturbance and industrial activity. Foreseeable mine development and exploration activities would extend those impacts for many years into the future and delay the final reclamation of all mine facilities/disturbance areas. Once final reclamation has occurred, the land could return to other land uses including wildlife habitat and grazing. Access to reclaimed areas would allow recreationists to use the area again for hunting and other activities, and the indirect visual impacts would be reduced.

4.7.6.2 Unavoidable Adverse Impacts

Indirect visual impacts to recreationists, and other users including Native Americans, will occur for the life of mine and until the area has been successfully reclaimed. Access to mining areas for hunting or sightseeing will continue to be restricted as long as the mines are operational. Use of mined lands for other purposes such as wildlife habitat and recreation (hiking, gathering forest products) would be precluded until after final reclamation.

4.7.6.3 Short-Term Use/Long-Term Productivity

Impacts to the productivity of disturbed lands to provide recreational opportunities have been occurring since 1979 and will continue for the life of mine, projected to be around eight years. Foreseeable developments could extend impacts for several more years. However, the long-term productivity of disturbed areas could be returned with successful reclamation. Reclaimed areas at both the Zortman and Landusky mines could, in the future, be used for wildlife habitat and for recreational use including hunting and hiking, although there would be some long-term reduction in the quality of the recreational environment due to residual visual impacts. Reclaimed land in Goslin Flats could most likely be used for livestock grazing, which is the current land use.

4.7.6.4 Irreversible or Irretrievable Resource Commitments

Mining activity at the Zortman and Landusky mines has caused an irretrievable change in the scenery of the area. Mine pits, waste rock dumps/repositories, heap leach pads, roads, limestone quarries, and other facilities will permanently change the topography in those disturbed areas. Visual scars caused by the pit highwalls will not be corrected by reclamation, and those facilities that will be graded and revegetated will still look like unnatural landforms and will be noticeable as a human modified landscape. For some recreationists, and for other users of the area including Native Americans using the surrounding peaks for vision quest sites, that will cause a permanent reduction in the quality of the environment. Revegetation of the reclaimed areas should reduce the impacts to acceptable levels for most users, but the area would not be returned to its original, pre-mining condition.

4.7.7 Impacts from Alternative 5

Under Alternative 5, the heap leach facility would be located in upper Alder Gulch. This would place all of the major new facilities at the Zortman mine in the Alder Gulch drainage. Siting the facilities in these locations would have no direct impact on developed recreation. New facilities would have an additive visual impact to those already existing at the mine. Short-term impacts, caused primarily from indirect visual impacts and access restrictions, would continue to be significant in the local area. After reclamation, long-term impacts should be reduced to non-significant levels.

With this alternative there would be no major land disturbance in Goslin Flats. The land application area in Goslin Flats would be used, but this would not create any significant long-term impacts. The overland conveyor system would not be necessary, eliminating impacts caused by the visual disturbance and access considerations associated with the conveyor. Noise impacts from the facilities in Goslin Flats would also be eliminated. During reclamation, an increased amount of clay liner material would have to be transported to mine facilities through the Town of Zortman, causing an increase in the traffic impacts to residents of Zortman.

Impacts to recreation and land use at the Landusky mine would generally be as described for Alternative 4. Any improvement in reclamation success due to agency mitigated reclamation measures would increase the potential of future land use objectives being met.

4.7.7.1 Cumulative Impacts

Reasonably foreseeable actions are similar to those described in alternative 4, except that the ore reserves in Pony Gulch would not be developed since there would be no heap leach pad in Goslin Flats nor a conveyor system to transport ore. Impacts from past, present and future actions would generally be as described in Alternative 4. This includes significant short-term impacts in the local area as a result of visual impacts and access restrictions. In alternative 5 there would be an increase in disturbance to land in Alder Gulch which would be noticeable to recreationists hiking the higher peaks surrounding the mine. The Goslin Flats area would not be developed, which would eliminate impacts to sightseers along the roads leading into the Town of Zortman and to the Camp Creek campground that would be caused by the proposed heap leach and related facilities in Goslin Flats.

4.7.7.2 Unavoidable Adverse Impacts

Unavoidable impacts would be as described for Alternative 4. Those include indirect impacts caused by visual disturbance to the landscape which affects recreationists and other users of the area, including Native Americans, that expect to view undisturbed mountain scenery and whose enjoyment of their activities are reduced by the impacts to the scenic quality of the disturbed areas.

4.7.7.3 Short-Term Use/Long-Term Productivity

Once reclamation is complete, disturbed lands could return to productive use, including wildlife habitat and dispersed recreation activities.

4.7.7.4 Irreversible or Irretrievable Resource Commitments

Irretrievable commitment of resources are generally the same as described for Alternative 4.

4.7.8 Impacts from Alternative 6

This alternative is the same as Alternative 4 except that the waste rock repository would be relocated from the proposed Carter Gulch site down to the Ruby Flats, northeast of the Goslin Flats heap leach pad. Impacts would be as described in Alternative 4, except for those associated with the waste rock repository. The siting of the waste rock repository in the Ruby Flats location would result in no direct impacts to developed recreation facilities. There would be an increase in the visibility of the facility compared to the Carter Gulch location, which would cause a corresponding increase in indirect impacts to the quality of the recreation environment. Noise generated from the Goslin Flats and Ruby Flats facilities would increase, causing indirect impacts to users of the Camp Creek Campground and to dispersed recreation use areas in the surrounding lands.

Locating the waste rock facility on the Ruby Flats would increase the amount of land taken out of livestock production (approximately 200 acres), and would require the use of privately owned land other than that presently controlled by ZMI. Approximately 134 acres of land currently owned by the Square Butte Grazing Association would be affected by the waste rock repository. Industrial use of the area would require additional lands to be rezoned from agriculture to industrial use. With successful reclamation those lands could return to livestock use.

4.7.8.1 Cumulative Impacts

Reasonable foreseeable developments would be the same as alternative 4. Cumulative impacts, based on the past, present and future developments would generally be the same as Alternative 4, except for an increase in the magnitude and intensity of visual impacts in the Goslin Flats area, which would, under this alternative, would contain both the Goslin Flats heap leach pad and the Ruby Flats waste rock repository.

4.7.8.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as in Alternative 4, except that with the relocation of the Carter Gulch waste rock repository to Ruby Flats, visual impacts would be reduced in the Alder Gulch drainage and increased in the Goslin Flats/Ruby Flats area.

4.7.8.3 Short-Term Use/Long-Term Productivity

Short-term uses and long-term productivity would generally be as described in Alternative 4.

4.7.8.4 Irreversible or Irretrievable Resource Commitments

Irretrievable resource commitments would be as described in Alternative 4. The location of some of the irretrievable changes in topography and corresponding loss in the natural scenic condition of the landscape would be transferred from upper Alder Gulch to the Ruby Flats, where it would be noticeable to more people, as the Ruby Flats area is visible to recreationists and other people traveling to the Town of Zortman and to the Camp Creek campground.

4.7.9 Impacts From Alternative 7

Most plans and facility designs under Alternative 7 are similar to Alternative 4, and impacts to recreation and land use would generally be the same as those described in Alternative 4, section 4.7.6. The major modification would be at the Zortman Mine where the waste rock repository would be constructed on top of existing facilities at the mine, instead of in Carter Gulch. Reclamation covers would also be modified to enhance reclamation success.

As in Alternative 4, there would be no direct impacts to recreation facilities. Indirect impacts to recreationists caused by visual impacts of the proposed Carter Gulch waste rock repository would be eliminated. Constructing the new waste rock repository on already disturbed land would not cause additional indirect visual impacts over those that currently exist. Other impacts to recreation and land use that would be caused by the Goslin Flats heap leach pad, conveyor system, limestone quarry development, access roads, and other ancillary facilities would remain the same as described for Alternative 4.

4.7.9.1 Cumulative Impacts

Foreseeable mine activities at both the Zortman and Landusky mines would be the same as described under Alternative 4, section 4.7.6.1. Potential impacts to recreation and land use would also be the same.

4.7.9.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would generally be the same as in Alternative 4 (section 4.7.6.2), except for the waste rock repository which will be relocated from Carter Gulch to the existing disturbance around and in the mine pit. This relocation of the waste rock repository would avoid indirect visual impacts to recreationists caused by facility development in Carter Gulch.

4.7.9.3 Short Term Use/Long Term Productivity

The relationship between short-term use and the long-term productivity of the land to provide recreational opportunities and productive land uses would be the same as described in Alternative 4, section 4.7.6.3.

4.7.9.4 Irreversible or Irretrievable Resource Commitments

Irreversible and irretrievable resource commitments would be as described for Alternative 4, section 4.7.6.4, except that the irreversible change to the landform in Carter Gulch caused by the waste rock repository would not occur.

4.8 VISUAL RESOURCES

4.8.1 Methodology

The assessment of visual impacts was based upon impact significance criteria and methodology developed in the BLM's visual contrast rating system. The degree to which project facilities would impact the scenic qualities of the landscape depends on the amount of visible contrast created by project facilities in relation to the existing landscape character. The amount of contrast between project facilities and the existing landscape features is defined by an analysis of each of the basic visual elements present in the landscape (line, form, color, and texture).

Two key issues were addressed in determining the level of visual contrast. These include the type and extent of actual physical contrast brought about by the project, and the visibility of the proposed project facilities to sensitive viewpoints within the study area. The type of physical contrast is determined by evaluating the following criteria: scale differential, spatial dominance, landforms, soil color, landscape diversity, structural compatibility, and vegetation patterns. Scale differential refers to the proportionate size of project components relative to the surroundings in which they are placed. Spatial dominance is related to scale and refers to the prominence of project components within the landscape. Variables considered in evaluating visibility of facilities included viewer orientation, view distance, duration of view, lighting conditions, topographic and/or vegetation screening, and viewer sensitivity.

The significance of impacts are evaluated by examining the visual contrasts brought about by project facilities, and how those contrasts affect the following: the quality of any scenic resource; scenic resources of rare or unique value; views from (or the visual setting of) parks, wilderness areas, natural areas or other sensitive land use; views from (or the visual setting of) travel routes, including roads and trails; and views from (or the visual setting of) established or planned recreational, educational, scientific or preservational facility or use area. Short-term impacts are defined as those lasting less than five years; long-term impacts are those lasting five years or more (USDOI 1986b).

Sensitive viewpoints within the study area, termed Key Observation Points (KOPs), were selected as representative views from travel routes, recreational areas, residential areas, and views from several sites of significance to Native Americans. A total of 21 KOPs were mapped within the study area, as shown in Figure 4.8-1. Table 4.8-1 describes significant visibility characteristics of the KOPs and results of the visibility analysis from each KOP. Visibility of the proposed facilities from the KOPs were analyzed through the examination of aerial photographs, 7.5 min. topographic maps, site visits, photographs taken from the KOPs, and computer visibility models.

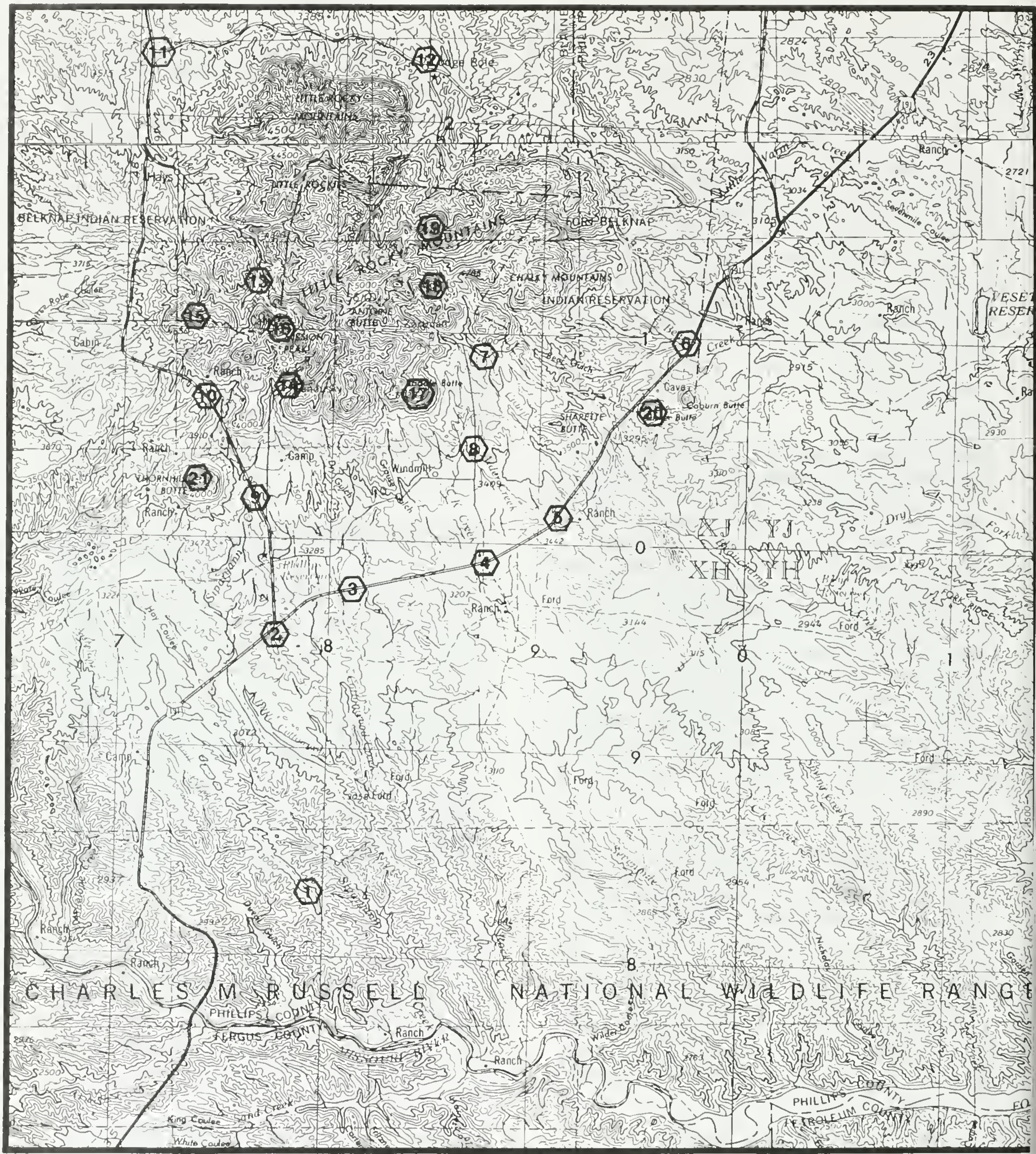
In addition to the visibility analysis, photographic simulations of the proposed action and alternative facilities were prepared from selected viewpoints. Simulations are from viewpoints with representative views from recreation areas, travel routes and areas traditionally used by Native Americans, and display the existing view and views with the proposed and/or alternative project facilities. Simulations are found in Appendix D.

4.8.2 Impacts from Mining, 1979 to Present

Modern mining began at the Zortman and Landusky mines in 1979. At that time, surface disturbance associated with historic mining activity was visible in Alder and Ruby Gulches near Zortman, and in the area surrounding Gold Bug Butte near Landusky. Visual contrasts were evident in the landscape, caused by road building, surface mining, adits, waste rock and tailing. However, these disturbances were on a relatively small scale and the area could still be characterized as being generally natural appearing, except in a few localized areas. Historic mining had disturbed approximately 37 acres in the vicinity of the Zortman mine and approximately 19 acres in areas surrounding the Landusky mine. Views of the disturbed areas were generally confined to a small local viewshed, and were not noticeable from the main roads surrounding the Little Rocky Mountains.

In 1979 the visual resources of the Little Rocky Mountains were evaluated by the BLM using the Visual Resource Management (VRM) methodology. The scenic quality of the area was classified as A scenery (the highest rating), and was given a VRM Class II rating. Objectives for Class II landscapes call for the retention of the existing character of the land. Changes in the landscape should be low and not attract attention.

Currently, 401 acres at the Zortman mine and 814 acres at the Landusky mine have been disturbed. This includes disturbance from open mine pits, heap leach pads, waste rock storage, roads, topsoil stockpiles, processing areas and other ancillary facilities/ disturbance areas. Impacts to the scenic quality of the



KEY OBSERVATION POINTS

FIG. 4.8-1

TABLE 4.8-1

KEY OBSERVATION POINTS

KOP No.[1]	Viewpoint	Jurisdiction[2]	Elevation (Feet)	View Distance (Miles)		Major Proposed and Alternative Project Facilities Seen[3]									
						Zortman							Landusky		
				Zortman Mine	Landusky Mine	Mine Pit Expansion	Carter Gulch Waste Rock Repository	Overland Conveyor	Goslin Flats Heap Leach	Limestone Quarry	Ruby Terrace Waste Rock Repository	Alder Gulch Heap Leach	Mine Pit Expansion	Heap Leach Pad Extension	Limestone Quarry King Creek
1	CMR-Auto Tour Route	USFW	2,953	17.6	16.3	N	N	N	N	N	N	N	Y	Y	N
2	DY Junction	BLM	3,220	10	8.4	N	N	N	N	N	N	N	Y	Y	N
3	U.S. Hwy. 191 ~3 mi. N of DY Junction	Private	3,120	8.4	7.4	N	N	N	N	N	N	N	Y	Y	N
4	U.S. Hwy. 191-Junction with Dry Fork Rd.	Private	3,220	8.1	8.3	N	N	N	Y	N	Y	N	N	N	N
5	U.S. Hwy. 191 ~3 mi. N of Dry Fork Rd.	State	3,380	8	8.9	Y	Y	N	Y	N	Y	N	N	N	N
6	Bear Gulch Road Junction w/U.S. Hwy. 191	FBIR	3,040	9.3	11.6	Y	N	N	N	N	N	N	N	N	N
7	Bear Gulch Road Landing Strip	Private	3,960	3	3.9	Y	N	Y	Y	N	Y	Y	N	N	N
8	7-Mile Road ~4 mi. N of U.S. Hwy. 191	Private	3,530	5.9	6.4	N	N	Y	Y	N	Y	N	N	N	N
9	State Hwy. 66-Junction w/Landusky Rd.	Private	3,500	6.7	4.5	N	N	N	N	N	N	N	Y	Y	N
10	State Hwy. 66 ~3.5 mi. N of Landusky Rd.	Private	3,880	5.9	3.2	N	N	N	N	N	N	N	Y	N	N
11	State Hwy. 66-Junction w/Lodge Pole Rd.	FBIR	3,280	10	9.5	N	N	N	N	N	N	N	Y	Y	N
12	Lodge Pole	FBIR	3,460	6.8	8.7	Y	N	N	N	N	N	N	N	N	N
13	Pow Wow Grounds-Mission Canyon	FBIR	4,040	3.5	2.1	N	N	N	N	N	N	N	N	Y	N
14	Landusky townsite	Private	4,000	3.6	1.1	N	N	N	N	N	N	N	Y	N	N

TABLE 4.8-1
(Concluded)

KOP No.[1]	Viewpoint	Jurisdiction[2]	Elevation (Feet)	View Distance (Miles)		Major Proposed and Alternative Project Facilities Seen[3]									
						Zortman							Landusky		
				Zortman Mine	Landusky Mine	Mine Pit Expansion	Carter Gulch Waste Rock Repository	Overland Conveyor	Goslin Flats Heap Leach	Limestone Quarry	Ruby Terrace Waste Rock Repository	Alder Gulch Heap Leach	Mine Pit Expansion	Heap Leach Pad Extension	Limestone Quarry King Creek
15	Eagle Child Mountain	FBIR	5,243	5.7	3.5	N	N	N	N	N	N	N	Y	N	N
16	Mission Peak	FBIR/BLM	5,480	3	3	N	N	N	N	N	N	N	Y	Y	Y
17	Saddle Butte	BLM	5,192	2.9	3.7	Y	Y	Y	Y	N	Y	N	N	N	N
18	Old Scraggy Peak	BLM	5,708	1.6	4.6	Y	Y	N	Y	Y	N	Y	N	N	N
19	Beaver Mountain	BLM	5,542	2.4	5	Y	N	N	N	Y	Y	N	N	N	N
20	Ricker Butte	FBIR/ Private	3,977	8.6	10.5	Y	Y	Y	Y	N	Y	Y	N	N	N
21	Thornhill Butte	BLM	4,636	7.6	5.1	N	N	N	N	N	N	N	Y	Y	N

[1] KOP number corresponds to numbers shown on Figure 4-8.

[2] USFW = United States Fish and Wildlife Service
BLM = Bureau of Land Management
FBIR = Fort Belknap Indian Reservation

[3] Y = seen; N = not seen; - = no data

area have been significant.

Open pit mining has caused major changes in landforms, creating sharp contrasts in the line, form, color and textures visible in the landscape. Areas where rock and soil have been exposed contrast with color and texture of the surrounding natural vegetation. Unnatural looking landforms have been created by the excavation of the mine pits, and by the large heap leach pads and waste rock stockpiles. Roads, especially the downhill sidecast along the roads, create color and line contrasts visible for miles from the mine sites. Benches along the highwall create strong geometric lines and forms that contrast with the characteristic lines and shapes naturally occurring mountain landscapes. The scale of the disturbance dominates the viewers attention.

At the Zortman mine these visual contrasts are visible to many of the surrounding peaks and buttes, including Old Scraggy Peak and Saddle Butte, both of which are used by recreationists for hiking, picnicking and wildlife viewing, and by Native Americans for cultural purposes. Although portions of the disturbed areas at the Zortman mine can be seen from several high viewpoints surrounding the mine, much of the disturbance is topographically enclosed and not visible from lower vantage points. The Landusky mine has twice the amount of disturbed acres as the Zortman Mine, and is visible not only to high points surrounding the mine, but to viewpoints as far away as the Missouri Breaks Backcountry Byway, located over 20 miles south of the mine. Closer to the mine, mine facilities can be seen by travellers along U.S. Highway 191 and State Highway 66. The current disturbance at both the Zortman and Landusky mines is not compatible with the scenery management objectives of VRM Class II landscapes.

4.8.3 Impacts from Alternative 1

Under Alternative 1, permitted activities would continue, but mine extension plans would not be approved. Previously permitted activities at the Zortman mine include continued leaching at the 89 pad and reclamation and closure activities. There is approximately one year of leaching capacity at the 89 pad, final reclamation should be completed by 1997. At the Landusky mine, ore is still being removed at the Gold Bug pit and leaching operations are active at the 87/91 and 91 heap leach pads. Ore removal will likely continue through 1995. Heap leaching will continue for several years after the last of the ore has been mined - final reclamation would take 2-3 years after active leaching is complete. Permitted operational activities would have no appreciable effect on the existing visual quality at the mines. Existing disturbance has already caused significant long-term impacts to the scenic quality of the mined areas.

After successful reclamation, visual contrasts would be reduced. Revegetation of reclaimed facilities would mitigate much of the color contrasts caused by the exposed rock and soil. However, reclamation specialists predict that the reclamation measures outlined for Alternative 1 would fail in many areas - the result of steep slopes on reclaimed facilities and the possible failure of the reclamation covers to prevent water quality problems and acidification of soil. In areas where revegetation was not successful, bare soil would be exposed and would continue the visual contrasts that currently exist. The alteration of topography caused by mine pits and the large man-made landforms caused by the heap leach and waste rock facilities would continue to be apparent, even after reclamation. Visual contrasts resulting from the failure of reclamation to establish ground cover in some areas, the contrasts in landforms, and the visual scar left by the pit highwalls would attract attention from several sensitive viewpoints, causing long-term significant impacts to the visual resources of the southern Little Rocky Mountains. These impacts would be especially evident at the Landusky mine, which is visible to a greater number of observers than the Zortman mine, including travellers along the two major highways in the area, U.S. 191 and State Highway 66.

4.8.3.1 Cumulative Impacts

Foreseeable future mine development or exploration activities in the Little Rocky Mountains are very limited under Alternative 1 since mining for already delineated ore reserves would not be approved. Any road building associated with exploration activities would cause additional color and line contrasts.

In summary, mining activity from 1979 to present has caused significant long-term impacts to the visual resource. Alternative 1 would not allow further ground disturbance which would stop additional, additive impacts from occurring, but has a reclamation plan which may not be successful. Long-term impacts would remain after implementation of the reclamation plan.

4.8.3.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts include contrasts created by the exposed rock of the mine pit highwalls, contrasts caused by large man-made landforms (heap leach pads and waste rock stockpiles), and possible color contrasts created by the failure of reclamation to establish vegetative cover in some areas.

4.8.3.3 Short-Term Use/Long-Term Productivity

Scenic resources of the area have been degraded in order for mine development to occur. The long-term productivity of the visual resource will return to some degree with reclamation, but not return to its original condition or quality.

4.8.3.4 Irreversible or Irretrievable Resource Commitments

Alteration of the topography has caused an irretrievable loss of the high scenic quality of the original landscape. Reclamation measures in this alternative may not correct or reduce many of the visual contrasts present in the landscape.

4.8.4 Impacts from Alternative 2

Under Alternative 2, already permitted activities would continue, but plans for mine extension would not be approved. Company-proposed corrective measures would be implemented. These corrective measures are primarily intended to effect source control and treatment of acid rock drainage.

Impacts would generally be as described for Alternative 1, with the exception that the possibility for successful reclamation is increased. With more areas successfully revegetated, color contrasts created by the exposure of bare soil would be reduced. The Seaford Clay pit, located approximately 7 miles south of Zortman, and the Williams Clay pit, located approximately 7 west of Landusky, would be used for clay liner material. Disturbance at these sites would not be a significant visual impact to identified sensitive viewpoints, although would be visible from nearby roadways.

Long-term impacts from both the Landusky and Zortman mines, caused primarily from the altered topography and vegetation patterns, would remain significant to close in viewpoints after mine closure and reclamation. Even though reclamation would reduce many of the existing visual contrasts, some contrasts would remain and be noticeable from several sensitive viewpoints, especially from many of the surrounding peaks. Post-reclamation contrasts include form, line, color, and texture contrasts of the pit highwalls and landform contrasts caused by heap leach pads and waste rock stockpiles. Objectives for VRM Class II landscapes are for landscape modifications not to be noticeable to the casual observer, and to retain the character of the landscape. These objectives may be met from the more long distance viewpoints but most likely would not be met from close in viewpoints such as Mission Peak and Old Scraggy.

4.8.4.1 Cumulative Impacts

Reasonably foreseeable mine development and exploration activities are as described for Alternative 1. Little additional visual impacts are expected. Past and present impacts to the scenic quality of the affected lands are significant. Post-reclamation impacts remain significant for sensitive viewpoints within close proximity to the mines, mostly from the surrounding peaks. Impacts to sensitive viewpoints located in the background distance zone (> 3-5 miles from the mines) would be reduced to non-significant levels.

4.8.4.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts include contrasts created by the exposed rock of the mine pit highwalls, contrasts caused by large man-made landforms (heap leach pads and waste rock stockpiles), and differences in the vegetative patterns and textures of the reclaimed surfaces compared to those occurring naturally in the surrounding lands.

4.8.4.3 Short-Term Use/Long-Term Productivity

Scenic resources of the area have been degraded in order for mine development to occur. The long-term productivity of the visual resource will return to some degree with reclamation, but not return to its original condition or quality.

4.8.4.4 Irreversible or Irretrievable Resource Commitments

Alteration of the topography has caused an irretrievable loss of the original scenery found in the area. This includes the large depressions in the ground surface caused by the mine pits and the large man-made landforms created by the heap leach pads and the waste rock stockpiles.

4.8.5 Impacts from Alternative 3

Alternative 3 would continue already permitted activities but would not approve plans for mine extension.

Agency-modified corrective actions would be implemented to effect source control and treatment of acid rock drainage. Part of those corrective actions include using limestone as capillary break material in the reclamation covers. This requires the mining of limestone at the LS-1 quarry, located about halfway between Shell Butte and Green Mountain (Zortman mine), and at the Kings Creek quarry for the Landusky Mine. The LS-1 quarry is currently located on mostly undisturbed, tree covered land and would be seen from Beaver Mountain and Old Scraggy. The King Creek quarry, located northwest of the Queen Rose Pit at the Landusky Mine, could be mined for approximately 50,000 tons of limestone. The quarry site is located on high ground with a generally northwest aspect, and would be visible from Mission Peak and other high mountain peaks in the vicinity of the Landusky Mine. Impacts from limestone mining would include line, form color and texture contrasts created by the exposed soil and rock, and clearing of vegetation.

Alternative 3 also calls for the Alder Gulch and OK waste rock dumps, the 85/86 leach pad and dike, and the tailing in Ruby Gulch above the town of Zortman to be moved from their present location and used as backfill in the mine pits. This would reduce existing landform contrasts caused by those facilities and would lessen the visual impact of the pits, as the surface depression caused by the pit would be partially filled in.

The reclamation measures used in Alternative 3 should give the best possibility of successful reclamation and revegetation, thereby reducing the color contrasts caused by exposed soil. Pit highwalls, landform contrasts, and contrasts in vegetation pattern and textures will still be evident in the landscape after reclamation, and would cause significant long-term impacts to close in viewpoints, especially at the Landusky mine. VRM Class II objectives would most likely be met from the more long distant viewpoints, but would not be met from close in viewpoints, mostly the result of the color and form contrasts of pit highwalls.

4.8.5.1 Cumulative Impacts

Reasonably foreseeable mine development and exploration activities are as described for Alternative 1. Little additional visual impacts are expected. Past and present impacts to the scenic quality of the affected lands are significant. Post-reclamation impacts remain significant for sensitive viewpoints within close proximity to the mines, mostly from the surrounding peaks. Impacts to sensitive viewpoints located in the background distance zone (> 3-5 miles from the mines) would be reduced to non-significant levels. Reclamation measures used in Alternative 3 would reduce the impacts at the Zortman mine compared to alternative 1 and 2.

4.8.5.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts include contrasts created by the exposed rock of the mine pit highwalls (including limestone quarries), contrasts caused by large man-made landforms (heap leach pads and waste rock stockpiles), and differences in the vegetative patterns and textures of the reclaimed surfaces compared to those occurring naturally in the surrounding lands.

4.8.5.3 Short-Term Use/Long-Term Productivity

Scenic resources of the area have been degraded in order for mine development to occur. The long-term productivity of the visual resource will return to some degree with reclamation, but not return to its original condition or quality.

4.8.5.4 Irreversible or Irretrievable Resource Commitments

Alteration of the topography has caused an irretrievable loss of the original scenery found in the area. This includes the large depressions in the ground surface caused by the mine pits and the large man-made landforms created by the heap leach pads and the waste rock stockpiles.

4.8.6 Impacts from Alternative 4

Alternative 4 involves company-proposed actions. Activities at the Zortman Mine would include expansion of existing pits; a waste rock repository in Carter Gulch; removal of the existing Alder Gulch waste rock dump and Ruby Gulch sulfide stockpile for processing at the Goslin Flats heap leach pad; an overland conveyor for ore transport from the mine area to Goslin Flats; a heap leach pad and processing facilities in Goslin Flats; rerouting of the Zortman-to-Landusky access road, power line and pipeline; upgrading of haul roads; and development of a limestone quarry south of Green Mountain (LS-1 quarry). Visibility of the major proposed and alternative facilities is given in Table 4.8-1. Impacts to visual resources would be significant during construction, operations, and from some vantage points, after reclamation.

The vertical and lateral extension of the mine pit would bring the total pit disturbance to about 200 acres. Visual impacts of the pit expansion would include an increase in the alteration of existing topography, and exposure of soil and rock from the newly disturbed area, which would create color, form and texture contrasts. The impacts caused by pit extension would be incremental to existing disturbance, and would not significantly change the magnitude of existing contrasts or draw additional visual attention to the site. The increased size of the disturbance would be most noticeable from viewpoints north of the Zortman Mine, including Beaver Mountain and the town of Lodge Pole.

The waste rock repository in Carter Gulch would cover an additional 149 acres. This area is currently mostly covered in conifers, and has a dark green color and a generally natural appearance, although there are a few exploration/access roads in this area. Visual impacts would include color, form and texture contrasts created by the alteration of the natural drainage pattern, and the light color of exposed soil and waste rock, which contrasts with the color and texture of the surrounding conifers. Although additional visual impacts would occur from the waste rock repository in Carter Gulch, such impacts would be in an area adjacent to existing disturbance, thereby causing a incremental increase in visual effects.

The overland conveyor for hauling ore from the mine area to the heap leach facility in Goslin Flats would be approximately 5.5 feet high, 4.5 feet wide, and 12,000 feet long. The conveyor corridor would be fenced for most of its length to limit public access; however, it would be engineered to maintain public access to Pony Gulch. A roadway, constructed along the conveyor route, would add additional disturbance, bringing the total width of visible ground disturbance to approximately 50 feet. The conveyor would pass through land which is generally undisturbed, mixed-forest/shrub land in the mountain section, and grassy pasture land in the Goslin Flats area. Construction of the conveyor would introduce a linear feature in the landscape, creating a line and color contrast noticeable from several roads the area (7-mile road and the Bear Gulch road), and from Saddle Butte and Old Scraggy Peak. Appendix D contains an artist's conception of the Goslin Flats heap leach pad and the conveyor system.

The heap leach pad and ancillary facilities in Goslin Flats would be located in what is now pasture land. Approximately 5,200 feet long by 1,800 feet wide, the facility would stack ore in 25-foot lifts up to a maximum depth of 200 feet. Other facilities include a topsoil stockpile on the east side of the leach pad, ore stockpiles and a building which would contain secondary and tertiary crushers, and solution ponds and a processing plant located on the south end of the facility. Construction of the leach pad and facilities would create a major new disturbance in the landscape, affecting approximately 250 acres of land. Visual impacts from the facilities would include strong form and color contrasts created by the introduction of a large geometric shape which would be incongruous with any natural features found in the surrounding landscape. Structures associated with the plant would also introduce line and form contrasts. Night lighting would be required at the mine pits, crusher facilities and at the new facilities in Goslin Flats, creating a visible light source for miles around.

The character of the land would be changed from agricultural to industrial. The leach pad and facilities would be most noticeable from the roads leading into the town of Zortman, and from several high peaks in the area including Saddle and Ricker buttes. Travellers along U.S. Highway 191 would be able to see the leach pad from the section of highway near the junction with 7-mile Road. Users on 7-mile Road would have the longest duration of view of the leach pad, as the facility would be visible along the entire section of road from the junction with U.S. 191 to the junction with Bear Gulch road. Color contrasts would be the most evident in morning light, when sun illumination would brighten the facilities.

Rerouting of the Zortman-to-Landusky access road, transmission line and pipeline (the pipeline and transmission line are to be buried), and building new or upgrading existing access/haul roads, would have an additive effect on the overall amount of disturbance visible from viewpoints within the study area. Strong color and line contrasts are created by linear features like roads and cleared right-of-ways, and these contrasts can be visible from very long distances.

A limestone quarry is planned for an area south of Green Mountain in the upper reaches of Lodge Pole Creek. Approximately 13 acres would be disturbed by the quarry, creating color and texture contrasts with the surrounding landscape features. The quarry would be visible from Beaver Mountain and Old Scraggy Peak. An additional 4.2 acres of disturbance would occur at the Seaford clay pit - visual contrasts from that disturbance would be seen from U.S. Highway 191. Duration of view would be short and contrasts would not attract attention.

The photographic simulations, located in Appendix D, show examples of existing and future landscape conditions that would occur with implementation of the various alternatives. The following figures show facilities associated with alternative 4 at the Zortman Mine. Figure D-2 shows the reclaimed Goslin Flats heap leach pad, as viewed from the junction of Highway 191 and Dry Fork Rd. Most color and texture contrasts have been reduced, however the shear size and scale of the landform and the geometric shape, still present a noticeable visual contrast. Figure D-5 shows the reclaimed Zortman facilities as viewed from Ricker Butte. Significant color contrasts are noticeable at the mine pit and surrounding area. Visual contrasts created by the reclaimed Goslin Flats heap leach have been reduced, however the straight edge of the top of the facility creates a unnatural looking line in the landscape. Figure D-13 shows the reclaimed Goslin Flats heap leach as viewed from Old Scraggy Peak. With successful revegetation, the color and texture contrasts are reduced, however the large geometric shape of the landform still presents noticeable line and form contrasts. Figure D-16 shows the mine pit area as viewed from Old Scraggy Peak. The pit highwalls retain significant visual contrasts, particularly the color contrast between the exposed rock of the highwall and the surrounding darker colored vegetation. Figure D-21 shows the reclaimed Zortman mine area as viewed from Saddle Butte. The mine pit highwalls display noticeable color, line, form and texture contrasts. Other reclaimed facilities, including the Carter Gulch waste rock repository, are less noticeable due to the revegetation, grading and scattered planting of trees. Figure D-26 shows the Goslin Flats heap leach pad at full buildout as viewed from Saddle Butte. The leach pad is a major change in the landscape. It's massive size and relative scale, the strong form and color contrasts, and close proximity to the viewpoint draws strong visual attention. Figure D-27 shows the same view after reclamation. Color and texture contrasts have been significantly reduced, however the strong form and line contrasts persist. Figure D-33 shows the view of the reclaimed Goslin Flats heap leach pad as viewed from Bear Gulch Road. Strong line and form contrasts remain, however revegetation has helped the color and texture of the leach pad blend in more with the surrounding landscape.

Activities at the Landusky Mine include extension of existing mine pits and leach pads, and development of a limestone quarry at King Creek. Mining at the Queen Rose and August pits (see Figure 2-7) would not involve new disturbances. Extension of the Gold Bug Pit (called the South Gold Bug Pit on Figure 2-7) would disturb approximately 20 acres of previously undisturbed ground. The area of the proposed extension is in a highly visible location on the south face of Gold Bug Peak. This area can be seen by travellers on U.S. Highway 191 and Montana Highway 66. Disturbance from the Landusky Mine, particularly the heap leach pads, is visible for long distances (30 to 40 highway miles) to the south of the Little Rocky Mountains, including U.S. Highway 191 and areas within the Charles M. Russell National Wildlife Refuge. The south side of Gold Bug Butte is visible from many locations, and existing exploration roads coming out of the Gold Bug Pit and running across portions of the south face of Gold Bug Peak can be seen. Extension of the pit onto the south face would create more visible disturbance from southerly viewpoints. Impacts would include line, form and color contrasts. The topographic changes in Gold Bug Peak would be silhouetted from some viewpoints, drawing visual attention. From viewpoints north of Gold Bug Peak, the extension of the Gold Bug Pit would not be as noticeable, as the new disturbance would blend in with the existing pit disturbance.

Additions to the existing 1987 and 1991 heap leach pads would create additional surface area of visible disturbance noticeable from several key viewpoints, including points along U.S. Highway 191, Montana Highway 66, the pow wow grounds in Mission Canyon, and several high points in the surrounding area, such as Mission Peak and Thornhill Butte.

Development of a limestone quarry at the King Creek location would disturb approximately 10 acres (includes disturbance from pit, storage and haul roads) and produce approximately 50,000 tons of limestone. Located on high ground northwest of the existing Queen Rose Pit, a new quarry at the King Creek site would create visual impacts, including color, form and texture contrasts, noticeable from Mission Peak and other dispersed areas in the surrounding landscape. Approximately 7 acres of disturbance would occur at the Williams Clay pit - visual contrasts from that disturbance would be seen from Highway 66 and would attract the viewers attention.

The following figures (found in Appendix D) display Alternative 4 at the Landusky Mine. Figure D-36 shows a view of the Landusky Mine from Thornhill Butte. The mine pit highwalls retain noticeable color and texture contrasts. Other reclaimed facilities have been regraded and revegetated to blend in the surrounding landscape and do not draw visual attention. Figure D-38 shows the view of the Landusky Mine as viewed from the PowWow grounds in Mission Canyon. The top of the 1987/1991 leach pad is visible and draws visual attention due to form and texture contrasts. During the summer when the grass on the reclaimed facility is a green color the contrasts would be reduced. Figure D-40 shows the Landusky Mine as viewed from Highway 66 at the

Landusky turnoff. Reclamation has reduced the visual impacts of most of the facilities to a point where they are not readily noticeable, except for the pit highwalls which retain strong line contrasts. Figure D-43 shows the Landusky Mine at full buildout as viewed from Mission Peak. This viewpoint looks directly down into the mine at very close range (~.3 mile). From this vantage point the mine presents very strong line, form, color and texture contrasts. Figure D-43 shows the reclaimed mine from the same viewpoint. Backfilling of the pit and revegetation on some of the facilities has reduced the contrasts, however the mined area, especially the pit highwalls, still presents a very strong visual contrast to viewers on Mission Peak.

4.8.6.1 Cumulative Impacts

Foreseeable developments at the Zortman Mine include mining activity in the Pony Gulch area south of the existing mine, extension of the Goslin Flats heap leach pad, additional limestone quarry development and continued exploration activities. At the Landusky mine foreseeable future actions include continued mining of ore and waste rock at existing pits, additional heap leach capacity, and additional limestone quarry operations at the King Creek quarry and a quarry in Montana Gulch.

Exploration activities could occur over a ten year period and disturb an additional 128 acres throughout that portion of the Little Rocky Mountains outside of the Fort Belknap Indian Reservation. This additional disturbance would be from road and trench construction and drill sites. Road construction creates strong line and color contrasts that can be seen for miles from the disturbance.

Mine development in the Pony Gulch area would disturb approximately 14 acres of land. This site is not in a prominent location, but can be seen from Old Scraggy Peak and would be seen by recreationists using the area for dispersed recreation. Disturbance from additional ore and waste rock mining and exploration activities would increase the amount of industrial activity occurring in the area and decrease the amount of land in the Little Rocky Mountains that provide undisturbed, intact landscapes and environments. Future mine development would prolong the use of facilities in Goslin Flats, increasing the duration of visual impacts in that area. These activities would add to the overall amount of visual contrasts present in the Little Rocky Mountains and cause further degradation of the scenic qualities of the high-value mountain landscapes.

In summary, past and present mining activities, and those activities proposed under this alternative would create significant long-term impacts to the scenic resource of the area. Reclamation would reduce many of the visual contrasts existing in the landscape, and those which would be created by the proposed expansion, but the residual impacts (impacts after reclamation) from sensitive viewpoints in close proximity to the mine would still draw attention, and would not be consistent with VRM Class II objectives, which calls for change in the landscape to be low and not attract attention.

4.8.6.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts include contrasts created by the exposed rock of the mine pit highwalls (including limestone quarries), contrasts caused by large man-made landforms (heap leach pads and waste rock stockpiles), and differences in the vegetative patterns and textures of the reclaimed surfaces compared to those occurring naturally in the surrounding lands.

4.8.6.3 Short-Term Use/Long-term Productivity

Scenic resources of the area have been degraded in order for mine development to occur. The long-term productivity or quality of the visual resource will return to some degree with reclamation, but will not return to its original condition or quality. Under Alternative 4, this would include the area of current mine disturbance, and the proposed areas of new disturbance including the Carter Gulch waste rock repository, the limestone quarries at LS-1 and Montana Gulch, and the heap leach and other ancillary facilities in Goslin Flats.

4.8.6.4 Irreversible or Irretrievable Resource Commitments

Alteration of the topography has caused an irretrievable loss of the original scenery found in the area. This includes the large depressions in the ground surface caused by the mine pits and the large man-made landforms created by the heap leach pads and the waste rock stockpiles.

4.8.7 Impacts from Alternative 5

In Alternative 5, the heap leach pad would be relocated from Goslin Flats to upper Alder Gulch. With implementation of this alternative, there would be no large-scale development of mine facilities in Goslin Flats or Ruby Flats. The overland conveyor system would also not be part of this alternative mine development plan. Impacts to the visual resource would remain significant at both the Zortman and Landusky mines for the life of the mines, although these impacts would not include the Goslin Flats or Ruby Flats lands. Reclamation measures would reduce most of the visual contrasts at the Zortman mine to non-significant levels except from sensitive viewpoints immediately surrounding the mine, including Old Scraggy Peak and Saddle Butte. Visual contrasts remaining after reclamation at the Landusky mine would leave significant impacts to several sensitive viewpoints including Mission Peak, and from selected viewpoints along U.S. 191 and State Highway 66.

A heap leach in upper Alder Gulch would permanently change the topography of Alder Gulch, which would be filled in with ore. The surface of the leach pad would create substantial form and color contrasts in an area that is relatively undisturbed, except for a few access roads. The site for the leach pad is in an area that is visually contained by surrounding topography, causing visual impacts to be mostly localized to high peaks east of Alder Gulch, including Old Scraggy Peak and Ricker Butte. Portions of the upper end of Alder Gulch can also be seen from Bear Gulch Road in the vicinity of the landing strip, although the duration of view would be quite short and from Ricker Butte, approximately 7 miles east of the mine. Other impacts associated with mine development plans at both the Zortman and Landusky mines would remain generally the same as those described in Alternate 4.

The following figures (found in Appendix D) display examples of future landscape condition associated with Alternative 5. Figure D-6 shows the reclaimed Zortman Mine as viewed from Ricker Butte. Color contrasts at the mine pit are still strong and very apparent from this viewpoint - approximately 7.4 miles distant. The upper Alder Gulch heap leach pad is visible to the left of the mine pit area, but revegetation has reduced the visual contrasts and the facility does not strongly attract the viewers attention. Figure D-11 shows the Zortman Mine after reclamation. Only a portion of the mine pit is visible from this viewpoint. Pit highwalls retain very high color and line contrasts. Improvement in the appearance of other areas that had been impacted by mining and exploration roads can be noticed. Figure D-17 shows the Zortman Mine as viewed from Old Scraggy Peak. This viewpoint is in close proximity to the mine (~ 1.6 miles) and looks directly down into the mined area. Strong visual color, line and texture contrasts caused by the pit highwalls are very apparent. Other areas, including the Upper Alder gulch heap leach pad and the Carter Gulch waste rock repository have been regraded and revegetated, which will reduced the color contrast. Figure D-22 shows the reclaimed Zortman Mine as viewed from Saddle Butte. The appearance of the site is similar to Alternative 4 except that trees were not included in the revegetation plan and the Upper Alder Gulch heap leach pad is also visible at the far left of the photo. Figure D-23 shows the Zortman Mine as viewed from Bear Gulch Road. The Upper Alder Gulch waste rock repository is visible from this viewpoint, however it does not attract the attention of the casual viewer.

4.8.7.1 Cumulative Impacts

Mine development in Pony Gulch would not be a foreseeable development in Alternative 5. At the Zortman mine, enlargement of the LS-1 limestone quarry or a new limestone quarry on the ridge above Zortman is foreseeable. Foreseeable activities at the Landusky mine are as described for Alternative 4.

Exploration activities could occur over a ten year period and disturb an additional 128 acres of land in the Little Rocky Mountains, outside of the Fort Belknap Indian Reservation. This additional disturbance would be from road and trench construction and drill sites. Road construction creates strong line and color contrasts that can be seen for miles from the disturbance.

Disturbance from additional ore, limestone and waste rock mining and exploration activities would increase the amount of industrial activity occurring in the area and decrease the amount of land in the Little Rocky Mountains that provide undisturbed, intact landscapes and environments.

In summary, past and present mining activities, and those activities proposed under this alternative would create significant long-term impacts to the scenic resource of the area. Reclamation would reduce most of the visual contrasts existing in the landscape, and those which would be created by the proposed expansion, but the residual impacts (impacts after reclamation) from sensitive viewpoints in close proximity to the mine would still draw attention, and would not be consistent with VRM Class II objectives, which calls for change in the landscape to be low and not attract attention. Alternative 5 would reduce the amount of land affected by these visual impacts compared to Alternative 4 by not allowing development in the Goslin Flats or Ruby Flats area, and by not including the Pony Gulch mine as a reasonably foreseeable development.

4.8.7.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts include contrasts created by the exposed rock of the mine pit highwalls (including limestone quarries), contrasts caused by large man-made landforms (heap leach pads and waste rock stockpiles), and differences in the vegetative patterns and textures of the reclaimed surfaces compared to those occurring naturally in the surrounding lands.

4.8.7.3 Short-Term Use/Long-Term Productivity

Scenic resources of the area have been degraded in order for mine development to occur. The long-term productivity or quality of the visual resource will return to some degree with reclamation, but will not return to its original condition or quality. Under Alternative 5, this would include the area of current mine disturbance, and the proposed areas of new disturbance including the Carter Gulch waste rock repository, the limestone quarries at LS-1 and Montana Gulch, and the heap leach and other ancillary facilities in Goslin Flats.

4.8.7.4 Irreversible or Irretrievable Resource Commitments

Alteration of the topography has caused an irretrievable loss of the original scenery found in the area. This includes the large depressions in the ground surface caused by the mine pits and the large man-made landforms created by the heap leach pads and the waste rock stockpiles.

4.8.8 Impacts from Alternative 6

Under Alternative 6, the waste rock repository for the Zortman mine would be relocated from Carter Gulch to Ruby Flats, located northeast of the proposed heap leach pad in Goslin Flats. Visual impacts from this alternative would be significant at both the Zortman and Landusky mines.

Ruby Flats is grassy, rolling pasture land, currently free from any major ground disturbance. Approximately 200 acres would be affected by the construction and operation of the waste rock repository. This disturbance would create additional visual impacts in the Goslin Flats viewshed, which is located in an area of higher visibility than the Carter Gulch site. Impacts from the waste rock repository would include strong form and color contrasts which, when combined with the proposed heap leach pad in Goslin Flats, would create a large industrial area of substantial visual impacts to travellers on 7-mile and Bear Gulch roads. Both the proposed heap leach pad and the waste rock repository are in the foreground distance zone for users of the two roads into Zortman, and even after reclamation and successful revegetation, would present large scale, unnatural looking landforms causing significant visual contrasts. Other visual impacts caused by the expansion of the Zortman and Landusky mines would be as described for Alternative 4.

The following figures (found in Appendix D) display examples of future landscape condition associated with Alternative 6. Figure D-3 shows the Goslin Flats heap leach pad and the Ruby Flats waste rock repository as viewed from the junction of Highway 191 and Dry Fork Road. The large size and relative scale of the facilities, the regular geometric shape, and homogeneous vegetation cover (grass) contrasts with the surrounding landscape and attracts the viewers attention. Figure D-7 shows the Zortman Mine as viewed from Ricker Butte. As in Alternative 4, the mine pit highwalls contrasts strongly with the surrounding darker colored vegetation. The Ruby Flats waste rock repository is visible north of the Goslin Flats heap leach pad. Figure-11 shows the Ruby Flats waste rock repository as viewed from Beaver Mountain. At this distance (~4.2 miles), and from this viewing angle, the facility does not attract the viewers attention. Figure D-14 shows the Goslin and Ruby Flats area as viewed from Old Scraggy Mountain. The heap leach pad and the waste rock repository are both highly visible and attract the viewers attention with their large size and geometric shape. Figure D-28 shows the reclaimed Goslin Flats heap leach pad and the Ruby Flats waste rock repository as viewed from Saddle Butte. View distance is approximately 1 mile. At this distance the large size and scale of the facilities, and the homogeneous surface and vegetation pattern contrasts with the surrounding landscape and is very noticeable. Figure D-31 shows the view from Bear Gulch Road and includes the toe of the slope of the Ruby Flats waste rock repository. Figure D-34 shows the waste rock repository from the same viewpoint but looking more to the southwest. The facility is directly in front of the viewpoint and completely dominates the view.

4.8.8.1 Cumulative Impacts

Reasonable foreseeable developments would be the same as Alternative 4, including the future development of the Pony Gulch ore reserves. Cumulative impacts would be as described for Alternative 4, except for the impacts caused by the waste rock repository. Locating the waste rock repository on the Ruby Flats would cause additional impacts over those that would be caused by locating the facility in Carter Gulch since visual contrasts at the Carter Gulch site would be screened from the view of many observers, where the Ruby Flats site is out in the open in a very visible location.

4.8.8.2 Unavoidable Adverse Impacts

Unavoidable impacts would generally be the same as described in Alternative 4. However, the Ruby Flats waste rock repository would cause additional unavoidable visual impacts in the Goslin Flats/Ruby Flats viewshed.

4.8.8.3 Short-Term Use/Long-Term Productivity

Short-term Use/Long-term Productivity would generally be the same as described in Alternative 4. The long-term quality of Goslin Flats/Ruby Flats landscape would be further degraded by the Ruby Flats waste rock repository.

4.8.8.4 Irreversible or Irretrievable Resource Commitments

Irreversible resource commitments would be as described in Alternative 4.

4.8.9 Impacts From Alternative 7

In Alternative 7, the major modification to ZMI's expansion plan (Alternative 4) at the Zortman Mine would be the location of the waste rock repository on top of existing facilities in and around the mine pit, instead of in Carter Gulch. At the Landusky Mine, rock fill would be removed from the head of King Creek, and the mine pits would be backfilled to a minimum elevation that would allow surface drainage into King Creek. Reclamation covers would be modified to enhance reclamation success. Other plans and facility designs, including the Goslin Flats heap leach and conveyor system, would be generally the same as those described in Alternative 4, and visual impacts would be as described in section 4.8.6.

Relocating the waste rock repository from Carter Gulch to existing disturbed areas around the mine pit would reduce the total amount of previously undisturbed land impacted by the proposed mine expansion, causing a small reduction in visual impacts to those locations with views of the Zortman Mine site. Impacts to the visual quality of the Landusky Mine site would remain relatively unchanged from those described for Alternative 4. Filling in more of the mine pits would cause a small improvement in the overall reclaimed appearance of the site. Any improvement in the success of reclamation and revegetation would have a positive effect on the visual quality at both mines.

The following figures (found in Appendix D) show examples of future landscape condition with Alternative 7. Figure D-18 shows the Zortman Mine pit area at the full buildout stage. The close proximity of the viewpoint to the mine (~ 1.6 mi.), the light color of the exposed rock and soil material, and the line and form contrasts created by the pit highwalls combine to create a high visual impact that dominates the view. Figure D-19 shows the same view but after reclamation. Recontouring and revegetation which has occurred to some of the facilities has reduced the color contrasts, but the pit area remains an area of high visual contrast that attracts visual attention. Figure D-23 shows the mine area at full buildout as viewed from Saddle Butte. Both the mine pit area and the waste rock storage areas present strong color and line contrasts. Figure D-24 shows the same view after reclamation. Revegetation has subdued the color contrasts, but the area is still attracts the attention and is noticeable as a highly modified landscape.

4.8.9.1 Cumulative Impacts

Foreseeable developments under Alternative 7 would be as described for Alternative 4, and impacts would be as described in section 4.8.6.1.

4.8.9.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would generally be the same as in Alternative 4 (section 4.8.6.2), except for the waste rock repository which will be relocated from Carter Gulch to the existing disturbance around and in the mine pit. This relocation of the waste rock repository would avoid visual impacts caused by facility development in Carter Gulch.

4.8.9.3 Short Term Use/Long Term Productivity

The relationship between Short-term Use/Long-term Productivity of the landscape's scenic quality would be the same as described in Alternative 4, section 4.8.6.3.

4.8.9.4 Irreversible or Irretrievable Resource Commitments

Irreversible and irretrievable resource commitments would be as described for Alternative 4, section 4.8.6.4, except that the irreversible change to the landform in Carter Gulch caused by the waste rock repository would not occur.

4.9 NOISE

4.9.1 Methodology

Noise impacts were assessed for each alternative by comparing expected noise levels from mining activities with guidelines set by the U.S. Environmental Protection Agency (EPA 1974). These guidelines were designed to protect against the interference of the public's outdoor activities. The guidance level the EPA has selected is 55 A-weighted decibels, shortened to "dBA." The dBA reflects a noise rating system which is adjusted to the human ear.

Noise impacts associated with the alternative actions were estimated by using data collected during on-site noise measurements, where possible. Noise measurements were made on days when no mining activities occurred to establish baseline levels. Operational noise levels were measured on days with normal mining activities.

4.9.1.1 Sources of Noise

Manufacturers data for noise levels for various pieces of equipment were used in the assessment. Table 4.9-1 presents noise levels for mining equipment and processes based on manufacturers specifications. These estimated noise levels from various sources were extrapolated to Zortman and Landusky mining operations using site specific information, if available. As an example, the manufacturers specifications indicate that noise levels from conveyors will be 56 dBA at 50 feet. Neither mine has a comparable conveyor, so the manufacturers estimates are used in the impact analysis. Similar noise levels have been reported in the literature for enclosed crushing operations. These noise levels are very close to background levels and would not be noticeable within a few hundred feet of the conveyor or enclosed crushing facilities. The secondary and tertiary crushers at the Zortman Mine under Alternatives 4, 6, and 7 would be enclosed and should have comparable noise levels. However, an unenclosed crusher would have noise levels of 72 dBA at 50 feet. The primary crusher for the Zortman Mine would not be enclosed and would exhibit the higher noise levels.

TABLE 4.9-1

OPERATIONAL NOISE LEVELS (DECIBELS) MEASURED AT 50 FEET FOR VARIOUS TYPES OF MINING EQUIPMENT

Equipment Type	Quantity	Noise Level (dBA)
Haul Trucks	13(1)	88
Loaders	3(1)	87
Dozers	5(1)	89
Drills	4(1)	90
Shovel	1(1)	95
Grader	1(1)	86
Water Truck	1(1)	88
Primary Crusher	1(2)	72
Secondary Crusher	1(3)	56
Tertiary Crusher	1(3)	56
Conveyor	1(3)	56
Blasting	2-3 per week	89(4)

Neg: Negligible

Source:
(1) Construction Engineering Research Laboratory 1978.
(2) CDM 1983.
(3) Gelhaus 1991b.
(4) Blasting noise measurement taken 1 mile from blasting location.

4.9.1.2 Source Areas

As shown on Table 4.9-1, there is a wide variety of individual sources generating noise at a mining operation. A very complicated modeling approach is required to estimate the combined noise levels from all of the different sources reaching a receptor. The noise analysis in this evaluation simplifies this problem by assuming that all individual noise sources would emanate from a single area location. Using this approach, the sources within an area are added logarithmically for a combined noise source. The combined noise level from each area source is then estimated at the receptor locations. This simplified approach can result in noise level over- or under-estimation, depending on where an actual noise emanates from within the source area.

The area noise sources for this analysis are the Zortman Mine, the Landusky Mine, and where applicable, the Goslin Flats leach pad and the Ruby Flats waste rock repository.

4.9.1.3 Noise Receptors

The sensitive receptors considered in this analysis are the people in the towns of Zortman and Landusky, and the Pow Wow Grounds, and wildlife at Azure Cave. To estimate the noise impacts at the closest sensitive receptors, the worst-case noise levels associated with each area source for each alternative was calculated by:

1) Determining the individual noise sources expected for the alternative

2) Logarithmically combining the individual sources into a single area source

3) Assuming a fixed attenuation (a constant reduction in noise) in noise level with distance

A common estimation of noise attenuation with distance is to reduce noise levels by 6 dBA with each doubling of distance from the source of the noise. For example, a noise level of 100 dBA at 50 feet would be reduced to 94 dBA at 100 feet and 88 dBA at 200 feet. This attenuation rate does not account for any intervening terrain between source and receptor or forestation, both of which may substantially reduce noise levels because of greater attenuation. Alternatively, the attenuation rate assumes that atmospheric conditions which could increase the distance which noise travels are not occurring. On the whole, the estimates are considered to be conservative, or higher, than would actually occur.

A potentially significant noise which is not included in the source area analysis is that caused by trucks hauling reclamation materials. Under many of the reclamation alternatives, haul trucks would travel through the towns of Zortman and Landusky to deliver materials such as clay, limestone, and soil to mine facilities. A separate analysis under the heading "Roads" is included for reclamation haul truck noise impacts. Noise impacts from reclamation materials hauling are estimated assuming no attenuation. In other words, the noise level generated would be that heard by the receptors in those two towns. This is appropriate considering the proximity of the haul trucks to businesses, schools, and residences in Zortman and Landusky.

4.9.1.4 Impact Significance

The noise levels estimated for each alternative have been compared against baseline noise conditions in the study area to determine whether impacts are positive or negative. In other words, the determination is based on whether a noise level would be lower than baseline conditions (positive impact) or higher than baseline conditions (negative impact). Table 4.9-2 shows typical noise values for various locations. Baseline noise conditions for this analysis are estimated to be typical of rural to wooded residential communities, approximately 40 to 50 dBA. All noise levels projected under this analysis, for all alternatives, would cause negative impacts. Baseline conditions would only be reached once all activity associated with the mines ceases.

The estimated impacts have been rated as low, medium, or high magnitude, using the EPA noise guideline for outdoor activity as the rating criterion (see Table 3.9-3). Low noise impacts are those that are below 53 dBA. Medium noise impacts were assigned to alternatives in which noise levels were estimated to be in the range of 53 to 57 dBA, and high noise impacts were assigned to alternatives in which substantial exceedances of the EPA guideline were estimated (above 57 dBA). Impacts are considered to be significant if the levels estimated at the receptor locations would interfere with outdoor activity, since outdoor recreation is a common activity of residents and visitors in the Little Rocky Mountains.

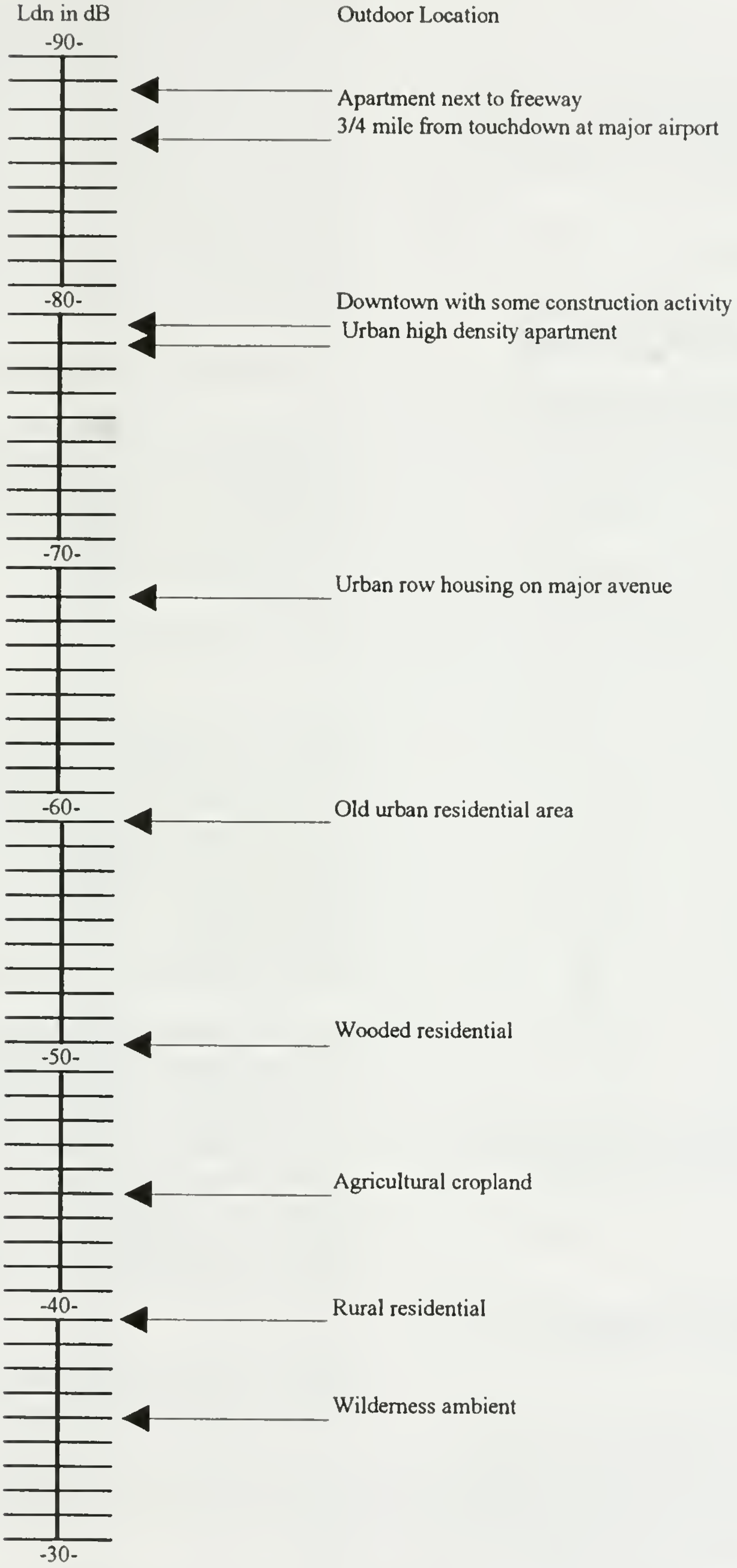
The frequency and duration of impacts are also evaluated. Noise caused by mining activities could be of a short-term duration, in that the noise would occur for short, possibly intense periods then cease. Or, the impacts could be of long-term duration, such as the noise from mining and reclamation which would extend until closure is approved. The frequency of noise also varies. In particular, noise from most mining and reclamation activities would be constant. The loud noise resulting from blasting would be of very short duration and occur infrequently. The noise resulting from haul trucks passing through Zortman and Landusky would occur on a frequent, but short-duration basis.

4.9.1.5 Cumulative Noise Impacts

Noise caused by historic and recent mine activities is not relevant to a cumulative impacts analysis, since noise dissipates almost immediately. Therefore, the cumulative impacts analysis for this resource relies on noise from existing sources (say, noise associated with the town of Zortman) combined with ongoing and/or projected mine activities, plus reasonably foreseeable developments if the noise generated would occur concurrent with the other noise sources. Because of the addition of all sources, cumulative noise impacts should always be higher than estimated direct impacts.

TABLE 4.9-2

EXAMPLES OF AVERAGE NOISE LEVELS IN dB MEASURED AT VARIOUS LOCATIONS



Source: U.S. Environmental Protection Agency, Protective Noise Levels, EPA 550/9-79-100, November 1978.

4.9.2 Impacts from Mining, 1979 to Present

No on-site noise monitoring is available prior to 1990. However, since no significant changes in the location of mining activities have occurred, noise levels for 1979 to present are probably similar to the noise levels measured in 1991 (see Table 4.9-3).

TABLE 4.9-3

OPERATIONAL NOISE LEVELS (dBA) MEASURED IN THE PROJECT AREA

Site	March 12, 1991	March 14, 1991
1	60.4	53.7
2	62.1	60.4
3	48.2	63.6
4	47.9	---
5	54.2	61.9
6	59.1	56.9
7	51.3	58.1
8	46.6	54.9
9	---	58.6
10	47.3	60.9
11	51.9	59.3
12	54.6	69.7
13	50.9	60.4
14	51.0	68.1
15	40.8	48.1
16	40.9	40.4
17	53.4	51.8

Source: Gelhaus 1991b.

Note: Refer to Table 3.9-1 for a description of the noise monitoring locations.

Noise levels from blasting were measured in 1990. Readings were 89 dBA at a location 1 mile from the blasting activities; and 65 dBA at the Pow Wow Grounds (2.5 miles from the blast). Peak noise levels from blasting lasted 2 to 3 seconds. Although blasting noise levels are above the EPA guidelines, these guidelines are based on continuous noise levels (24 hours per day). Therefore, even though the magnitude of the blasting noise is above the noise guidelines, the duration of the blasting noise is much less than the duration used to develop the guidelines. The blasting has historically occurred up to 5 times per week. An existing permit stipulation from 1990 requires that blasting at the Landusky mine be decreased by four days per year, so that it does not occur during the Native American Sundance Ceremony. The Tribe is to provide the agencies 60 days advance notice, so that ZMI has sufficient time to plan for the change in operations.

4.9.3 Impacts from Alternative 1

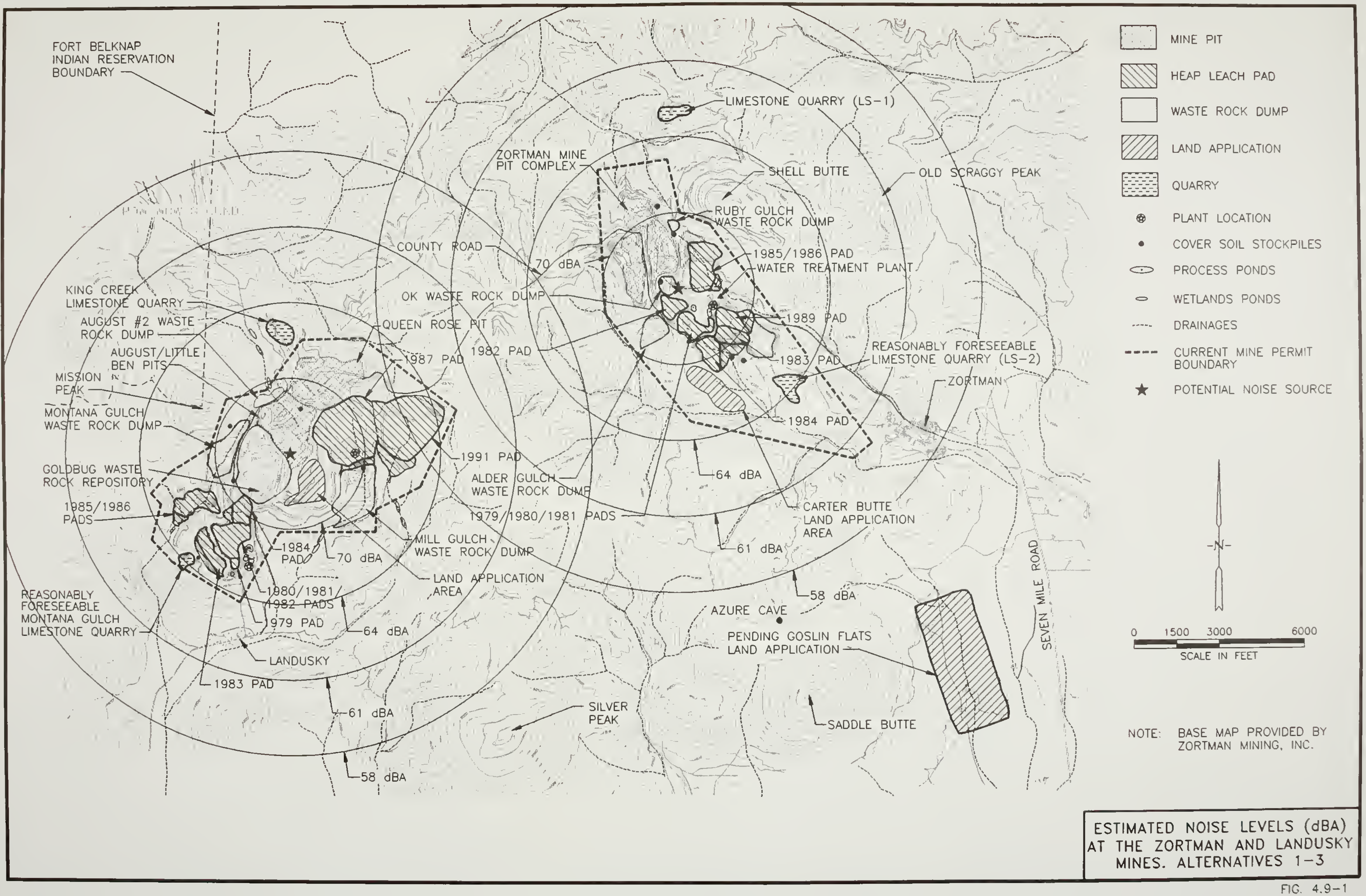
This no action alternative limits activities at the Zortman and Landusky mines to already permitted actions. Noise impacts would result from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and reclamation at both mines.

4.9.3.1 Impacts

Noise levels in the project area were measured for baseline and operational activities during March 1991, and are reported in the "Application for Amendment to Operating Permit No. 00096" (ZMI 1993). (See Table 4.9-3 for operational noise levels measured during March 1991.) Operational noise levels ranged from 40 to 70 dBA. Operational noise levels were greater than baseline noise levels, ranging from 17 dBA greater at monitoring locations within 500 feet of the mining activities; to 4 dBA greater at the property boundary.

Figure 4.9-1 presents estimated noise levels generated at the Zortman and Landusky mines for this alternative, using as sources the noise levels of the mining equipment listed in Table 4.9-1 applicable to each mine under this alternative. For the Landusky mine, noise levels for all equipment listed in Table 4.9-1 except crushing and conveying were logarithmically added together. For the Zortman Mine, activities would include ore processing and hauling; other mining activities at the Zortman Mine ended in 1990.

Mine. The noise level for the Landusky mine was calculated by logarithmically adding noise levels from the sources, yielding an estimated noise level of 104 dBA at a distance of 50 feet from the Landusky mine. Noise levels caused by Zortman Mine activities were estimated at 99 dBA at a distance of 50 feet from the Zortman mine.



ESTIMATED NOISE LEVELS (dBA) AT THE ZORTMAN AND LANDUSKY MINES. ALTERNATIVES 1–3

ZLF-NLA1

FIG. 4.9–1

4.9.2 Impacts from Mining, 1979 to Present

No on-site noise monitoring is available prior to 1990. However, since no significant changes in the location of mining activities have occurred, noise levels for 1979 to present are probably similar to the noise levels measured in 1991 (see Table 4.9-3).

TABLE 4.9-3

OPERATIONAL NOISE LEVELS (dBA) MEASURED IN THE PROJECT AREA

Site	March 12, 1991	March 14, 1991
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4	47.9	---
5	54.2	61.9
6	59.1	56.9
7	51.3	58.1
8	46.6	54.9
9	---	58.6
10	47.3	60.9
11	51.9	59.3
12	54.6	69.7
13	50.9	60.4
14	51.0	68.1
15	40.8	48.1
16	40.9	40.4
17	53.4	51.8

Source: Gelhaus 1991b.

Note: Refer to Table 3.9-1 for a description of the noise monitoring locations.

Noise levels from blasting were measured in 1990. Readings were 89 dBA at a location 1 mile from the blasting activities; and 65 dBA at the Pow Wow Grounds (2.5 miles from the blast). Peak noise levels from blasting lasted 2 to 3 seconds. Although blasting noise levels are above the EPA guidelines, these guidelines are based on continuous noise levels (24 hours per day). Therefore, even though the magnitude of the blasting noise is above the noise guidelines, the duration of the blasting noise is much less than the duration used to develop the guidelines. The blasting has historically occurred up to 5 times per week. An existing permit stipulation from 1990 requires that blasting at the Landusky mine be decreased by four days per year, so that it does not occur during the Native American Sundance Ceremony. The Tribe is to provide the agencies 60 days advance notice, so that ZMI has sufficient time to plan for the change in operations.

4.9.3 Impacts from Alternative 1

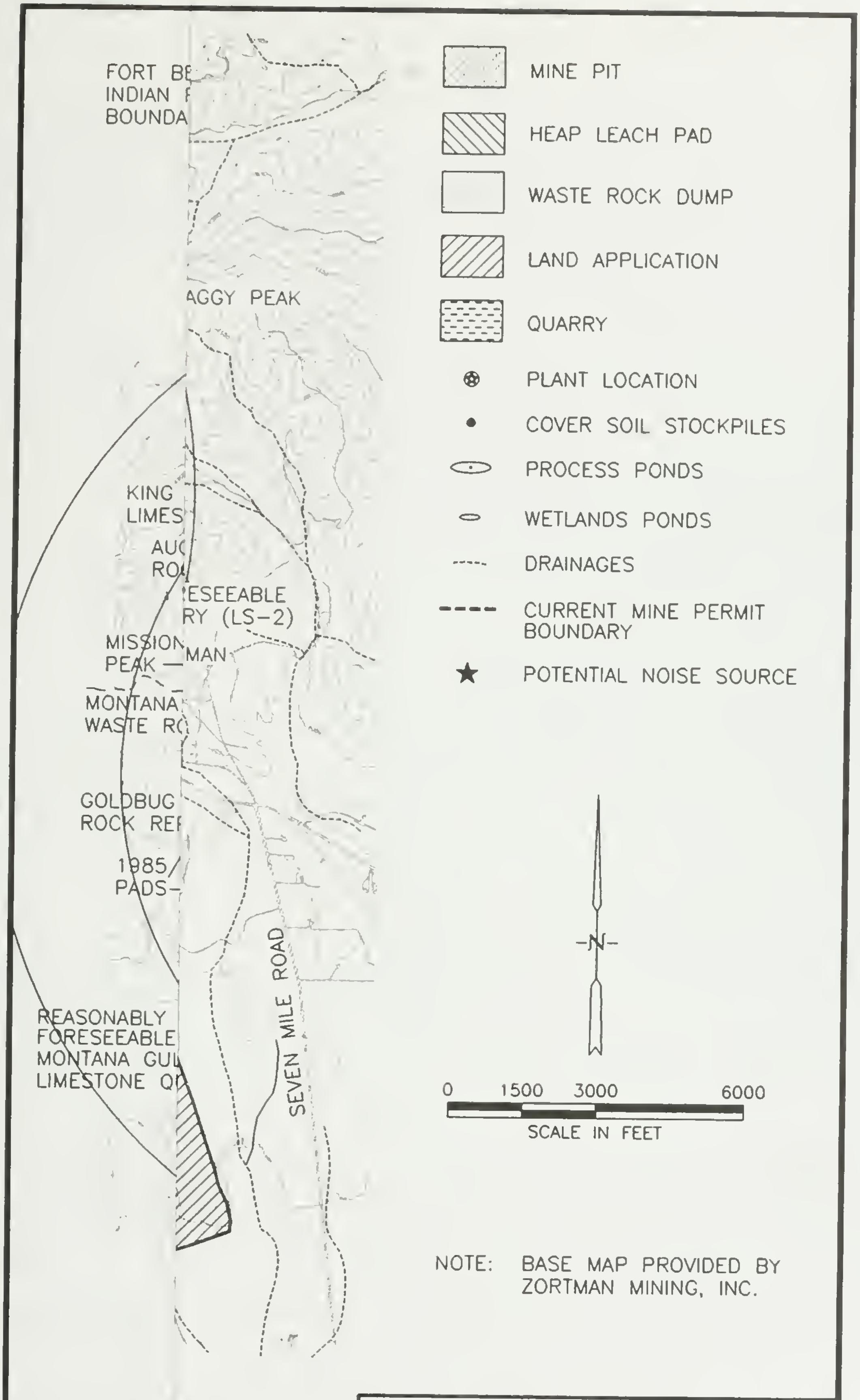
This no action alternative limits activities at the Zortman and Landusky mines to already permitted actions. Noise impacts would result from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and reclamation at both mines.

4.9.3.1 <u>Impacts</u>

Noise levels in the project area were measured for baseline and operational activities during March 1991, and are reported in the "Application for Amendment to Operating Permit No. 00096" (ZMI 1993). (See Table 4.9-3 for operational noise levels measured during March 1991.) Operational noise levels ranged from 40 to 70 dBA. Operational noise levels were greater than baseline noise levels, ranging from 17 dBA greater at monitoring locations within 500 feet of the mining activities; to 4 dBA greater at the property boundary.

Figure 4.9-1 presents estimated noise levels generated at the Zortman and Landusky mines for this alternative, using as sources the noise levels of the mining equipment listed in Table 4.9-1 applicable to each mine under this alternative. For the Landusky mine, noise levels for all equipment listed in Table 4.9-1 except crushing and conveying were logarithmically added together. For the Zortman Mine, activities would include ore processing and hauling; other mining activities at the Zortman Mine ended in 1990.

<u>Mine</u>. The noise level for the Landusky mine was calculated by logarithmically adding noise levels from the sources, yielding an estimated noise level of 104 dBA at a distance of 50 feet from the Landusky mine. Noise levels caused by Zortman Mine activities were estimated at 99 dBA at a distance of 50 feet from the Zortman mine.



ESTIMATED NOISE LEVELS (dBA) AT THE ZORTMAN AND LANDUSKY MINES. ALTERNATIVES 1–3

FIG. 4.9-1

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Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman and Landusky mines were calculated at each sensitive receptor. The noise levels from the Zortman mine have been estimated at 54 dBA at the town of Zortman, 48 dBA at the town of Landusky, 48 dBA at the Pow Wow Grounds, and 49 dBA at Azure Cave.

The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave. The frequency of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise impacts from mining operations would generally be low to medium magnitude and not significant, except for noise generated at the Landusky Mine and heard at the town of Landusky. This noise (61 dBA) is significant with a high magnitude of impact because it is well above the EPA guideline for outdoor activity.

Corrective actions (such as construction and pump operation) stipulated under the Water Quality Improvement Plan (see Appendix A) for existing water quality problems would not be expected to generate noise impacts greater than those described above. Noise levels would return to background levels after mine operations, mine reclamation, and remediation are completed.

Roads. Under this No Action Alternative, mine activities include the haulage of supplies and limited reclamation materials through Landusky to the Landusky Mine. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of fifteen trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Landusky mine under this Alternative is 500 to 800 trips per year, until reclamation stops in approximately 1996. Refer to Table 4.11-2 for a schedule of reclamation haul trips for each Alternative.

4.9.3.2 Cumulative Impacts

Although mine exploration and development is a reasonably foreseeable development under this alternative, there is no projection of the extent of such development (see Section 2.5.6). Therefore, cumulative noise impacts are estimated by logarithmically adding the impacts to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave. Average noise levels in Zortman and Landusky are approximately 57 dBA. Average ambient noise level is estimated to be 45 dBA at the Pow Wow Grounds and Azure Cave. Combining background noise levels with those predicted to occur for Alternative 1 implementation results in cumulative noise levels of 60 dBA at Zortman, 62 dBA at Landusky, 55 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. Impacts at Zortman and Landusky would be significant and of a high magnitude, while impacts at the other locations would be of medium magnitude and not significant.

4.9.3.3 Unavoidable Adverse Impacts

The significant adverse impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.3.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 2002 (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.3.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise levels would return to background levels after reclamation is completed.

4.9.4 Impacts from Alternative 2

This non-expansion alternative limits activities at the Zortman and Landusky mines to already permitted actions, with some enhanced reclamation as proposed by ZMI. Noise impacts would result from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and reclamation at both mines.

4.9.4.1 Impacts

Figure 4.9-1 presents estimated noise levels generated at the Zortman and Landusky mines for this Alternative, using as sources the noise levels of the mining equipment listed in Table 4.9-1 applicable to each mine under this alternative. For the Landusky mine, noise levels for all equipment except crushing and conveying were logarithmically added together. For the Zortman mine, activities would include ore processing and hauling; other mining activities at the Zortman mine ended in 1990.

Mine. The noise level for the Landusky Mine was calculated by logarithmically adding noise levels from the sources, yielding an estimated combined noise level of 104 dBA at a distance of 50 feet from the Landusky Mine. Noise levels caused by Zortman Mine activities were estimated at 99 dBA at a distance of 50 feet from the Zortman Mine.

Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman and Landusky mines were calculated at each sensitive receptor. The noise levels from the Zortman mine have been estimated at 54 dBA at Zortman, 48 dBA at Landusky, 48 dBA at the Pow Wow Grounds, and 49 dBA at Azure Cave.

The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave. The frequency of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise impacts from mining operations would generally be low to medium magnitude and not significant, except for noise generated at the Landusky Mine and heard in Landusky. This noise is significant with a high magnitude because it is well above the EPA guideline for outdoor activity.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this No Action Alternative, reclamation activities include the haulage of clay and other materials through the towns of Zortman and Landusky to the mines. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of fifteen trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high magnitude impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Zortman mine under this Alternative would peak at 1,800 round trips (with each round trip including travel through town twice) for the year 1998. Reclamation would be expected to end and haul trucks cease at the Zortman Mine in 1998. The frequency of haul trips required for leaching and reclamation activities at the Landusky mine under this Alternative would peak at 4,050 round trips (again, through town twice for each round trip) in the year 2000. Reclamation would be expected to end and haul trucks cease at the Landusky Mine in 2000.

4.9.4.2 Cumulative Impacts

No reasonably foreseeable development activities are anticipated under this alternative. Therefore, cumulative noise impacts are estimated by logarithmically adding the impacts to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave. Average noise levels for these locations were listed in Section 4.9.3.2. Combining background noise levels with those predicted to occur for Alternative 2 implementation results in cumulative noise levels of 60 dBA at Zortman, 62 dBA at Landusky, 55 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. Impacts at Zortman and Landusky would be significant and of a high magnitude, while impacts at the other locations would be of medium magnitude and not significant.

4.9.4.3 Unavoidable Adverse Impacts

The significant noise impacts in Zortman and Landusky are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.4.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative will last until 1998 for the Zortman mine and until 2000 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.4.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.9.5 Impacts from Alternative 3

This non-expansion alternative limits activities at the Zortman and Landusky mines to already permitted actions, with Agency-mitigated reclamation imposed. Noise impacts would result from the limited ore processing operations at the Zortman Mine, continued mining at the Landusky Mine until approximately early 1996, and enhanced reclamation at both mines.

4.9.5.1 Impacts

Figure 4.9-1 presents estimated noise levels generated at the Zortman and Landusky mines for this Alternative based on noise levels of the mining equipment listed in Table 4.9-1. For the Landusky Mine, noise levels for all equipment except crushing and conveying were logarithmically added together. For the Zortman Mine, activities would include ore processing and hauling; other mining activities at the Zortman Mine ended in 1990.

Mine. The noise level for the Landusky Mine was calculated by logarithmically adding noise levels from the sources, yielding an estimated combined noise level of 104 dBA at a distance of 50 feet from the Landusky Mine. Noise levels caused by Zortman Mine activities were estimated at 99 dBA at a distance of 50 feet from the Zortman mine.

Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman and Landusky mines were calculated at each sensitive receptor. The noise levels from the Zortman mine have been estimated at 54 dBA at Zortman, 48 dBA at Landusky, 48 dBA at the Pow Wow Grounds, and 49 dBA at Azure Cave.

The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave. The frequency of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise impacts from mining operations would generally be low to medium magnitude and not significant, except for noise generated at the Landusky Mine and heard at Landusky (61 dBA). This noise is significant with a high magnitude because it is well above the EPA guideline for outdoor activity.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this Alternative, reclamation activities include the haulage of clay and other materials through the towns of Zortman and Landusky to the mines. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of fifteen trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high magnitude impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Zortman Mine under this Alternative would peak at 2100 round trips during 1999. Reclamation would be expected to end and haul trucks cease at the Zortman Mine in 1999. The frequency of haul trips required for leaching and reclamation activities at the Landusky Mine under this Alternative would peak at 5250 round trips in the year 2001. Reclamation would be expected to end and haul trucks cease at the Landusky Mine in 2001.

4.9.5.2 Cumulative Impacts

No reasonably foreseeable development activities are anticipated under this Alternative. Therefore, cumulative noise impacts were estimated by logarithmically adding the impacts to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave. Average noise levels for these location were listed in Section 4.9.3.2. Combining background noise levels with those predicted to occur for Alternative 3 implementation results in cumulative noise levels of 60 dBA at Zortman, 62 dBA at Landusky, 55 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. Impacts at Zortman and Landusky would be significant and of a high magnitude, while impacts at the other locations would be of medium magnitude and not significant.

4.9.5.3 Unavoidable Adverse Impacts

The significant, high magnitude impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.5.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 1999 for the Zortman mine and until 2001 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.5.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.9.6 Impacts from Alternative 4

The Company Proposed Action includes extension of mine activities at both the Zortman and Landusky mines. Increased reclamation would be implemented at both mines as well. Noise impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development actions are reasonably foreseeable.

4.9.6.1 Impacts

Figure 4.9-2 presents estimated noise levels generated at the Zortman and Landusky mines for this Alternative, based on a worst-case scenario that all mining equipment listed in Table 4.9-1 would be operating at the same time. For the Goslin Flats leach pad, noise levels for haul trucks, loaders, graders, and water trucks were used to estimate the worst-case noise level for leaching activities. The secondary and tertiary crushers to be sited near the leach pad were not included in the analysis because they would be enclosed in buildings.

Mine. The noise level for both the Landusky and Zortman mines was calculated to be 104 dBA at a distance of 50 feet from the mines. The noise level generated by activities at the Goslin Flats leach pad was estimated to be 99 dBA at a distance of 50 feet from the leach pad.

Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman and Landusky mines were calculated at each sensitive receptor. The noise levels from the Zortman mine have been estimated at 59 dBA at Zortman, 52 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave. The noise levels from the Goslin Flats leach pad have been estimated at 59 dBA at Zortman, 47 dBA at Landusky, 43 dBA at the Pow Wow Grounds, and 58 dBA at Azure Cave.

The frequency of all of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise generated at the Zortman Mine would exceed the outdoor activity criterion at Zortman. This impact would be significant and of a high magnitude. Noise generated at the Landusky Mine would exceed the criterion at Landusky and at the Pow Wow Grounds. These impacts would be significant and of a high magnitude. Noise generated at the Goslin Flats leach pad would exceed the criterion at Azure Cave and the town of Zortman, resulting in significant impacts of a high magnitude. Other noise impacts from mining operations would generally be of a low to medium magnitude and not significant.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this Alternative, reclamation activities include the haulage of clay and other materials through the towns of Zortman and Landusky to the mines. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of fifteen trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high magnitude impact of short duration. The frequency of haul trips required for

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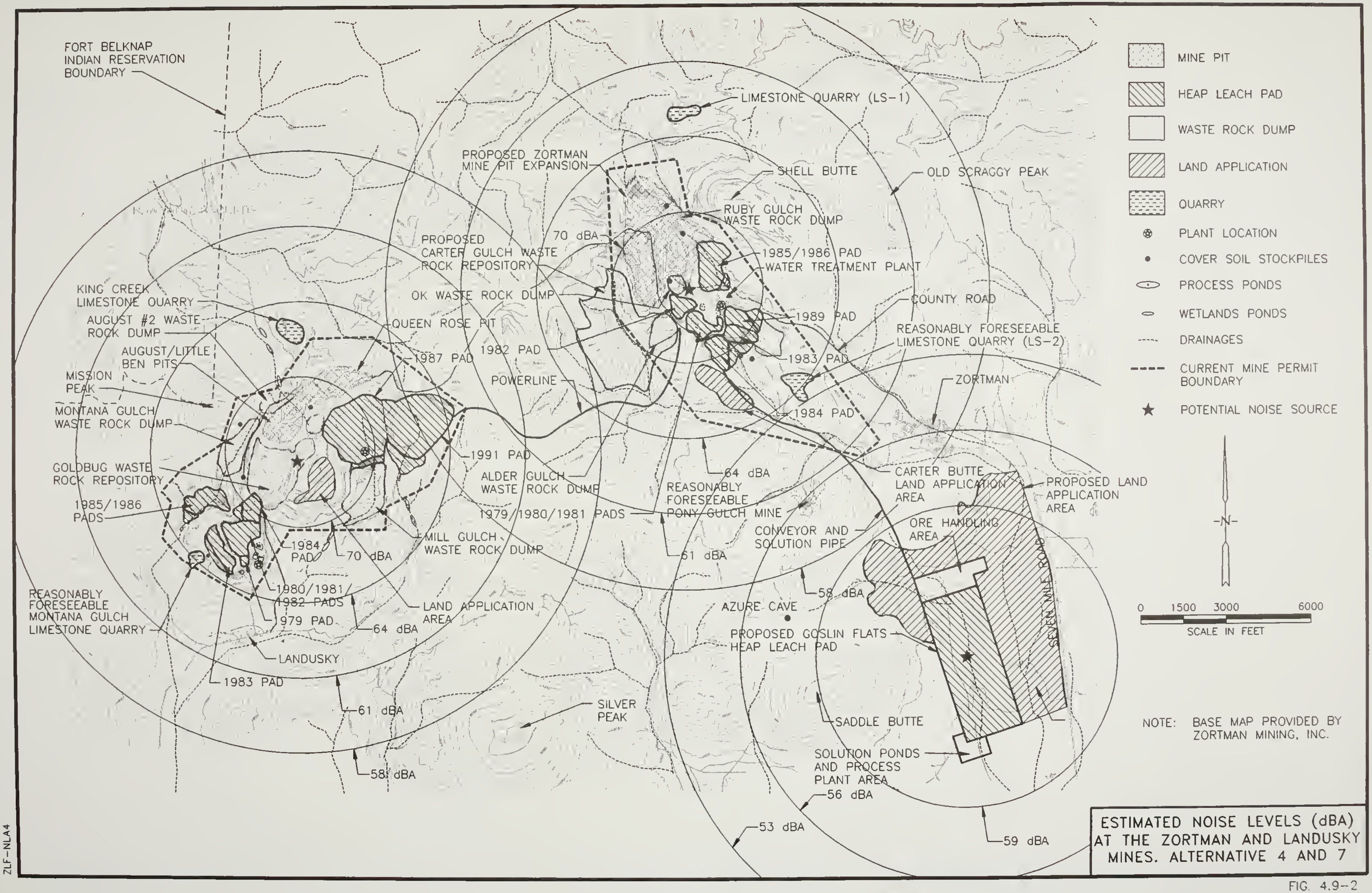

ESTIMATED NOISE LEVELS (dBA) AT THE ZORTMAN AND LANDUSKY MINES. ALTERNATIVE 4 AND 7

FIG. 4.9-2

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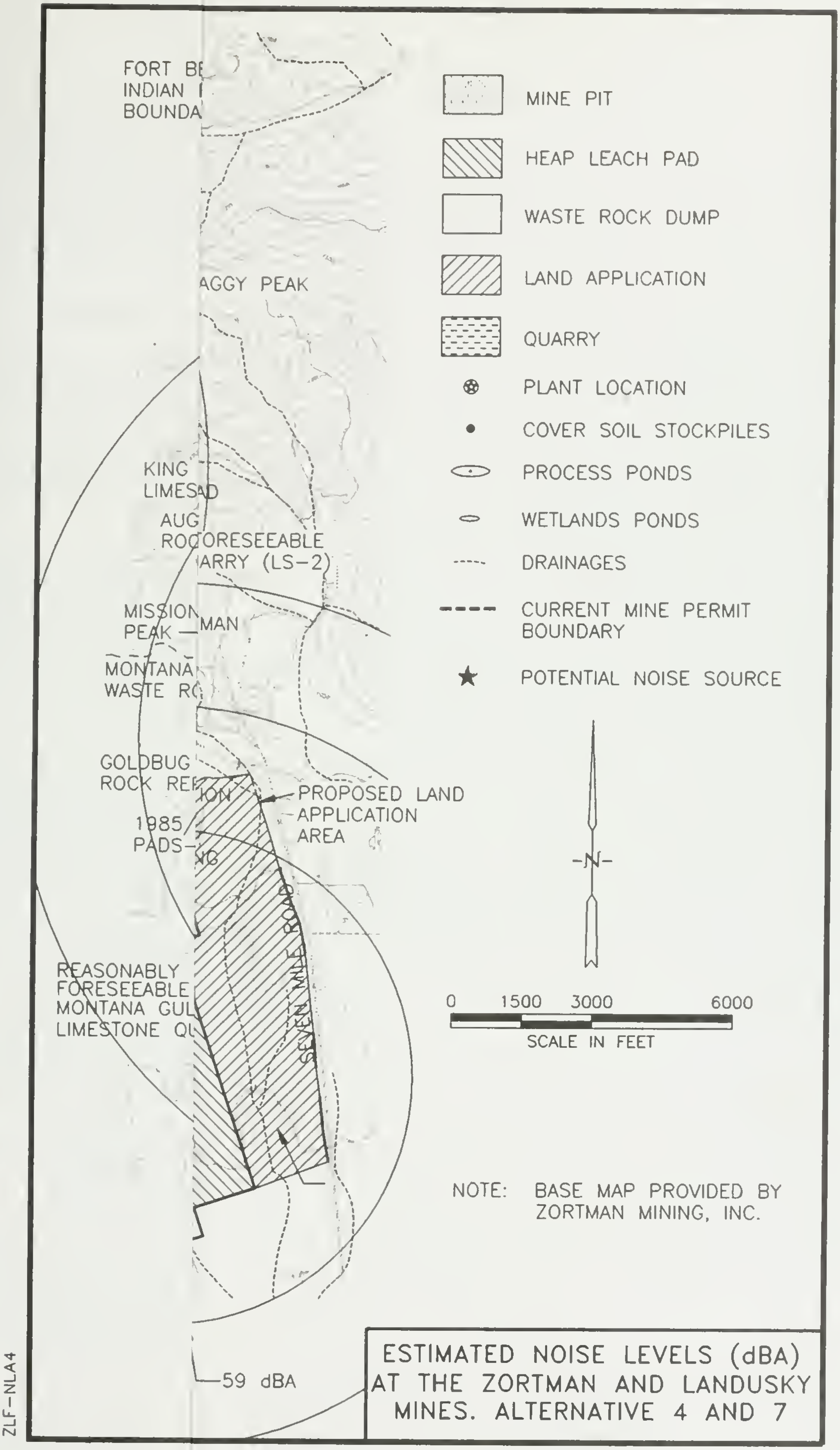

ESTIMATED NOISE LEVELS (dBA) AT THE ZORTMAN AND LANDUSKY MINES. ALTERNATIVE 4 AND 7

FIG. 4.9-2

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leaching and reclamation activities at the Zortman Mine under this Alternative would peak at 2,500 round trips in the year 2007. Reclamation would be expected to end and haul trucks cease at the Zortman Mine in the year 2007. The frequency of haul trips required for leaching and reclamation activities at the Landusky mine under this Alternative would peak at 4,500 round trips in 2002. Reclamation would be expected to end and haul trucks cease at the Landusky Mine in the year 2002.

4.9.6.2 Cumulative Impacts

The reasonably foreseeable developments under Alternative 4 include mining extension into Pony Gulch. The Pony Gulch area is approximately 4000 feet from the town of Zortman. Noise levels from mining activities at Pony Gulch would be approximately 65 dBA at Zortman, 53 dBA at Landusky, 48 dBA at the Pow Wow Grounds, and 64 dBA at Azure Cave.

Cumulative noise impacts were estimated by logarithmically adding the impacts from mining and reclamation activities to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave, plus noise levels from reasonably foreseeable activities. Average noise levels for these locations were listed in Section 4.9.3.2.

Combining background noise levels with those predicted to occur for Alternative 4 and under reasonable foreseeable development scenarios results in cumulative noise levels of 66 dBA at Zortman, 63 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 66 dBA at Azure Cave. Cumulative impacts at all receptor locations would be significant and of a high magnitude.

4.9.6.3 Unavoidable Adverse Impacts

The significant, high magnitude impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.6.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 2007 for the Zortman mine and until 2002 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.6.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.9.7 Impacts from Alternative 5

This alternative includes extension of mine activities at both the Zortman and Landusky mines. A major operational modification affecting noise impacts would place the Zortman Mine heap leach pad in Upper Alder Gulch. Agency mitigated reclamation would be implemented at both mines. Noise impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities.

4.9.7.1 Impacts

Figure 4.9-3 presents estimated noise levels generated at the Zortman and Landusky mines for this Alternative, based on a worst-case scenario that all mining equipment listed in Table 4.9-1 would be operating at the same time. The mining and reclamation activities associated with the heap leach pad in Upper Alder Gulch are considered part of the Zortman Mine area source for noise.

Mine. As was the case for Alternative 4, the noise level for both the Landusky and Zortman mines was calculated by logarithmically adding individual sources to be 104 dBA at a distance of 50 feet from the mines.

Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman and Landusky mines were calculated at each sensitive receptor location. The noise levels from the Zortman mine have been estimated at 59 dBA at Zortman, 52 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave.

The frequency of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise generated at the Zortman Mine would exceed the outdoor activity criterion at Zortman. This impacts would be significant and of a high magnitude. Noise generated at the Landusky Mine would exceed the criterion at Landusky and at the Pow Wow Grounds. These impacts would be significant and of a high magnitude. Noise impacts from mining operations at other receptor locations would generally be of a medium magnitude and not significant.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this Alternative, reclamation activities include the haulage of clay and other materials through the towns of Zortman and Landusky to the mines. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of five trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Zortman mine under this Alternative would peak at 3,800 round trips in the year 1996. This high frequency would be associated with construction of the liner for the Upper Alder Gulch leach pad. Reclamation would be expected to end and haul trucks cease in the year 2007. The frequency of haul trips required for leaching and reclamation activities at the Landusky mine under this Alternative would peak at 4000 round trips in the year 2002. Reclamation would be expected to end and haul trucks cease in the year 2002.

4.9.7.2 Cumulative Impacts

No reasonably foreseeable development activities are anticipated under this Alternative. Therefore, cumulative noise impacts were estimated by logarithmically adding the impacts from mining and reclamation activities to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave. Average noise levels for these locations were listed in Section 4.9.3.2.

Combining background noise levels with those predicted to occur for Alternative 5 implementation results in cumulative noise levels of 63 dBA at Zortman, 62 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 58 dBA at Azure Cave. Cumulative impacts at all receptor locations would be significant and of a high magnitude.

4.9.7.3 Unavoidable Adverse Impacts

The significant, high magnitude impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.7.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 2007 for the Zortman mine and until 2002 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.7.5 Irreversible or Irretrievable Resource Commitments

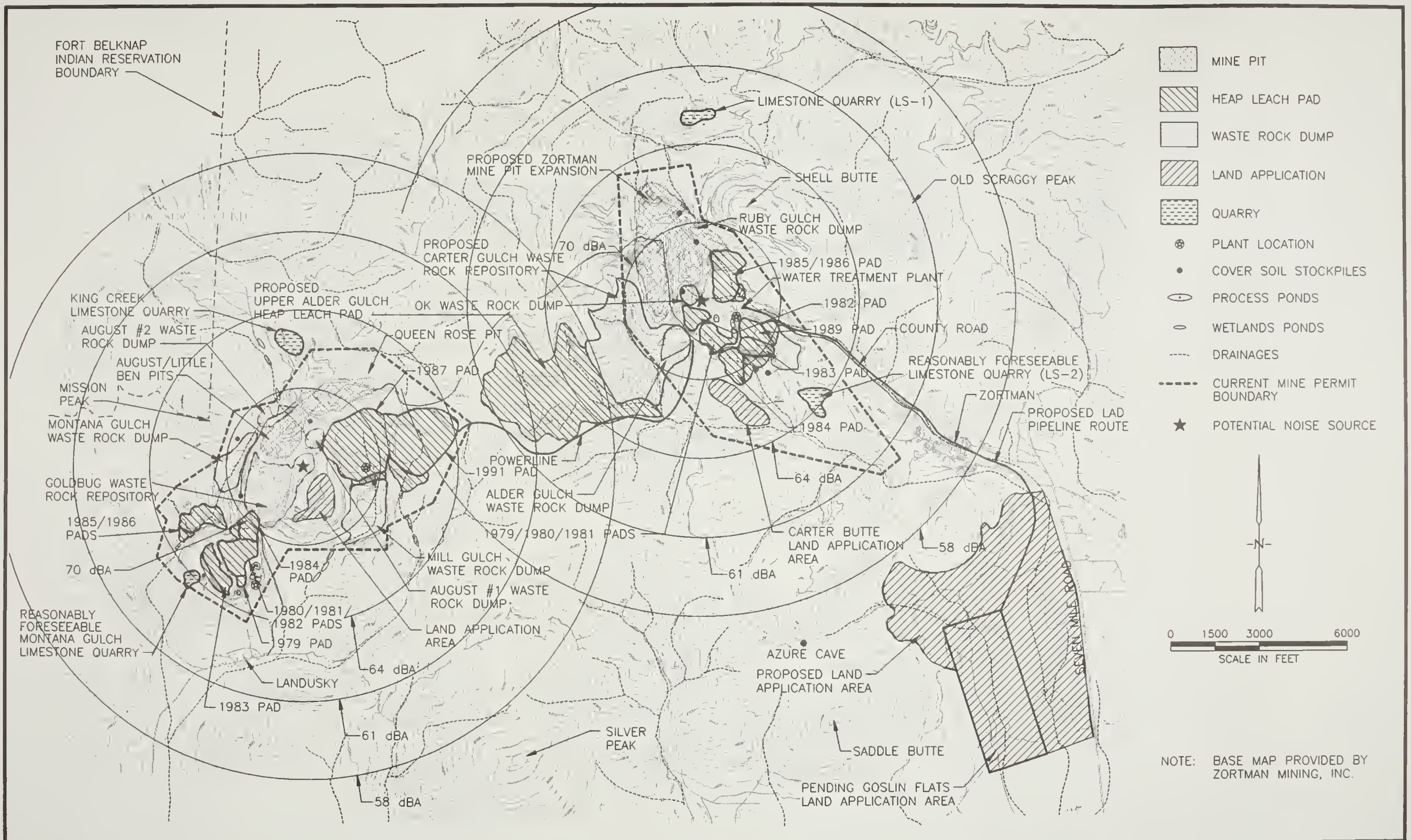
There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.9.8 Impacts from Alternative 6

This alternative includes extension of mine activities at both the Zortman and Landusky mines. A major operational modification affecting noise impacts would place the Zortman Mine waste rock repository on the Ruby Flats. Agency mitigated reclamation would be implemented at both mines. Noise impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development activities are reasonably foreseeable.

4.9.8.1 Impacts

Figure 4.9-4 presents estimated noise levels generated at the Zortman and Landusky mines for this Alternative, based on a worst-case scenario that all mining equipment listed in Table 4.9-1 would be operating at the same time. For the Goslin Flats leach pad, noise levels for haul trucks, loaders, graders, and water trucks were used to estimate the worst-case noise level for leaching activities. The secondary and tertiary crushers to be sited near the leach pad were not included in this analysis because they would be enclosed in buildings.



NOTE: BASE MAP PROVIDED BY ZORTMAN MINING, INC.

ESTIMATED NOISE LEVELS (dBA)
AT THE ZORTMAN AND LANDUSKY
MINES. ALTERNATIVE 5

FIG. 4.9-3

ZORT493

would be significant and of a high magnitude. Noise generated at the Landusky Mine would exceed the criterion at Landusky and at the Pow Wow Grounds. These impacts would be significant and of a high magnitude. Noise impacts from mining operations at other receptor locations would generally be of a medium magnitude and not significant.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this Alternative, reclamation activities include the haulage of clay and other materials through the towns of Zortman and Landusky to the mines. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of five trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Zortman mine under this Alternative would peak at 3,800 round trips in the year 1996. This high frequency would be associated with construction of the liner for the Upper Alder Gulch leach pad. Reclamation would be expected to end and haul trucks cease in the year 2007. The frequency of haul trips required for leaching and reclamation activities at the Landusky mine under this Alternative would peak at 4000 round trips in the year 2002. Reclamation would be expected to end and haul trucks cease in the year 2002.

4.9.7.2 Cumulative Impacts

No reasonably foreseeable development activities are anticipated under this Alternative. Therefore, cumulative noise impacts were estimated by logarithmically adding the impacts from mining and reclamation activities to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave. Average noise levels for these locations were listed in Section 4.9.3.2.

Combining background noise levels with those predicted to occur for Alternative 5 implementation results in cumulative noise levels of 63 dBA at Zortman, 62 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 58 dBA at Azure Cave. Cumulative impacts at all receptor locations would be significant and of a high magnitude.

4.9.7.3 Unavoidable Adverse Impacts

The significant, high magnitude impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.7.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 2007 for the Zortman mine and until 2002 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.7.5 Irreversible or Irretrievable Resource Commitments

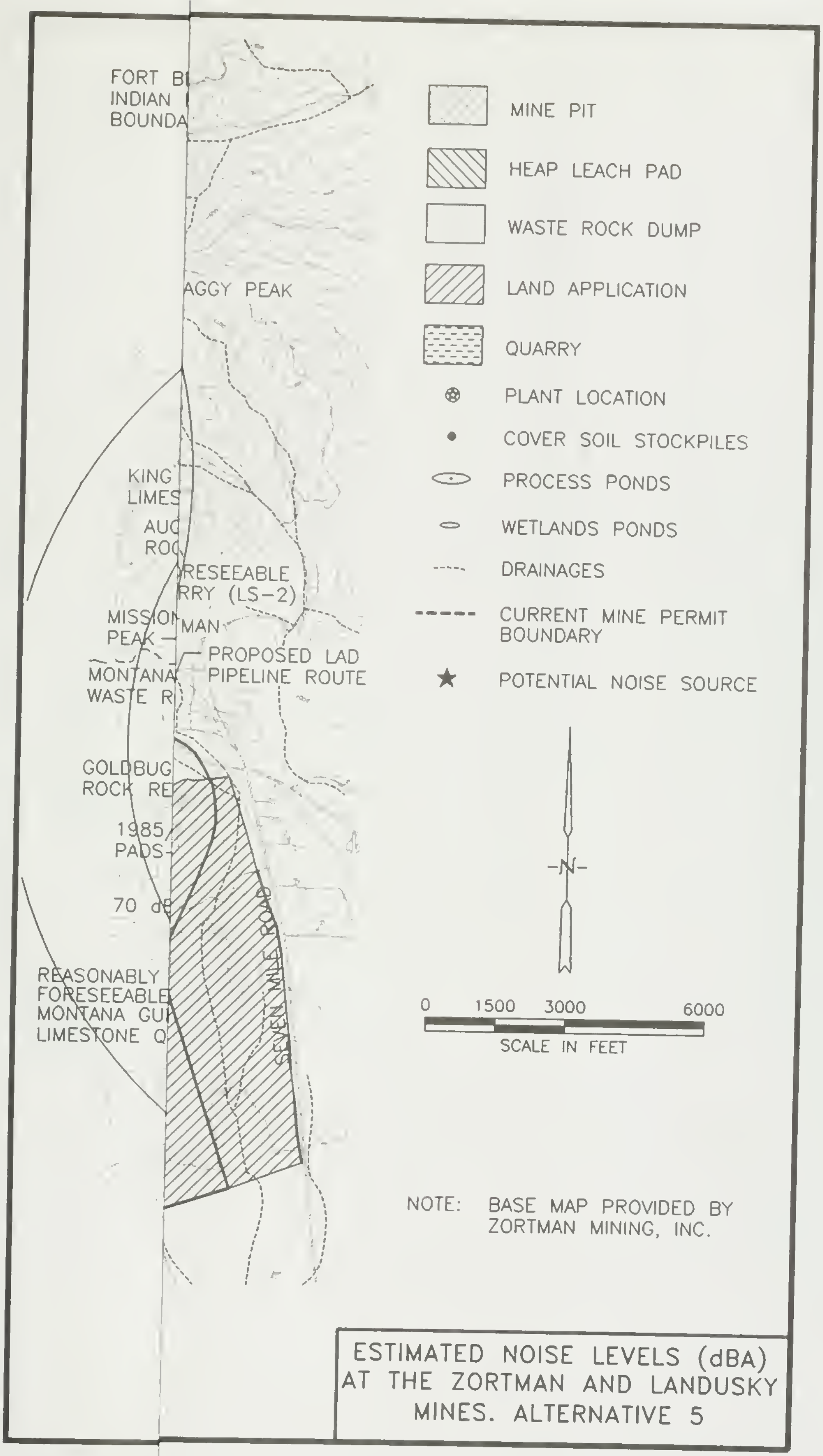
There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.9.8 Impacts from Alternative 6

This alternative includes extension of mine activities at both the Zortman and Landusky mines. A major operational modification affecting noise impacts would place the Zortman Mine waste rock repository on the Ruby Flats. Agency mitigated reclamation would be implemented at both mines. Noise impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development activities are reasonably foreseeable.

4.9.8.1 Impacts

Figure 4.9-4 presents estimated noise levels generated at the Zortman and Landusky mines for this Alternative, based on a worst-case scenario that all mining equipment listed in Table 4.9-1 would be operating at the same time. For the Goslin Flats leach pad, noise levels for haul trucks, loaders, graders, and water trucks were used to estimate the worst-case noise level for leaching activities. The secondary and tertiary crushers to be sited near the leach pad were not included in this analysis because they would be enclosed in buildings.



NOTE: BASE MAP PROVIDED BY ZORTMAN MINING, INC.

ESTIMATED NOISE LEVELS (dBA) AT THE ZORTMAN AND LANDUSKY MINES. ALTERNATIVE 5

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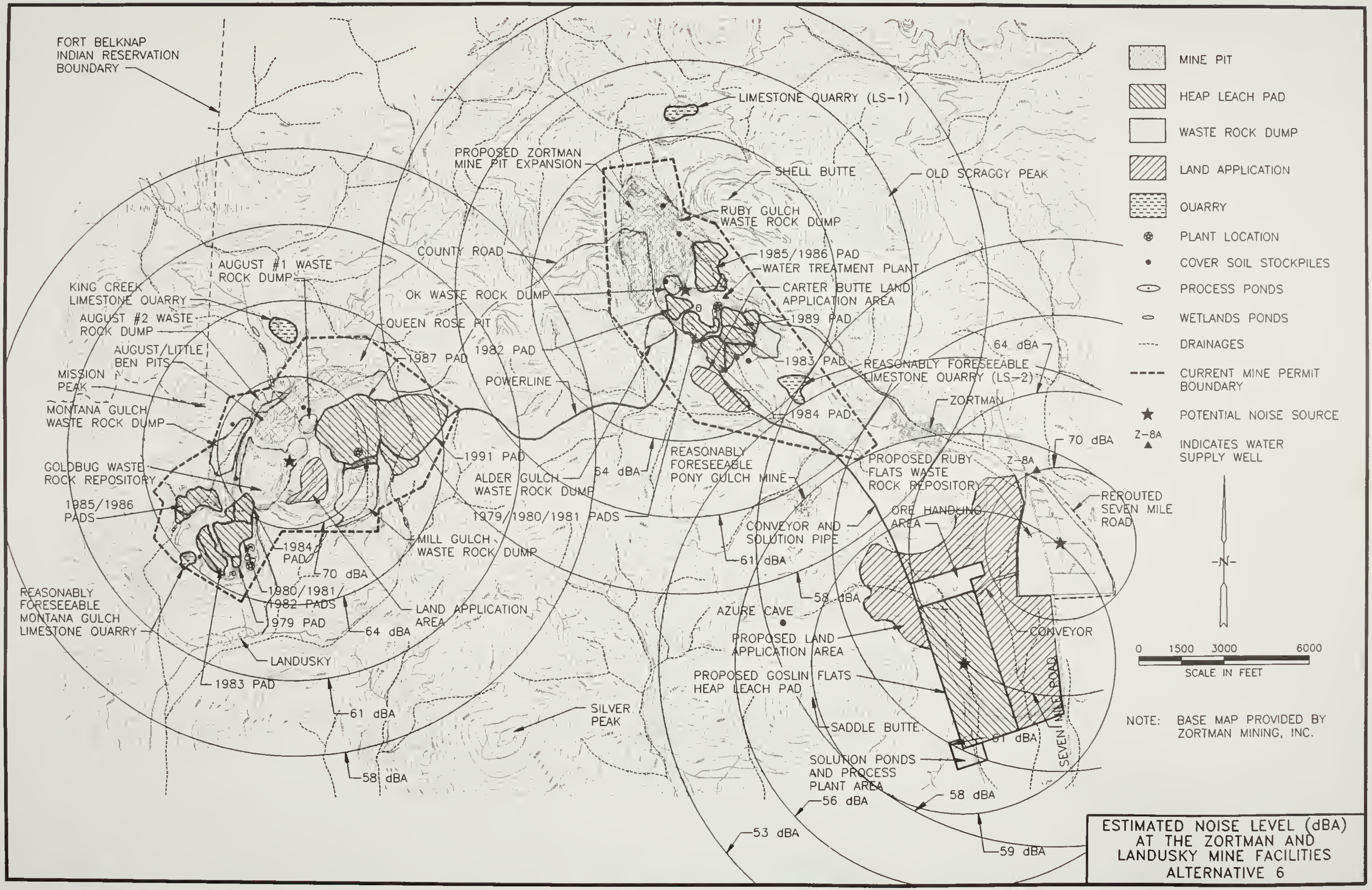

ESTIMATED NOISE LEVEL (dBA)
AT THE ZORTMAN AND
LANDUSKY MINE FACILITIES
ALTERNATIVE 6

FIG. 4.9-4

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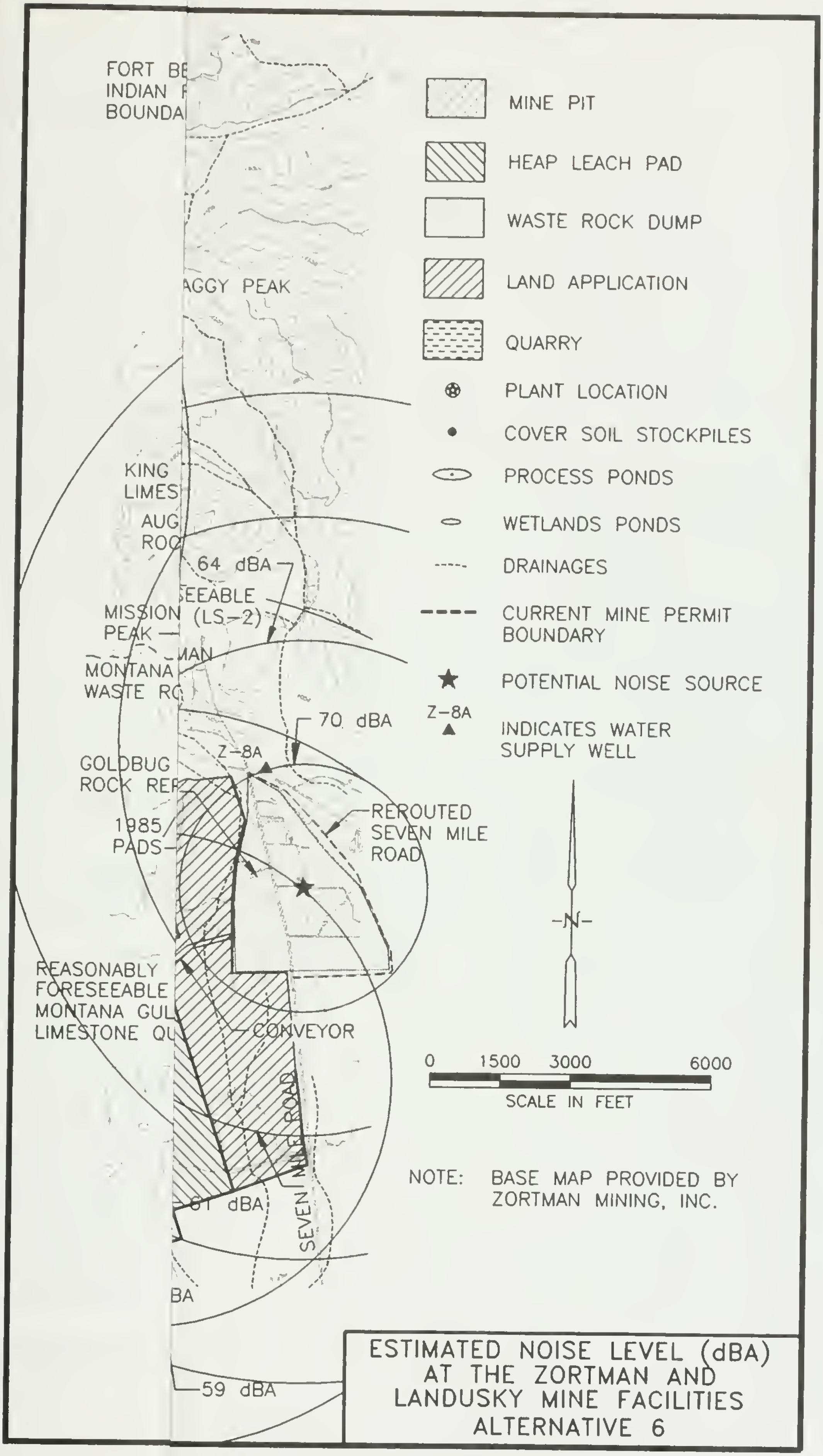

ESTIMATED NOISE LEVEL (dBA) AT THE ZORTMAN AND LANDUSKY MINE FACILITIES ALTERNATIVE 6

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For the Ruby Flats waste rock repository, noise levels for haul trucks, loaders, and water trucks were used to estimate the worst-case noise level for leaching activities.

Mine. The noise level for both the Zortman and Landusky mines was calculated to be 104 dBA at a distance of 50 feet from the mines. The noise level generated by activities at the Goslin Flats leach pad and Ruby Flats waste rock repository was calculated to be 99 dBA at a distance of 50 feet from each facility (each facility was modeled as a separate noise source area).

Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman mine, the Landusky mine, the Goslin Flats leach pad, and the Ruby Gulch waste rock repository were calculated at each sensitive receptor location. The noise levels from the Zortman mine have been estimated at 59 dBA at Zortman, 52 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave.

The noise levels from the Goslin Flats leach pad have been estimated at 58 dBA at Zortman, 47 dBA at Landusky, 43 dBA at the Pow Wow Grounds, and 58 dBA at Azure Cave. The noise levels from the Ruby Flats waste rock repository have been estimated at 62 dBA at Zortman, 44 dBA at Landusky, 43 dBA at the Pow Wow Grounds, and 57 dBA at Azure Cave.

The frequency of all of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise generated at the Zortman Mine would exceed the outdoor activity criterion at Zortman. This impact would be significant and of a high magnitude. Noise generated at the Landusky Mine would exceed the criterion at Landusky and at the Pow Wow Grounds. These impacts would be significant and of a high magnitude. Noise generated at the Goslin Flats leach pad would exceed the criterion at Azure Cave and at Zortman, resulting in significant impacts of a high magnitude. Noise generated at the Ruby Flats waste rock repository would exceed the criterion at Zortman and at Azure Cave. These impacts would be significant and of a high magnitude. Noise impacts from mining operations at other receptor locations would generally be of low or medium magnitude and not significant.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this Alternative, reclamation activities include the haulage of clay and other materials through the towns of Zortman and Landusky to the mines. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of five trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high magnitude impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Zortman mine under this Alternative would peak at 2000 round trips in the year 2006. This frequency is much less than the other mine extension alternatives because both the waste rock repository and heap leach pad are south of Zortman; clay haul trucks would not be required to drive through town. Reclamation would be expected to end and haul trucks cease at the Zortman Mine in the year 2006.

The frequency of haul trips required for leaching and reclamation activities at the Landusky mine under this Alternative would peak at 4000 round trips in the year 2002. Reclamation would be expected to end and haul trucks cease at the Landusky Mine in the year 2002.

4.9.8.2 Cumulative Impacts

The reasonably foreseeable developments under Alternative 6 include mining extension into Pony Gulch. As described in Section 4.9.6.2, noise levels from mining activities at Pony Gulch would be approximately 65 dBA at Zortman, 53 dBA at Landusky, 48 dBA at the Pow Wow Grounds, and 64 dBA at Azure Cave.

Cumulative noise impacts were estimated by logarithmically adding the impacts of mining (including ore conveyance) and reclamation activities to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave, plus noise levels from reasonably foreseeable activities. Average noise levels for these locations were listed in Section 4.9.3.2.

Combining background noise levels with those predicted to occur for Alternative 6 and under reasonably foreseeable development scenarios results in cumulative noise levels of 67 dBA at Zortman, 63 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 66 dBA at

Azure Cave. Cumulative impacts at all receptor locations would be significant and of a high magnitude.

4.9.8.3 Unavoidable Adverse Impacts

The significant, high magnitude impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.8.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 2006 for the Zortman mine and until 2002 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.8.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.9.9 Impacts from Alternative 7

This alternative includes extension of mine activities at both the Zortman and Landusky mines. A major operational modification affecting noise impacts would place the Zortman Mine waste rock repository on top of existing disturbances and undisturbed areas around the mine site. Agency mitigated reclamation would be implemented at both mines. Noise impacts would result from ore blasting, hauling, and processing at both mines, and ongoing reclamation of existing and new facilities. Additional exploration and development activities are reasonably foreseeable.

4.9.9.1 Impacts

Figure 4.9-2 illustrated estimated noise levels generated at the Zortman and Landusky mines for Alternative 7. The noise levels for this alternative would be expected to be similar to Alternative 4, since the new waste rock repository would be within the mine source area, as was the Carter Gulch waste rock repository under Alternative 4. Noise impact analyses for this Alternative are also based on a worst-case scenario that all mining equipment listed in Table 4.9-1 would be operating at the same time. For the Goslin Flats leach pad, noise levels for haul trucks, loaders, graders, and water trucks were used to estimate the worst-case noise level for leaching activities. The secondary and tertiary crushers to be sited near the leach pad were not included in the analysis because they would be enclosed in buildings.

Mine. The noise level for both the Landusky and Zortman mines was calculated to be 104 dBA at a distance of 50 feet from the mines. The noise level generated by activities at the Goslin Flats leach pad was estimated to be 99 dBA at a distance of 50 feet from the leach pad.

Using the method for noise attenuation with distance described in Section 4.9.1, noise levels from mining activities at the Zortman and Landusky mines were calculated at each sensitive receptor. The noise levels from the Zortman mine have been estimated at 59 dBA at Zortman, 52 dBA at Landusky, 53 dBA at the Pow Wow Grounds, and 55 dBA at Azure Cave. The noise levels from the Landusky mine have been estimated at 52 dBA at Zortman, 61 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 54 dBA at Azure Cave. The noise levels from the Goslin Flats leach pad have been estimated at 59 dBA at Zortman, 47 dBA at Landusky, 43 dBA at the Pow Wow Grounds, and 58 dBA at Azure Cave.

The frequency of all of the noise levels described above is considered to be continuous and would occur until mining and reclamation activities have been completed.

Noise generated at the Zortman Mine would exceed the outdoor activity criterion at Zortman. This impact would be significant and of a high magnitude. Noise generated at the Landusky Mine would exceed the criterion at Landusky and at the Pow Wow Grounds. These impacts would be significant and of a high magnitude. Noise generated at the Goslin Flats leach pad would exceed the criterion at Azure Cave and Zortman, resulting in significant impacts of a high magnitude. Noise impacts from mining operations at other receptor locations would generally be of a medium magnitude and not significant.

As with other alternatives, corrective actions for existing water quality problems would not be expected to have noise impacts greater than those described above. Noise levels would return to baseline conditions after mine operations, mine reclamation, and remediation is complete.

Roads. Under this Alternative, reclamation activities include the haulage of cover soil through the towns of Zortman and Landusky to the mines. Clay haulage would only be in support of leach pad liner development at the Goslin Flats. Noise levels from haul trucks are 88 dBA at 50 feet. If the haul trucks travel through town in convoys of fifteen trucks, a peak noise level of 98 dBA at 50 feet can be expected for short periods as the trucks pass through town. This is a significant, high magnitude impact of short duration. The frequency of haul trips required for leaching and reclamation activities at the Zortman Mine under this Alternative would peak at 5,500 in the year 2007. Reclamation would be expected to end and haul trucks cease at the Zortman Mine in the year 2007. Soil for reclamation covers at the Landusky Mine would be provided by existing stockpiles. Therefore, no truck trips through Landusky in support of reclamation activities at the Landusky Mine would be required.

4.9.9.2 Cumulative Impacts

The reasonably foreseeable developments under Alternative 7 include mining extension into Pony Gulch. The Pony Gulch area is approximately 4000 feet from Zortman. Noise levels from mining activities at Pony Gulch would be approximately 65 dBA at Zortman, 53 dBA at Landusky, 48 dBA at the Pow Wow Grounds, and 64 dBA at Azure Cave.

Cumulative noise impacts were estimated by logarithmically adding the impacts from mining and reclamation activities to representative or estimated background noise levels at the towns of Zortman and Landusky, the Pow Wow Grounds on the Ft. Belknap Reservation, and Azure Cave, plus noise levels from reasonably foreseeable activities. Average noise levels for these locations were listed in Section 4.9.3.2.

Combining background noise levels with those predicted to occur for Alternative 4 and under reasonable foreseeable development scenarios results in cumulative noise levels of 66 dBA at Zortman, 63 dBA at Landusky, 59 dBA at the Pow Wow Grounds, and 66 dBA at Azure Cave. Cumulative impacts at all receptor locations would be significant and of a high magnitude.

4.9.9.3 Unavoidable Adverse Impacts

The significant, high magnitude impacts described are considered unavoidable and adverse. It is possible some mitigation could be applied to help reduce the magnitude of, but not eliminate, the impacts.

4.9.9.4 Short-term Use/Long-term Productivity

Mining and reclamation noise impacts under this Alternative would last until 2007 for the Zortman mine and until 2002 for the Landusky mine (see Table 4.11-2). After reclamation is completed, noise levels would return to background levels.

4.9.9.5 Irreversible or Irretrievable Resource Commitments

There are no irreversible or irretrievable resource commitments for noise for this Alternative. Noise impacts would return to background levels after reclamation is completed.

4.10 SOCIOECONOMICS

4.10.1 Methodology

4.10.1.1 Economic Assumptions

For the socioeconomics analysis, descriptions of the proposed action and alternatives as presented in Chapter 2 have been supplemented by information presented in Chapter 3 about the existing Zortman and Landusky mines. Assumptions about the economic characteristics of the alternatives have been developed after reviewing additional information provided by ZMI (Ryan 1994 and 1995). The economic characteristics that most affect the socioeconomic analysis are employment, payroll, business expenditures, and tax payments. Assumptions about the magnitude and timing of these characteristics are summarized in Tables 4.10-1 through 4.10-4.

Under the non-expansion alternatives, Alternatives 1 through 3, mining would cease in the near future. Differences among the non-expansion alternatives in terms of projected employment, payroll, business purchases, and taxes reflect differing activities due to the modification of reclamation procedures proposed by ZMI under Alternative 2 and the agency-mitigated reclamation procedures proposed under Alternative 3. ZMI's total tax liability is estimated to be virtually the same under the three non-expansion alternatives because they are similar in terms of capital spending and the outputs of gold and silver. These outputs are the economic characteristics which drive ZMI's liabilities for property taxes and the gross proceeds and metal mines license taxes.

The expansion alternatives, Alternatives 4 through 7, would permit continued mineral development activity and the construction of expanded or new facilities at the Zortman and Landusky mines. Differences among the expansion alternatives in terms of projected employment, payroll, business purchases, and taxes reflect the various locations and configurations of heap leaching and ore and waste rock handling facilities, as well as differing methods and intensities of reclamation activity. The timing of additional construction, mining, and reclamation is similar among the expansion alternatives although Alternative 6 lasts a year less overall compared to Alternatives 4, 5, and 7. Differences in the timing of additional construction, mining, and reclamation also account for the differences in how employment levels begin to decline as the transition is made from mineral development activity to the activities of the closure cycle. This effect is most noticeable in Alternatives 5 and 6, where employment levels for the year 2004 are substantially lower than the employment levels projected for Alternatives 4 and 7 for the same year. ZMI's tax liability would differ somewhat among the expansion alternatives, mainly because of varying levels of capital expenditure and productivity. In general, however, differences among Alternatives 4 through 7 fall within a relatively narrow range.

Figures 4.10-1 and 4.10-2 illustrate the similarities and differences across all seven alternatives in graphical terms by plotting employment and spending from 1996 to 2012, the time horizon encompassed by this assessment. The employment levels plotted in the figure are taken from Table 4.10-1, and they represent direct ZMI employment. The spending levels are taken from Table 4.10-3, and they represent the sum of operating and capital expenditures, plus expenditures for contracting, all expressed in 1994 dollars.

Readers of the following assessment should note that in socioeconomic terms, the key difference between the non-expansion alternatives (Alternatives 1 - 3) and the expansion alternatives (Alternatives 4 - 7) is the timing of the end of mineral development activity, and therefore the timing of impacts upon the social and economic environment. The end of mineral development activity occurs almost immediately under Alternatives 1 through 3 and is delayed for 5 to 7 years under Alternatives 4 through 7. Despite the difference in timing, it should be emphasized that the impacts that would occur as a result of the end of mineral development would be similar and would inevitably occur under all alternatives, even though these impacts would be delayed for a number of years under the expansion alternatives.

Some consideration has been given in this analysis to the economic effects of reasonably foreseeable future actions which may be undertaken by ZMI. This includes mining of ore in the Pony Gulch area and exploration activities. Development of Pony Gulch potentially would occur under Alternatives 4, 6 and 7. This development would add about 2 million tons of ore (or about 2.5%) to the prospective 80 million tons to be mined under these alternatives, translating into about two months of additional mining activity. It is unlikely that this additional development would require ZMI to add employees; additional spending would be proportional to the amount of new ore to be extracted and therefore would be relatively small.

Reasonably foreseeable exploration activity would be a drilling program to possibly expand ore reserves or

TABLE 4.10-1

ASSUMPTIONS ABOUT DIRECT ZMI EMPLOYMENT: ALTERNATIVES 1-7
(full- and part-time jobs)

Year	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
1996	185	185	185	205	205	205	205
1997	25	108	185	238	238	238	238
1998	15	15	15	238	238	238	238
1999	15	15	15	238	238	238	238
2000	8	8	8	238	238	238	238
2001	5	5	5	238	238	185	238
2002	5	5	5	185	185	185	185
2003	5	5	5	185	185	185	185
2004	5	5	5	113	40	30	185
2005	3	3	3	25	25	20	30
2006				15	15	15	20
2007				15	15	5	15
2008				5	5	5	5
2009				5	5	5	5
2010				5	5	5	5
2011				5	5	5	5
2012				5	5		5
Cumulative	271	354	431	1,958	1,885	1,802	2,040

Note: Employment figures reflect average annual full- and part-time jobs direct with ZMI. Cumulative is in full- and part-time job-years.

TABLE 4.10-2

ASSUMPTIONS ABOUT ZMI PAYROLL: ALTERNATIVES 1-7
(in millions of 1994 dollars)

Year	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
1996	$6.198	$6.198	$6.198	$6.868	$6.868	$6.868	$6.868
1997	0.838	3.618	6.198	7.973	7.973	7.973	7.973
1998	0.503	0.503	0.503	7.973	7.973	7.973	7.973
1999	0.503	0.503	0.503	7.973	7.973	7.973	7.973
2000	0.268	0.268	0.268	7.973	7.973	7.973	7.973
2001	0.168	0.168	0.168	7.973	7.973	6.198	7.973
2002	0.168	0.168	0.168	6.198	6.198	6.198	6.198
2003	0.168	0.168	0.168	6.198	6.198	6.198	6.198
2004	0.168	0.168	0.168	3.786	1.340	1.005	6.198
2005	0.101	0.101	0.101	0.838	0.838	0.670	1.005
2006				0.503	0.503	0.503	0.670
2007				0.503	0.503	0.168	0.503
2008				0.168	0.168	0.168	0.168
2009				0.168	0.168	0.168	0.168
2010				0.168	0.168	0.168	0.168
2011				0.168	0.168	0.168	0.168
2012				0.168	0.168		0.168
Cumulative	9.083	11.863	14.443	65.599	63.153	60.372	68.345

Note: ZMI payroll is wages and salaries, excluding benefits. ZMI benefits average an additional 33 cents per wage and salary dollar. Contractor payrolls are accounted for separately, under total ZMI expenditures. Total is cumulative expenditure in millions of 1994 dollars.

TABLE 4.10-3

ASSUMPTIONS ABOUT TOTAL EXPENDITURES BY ZMI: ALTERNATIVES 1-7
(in millions of 1994 dollars)

Year	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
1996	$10.919	$10.919	$10.919	$42.371	$38.600	$44.350	$42.371
1997	1.585	5.733	9.927	28.433	32.975	31.385	28.370
1998	0.569	0.569	0.569	27.449	27.081	30.514	27.326
1999	0.358	0.358	0.358	27.410	27.042	30.475	27.288
2000	0.464	0.937	0.937	27.372	27.005	30.438	27.250
2001	0.041	0.041	0.041	27.336	26.968	15.811	27.205
2002	0.039	0.039	0.039	20.613	13.269	12.923	20.679
2003	0.032	0.032	0.032	13.441	12.491	2.026	13.380
2004	0.031	0.031	0.031	3.467	2.351	0.711	6.684
2005	0.030	0.030	0.030	0.705	0.705	1.416	0.705
2006				1.384	1.068	1.016	1.384
2007				0.993	0.800	0.068	0.993
2008				0.066	0.066	0.066	0.066
2009				0.064	0.064	0.096	0.064
2010				0.026	0.026	0.026	0.026
2011				0.025	0.025	0.025	0.025
2012				0.025	0.025		0.025
Cumulative	14.068	18.689	22.883	221.180	210.561	201.346	223.841

Note:Expenditures include operating and capital expenditures, plus expenditures for contracting. Capital expenditures include expenditures for capital projects, plus working capital charges. Cumulative expenditure in millions of 1994 dollars.

TABLE 4.10-4

ZMI TAX PAYMENTS ESTIMATES: ALTERNATIVES 1-7
(in millions of 1994 dollars)

Year	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
1996	$0.666	$0.666	$0.666	$2.030	$2.259	$2.315	$2.264
1997	0.302	0.302	0.302	2.102	1.947	1.676	1.640
1998	0.129	0.129	0.129	1.990	1.990	1.990	1.990
1999	0.091	0.091	0.091	1.990	1.990	1.990	1.990
2000	0.071	0.085	0.085	1.990	1.990	1.990	1.990
2001	0.019	0.019	0.019	1.990	1.990	1.258	1.990
2002	0.019	0.019	0.019	0.981	0.886	0.620	0.981
2003	0.012	0.012	0.012	0.404	0.260	0.254	0.404
2004	0.012	0.012	0.012	0.230	0.134	0.134	0.230
2005	0.012	0.012	0.012	0.134	0.096	0.091	0.134
2006				0.091	0.071	0.071	0.091
2007				0.054	0.020	0.019	0.054
2008				0.019	0.019	0.019	0.019
2009				0.012	0.012	0.012	0.012
2010				0.012	0.012	0.012	0.012
2011				0.012	0.012	0.012	0.012
2012				0.012	0.012		0.012
Cumulative	1.333	1.347	1.347	14.053	13.700	12.463	13.825

Note: Tax payments estimate represent estimates of ZMI's total liability for ad valorem taxes due Phillips County on real and personal property and gross proceeds, plus liability for Metal Mines License Taxes due the State. Total tax liabilities are to be further allocated among taxing entities within the County and entities due Metal Mines License Tax allocations by statute. Total is cumulative tax payments in millions of 1994 dollars.

Fig. 4.10-1. Direct ZMI Employment

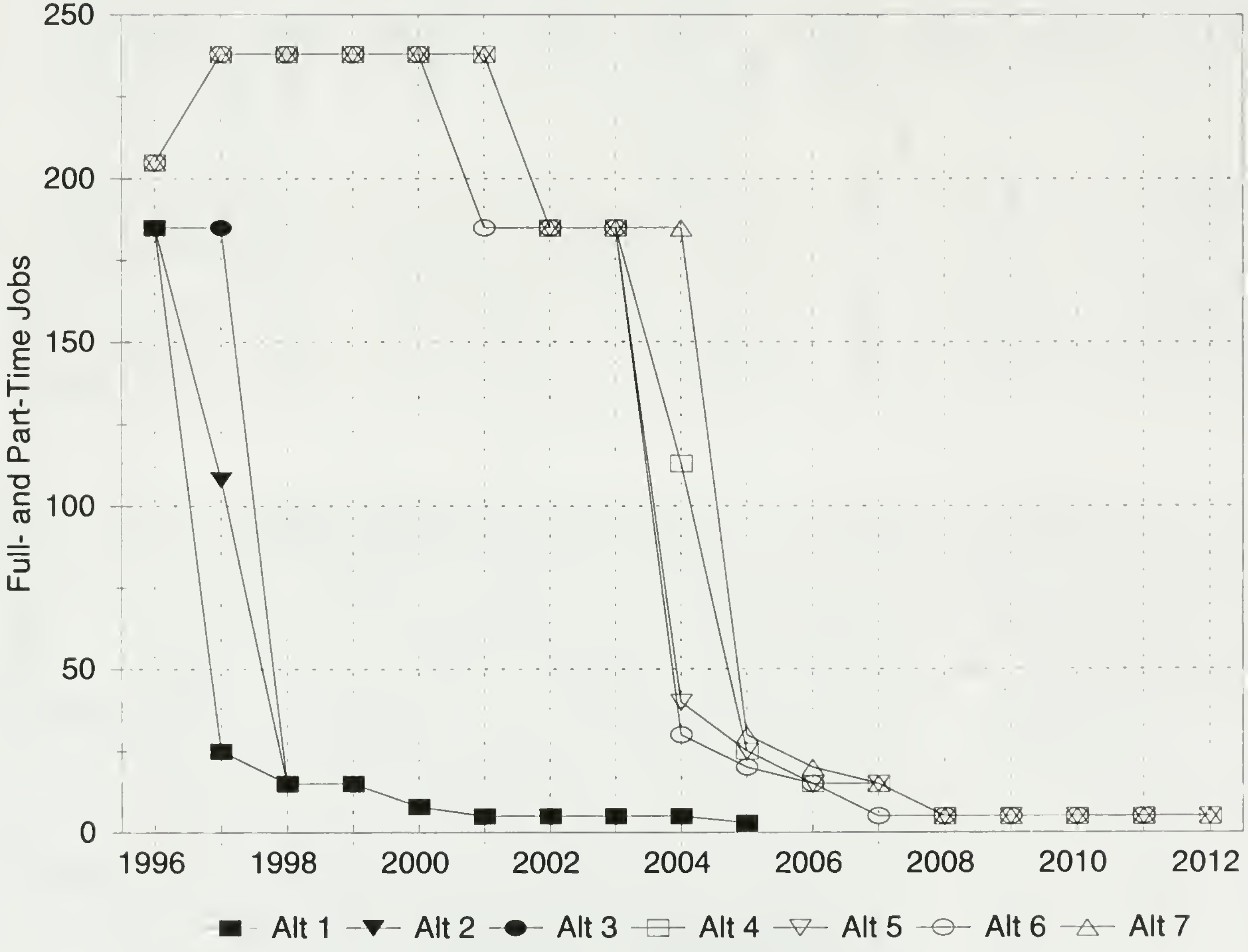
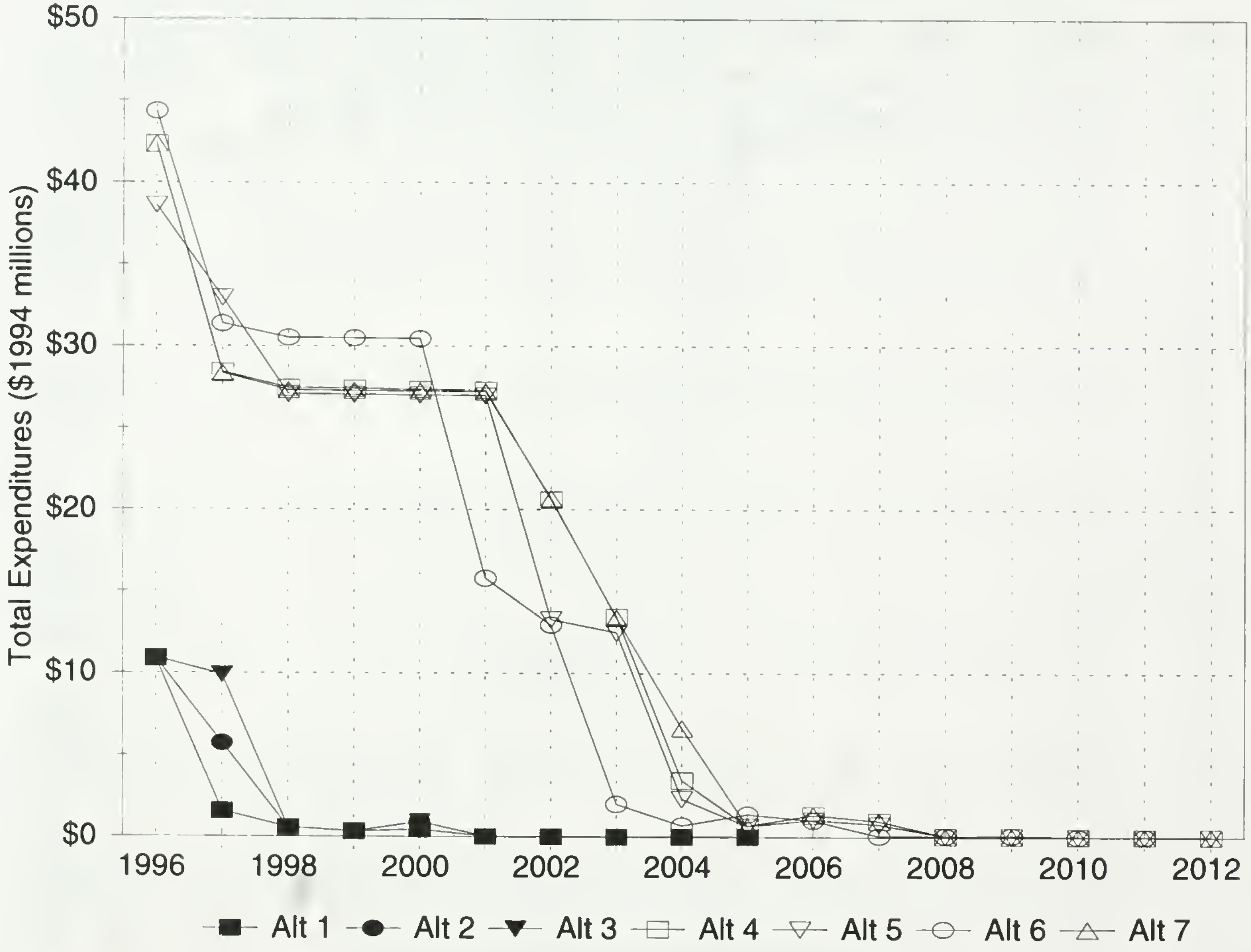


Fig. 4.10-2. Total Expenditures by ZMI (in $1994 millions)



further define existing reserves. Such a program could involve a contract drilling crew of about 4 persons costing ZMI between $100,000 and $200,000 per year in each of 3 to 5 years. ZMI potentially could hire a local company, as it has in the past, or an outside contractor, in which case perhaps one-fifth of exploration expenditures would be made locally. In either case, local or outside contractor, the additional employment and spending would be quite small in comparison to proposed spending levels under Alternatives 4 through 7.

Therefore, reasonably foreseeable future actions, namely mining of Pony Gulch and exploration activity, would not materially change the magnitude, character, or evaluation of any of the impacts associated with Alternatives 4 through 7.

4.10.1.2 Economic Impact Assessment Methods

Economic impacts are measured in terms of changes in employment, earnings, total population and numbers of school age children. Employment and earnings changes were estimated using a multiplier approach similar to the one described in a report by the U.S. Department of Commerce (USDOC 1992). A multiplier is an economic ratio used to estimate the secondary economic repercussions of a direct economic impact.

Dollar impacts have been converted to 1994 dollars for consistency. Employment and earnings reflect jobs and earnings counted at the work site, regardless of where the person holding a job lives. In contrast, per capita income effects (which are described qualitatively in the following sections) reflect the income of workers by place of residence.

Multipliers used in the analysis were those available for the State of Montana as a whole from the Regional Input-Output Modeling System (RIMS II) of the Regional Economic Analysis Division, Bureau of Economic Analysis, USDOC (1992). County-level impacts and study area-level impacts were estimated by allocating expenditures to the counties and the study area, and then applying the state-level multipliers to each expenditure type. The allocations reflect local spending information obtained from ZMI (Eickerman 1993).

Changes in total population and school-age population were estimated from changes in total employment by using factors derived from information in Section 3.10. Perhaps the most important issue concerning changes in total and school-age population is the potential for outmigration of households of employees laid off due to ZMI's closure. The outmigration projections in this assessment are derived from the changes in direct and secondary employment estimated and projected as described above.

To develop factors needed to derive outmigration from employment changes, interviews were conducted with ZMI and knowledgeable individuals in the community to gather information about the percentage of workers with strong local ties and an impression of the likelihood of different types of workers to stay or out-migrate after loss of employment at ZMI (Boothe 1994, Boland 1994, Ereaux 1994, Erickson 1994, Kalal 1994, Rust 1994, Soiseth 1994).

Based on the information gathered in this process, assumptions were developed for three categories of workers. First, ZMI's managerial and professional employees, about 15 percent of ZMI employment, are all assumed to out-migrate because no comparable employment in gold mining would be available locally. Second, half of the hourly work force and their households are assumed to out-migrate. On one the one hand, this reflects the fact that about 77 percent were hired locally (BLM 1992a) and have strong ties to communities in Phillips and Blaine counties through land ownership, involvement in agriculture, family allegiances, and other personal relationships. On the other hand, the local economy probably would not be strong enough at time of closure, either sooner under the non-expansion alternatives or later under the expansion alternatives, to offer satisfactory replacement employment for the long-term. If all workers with local ties were to remain in place, the outmigration rate for hourly workers would be about 23 percent. This has been increased to 50 percent on the assumption that some locally-hired workers would out-migrate for economic reasons and despite local ties. Finally, it was assumed that households of workers employed in communities as a result of secondary spending impacts would out-migrate at the same rate as hourly ZMI workers. After using these assumptions to project total outmigration, outmigration by community was projected in proportion to residency of the ZMI work force by community.

Readers of this assessment should note that the state-level multipliers used reflect conditions found in the Montana economy as a whole, an economy that is much more diversified than the local economies within the study area. Secondary, or multiplier, effects are smaller in local economies, like Phillips and Blaine counties, because of leakage, the loss of local business and household spending to markets and trade centers outside the local area. If accurate local multipliers were available for Phillips and Blaine counties, they would be smaller than the multiplier for the state as a whole. However, accurate local multipliers were not available and could not be estimated for this assessment.

The state-level multiplier has been used instead. As a result, employment, earnings, and population impacts are probably overstated. In other words, the secondary effect of ZMI's operation within the local economies of Phillips and Blaine counties probably is less than has been estimated and reported in this assessment. Similarly, the potential secondary effect of ZMI's closure probably would be less than has been projected and reported in this assessment.

Projections of outmigration presented in this assessment also probably overstate the amount of outmigration that actually would occur. In general, this is because of the combined effect of the uncertainty associated with each of the factors used to produce the projections. First, the projections of outmigration are derived from estimates and projections of employment change; therefore, they are subject to the limitations of the multiplier analysis used to estimate the secondary economic effects of ZMI employment in Phillips and Blaine counties. These limitations are discussed above. Second, there is the uncertainty associated with the outmigration rates developed for this assessment. Empirical information available was limited to the percentage of locally hired employees. Other rates have been assigned based upon impressions gathered from sources cited above, theory and professional experience. This approach may not sufficiently account for the strength of local ties, willingness to accept a lowered standard of living, or the possibility that other economic opportunities may arise at some point in the future, all contingencies that may mitigate the tendency for chronically unemployed or underemployed households to out-migrate to regions where there are job opportunities. In addition, information was not available to account for households containing more than one job holder; this adds to the overstating outmigration. Finally, note that actual outmigration by community may vary from the community-level projections presented here.

4.10.1.3 Facilities and Services Impact Assessment Methods

Facilities and services impacts were assessed by determining whether estimated population changes in communities of the study area would potentially alleviate or aggravate the specific limitations described in Section 3.10.

4.10.1.4 Fiscal Impact Assessment Methods

Changes in local government fiscal conditions were assessed for selected jurisdictions by comparing estimated changes in revenues and expenditures. Jurisdiction-specific revenues generated by the mines were projected from information presented in Section 3.10, combined with information provided by ZMI (Ryan 1994 and 1995) on the level of operation of the mine under each alternative.

Funds from the Phillips County Hard Rock Trust Reserve would be available to local officials to directly address the economic and fiscal effects of mine closure in Phillips County. These funds would potentially be available within a year or two after a decision is made to proceed under Alternatives 1 through 3 and within a year or two after the cessation of mining under Alternatives 4 through 7. The use of Hard Rock Trust Reserve funds to alleviate economic and fiscal impacts has been considered in the evaluation of impacts under the alternatives. These provisions would not address the localized economic impacts of closure in the community of Hays on the Fort Belknap Indian Reservation.

4.10.1.5 Social Impact Assessment Methods

Impacts on social conditions were assessed by considering the potential effects of the alternatives on objective conditions and attitudes affecting the sense of well-being or perception of the local quality of life among various groups as described in Section 3.10. The potential effects of the alternatives were projected on the basis of theory and professional experience. No scientific surveys or formal interviews with representatives of potentially affected groups were conducted in connection with this analysis.

To the extent there is some alleviation of economic and local government fiscal distress by the allocation of moneys from the Hard Rock Trust Reserve, some of the negative effects of mine closure on the sense of well-being also may be alleviated for Phillips County residents. This potential effect has been considered in the evaluation of the social impacts of the alternatives.

4.10.1.6 Impact Assessment Criteria

Potential socioeconomic impacts were determined to be either positive or negative, and were evaluated for significance (see introductory comments on impact methodology, Section 4.0).

Impacts are determined to be positive or negative according to the following definitions:

- Increases in employment and earnings are considered positive; decreases are considered negative.
- Increases in population are a positive economic impact, but may lead to negative facilities, services, or fiscal impacts.
- Facilities and services and fiscal impacts often interact; therefore these potential effects are considered in combination with each other. Impacts are positive if resources are created which allow for the alleviation of existing deficiencies in the balance of supply and demand or in the quality of service. Impacts are negative if demands are created without adequate resources to enhance supply or the quality of service. Impacts also are negative if surplus supply is created or left in place without adequate resources to support it.
- Social impacts are positive if they enhance a group's sense of social well-being or satisfaction with the quality of life. Social well-being may be enhanced by positive changes in socioeconomic factors (e.g., more jobs, higher incomes, lower taxes, better services, more shopping alternatives or a wider selection of commercial services), or by effects (or perhaps no effect) upon social, political or environmental characteristics that are in agreement with a group's strongly-held preferences. Environmental changes that can have an effect on social well-being and general satisfaction with the quality of life may include, but are not limited to, aspects of the physical and social environment such as recreation, transportation, water quality, air quality, noise, the ability to pursue habitual, customary, or traditional lifestyles, and the appearance of one's surroundings. Note that social impacts may differ for different groups within a community and therefore may not be identifiable or subject to evaluation in the aggregate.

The following topic-specific criteria for significance were also used:

- Economic and demographic impacts were rated significant if changes represented 10 percent or more of base conditions. Duration also was taken into account; impacts lasting more than a year are considered long-term and therefore of greater potential significance.
- Combined facilities, services and fiscal impacts were considered significant if changes in supply, demand, revenues, or expenditures would cause or prolong a lasting strain on the ability of an affected entity to maintain established or appropriate services or levels or service; or would leave an entity with excessive operating or debt service costs which cannot be reduced to match projected resources.
- Social impacts were considered significant if changes in social well-being would be manifested in lasting changes in group lifestyles or social behaviors.

Most impacts were evaluated in the local context or, in other words, whether they are significant when compared to existing conditions at the local level. However, statewide economic effects also were considered and were evaluated in a statewide context.

The following general criteria also were considered in evaluating the significance of impacts: the likelihood of the impact occurring, the extent to which an impact is reversible or may be mitigated, whether there is controversy over the impact, and whether the impact is relevant to the agencies' decision to permit or curtail additional mining activities.

4.10.2 Impacts of the Zortman and Landusky Mines, 1979 to 1994

The existing Zortman and Landusky mines have been in operation in Phillips County since 1979. At that time, no other economic activity approached agriculture in importance in Phillips County and in the Little Rockies area. Over time, the mines have added diversity to an economy hampered by limited natural resources and distance from population centers. Initially, the mines created about 30 to 40 direct jobs in Phillips County, (DSL 1979a), a level that equated to about 1 percent of all the jobs available in the county in 1980. By 1985, there were about 190 direct jobs at the mines, consisting of about 90 jobs with Zortman Mining Inc. and about 100 jobs with contract miner N.A. Degerstrom (DSL/BLM 1990). Currently employment at the mines averages about 200 workers. The mines also employ about 20 additional persons annually between April and October to perform reclamation and other seasonal work.

Since their inception, the Zortman and Landusky mines have had a significant effect on the economic situation in Phillips County by diversifying the local economy, increasing local employment and earnings, and contributing to the local tax base. ZMI also has caused significant growth in Zortman and supported or enhanced property values in Phillips County, Malta, and Zortman. In Landusky, there seems to be little economic effect from the mines. ZMI has had little economic impact upon Blaine County or the bulk of the Fort Belknap Indian Reservation. However, jobs available at the mines are accessible to and are now being held by residents of Hays in the southern part of the reservation, providing employment for and improving the economic well-being of a number of households.

Social impacts of ZMI have been significant and beneficial in Malta and Zortman over the past 15 years, as mine employees have integrated into and strengthened local social structures. The impact of the mines on the social environment on the Fort Belknap Indian Reservation has been significant as well, and generally adverse. Although some Native Americans residing on the reservation are employed by ZMI and feel better off economically, many Native Americans oppose the mine and have expressed a high level of concern about its presence because of impacts on social and cultural activities, on sites of contemporary or heritage significance, on lifestyles which depend upon access to relatively natural land within the Little Rocky Mountains, and on watersheds which drain into the Fort Belknap Indian Reservation.

Table 4.10-5 presents total employment in Phillips County from 1979 to 1994 compared to the estimated number of direct and secondary jobs attributable to ZMI. For almost the entire 15-year period, employment attributable to ZMI has ranged between 8 percent and 16 percent of total employment in the county. Estimates for 1993 and 1994 show the influence of new shifts added at the mines and contract employment for reclamation and their effects on generating additional employment in Phillips County. The effect on earnings within the county has been proportionate to employment. ZMI's contribution to employment in Phillips County is illustrated graphically in Figure 4.10-3. (Impacts in Phillips County may be overstated, as described in Section 4.10.1.2)

The diversifying effect of ZMI's operations was felt most strongly in 1988 when the American Colloid bentonite operation, which also opened in 1979, closed abruptly. The impact of the departure was softened by the concurrent increases in ZMI's level of activity (Halverson 1994).

ZMI also has had a significant effect on the tax base of Phillips County. In 1978 the taxable value of Phillips County was about $14.5 million. Table 4.10-6 presents the taxable value of the combined Zortman and Landusky mines from 1979 to 1988. The total taxable valuation of Phillips County in 1988 was $32.8 million. The combined taxable valuation for ZMI and its construction and mining contractor was a total of about $2.3 million in 1988, or about 7 percent of the taxable valuation of Phillips County. In 1994, the Zortman and Landusky mines provide about 20 percent of the county's ad valorem tax base (Barnard 1994).

After 1988, equalization of valuations by the State caused a reduction of 14 percent in Phillips County's valuations (Barnard 1994). In the past few years, the state legislature made changes in tax categories and percentages of value that are taxable. The result is that in 1983 the county's property had a market value of $214 million and a taxable value of $35 million; in 1993 the county's property had a market value of $280 million but a taxable value of only $20 million—all due to the legislated changes (Halverson 1994).

The taxes paid by ZMI and its contractor have been significant for Phillips County. The $587,324 in taxes paid in 1989 was about 13 percent of the Phillips County government's non-levied tax budget for the year. From 1983 on, ZMI also paid the Metalliferous Mines License Tax, Resource Indemnity Trust Tax, and the Gross Proceeds Tax to the state of Montana. Note that all of the gross proceeds tax, except for a six mill university system levy, was returned to Phillips County during this period (DSL/BLM 1990). The total direct tax contribution of the mines to various taxing jurisdictions in Phillips County, mainly Phillips County government and school districts in Landusky, Malta (which includes the Zortman Elementary School), and Dodson, has fluctuated over the years, but has generally been within the range of $1 million to $1.2 million per year since about 1983.

A significant impact of ZMI's operations over the past 15 years has been to cause the town of Zortman to grow. Zortman's population is about 150 people, up

TABLE 4.10-5

TOTAL AND ZMI EMPLOYMENT IN PHILLIPS COUNTY, 1979 TO 1994
(full- and part-time jobs)

Year	Total Phillips County Employment	Direct and Secondary Employment Due to ZMI	Direct and Secondary Employment due to ZMI as Percent of Total
1979	2,508	70	0.03
1980	2,574	220	0.09
1981	2,532	260	0.10
1982	2,547	290	0.11
1983	2,647	300	0.11
1984	2,705	320	0.12
1985	2,574	300	0.12
1986	2,679	300	0.11
1987	2,689	310	0.12
1988	2,737	330	0.12
1989	2,784	330	0.12
1990	2,857	330	0.12
1991	2,782	310	0.11
1992	2,730	330	0.12
1993	2,760	380	0.14
1994	2,800	460	0.16
Cumulative	42,905	4,840	0.11

Sources: Total Phillips County employment from 1979 to 1992 from USDOC, Bureau of Economic Analysis 1994. Other estimates by Planning Information Corporation. Total employment is expressed in terms of full- and part-time job-years.

Fig. 4.10-3. Total and ZMI Employment in Phillips County, 1979-1994

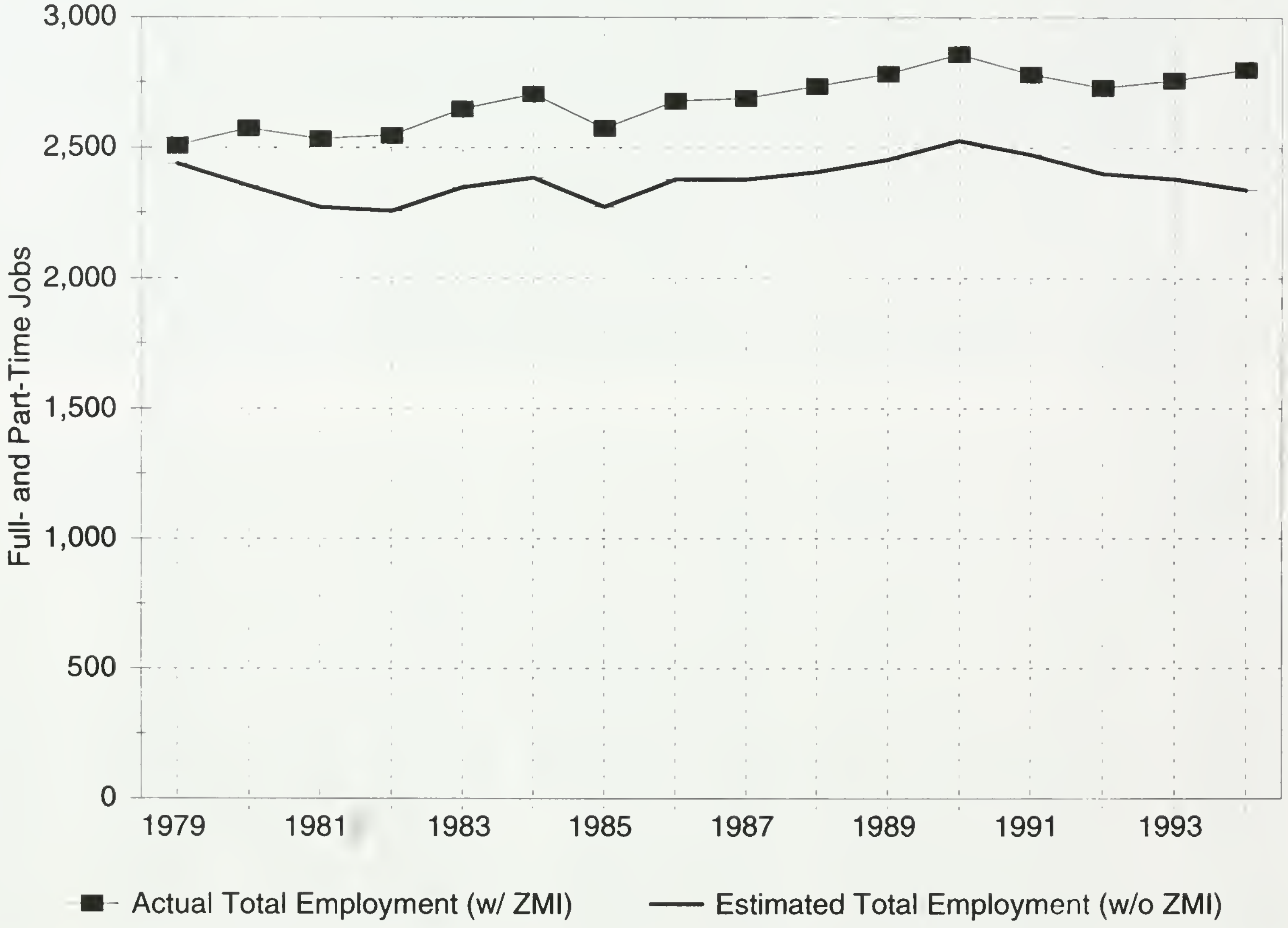


TABLE 4.10-6

TAXABLE VALUATION OF PHILLIPS COUNTY ATTRIBUTABLE TO THE ZORTMAN-LANDUSKY MINES, 1979 TO 1988

(in current dollars)

Year	Taxable Valuation of Mines	Taxable Valuation of Contractor Equipment	Taxable Valuation of Phillips County	Mine/Equipment Valuation as Percent of Total
1979	$ 45,949	$0	$19,151,583	< 1%
1980	950,036	384,449	25,135,640	5.3%
1981	504,106	131,806	26,645,930	2.4%
1982	413,620	455,252	32,895,781	2.6%
1983	1,018,006	539,360	35,121,783	4.4%
1984	787,758	673,155	39,347,917	3.7%
1985	594,251	714,335	38,313,122	3.4%
1986	1,006,854	835,674	27,107,642	6.8%
1987	1,493,866	684,503	32,650,350	6.7%
1988	1,493,658	772,145	32,839,024	6.9%

Sources: DSL 1990; and Phillips County Assessor's Office 1994.

from 10 residents only 15 years ago. In 1979, Zortman had two retail establishments, a small saw mill, and a self-employed building wholesaler (DSL 1979a). Zortman now has a post office, grocery store, bar and cafe, garage and motel, volunteer fire department and ambulance service, cable television, and a public water system which was developed by ZMI but is operated by the community (Boland 1994).

General tourism is not a factor in Zortman's economy although a few fossil hunters, geologists, and bird watchers come to Zortman from time to time. Hunting is a factor seasonally, and involves predominantly deer hunting and prairie dog shooting, with some elk hunting. Housing prices are stable now, but demand has diminished as people await a decision regarding ZMI's future (Boland 1994).

Impacts of ZMI's operations on the community of Landusky over the past 15 years have been mixed. Five Landusky households, or about a third of the households in the community, include mine employees, and two or three children from these households attend the Landusky Elementary School. ZMI offered to develop but not operate a water system for the town, but the offer was declined because of the cost to maintain the system. A few residents of the Landusky area have been concerned about water runoff from the mine and the changing face of the mountain (Mitchell 1994).

The presence of ZMI's operations has tended to support the value of private property in Phillips County. Therefore, property values have remained relatively stable over the past 15 years, in spite of the general lack of economic growth (Halverson 1994). ZMI bought a few lots near Camp Creek Acres for a landing strip (Barnard 1994), some near Seven-Mile Road for a leaching pad (Boland 1994), and an older house in Landusky, right below the mine as a buffer (Knudson 1994). Though the company paid relatively high prices for the lots, this has not affected sales prices in general (Knudson 1994).

Housing prices have been stable in Malta, too, at least up until about two years ago, when they began to rise and some new home construction was stimulated because a greater demand arose for houses to purchase than the market could provide. A house built and sold in 1989 for $70,000 would sell today for $90,000. ZMI itself owns five to seven houses for its upper management. More recently, uncertainty about the future of the Zortman and Landusky mines has caused demand for housing in Malta to fall off again (Knudson 1994).

Because most of the ZMI's employees and all of its property are physically in another county, the mine's presence has had little effect on the economy and property values in Blaine County. Prices for homes have been stable or fallen in past few years, and the housing market has been very slow recently (McMaster 1994).

ZMI's operations have provided a job base accessible to the Hays-Lodgepole area near the southern boundary of the Fort Belknap Indian Reservation and in the areas of the Reservation extending northward into Phillips County. These parts of the reservation had virtually no stable economic base and high unemployment in 1979 (DSL 1979). In 1993, according to ZMI, 41 employees of the mine were Native American (Eickerman 1993). Several ZMI employees live in Hays, although none currently live in Lodgepole (Ryan 1994). It is not known how many Native American employees of ZMI are members of the Fort Belknap Indian Community.

The amount of privately-owned land on the Fort Belknap Indian Reservation is very small, and land values have not been affected by ZMI's presence over the past 15 years (Sather 1994).

Recreation resources which generate employment and income in Phillips and Blaine counties have been impacted by ZMI's operations between 1979 and 1994. Impacts like conversion of land to industrial use, access restrictions, and the indirect effects of visible and audible disturbance, all of which are known to reduce the quality of the recreation experience (see Section 4.7), have probably affected hunters, campers, picnickers, hikers, and sightseers, all of whom may contribute in some degree to the local economy (BLM 1992). Although developed recreation facilities and lands accessible to hunters and other dispersed recreationists continue to be used in the vicinity of the Zortman and Landusky mines, (SBS Economic Consulting 1990, Martin 1993), it is probable that the level of recreation use prevailing from 1979 to 1994 has been lower than it would have been otherwise, absent ZMI's operations. However, information is not available to estimate, in numerical terms, the level of use that has occurred, the magnitude of the impact on use, and the resulting indirect economic impact on the local economy, in terms of employment and income changes.

The Zortman and Landusky mines have had a beneficial impact on consumer electric rates charged by the Big Flat Electric Cooperative over the past 15 years. Big Flat purchases its electricity from a generation and transmission company, and the constancy of demand for power by the mine decreases the unit price of electricity significantly. The mine accounts for about 50 or 60 percent of the Big Flat's electric sales. The nature of the mine's operations (24 hours a day, seven days a week) causes a leveling of the demand for electricity by the cooperative, and, in turn, the cooperative's supplier lowers its demand charge to the cooperative. This lower cost is reflected in rates for all users of Big Flat (residential and commercial) as well as the mine (Henderson 1994).

The lower electric rates charged by Big Flat have disproportionately benefited homes heated by electricity within Big Flat's service area. These are concentrated in rural areas of Phillips and Blaine counties where natural gas is not available. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation (Fewer 1995). Households heating with electricity benefit from lower rates because of the lower total cost they incur for the higher consumption of electricity that electric heat entails, especially in the winter months.

4.10.3 Impacts from Alternative 1

4.10.3.1 Impacts

Under Alternative 1 (the No Action Alternative), mining at the Zortman and Landusky mines would cease in the near future but certain permitted actions including ore leaching and rinsing would continue as a transition is made to reclamation and closure activities. As a result, Phillips County and the communities of Malta and Zortman would sustain almost immediate significant negative impacts to economic and fiscal conditions, community resources, and social well-being among its residents. Impacts also would be felt in Blaine County. However, impacts in Blaine County would be small compared to existing conditions. Businesses elsewhere in the state of Montana would be negatively affected, especially those in Billings and Helena which supply ZMI with goods and services. Property values potentially would decline in Phillips County, and especially in the communities of Malta and Zortman. There would be a significant increase in the amount that consumers pay for power purchased from the Big Flat Electric Cooperative.

The State treasury would sustain revenue losses over time; however, this impact also would be relatively small. Economic effects on the Fort Belknap Indian Reservation would be minor, and there would be no fiscal impact there because no direct revenues are derived from the mine. On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed (Eickerman 1993).

Social impacts of the alternative would be significant and negative, especially in Malta and Zortman where mine employees and their families are an integral part of local social structures. The impact of Alternative 1 on the social environment on the Fort Belknap Indian Reservation would be significant and generally beneficial. Although some Native Americans residing on the reservation are employed by ZMI and would be adversely affected in terms of economic well-being, many Native Americans who oppose the mine and have expressed a high level of concern about its presence would perceive an improvement in the local quality of life as closure activities begin and the mines ultimately are closed.

Under Alternative 1, ZMI would continue to mine under its current permits through the end of 1995. The closure cycle of residual leaching, rinsing and final reclamation would begin in 1996. Final reclamation would occur by the year 2000, and some on-site monitoring activity would take place through 2005. The direct employment, payroll and expenditure associated with ZMI's continued operations under Alternative 1 are presented in Tables 4.10-1 through Table 4.10-3.

Table 4.10-7 summarizes the economic and fiscal impact impacts of Alternative 1 compared to the impacts of Alternatives 2 and 3. Under Alternative 1, ZMI's operations from 1996 to 2005 would cumulatively generate a total of 561 job-years of direct and secondary employment and $14.8 million in 1994 dollars of direct and secondary earnings within the state of Montana. This would include 437 job-years of employment and $12.3 million in 1994 dollars of earnings in Phillips County. During the same period, Blaine County would accumulate a total of 20 job-years of employment and $400,000 in earnings in 1994 dollars. (A job-year is a full- or part-time job held for a year, on average. Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2)

Significant negative economic impacts would occur almost immediately under Alternative 1 because ZMI would begin to scale down its activities almost immediately and ultimately would eliminate all jobs and spending at the Zortman and Landusky mines. Cutbacks would begin in 1996 or 1997 under Alternative 1. By 1998, there would be only 15 jobs at the Zortman and Landusky mines, down from 260 jobs in 1994. This reduction of 94 percent in direct employment would occur within the space of only four years. The impacts of this reduction in employment would be felt almost

TABLE 4.10-7

ECONOMIC AND FISCAL IMPACTS OF ALTERNATIVES 1-3 FOR THE PERIOD 1996-2005

Impact	Alternative 1	Alternative 2	Alternative 3
Employment (cumulative, in job-years)			
Montana	561	744	909
Phillips County	437	571	698
Blaine County	20	26	32
Earnings (cumulative, in millions of 1994 dollars)			
Montana	$14.8	$19.5	$23.8
Phillips County	12.3	16.0	19.6
Blaine County	0.4	0.5	0.6
Direct Tax Revenues (cumulative, in millions of 1994 dollars)			
Montana	$0.44	$0.44	$0.44
Phillips County	0.25	0.25	0.25
Malta School Districts	0.12	0.12	0.12
Dodson High School District	0.11	0.11	0.11
Landusky School District	0.07	0.07	0.07
City of Malta	Negligible	Negligible	Negligible
Phillips Co. Hard Rock Trust Reserve	0.06	0.06	0.06

Notes: Employment and earnings impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2. Employment is cumulative direct and secondary full- and part-time employment generated by ZMI operations. A job-year represents one full- or part-time job offered for one year within a particular area. The amounts in the table are the cumulative sums of employment, earnings, and direct tax revenues generated by ZMI activity over the life of the alternative. The Zortman Elementary School is operated by the Malta Elementary School district. Montana tax revenues are due to the Metal Mines License Tax. Local tax revenues are due to ad valorem taxes on real and personal property and gross proceeds of mines.

immediately. Smaller impacts would be felt as more reductions are made in employment and spending due to the gradually declining level of intensity of closure activities extending through the year 2005, the last year in which it is projected ZMI would require any jobs at the mine sites. Note that even though negative impacts would occur in the near future under Alternative 1 (and under Alternatives 2 and 3), as compared to Alternatives 4 through 7, ultimately these impacts are inevitable under all alternatives.

The impact of first job cutback, including its secondary repercussions, would be relatively large in comparison to the size of the Phillips County economy. Expressed on an average annual basis, ZMI's operations in 1994 generated a total of 460 direct and secondary jobs (a 16% impact) and $12.8 million in earnings (24% impact) within Phillips County. Almost all of the impact would be felt within four years, resulting in a significant shock to the local economy. Figure 4.10-4 illustrates the impact of Alternative 1 (and, for comparison, the impacts of Alternative 2 through Alternative 7) on projected total employment in Phillips County through the entire time horizon projected for both the non-expansion and expansion alternatives.

Economic impacts also would be felt in Blaine County, where ZMI's operations in 1994 generated a total of about 19 secondary jobs and $350,000 in earnings on an average annual basis. The loss of this economic activity would constitute an impact of less than one percent to the economy in Blaine County. However, the impacts within Blaine County would be concentrated on the Fort Belknap Indian Reservation, where a number of mine employees reside. (Impact in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.)

The State of Montana as a whole also would lose direct and secondary jobs and earnings. As a whole the impact on the state economy would not be significant. However, effects would be noticeable in specific cities where businesses are located that provide goods and services to ZMI. In the past, ZMI has made business expenditures ranging from a few thousand dollars a year to millions of dollars a year in 25 or more cities around the state. The most affected city would be Billings, where ZMI spent $6 million in 1993.

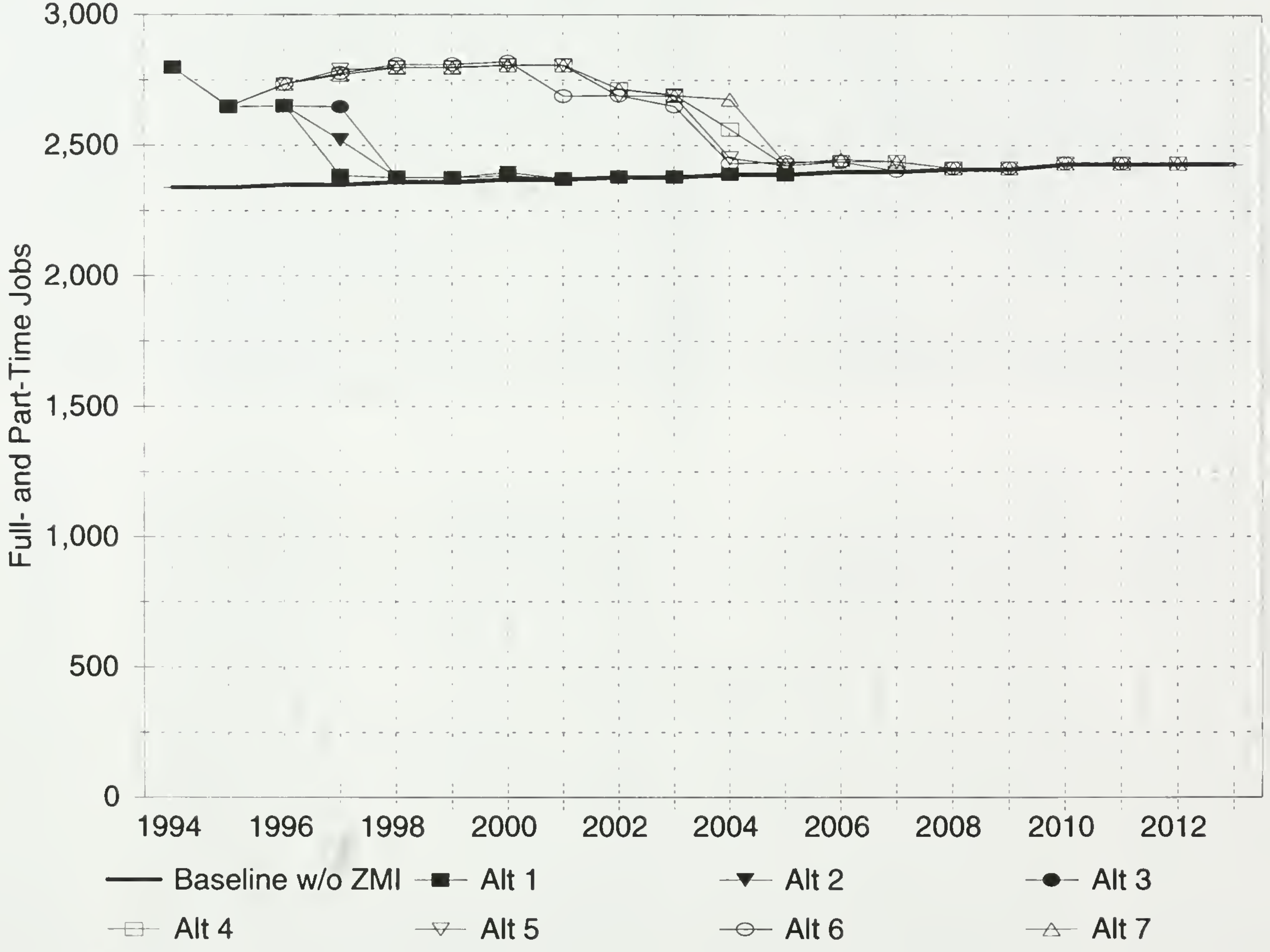
In the short-term, Alternative 1 would negatively affect the local economy as a whole; however, the alternative simultaneously may benefit specific economic sectors that depend on spending by recreationists attracted to the area by its recreation resources. Recreation resources that generate employment and income in Phillips and Blaine counties have been impacted by ZMI's operations in the past; Alternative 1 would continue these impacts until the Zortman/Landusky County road is restored to public use and reclamation and revegetation begins to take effect, reducing the indirect impacts of land disturbances. Once that occurs, business in the retail trade and services sectors of the economy (such as eating and drinking places, lodging places, suppliers, and outfitters) potentially would be affected if an improvement in the quality of recreation resources leads to more than expected hunters, campers, hikers, and sightseers using lands surrounding the Zortman and Landusky mines. The information needed to estimate this beneficial effect in numerical terms is not available. Although likely to occur, the economic repercussions of this effect probably would be quite small, especially in comparison to the adverse effects of mine closure. However, the impact does represent the restoration of some recreation-based economic development potential, due to the reduction of impacts on recreation resources; this would occur in exchange for the loss of the economic development due to mine closure, as described above.

Outmigration potentially would occur as ZMI eliminates jobs although several factors would reduce the impact of the layoffs on the population within the study area. Current ZMI employees, many of whom were hired from the local labor force, maintain strong ties to communities in Phillips and Blaine counties through land ownership and involvement in agriculture, family allegiances, and other personal relationships.

Because of these ties, many newly unemployed workers would attempt to stay in the area. This probably would require a reduction in earnings and standard of living since, given recent trends, few jobs comparable to those offered by ZMI are likely to be available within the local economy. Others may not leave the area simply because of a lack of job availability in other nearby areas. Also, some of the jobs at the Zortman and Landusky mines (and perhaps at potentially affected trade and service businesses) currently are held by persons who reside outside the study area and therefore are not accounted for directly in this assessment.

The projections of outmigration that follow probably overstate the amount of outmigration that actually would occur over time, following closure of the Zortman and Landusky mines. Section 4.10.1.2 discusses the methods and assumptions used in the outmigration analysis and their limitations. Based on these assumptions, it is projected that approximately 150 direct and indirect worker households would out-migrate from Phillips County and about 10 direct and indirect worker

Fig. 4.10-4. Baseline and Impact
Total Employment in Phillips County



households would out-migrate from Blaine County. Note that the potential exists for outmigration of worker households from Blaine County even though most ZMI employees living in Blaine County are residents of the Fort Belknap Indian Reservation who have very strong personal, social and economic ties to their place of residence.

Assuming 150 households would out-migrate, the total impact on the population of Phillips County would be an outmigration of about 400 persons (an impact of about 8%). This number potentially could include about 160 school-age children. Similarly, assuming an outmigration of 11 households, the total impact on the population of Blaine County would be an outmigration of about 40 persons (an impact of less than 1%). This total potentially could include about 10 school-age children. The estimates of total population and school-age children in relation to worker households are based on relationships that have actually existed within the current ZMI workforce, as reported by ZMI (Eickerman 1993).

Key communities in Phillips County that potentially would experience outmigration of direct and indirect worker households are Malta (100 households, 330 persons, and 130 school-age children) and Zortman (45 households, 50 persons, and 20 school-age children). Some ZMI worker households also reside in Dodson and Landusky, so these communities may experience outmigration; however, specific projections of outmigration are likely to be inaccurate because only a small number of households are involved. In Blaine County, the community of Hays potentially would experience outmigration of a projected 6 households, 20 persons, and 6 or 7 school-age children. Some ZMI worker households reside in Harlem, too; however, a specific projection of outmigration from Harlem is likely to be inaccurate because of the small number of households involved.

Although ZMI would eliminate jobs quickly under Alternative 1, population outmigration would occur more gradually as employment levels are reduced, because unemployed workers would take time to adjust to being laid off and may be able to subsist for a time on severance and unemployment benefits or other sources of household income. Unemployment probably would increase in Phillips County and on the Fort Belknap Indian Reservation immediately after mine closure and would then decline as workers either find new jobs, out-migrate, or become discouraged and become long-term unemployed workers. Per capita personal income also would tend to decline in Phillips and Blaine counties, all else being equal, since jobs at ZMI are among the highest-paying available.

Alternative 1 also would have an indirect but significant effect on property values and electric power costs. Property values potentially would decline in Phillips County, and especially in the communities of Malta and Zortman. Property values in Malta would be reduced significantly if the projected 100 employee households were to out-migrate from the community (Knudson 1994; Halverson 1994). The effect on Zortman also would be significant, in light of the fact that almost all the current population and economic development evident in the community today is attributable to the presence of ZMI's operations. As ZMI reduces its employment levels, residential and commercial property values would drop in Zortman. Over the long term, in the absence of other industrial development or another basis for attracting new residents, Zortman potentially would wither away to the size it was in 1979 before the inception of mining activity (Boland 1994).

The amount that consumers pay for electricity from the Big Flat Electric Cooperative potentially would increase significantly if ZMI closes. This is because Big Flat would lose the lower rates it currently enjoys due to the volume and pattern of ZMI's power consumption. The local utility would have to pay more for the power it purchases, and Big Flat would still face a number of fixed costs which could not be cut to any appreciable degree, including existing debt. Big Flat would pass on higher unit costs to its remaining customers, and this would have significant impact on customer electric bills. It is estimated that a household now heating with electricity (as do a third or more of the homes in Big Flat's service area) could pay $280 a month for electricity in the winter instead of $200 a month (Henderson 1994).

Homes heated by electricity within Big Flat's service area are concentrated in rural areas of Phillips and Blaine counties where natural gas is not available. These areas include the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation (Fewer 1995). Households heating with electricity would be affected by higher electric rates because of the higher total cost they incur for the higher consumption of electricity that electric heat entails, especially in the winter months.

Local jurisdictions in Phillips County would accumulate direct tax revenues under Alternative 1. However, average annual revenues would decline rapidly after 1996 and would eventually disappear entirely at the conclusion of all activity at the mine site in 2005. ZMI's operations from 1996 to 2005 would generate cumulative total revenues of $250,000 for Phillips County, $120,000 for the Malta High School and Elementary School districts combined, $110,00 for the Dodson High School District, and $70,000 for Landusky Elementary School, all in 1994 dollars (Table 4.10-7). Direct revenues to the City of Malta would be negligible.

The impact of the decline of average annual revenues between 1996 and 2005 and their disappearance beginning in 2006 may be measured by the degree to which local jurisdictions depend on revenues generated by ZMI now. In 1994, Landusky Elementary School District received $96,000 in property and gross proceeds taxes, or about 81 percent of total budgeted revenues; Dodson School District received $125,000, or about 20 percent of total budgeted revenues; the Malta high school and elementary school districts received about $158,00, or about 13 percent of total budgeted revenues; and Phillips County received $388,000, or about 9 percent of total budgeted revenues. Under Montana's system of school finance, schools would also lose direct state aid and budget capacity for every student lost.

Phillips County also would lose annual Metal Mines License Tax distributions to the Phillips County Hard Rock Trust Reserve, which had a balance of about $1 million in 1994. Under Alternative 1, the Hard Rock Trust Reserve would be projected to accumulate only an additional $60,000. The school districts also would lose about $16,000 per year per district in Metal Mines License Tax distributions.

In 1994, the Zortman and Landusky mines paid about $765,000 in metal mines license taxes, 75 percent of which is retained by the State. Although ZMI would continue to pay metal mines license taxes for a time under Alternative 1, the amount would decline rapidly between 1996 and 2000, the last year of gold and silver production. Under Alternative 1, the State would accumulate an additional $440,000 in metal mines license taxes.

Costs for providing services may decline somewhat for Phillips County government as mine employment declines and population begins to out-migrate. However, revenues lost would potentially exceed the County's ability to cut costs for several reasons. Agriculture continues to generate most of the demand for County services, the County already is at minimal levels for many services, and Phillips County officials probably would find it politically unacceptable to raise taxes sufficiently to offset all lost mine-generated revenues. Therefore, it is likely that some services would have to be reduced or cut entirely. Among existing services, those provided to seniors citizens are potentially vulnerable to cuts or elimination (Kienenberger 1994; Cowan 1994).

The general fund of the City of Malta relies very little on direct tax revenue from ZMI, although the City does rely on revenues from property owned by mine-related employees or paid by mine-related employees for utilities. Therefore, as ZMI phases out its operations and population possibly declines, the City may have to raise utility rates or increase taxes somewhat to cover the fixed costs of operating its water, sewer, and landfill. In particular, the City has outstanding debt on a new land fill and on two improvement districts, all serviced by property tax revenues. If additional revenues must be raised to offset the losses due to the mine closure, the City may be required to cut its recreation budget, which now runs about $15,000 to $20,000 a year (Ereaux 1994).

School district costs, which relate primarily to staff salaries and benefits, would potentially decline over the long run, as the student population declines. However, school staff and program reductions are hard to accomplish in proportion to incremental declines in student population. Therefore, the net impact for the school districts would potentially be negative, especially for the Dodson High School District, where mine-related revenues are relatively large in proportion to the number of mine-related students.

In schools in Malta and Dodson, the school board probably would have to increase taxes to make up for tax base lost to mine closure. However, it is unlikely that the board would raise tax rates enough to continue all programs at current levels. Some teachers might be replaced with lower-salaried aides, classes might be consolidated, certain classes may be offered less frequently, and high-cost extracurricular activities such as drama and speech would be vulnerable to cuts or elimination. As a result the quality of education would likely decline overall within affected school districts (Rust 1994; Sherman 1994).

The Zortman K-6 school, operated by the Malta Elementary School District, also would be impacted. This school serves about 20 students, all but two or three of whom are children of mine employee families. With the closure of the mine, the Zortman school would potentially close, and the school district would have to bus several students from Zortman to Malta daily (Rust 1994).

The Hays-Lodgepole School District relies on Montana state school aid programs, and on Federal Impact Aid under Title 8 of the Education Act, for virtually all of its funding. Federal Impact Aid is awarded on a per capita basis to districts that educate certain categories of students, including those who live on American Indian lands. The district derives almost no revenue from property taxes. Recently, the district has experienced budget difficulties, and in 1994 ZMI made a $10,350 grant to the district to help offset a budget shortfall (Ryan 1994). The district is projected to lose a cumulative total of 6 or 7 students due to Alternative 1 and would lose Federal Impact Aid and state school aid almost in direct proportion to each student lost. This would contribute somewhat to the district's long-term financial problems.

A distribution from the Phillips County Hard Rock Trust Reserve would be limited in its ability to mitigate impacts to local governments and schools. The amount distributed would be relatively small and available only on a one-time basis, while fiscal problems faced by each jurisdiction would be long-term. The Phillips County Hard Rock Trust Reserve had a balance of about $1 million in 1994; under Alternative 1 the fund would accumulate an additional $60,000. Money in this account potentially would be released for local use in 1996 or 1997 when mine employment potentially would drop to 50 percent of the average for the preceding 5 years.

At least one-third of the principal and interest in the trust reserve account must be allocated proportionally among affected school districts within the county. Assuming the minimum one-third of the funds are allocated, all the affected school districts in Phillips County would proportionally share in an estimated total of about $350,000. Districts affected by the closure might include those where ZMI employees' school-age children reside or attend school and districts where the mines have been a part of the tax base. After the school district allocation, the remaining funds in the trust reserve account may be expended directly by Phillips County. Alternatively, the County may make grants and loans to other local government units to pay off debt, offset tax increases caused by the mine shutdown, promote economic development, recruit new industry, or assist with impacts caused by the mine shutdown.

Alternative 1 would involve on-site employment of contractor crews consisting of 4 workers in 1996 for a water treatment plant construction and 8 workers in the year 2000 for reclamation. Crews of this size on temporary assignment can generally be accommodated within housing and temporary lodging in the town of Zortman.

The social impacts of Alternative 1 would differ among the potentially affected groups within the study area. For residents of Phillips County and its communities, the closure of the Zortman and Landusky mines would have a significant negative impact on social well-being. The primary effect on local residents would be due to the negative impact on local economic vitality, both because of the immediate shock of mine layoffs and the long-term effect of reduced employment opportunities, personal income levels, and fiscal resources. Mine employees are among the highest wage earners in the communities where they live; for example, only 30 or so oil and gas workers in Phillips County earn at the same level.

The secondary and cumulative repercussions of these effects would be felt as negative impacts on local social structures, facilities and services, and retail trade and service sectors in Malta and Zortman. In communities where they live, especially Malta, ZMI employees are active in local churches, civic service and economic development organizations, volunteer public safety and emergency services, and youth recreation programs. Over the years, ZMI's donations have help to sustain or enhance the activities of various educational, civic, and social organizations. Traditional rural family values have been sustained to some extent in Malta and Phillips County by ZMI's policy of hiring local youth both for seasonal and permanent work, thereby allowing generations of families to live and work near one another (Rust 1994; Boothe 1994; Ereaux 1994).

Some facilities and services offered by local governments in Phillips County would be at risk due to diminished fiscal resources. As noted above, these would include the County's programs for senior citizens and recreation programs offered by the City. Assuming the projected loss of population, Malta potentially would lose one physician (Wambold 1994).

Projected population losses also would negatively effect the retail trade and service sectors in Malta, the main shopping center located in Phillips County, where many businesses have been struggling. ZMI and its employees represent a significant market for goods and services in Malta now. This market has been especially important to Malta's business community of late because prices for cattle have been depressed and local ranchers have had less to spend. Therefore, there would be an even larger cumulative effect of the loss of this market represented by ZMI and its employees (Boothe 1994).

The impact of closure upon the sense of well-being of most residents of Blaine County would be minimal because relatively few mine employees live in the communities of the county. Most mine employees living in Blaine County live in the southern part of the Fort Belknap Indian Reservation. For these residents, Alternative 1 would represent a loss of economic opportunity, a negative impact affecting about 20 households of workers employed directly by ZMI and a few households of workers in secondary jobs attributable to ZMI's economic impacts.

Alternative 1 potentially would impact the sense of well-being among residents of the Fort Belknap Indian Reservation as a whole, despite the loss of the mine as a source of economic opportunity, but for an entirely different reason. This is because Native Americans on the reservation have expressed a high level of concern about the presence of ZMI's operations and its impacts; that is, a secondary impact of the mine's direct effects on the physical and human environment has been its effect on the way many residents of the Fort Belknap Indian Reservation feel about the quality of life in their community. Native American quality of life issues reflect a distinctive social and cultural group's reaction to how ZMI's presence and the actual effects of ZMI operations upon the environment have affected social and cultural activities, sites of contemporary or heritage significance, lifestyles which depend on access, use and appreciation of relatively natural land within the Little Rocky Mountains, and the use and appreciation of streams that drain portions of the Zortman and Landusky mining area and eventually enter the Fort Belknap Indian Reservation. Although some Native Americans residing on the reservation are employed by ZMI and feel better off economically, many Native Americans would view closure of the mine as potentially benefitting social well-being within the Native American community because mineral development activity would halt within a relatively short period of time, additional modification of the landscape of the Little Rocky Mountains would be avoided, and disturbed areas would be reclaimed and returned to other non-mining uses. This would be the likely net effect of Alternative 1 on the social well-being of the Fort Belknap Indian Reservation, even though for some Native Americans, as well as some in the non-Native American community, some impacts of Alternative 1 would be viewed as unsatisfactory, e.g. risk of reclamation failure, the perpetual need for water capture and treatment, risk of overtopping capture systems, and the loss of drainage area to northern tributaries.

Some non-Native Americans may react positively to the impacts of Alternative 1, viewing the more immediate conclusion of ZMI operations and reclamation of disturbed areas as having a positive effect on the quality of life within the study area. However, within the non-Native American community as a whole within the study area, these views probably would not affect the likely consensus that closure of the mine would lead to a negative impact on social well-being within the study area because economic opportunity may shrink and social vitality may decline.

4.10.3.2 Cumulative Impacts

Further mining at the Zortman and Landusky mines would not be allowed beyond that already permitted under this alternative, and the agencies believe the reasonably foreseeable opportunity for future mining would be limited. Therefore, no significant additional socioeconomic impacts would occur under Alternative 1 due to reasonably foreseeable developments.

The cumulative economic impact of the Zortman and Landusky mines may be represented in summary fashion in terms of the cumulative employment generated by ZMI's operations in the past and projected in the future. From 1979 through 1994, ZMI's operations are estimated to have generated 4,840 job-years of full- and part-time direct and secondary employment in Phillips County (see Table 4.10-5), 170 job-years in Blaine County, and 6,930 job-years in Montana as a whole. Alternative 1 would generate an additional 437 job-years of employment in Phillips County, 20 job-years in Blaine County, and 561 job years in Montana as a whole. Therefore, the cumulative impact of Alternative 1 would be 5,277 job-years of employment in Phillips County, 190 job-years of employment in Blaine County, and 7,491 job years of employment in Montana as a whole. Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.

Over time, the Zortman and Landusky mines also have had a cumulative effect on the social environment of the communities and groups within the study area. Social impacts of ZMI have been significant and beneficial in Malta and Zortman over the past 15 years as mine employees have integrated into and strengthened local social structures. In the absence of other economic development, the relatively immediate closure of ZMI's operation under Alternative 1 and the potential for outmigration of employees who are also key members of community social structures will curtail and potentially reverse some of the positive social effects that have accumulated over time. For the Fort Belknap Indian Reservation, the more immediate end to mining in the Little Rocky Mountains and the likelihood that no other mining operations would be developed would potentially help to alleviate the negative effect that ZMI's operation has had in the past on the sense of social well-being among Native Americans on the reservation. Because relatively few employees of the mine reside in Blaine County outside the Fort Belknap Indian Reservation, the cumulative social effect that has occurred in the past or would occur in the future in conjunction with this alternative would be negligible.

4.10.3.3 Unavoidable Adverse Impacts

All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 1 would be unavoidable. Adverse impacts described in detail above are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.3.4 Short-term Use/Long-term Productivity

Alternative 1 involves the closure and reclamation of the Zortman and Landusky mines and the restoration of pre-disturbance land uses, to the extent practicable under the proposed reclamation procedures. To a reasonable degree, long-term productivity for wildlife habitat, grazing, and recreation would be restored. However, in the short-run, the more intensive economic development and productivity associated with mining would be foregone.

4.10.3.5 Irreversible or Irretrievable Resource Commitments

No irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 1.

4.10.4 Impacts from Alternative 2

4.10.4.1 Impacts

Under Alternative 2, as under Alternative 1, the agencies would not approve expansion of the Zortman and Landusky mines, although mine activities already permitted would continue. Reclamation procedures currently in use at the two mines would be modified as proposed by ZMI. Due to the proposed modifications to reclamation procedures under Alternative 2, total expenditures by ZMI over the life of Alternative 2 would be slightly more than under Alternative 1, and contract employment under Alternative 2 would be somewhat higher than Alternative 1. (See Table 4.10-1 and 4.10-3.) These differences would have only a small effect upon the socioeconomic impacts of the alternative. Therefore, the impacts of Alternative 2 and the rationale for those impacts would be virtually the same as those described for Alternative 1. For details, the reader may refer to Section 4.10.3. and Table 4.10-7.

Implementation of Alternative 2 could begin in early 1996, and ZMI would continue to operate through the year 2005 under its current permits. Significant negative economic impacts would occur because ZMI would scale down its activities and ultimately eliminate all jobs and spending at the Zortman and Landusky mines. Cutbacks would begin in 1996, and by 1998, there would be only 15 jobs, down from 260 jobs in 1994. This reduction of 94 percent in direct employment would be felt almost immediately. Smaller impacts would be felt as further reductions are made in employment and spending due to the gradually declining level of intensity of closure activities through the year 2005. Note that although negative impacts would occur in the near future under Alternative 2 (and under Alternatives 1 and 3), as compared to Alternatives 4 through 7, ultimately these impacts are inevitable under all alternatives.

Under Alternative 2, Phillips County and the communities of Malta and Zortman would sustain significant negative impacts to economic and fiscal conditions, community resources, and social well-being among its residents. Impacts also would be felt in Blaine County. However, these would be small compared to existing conditions. Businesses elsewhere in the State of Montana would be negatively affected, especially those in Billings and Helena which supply ZMI with goods and services. Property values potentially would decline in Phillips County and especially in the communities of Malta and Zortman. There would be a significant increase in the amount that consumers pay for power purchased from the Big Flat Electric Cooperative. This effect would be concentrated in parts of Big Flat's service area that rely disproportionately on electric heat for home heating because they lack access to natural gas. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation. On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed.

The State treasury would sustain revenue losses over time; however, this impact also would be relatively small. Economic effects on the Fort Belknap Indian Reservation would be minor, and there would be no fiscal impact because no direct revenues are derived from the mine.

Under Alternative 2, the short-term effects to recreation resources would be similar to those of Alternative 1.

Therefore, there would be some restoration of recreation-based economic development potential, due to the reduction of impacts on recreation resources. The trade-off would be the loss of mining-based economic development due to mine closure that is described above. The potential for economic benefit over the long term due to restoration of recreation resources may be slightly greater because of the improved probability of reclamation success under Alternative 2. However, the benefit gained would continue to be quite small, especially when compared to the adverse effects of mine closure.

Social impacts of the alternative would be significant and negative especially in Malta and Zortman where mine employees and their families are in integral part of local social structures. The impact of Alternative 2 on the social environment on the Fort Belknap Indian Reservation would be significant and generally beneficial. Although some Native Americans residing on the reservation are employed by ZMI and would be adversely affected in terms of economic well-being, Native Americans who oppose the mine and have expressed a high level of concern about its presence would be beneficially affected as the closure activities begin and the mines ultimately are closed. This beneficial impact of Alternative 2 would be slightly higher than under Alternative 1 because of the improved probability of successful reclamation and correcting existing water quality problems. However, the improvement would not be significant because there still may be some areas where reclamation efforts would not completely succeed and where water quality and loss of drainage area may still be an issue.

4.10.4.2 Cumulative Impacts

Further mining at the Zortman and Landusky mines would not be allowed beyond that already permitted under Alternative 2, and the agencies believe the reasonably foreseeable opportunity for future mining would be limited. Therefore, no significant additional socioeconomic impacts would occur under Alternative 2 due to reasonably foreseeable future actions. In terms of employment, the cumulative impact of Alternative 2 would be 5,411 job-years of full- and part-time employment in Phillips County, 196 job-years of employment in Blaine County, and 7,764 job years of employment in Montana as a whole. Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2. The cumulative social impacts of Alternative 2 would be the same as those of Alternative 1; these are described in Section 4.10.3.2.

4.10.4.3 Unavoidable Adverse Impacts

All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 2 would be unavoidable. Adverse impacts described above are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.4.4 Short-term Use/Long-term Productivity

Alternative 2 involves the closure and reclamation of the Zortman and Landusky mines and the restoration of pre-disturbance land uses, to the extent practicable under the company modified reclamation procedures. To a reasonable degree, long-term productivity for wildlife habitat, grazing, and recreation would be restored. However, in the short-run, more intensive economic productivity associated with mining would be foregone.

4.10.4.5 Irreversible or Irretrievable Resource Commitments

No irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 2.

4.10.5 Impacts from Alternative 3

4.10.5.1 Impacts

Under Alternative 3, as under Alternative 1, the agencies would not approve expansion of the Zortman and Landusky mines, although mine activities already permitted would continue. Reclamation procedures currently in use at the two mines would be modified to incorporate changes developed by the agencies. Due to the proposed agency modifications to reclamation procedures under Alternative 3, total expenditures by ZMI would be greater than under Alternative 1 or Alternative 2 while contract employment under Alternative 3 would be greater than under Alternative 1 and the same as Alternative 2 (see Tables 4.10-1 through 4.10-3).

Total expenditures by ZMI under Alternative 3 are about 3 times as much as under the other two non-extension alternatives. This difference has a noticeable effect on the socioeconomic impacts of the alternative;

however, they are short-lived since the additional expenditures are concentrated within 1 year. The employment and earnings impacts of Alternative 3, compared to those of Alternatives 1 and 2, are described in Table 4.10-7. Other impacts of Alternative 3 and the rationale for those impacts would be essentially the same as those described for Alternative 1; these are detailed in Section 4.10.3.

As under the other no-expansion alternatives, implementation of Alternative 3 could begin in early 1996, and ZMI would continue to operate through the year 2005 under its current permits. Significant negative economic impacts would occur because ZMI would scale down its activities and ultimately eliminate all jobs and spending at the Zortman and Landusky mines. Cutbacks would begin in 1996, and by 1998, there would be only 15 jobs, down from 260 jobs in 1994. This reduction of 94 percent in direct employment would be felt almost immediately. Smaller impact would be felt as further reductions are made in employment and spending due to the gradually declining level of intensity of closure activities through the year 2005. Note that although negative impacts would occur in the near future under Alternative 3 (and under Alternatives 1 and 2), as compared to Alternatives 4 through 7, ultimately these impacts are inevitable under all alternatives.

Under Alternative 3, Phillips County and the communities of Malta and Zortman would sustain significant negative impacts to economic and fiscal conditions, community resources, and social well-being among its residents. Impacts also would be felt in Blaine County. However, they would be small compared to existing conditions. Businesses elsewhere in the state of Montana would be negatively affected, especially those in Billings and Helena which supply ZMI with goods and services. Property values potentially would decline in Phillips County and especially in the communities of Malta and Zortman. There would be a significant increase in the amount that consumers pay for power purchased from the Big Flat Electric Cooperative. This effect would be concentrated in parts of the Big Flat's service area that rely disproportionately on electric heat for home heating because they lack access to natural gas. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation. On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed.

The state treasury would sustain revenue losses over time; however, this impact also would be relatively small. Economic effects on the Fort Belknap Indian Reservation would be minor, and there would be no fiscal impact because no direct revenues are derived from the mine.

Under Alternative 3, the short-term effects to recreation resources would be similar to those of Alternative 1. There would be some restoration of recreation-based economic development potential due to the reduction of impacts on recreation resources; this would occur in exchange for the loss of mining-related economic development due to mine closure. The potential for recreation-based economic development over the long term may be slightly greater under Alternative 3, compared to Alternative 1 and Alternative 2, because Alternative 3 further improves the probability of reclamation success. However, the effect would still be quite small, especially when compared to the adverse effects of mine closure.

Social impacts of the alternative would be significant and negative especially in Malta and Zortman where mine employees and their families are in integral part of local social structures. The impact of Alternative 3 on the social environment on the Fort Belknap Indian Reservation would be significant and generally beneficial. Although some Native Americans residing on the reservation are employed by ZMI and would be adversely affected in terms of economic well-being, many Native Americans who oppose the mine and have expressed a high level of concern about its presence would be beneficially affected as the closure activities begin and the mines ultimately are closed. This beneficial impact of Alternative 3 would be slightly higher than under Alternative 1 or Alternative 2 because of further improvement in the probability of reclamation success and correction of existing water quality problems. The improvement may be significant to those Native Americans whose concerns have centered upon access to relatively natural land within the Little Rocky Mountains and upon water quality. This would be in spite of a potential for a short-term decrease in water quality in the Kings Creek drainage due to the additional disturbance required to mine limestone for use in reclamation.

4.10.5.2 Cumulative Impacts

Further mining at the Zortman and Landusky mines would not be allowed beyond that already permitted under Alternative 3, and the agencies believe the reasonably foreseeable opportunity for future mining would be limited. Therefore, no significant additional socioeconomic impacts would occur under Alternative 3 due to reasonably foreseeable future actions. In terms of employment, the cumulative impact of Alternative 3 would be 5,538 job-years of full- and part-time employment in Phillips County, 202 job-years of employment in Blaine County, and 7,839 job years of employment in Montana as a whole. Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2. The cumulative social impacts of Alternative 3 would be the same as those of Alternative 1; these are described in Section 4.10.3.2.

4.10.5.3 Unavoidable Adverse Impacts

All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 3 would be unavoidable. Adverse impacts described above are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.5.4 Short-term Use/Long-term Productivity

Alternative 3 involves the closure and reclamation of the Zortman and Landusky mines and the restoration of pre-disturbance land uses, to the extent practicable under the agency-modified reclamation procedures. To a reasonable degree, long-term productivity for wildlife habitat, grazing, and recreation would be restored. However, in the short-run, more intensive economic productivity associated with mining would be foregone.

4.10.5.5 Irreversible or Irretrievable Resource Commitments

No irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 3.

4.10.6 Impacts from Alternative 4

4.10.6.1 Impacts

Under Alternative 4 (the Company Proposed Action), the Zortman and Landusky mines would be expanded and operated for an additional 7 years before a transition is made and closure activities begin. Implementation of Alternative 4 could begin as early as 1996. Construction of new facilities would require substantial capital expenditure and employment of some construction contracting. This is assumed to occur in 1996 and 1997. During the extended mining operations, which last into the year 2002, ZMI would require levels of employment similar to those characterizing full operations in the past and would expend similar levels of annual operating and working capital expenditures. Closure activities are assumed to begin in the year 2002 and last through 2012, with final reclamation taking place in 2006 and 2007 and monitoring occurring thereafter. The direct employment, payroll and expenditure associated with ZMI's continued operations under Alternative 4 are presented in Table 4.10-1 through Table 4.10-3.

During the extended mining period, Alternative 4 would sustain direct and indirect economic activity in the State of Montana, in Phillips County and, to a much lesser extent, in Blaine County. The additional employment and earnings generated as a result would be a significant benefit, especially when compared in magnitude to the effects of the no expansion alternatives (Alternatives 1 through 3).

Also, sustaining ZMI operations at historical operating levels for 7 more years would have significant positive impacts on Phillips County and the communities of Malta and Zortman in terms of fiscal conditions, community resources, and social well-being among its residents. Positive effects also would be felt in Blaine County. However, they would be small compared to existing conditions. Businesses elsewhere in the State of Montana would continue to be positively affected over the extended life of ZMI's operations, especially those in Billings and Helena which supply ZMI with goods and services. Property values would be supported at present levels in Phillips County and especially in the communities of Malta and Zortman. Consumers who buy electricity from the Big Flat Electric Cooperative would continue to benefit from the volume and demand-spreading discounts Big Flat earns from its supplier by having the mines as a customer. This effect would be concentrated in parts of Big Flat's service area that rely disproportionately on electric heat for home heating because they lack access to natural gas. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation. On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed (Eickerman 1993).

The State treasury would earn additional revenues for each year of continued operation, a positive impact. Economic effects on the Fort Belknap Indian Reservation would be relatively small, if positive, and there would be no fiscal impact because no direct revenues are derived from the mine.

The extended mining phase of Alternative 4 also would sustain beneficial conditions in the social environment in Malta and Zortman, where mine employees and their families are perceived as positive contributors to, and an integral part of, local social structures. The impact of Alternative 4 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. Although some Native Americans residing on the reservation are employed by ZMI and would benefit economically from the additional years of employment and income, many Native Americans who oppose the mine and have expressed a high level of concern about its presence and its impact on the environment. Their sense of well-being and evaluation of the quality of life on the Fort Belknap Indian Reservation would continue to be adversely affected during the extended mining phase before closure activities begin and the mines ultimately are closed.

The economic impacts of closure under Alternative 4 would be the similar to those described for Alternative 1 in Section 4.10.2. The main difference is that, for Alternative 4, the impacts would occur later than under Alternative 1. It is possible that by delaying closure under Alternative 4, the relative magnitude of the impacts may be somewhat different because conditions may change farther out in the future. However, this is not likely since population and employment projections available now for Phillips County indicate that almost no growth is anticipated for the county through the year 2012. In Blaine County, where the available population and employment projections indicate some growth is anticipated through the year 2012, the relative impacts of closure would therefore be even smaller under Alternative 4 than under Alternative 1, because they would occur against the backdrop of a somewhat larger local economy.

Table 4.10-8 summarizes the economic and fiscal impacts of Alternative 4 compared to the impacts of Alternatives 5 through 7. Under Alternative 4, ZMI's operations from 1996 to 2012 would cumulatively generate an additional 5,000 job-years of direct and secondary employment and $126.4 million in 1994 dollars of direct and secondary earnings within the State of Montana. These cumulative effects on state employment are more than 9 times the magnitude of the effects of Alternative 1. The statewide cumulative effects include 3,480 job-years of employment and $95.6 million in 1994 dollars of earnings in Phillips County, about 8 times the employment effects of Alternative 1. During the same period, Blaine County would accumulate an additional 144 job-years of employment and $2.6 million in earnings in 1994 dollars, about 7 times the employment effects of Alternative 1. (A job-year is a full- or part-time job held for a year, on average.) Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.

Although the one overall economic effect of Alternative 4 is to sustain employment and income for the economy as a whole for some additional years, the alternative may simultaneously adversely affect specific economic sectors that depend on spending by recreationists attracted to the area by its recreation resources. Recreation resources which generate employment and income in Phillips and Blaine counties have been impacted by ZMI's operations in the past; Alternative 4 would continue these impacts for a number of years and would intensify them somewhat (see Section 4.7). Businesses in the retail trade and services sectors of the economy (e.g., eating and drinking places, lodging places, suppliers, and outfitters) potentially would be affected if an additional decline in the quality of recreation resources leads to fewer than expected hunters, campers, hikers, and sightseers using lands surrounding the Zortman and Landusky mines. Information to estimate this adverse effect in numerical terms is not available. Although likely to occur, the economic repercussions of this effect probably would be quite small. Nevertheless, the impact represents the foregoing of some recreation-based economic development, due to impacts of mining on recreation resources, in exchange for the economic development described above, which is based on the mining itself.

Under Alternative 4, the existing work force potentially would stay in place for an additional 7 years, and because there would be no significant change in employment level during this time period, no change would be expected in total community and school population, other than the aging and turnover consistent with the trends described in Section 3.10.

ZMI would employ contract crews for construction of new facilities, including a water treatment plant, crusher, conveyor, and leach pad, as well as contract crews for final reclamation. It is assumed Big Flat Electric Cooperative would employ a contracted crew for construction of a power line between the Zortman and Landusky mines. Contract employment would occur in 1996 and 1997 and in 2006 and 2007.

Contractor employees would seek temporary housing in Zortman and would be likely to commute weekly without their families. Accommodating this demand would be most difficult when permanent employment at the mines is at full strength. In addition, there is a greater demand for housing in Zortman during the

TABLE 4.10-8

ECONOMIC AND FISCAL IMPACTS OF ALTERNATIVES 4-7 FOR THE PERIOD 1996-2012

Impact	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Employment (cumulative, in job-years)				
Montana	5,000	4,821	4,524	5,156
Phillips County	3,480	3,356	3,173	3,608
Blaine County	144	139	133	133
Earnings (cumulative, in millions of 1994 dollars)				
Montana	$126.4	$121.8	$114.8	$130.6
Phillips County	95.6	92.2	87.4	99.3
Blaine County	2.6	2.5	2.4	2.7
Direct Tax Revenues (cumulative, in millions of 1994 dollars)				
Montana	$4.46	$4.30	$3.60	$4.29
Phillips County	2.63	2.57	2.44	2.61
Malta School Districts	1.25	1.22	1.15	1.24
Dodson High School District	1.12	1.10	1.03	1.11
Landusky School District	0.73	0.72	0.68	0.73
City of Malta	< $10,000	< $10,000	< $10,000	< $10,000
Phillips Co. Hard Rock Trust Reserve	0.59	0.57	0.48	0.57

Notes: Employment and earnings impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2. Employment is cumulative direct and secondary full- and part-time employment generated by ZMI operations. A job-year represents one full- or part-time job offered for one year within a particular area. The amounts in the table are the cumulative sums of employment, earnings, and direct tax revenues generated by ZMI activity over the life of the alternative. The Zortman Elementary School is operated by the Malta Elementary School district. Montana tax revenues are due to the Metal Mines License Tax. Local tax revenues are due to ad valorem taxes on real and personal property and gross proceeds of mines.

summer, when the mine hires temporary workers; during prairie dog season, from March through October; and during the big game hunting season, from September to November. However, sufficient housing has been available in the past for contract crews and would probably be available when needed during the construction phases (Kalal 1994).

Local jurisdictions in Phillips County would accumulate additional tax revenues under Alternative 4. Revenue flows would be sustained for an additional 7 years, but average annual revenues would decline rapidly after 2001 and would disappear entirely after the conclusion of all activity at the mine site in 2012.

Under Alternative 4, additional direct revenues due to ZMI's operations from 1996 to 2012 would accumulate for local jurisdictions. Projected amounts would be a cumulative total of $2.6 million for Phillips County, $1.3 million for the Malta High School and Elementary School districts combined, $1.1 million for the Dodson School District, and $730,000 for Landusky Elementary School, all in 1994 dollars (Table 4.10-8). The impact of the decline and loss of these annual tax revenues may be measured by the degree to which local jurisdictions depend on revenues generated by ZMI now. In 1994, Landusky Elementary School District received $96,000 in property and gross proceeds taxes, or about 81 percent of total budgeted revenues; Dodson School District received $125,000, or about 20 percent of total budgeted revenues; Malta High School and Elementary School districts received about $158,000, or about 13 percent of total budgeted revenues; and Phillips County received $388,000, or about 9 percent of total budgeted revenues. Under Montana's system of school finance, schools would also lose direct state aid and budget capacity for every student lost.

The Phillips County Hard Rock Revenue Fund would potentially receive annual distributions from state Metal Mines License Tax receipts for an additional 7 years. Local school districts would also receive about $16,000 annually per district in Metal Mines License Tax distributions for additional years of mining.

A distribution from the Phillips County Hard Rock Trust Reserve would be limited in its ability to mitigate impacts to local governments and schools. The amount distributed would be relatively small and available only on a one-time basis, while fiscal problems faced by each jurisdiction would be long-term. The Phillips County Hard Rock Trust Reserve had a balance of about $1 million in 1994; under Alternative 4 the fund would accumulate an additional $590,000. Money in this account potentially would be released for local use in range of the years 2004 through 2006, depending on when mine employment potentially would drop to 50 percent of the average for the preceding 5 years. At least one-third of the principal and interest in the trust reserve account must be allocated proportionally among affected school districts within the county. Assuming the minimum one-third of the funds are allocated, all the affected school districts in Phillips County would proportionally share in an estimated total of about $530,000. Districts affected by the closure might include those in which ZMI employees' school age children reside or attend school and districts where the mines have been a part of the tax base. After the school district allocation, the remaining funds in the trust reserve account may be expended directly by Phillips County. Alternatively, the County may make grants and loans to other local government units to pay off debt, offset tax increases caused by the mine shutdown, promote economic development, recruit new industry, or assist with impacts caused by the mine shutdown.

In 1994, the Zortman and Landusky mines paid about $765,000 in metal mines license taxes, 75 percent of which is retained by the State. ZMI is projected to continue paying metal mines license taxes under Alternative 4 through 2007. Under Alternative 4, the State would be projected to accumulate an additional $4.5 million in metal mines license taxes, about 10 times the total projected to be accumulated under Alternative 1.

Under Alternative 4, costs for providing services would continue at current levels for most jurisdictions through 2003 or 2004, when layoffs would begin as the closure cycle commences at the Zortman and Landusky mines. Until that time, facilities within the study area that presently are at capacity would continue to operate under some strain. These include Malta's water and wastewater utilities, schools in Malta, medical care and emergency-response providers in Phillips County, and schools at Hays and Lodgepole. Additional revenues accumulated during ZMI's additional 7 years of mining may provide sufficient fiscal resources to accomplish some improvements for the Phillips County providers. Schools at Hays and Lodgepole, however, would not benefit because the mine facilities are not taxable by the Hays-Lodgepole school district.

The social impacts of Alternative 4 would differ among the potentially affected groups within the study area. For residents of Phillips County and its communities, the mine would have a significant positive impact on social well-being. The primary effect on local residents would be due to sustaining the local economy at its current level and maintaining employment opportunities, personal income levels, and fiscal resources for an additional 7 years.

The secondary and cumulative repercussions of these effects would be felt as positive impacts on local social structures, facilities and services, and retail trade and service sectors in Malta and Zortman. Mine employees are among the highest wage earners in the communities where they live; for example, only 30 or so oil and gas workers in Phillips County earn at the same level. ZMI employees also would remain active in local churches, civic service and economic development organizations, volunteer public safety and emergency services, and youth recreation programs. ZMI also directly donates funds which help to sustain or enhance the activities of various educational, civic, and social organizations; this pattern potentially would continue. Traditional rural family values would continue to be sustained to some extent in Malta and Phillips County by ZMI's policy of hiring local youth both for seasonal and permanent work (Rust 1994; Boothe 1994; Ereaux 1994).

Facilities and services offered by local governments in Phillips County would continue to be offered at current levels. Additional revenue flows will allow reduction of debt in Malta (Ereaux 1994). Senior citizen programs, recreation programs, and population sensitive services, such as medical practices, would be sustained for at least another 7 years (Wambold 1994).

By sustaining the current population, Alternative 4 also would positive affect retail trade and service sectors in Malta, the main shopping center located in Phillips County, since ZMI and its employees are a significant market for goods and services in Malta now (Boothe 1994).

The impact of Alternative 4 on the well-being of groups in Blaine County, such as farmers, ranchers, and townspeople, would be similar to those described for Phillips County. However, the effect would be much less intense and much less widely felt because so many fewer residents of Blaine County depend on the mines as an economic generator.

Alternative 4 potentially would have a negative impact on the sense of social well-being of residents of the Fort Belknap Indian Reservation as a whole, even though the extension of mine operation would represent sustained economic opportunity for those Native Americans employed by ZMI and others who may benefit from the secondary economic effects of ZMI's operations. This is because, regardless of economic issues, many Native Americans on the reservation oppose the mines and have expressed a high level of concern about their presence and their impacts in the past and potentially in the future. In other words, a secondary impact of the mine's direct effects on the physical and human environment has been, and potentially would continue to be, its effect on the way many residents of the Fort Belknap Indian Reservation feel about the quality of life in their community.

Native American concerns about quality of life reflect a distinctive social and cultural group's reaction to how ZMI's presence and the mines' effects upon the environment have affected social and cultural activities, sites of contemporary or heritage significance, lifestyles which depend on access, use and appreciation of relatively natural land within the Little Rocky Mountains, and the use and appreciation of streams that drain portion of the Zortman and Landusky mining area and eventually enter the Fort Belknap Indian Reservation. Although some Native Americans residing on the reservation are employed by ZMI and feel better off economically, expansion of mining activity potentially would be viewed, because of past and potential future impacts, and because closure would be delayed another 7 years, as a significant and generally adverse quality of life impact by the Fort Belknap Indian Reservation in general.

Therefore, the net effect of Alternative 4 on the social well-being of the Fort Belknap Indian Reservation, and on some non-Native Americans within the study area as well, would be negative, even though some Native Americans, as well as some in the non-Native American community, would view the predominantly positive economic effects of the alternative as benefitting the quality of life.

Also, some non-Native Americans, for similar or other reasons, may react negatively to the impacts of Alternative 4, viewing the extension of ZMI's operations, its expansion in terms of additional land disturbance, and the delay of closure and reclamation as having a negative effect on the quality of life within the study area. However, for the non-Native American community as a whole within the study area, these views probably would not affect the likely consensus that extension of mineral development activity and delaying closure and reclamation would have a beneficial effect on social well-being since the alternative represents prolonging the life of a source of economic and fiscal opportunity and social vitality for localities such as Malta and Zortman and for Phillips County as a whole.

4.10.6.2 Cumulative Impacts

The development of Pony Gulch would add about 2 million tons of ore (or about 2.5%) to the prospective 80 million tons to be mined. This would translate into about two months of additional mining activity. It is unlikely the additional mining would lead ZMI to add employees, and additional spending would be proportionately small. Reasonably foreseeable exploration activity to possibly expand ore reserves or further define existing reserves could involve the hiring of a contract drilling in crew of about 4 persons costing ZMI between $100,000 and $200,000 per year for 3 to 5 years, a small increment of employment and spending in comparison to proposed spending levels under Alternative 4. Therefore, neither reasonably foreseeable development would materially change the magnitude or duration of any of the impacts identified for Alternative 4.

The cumulative socioeconomic impact of Alternative 4 may be represented in summary fashion in terms of the employment generated by the ZMI's operations in the past and in the future. From 1979 through 1994, ZMI's operations are estimated to have generated 4,840 job-years of full- and part-time direct and secondary employment in Phillips County (see Table 4.10-5), 170 job-years in Blaine County, and 6,930 job-years in Montana as a whole. Alternative 4 would generate an additional 3,480 job-years of employment in Phillips County, 144 job-years in Blaine County, and 5,000 job years in Montana as a whole. Therefore, the cumulative impact of Alternative 4 would be 8,320 job-years of employment in Phillips County, 314 job-years of employment in Blaine County, and 11,930 job years of employment in Montana as a whole.

Over time, the Zortman and Landusky mines also have had a cumulative effect on the social environment of the communities and groups within the study area. Social impacts of ZMI have been significant and beneficial in Malta and Zortman over the past 15 years as mine employees have integrated into and strengthened local social structures. Those beneficial effects would be sustained for an additional 7 years under Alternative 4. This effect would be especially important in the absence of other economic development, delaying the potential for outmigration of employees who are also key members of community social structures. For the Fort Belknap Indian Reservation, delaying the closure and reclamation of the mines under Alternative 4 would prolong the sense that the quality of life for reservation residents is being negatively impacted by ZMI's presence and the effects upon the physical and human environment. Because relatively few employees of the mine reside in Blaine County outside the Fort Belknap Indian Reservation, the cumulative social effect that has occurred in the past or would occur in the future in conjunction with this alternative would be negligible.

4.10.6.3 Unavoidable Adverse Impacts

The impact of Alternative 4 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. This impact would be unavoidable. All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 4 would be unavoidable, as well. Adverse impacts described above are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.6.4 Short-term Use/Long-term Productivity

Under Alternative 4, the productivity of pre-existing and additional existing economic resources such as grazing land would be disturbed in exchange for mining, a significantly more intensive economic development. However, in the long run, assuming the success of reclamation procedures, pre-disturbance uses could be restored to long-term productivity.

4.10.6.5 Irreversible or Irretrievable Resource Commitments

In economic terms, no irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 4. Native Americans may view physical impacts upon cultural resource sites important to their lifestyle as an irreversible and irretrievable resource commitment associated with the alternative.

4.10.7 Impacts from Alternative 5

4.10.7.1 Impacts

Alternative 5 would allow expansion of both the Zortman and Landusky mines but impose agency-developed mitigation on the expansion and reclamation activities. The major modification to ZMI's expansion plans would be at the Zortman Mine where the proposed ore heap leach facility would be within Upper Alder Gulch instead of at Goslin Flats. Also, at the Landusky Mine, ZMI would be required to remove fill from the head of King Creek and backfill mine pits so that the reclaimed area drains freely into King Creek. Under Alternative 5, it is assumed mining would occur for about 6 years before a transition is made and closure activities begin. Although many of the plans and facilities for Alternative 5 are similar to, or the same as, those described in Alternative 4, total expenditures by ZMI would be less under Alternative 5 than Alternative 4 because, with the leach pad in Upper Alder Gulch, a conveyor system would not have to be built.

After construction but during the extended mining operations, which would last through the year 2001, ZMI would require levels of employment similar to those in the past and would expend similar levels of annual operating and working capital expenditures. Closure activities are assumed to begin in the year 2002 and last through 2012, with final reclamation occurring in the years 2006 and 2007. During closure and reclamation, employment and spending would be similar to that for Alternative 4. The direct employment, payroll and expenditure associated with ZMI's continued operations under Alternative 5 are presented in Table 4.10-1 through Table 4.10-3.

During the extended mining period, Alternative 5 would sustain direct and indirect economic activity in the state of Montana, in Phillips County and, to a much lesser extent, in Blaine County. The additional employment and earnings generated as a result would be a significant benefit, especially when compared in magnitude to the effects of the no-expansion alternatives, Alternatives 1 through 3.

Also, sustaining ZMI operations at current levels for about 6 more years would have significant positive impacts on Phillips County and the communities of Malta and Zortman in terms of fiscal conditions, community resources, and social well-being among its residents. Cumulative positive effects also would be felt in Blaine County. However, they would be small, compared to existing conditions. Businesses elsewhere in the State of Montana would continue to be positively affected over the extended life of ZMI's operations, especially those in Billings and Helena which supply ZMI with goods and services. Property values would be supported at present levels in Phillips County and especially in the communities of Malta and Zortman. Consumers who buy electricity from the Big Flat Electric Cooperative would continue to benefit from the volume and demand-spreading discounts Big Flat earns from its supplier by having the mines as a customer. This effect would be concentrated in parts of Big Flat's service area that rely disproportionately on electric heat for home heating because they lack access to natural gas. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation.On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed.

Under Alternative 5, the short-term effects to economically-beneficial recreation resources would be similar to those of Alternative 4. Although disturbance to the visible landscape would increase in Alder Gulch, some access would be preserved because no conveyor would be built and disturbance to the landscape in Goslin Flats would be avoided. The net effect of these differences may mean that Alternative 5, as compared to Alternative 4, would slightly reduce the adverse impact to the potential for recreation-based economic development in the short-term. The effect is likely to occur but probably would be quite small.

The State treasury would earn cumulative revenues, a significant beneficial impact. Economic effects on the Fort Belknap Indian Reservation would also be relatively small, if positive, and there would be no fiscal impact because no direct revenues are derived from the mine.

The extended mining phase of Alternative 5 also would sustain beneficial conditions in the social environment in Malta and Zortman, where mine employees and their families are positive contributors to, and an integral part of, local social structures. The impact of Alternative 5 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. Although some Native Americans residing on the reservation are employed by ZMI and would benefit economically from the additional years of employment and income, many Native Americans who oppose the mine and have expressed a high level of concern about its presence would continue to be adversely affected during the extended mining phase before closure activities begin and the mines ultimately are closed.

The predominantly negative impacts of closure under Alternative 5 would be similar to those described for Alternative 1 in Section 4.10.2, and which also occur under Alternatives 2 and 3. The only difference is that, for Alternative 5, the impacts would occur later than under the no-expansion alternatives, Alternatives 1 through 3. It is possible that by delaying closure under Alternative 5, the relative magnitude of the impacts may be somewhat different because conditions may change farther out in the future. However, this is not likely since population and employment projections available now for Phillips County indicate almost no growth is anticipated for the county through the year 2012. In Blaine County, where the available population and employment projections indicate some growth is anticipated through the year 2012, the relative impacts of closure would therefore be even smaller under Alternative 5 than under Alternative 1.

Table 4.10-8 summarizes the economic and fiscal impact impacts of Alternative 5 compared to the impacts of Alternatives 4, 6 and 7. Under Alternative 5, ZMI's operations from 1996 to 2012 would generate a cumulative total of 4,821 job-years of direct and secondary employment and $121.8 million in 1994 dollars of direct and secondary earnings within the state of Montana. These cumulative effects on state employment are about 9 times the magnitude of the effects of Alternative 1. The statewide effects include a cumulative total of 3,356 job-years of employment and $92.2 million in 1994 dollars of earnings in Phillips County, about 8 times the employment effects of Alternative 1. During the same period, ZMI's operations would generate a cumulative total of 139 job-years of employment and $2.5 million in earnings in 1994 dollars for Blaine County, about 7 times the employment effects of Alternative 1. (A job-year is a full- or part-time job held for a year, on average.) Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.

Under Alternative 5, the existing work force potentially would stay in place, and because there would be no significant change in employment level, no change would be expected in total community and school population, other than the aging and turnover consistent with the trends described in Section 3.10.

ZMI would employ contract crews for construction of new facilities, including a water treatment plant, crusher, and leach pad, as well as contract crews for final reclamation. It is assumed Big Flat Electric Cooperative would employ a contracted crew for construction of a power line between the Zortman and Landusky mines. Contract employment would occur in 1996 and 1997 and in 2006 and 2007. Temporary housing accommodations would be available for contractor employees as described in section 4.10.6.1.

Local jurisdictions in Phillips County would accumulate additional tax revenues under Alternative 5. Revenue flows would be sustained for an additional 6 years, but revenues would decline rapidly after 2002, and would disappear entirely after the conclusion of all activity at the mine site in 2012. ZMI's operations from 1996 to 2012 would generate additional direct revenues for local jurisdictions. Projected amounts would be a cumulative total of $2.6 million for Phillips County, $1.2 million for the Malta High School and Elementary School districts combined, $1.1 million for the Dodson High School district, $720,000 for Landusky Elementary School, all in 1994 dollars (Table 4.10-8). Revenues are somewhat lower under Alternative 5 because of ZMI's lower capital spending requirements, compared to Alternative 4. Under Alternative 5, the impact on local jurisdictions of the decline and eventual loss of tax revenues would be essentially the same as under Alternative 4. This was described in Section 4.10.6.1.

The Phillips County Rock Hard Trust Reserve Fund would potentially receive annual distributions from state Metal Mines License Tax receipts for an additional 6 years, and the funds would be available for distribution when mine employment declines to half the previous five-year average. A distribution from the Phillips County Hard Rock Trust Reserve would be limited in its ability to mitigate impacts to local governments and schools. The amount distributed would be relatively small and available only on a one-time basis, while fiscal problems faced by each jurisdiction would be long-term. The Phillips County Hard Rock Trust Reserve had a balance of about $1 million in 1994; under Alternative 5 the fund would accumulate an additional $570,000. According to the statutory formula (described in Section 4.10.6.1) all the affected school districts in Phillips County would proportionally share in at least an estimated total of about $530,000 while the remainder of the fund would be available for expenditure directly by Phillips County or for distribution by the County as grants and loans to other local government units.

ZMI would continue to pay metal mines license taxes under Alternative 5 through 2006. Under Alternative 5, the state would accumulate an additional $4.3 million in metal mines license taxes, about 10 times the total collected under Alternative 1.

Under Alternative 5, costs for providing services would continue at current levels for most jurisdictions through 2003 or 2004. Facilities within the study area that presently are at capacity would continue to operate under some strain. These include Malta's water and wastewater utilities, schools in Malta, medical care and emergency-response providers in Phillips County, and schools at Hays and Lodgepole. Additional revenues accumulated during ZMI's additional 6 years of mining may provide sufficient fiscal resources to accomplish some improvements for the Phillips County providers. Schools at Hays and Lodgepole, however, would not benefit because the mine facilities are not taxable by the Hays-Lodgepole school district.

The social impacts of Alternative 5 would differ among the potentially affected groups within the study area. For residents of Phillips County and its communities, the mine would have a significant positive impact on social well-being. The primary effect on local residents would be due to sustaining the local economy at its current level and maintaining employment opportunities, personal income levels, and fiscal resources for 6 more years.

The secondary and cumulative repercussions of these effects would be felt as positive impacts on local social structures, facilities and services, and retail trade and service sectors in Malta and Zortman. Mine employees are among the highest wage earners in the communities where they live; for example, only 30 or so oil and gas workers in Phillips County earn at the same level. ZMI employees also would remain active in local churches, civic service and economic development organizations, volunteer public safety and emergency services, and youth recreation programs. ZMI also directly donate funds which help to sustain or enhance the activities of various educational, civic, and social organizations; this pattern potentially would continue. Traditional rural family values would continue to be sustained to some extent in Malta and Phillips County by ZMI's policy of hiring local youth both for seasonal and permanent work (Rust 1994; Boothe 1994; Ereaux 1994).

Facilities and services offered by local governments in Phillips County would continue to be offered at current levels. Additional revenue flows will allow reduction of debt in Malta (Ereaux 1994). Senior citizen programs, recreation programs, and population sensitive services, such as medical practices, would be sustained for at least another 6 years (Wambold 1994).

By sustaining the current population, Alternative 5 also would positively affect retail trade and service sectors in Malta, the main shopping center located in Phillips County. This would be the case because ZMI and its employees are a significant market for goods and services in Malta now (Boothe 1994).

The impact of Alternative 5 on the well-being of groups in Blaine County, such as farmers, ranchers, and townspeople, would be similar to those described for Phillips County. However, the effect would potentially be much less intense and much less widely felt because so many fewer residents of Blaine County depend on the mines as an economic generator.

The effect of Alternative 5 on the sense of social well-being of residents of the Fort Belknap Indian Reservation as a whole was described in Section 4.10.6.1, and that description is incorporated here by reference. Although some Native Americans residing on the reservation are employed by ZMI and would feel better off economically, Alternative 5, like Alternative 4, would be viewed by many Native Americans as allowing a significant and generally adverse quality of life impact to persist and expand in extent over an additional 6 years. A difference is that under Alternative 5, the adverse impact to the social well-being of Native Americans may be slightly lower than under Alternative 4 because of long-term improvements in terms of a higher probability of reclamation success, the potential to correct existing water quality problems, and the restoration of drainage to King Creek. However, there may be a higher level of concern about the quality of water flowing into King Creek. Although these positive effects probably would occur, they may not be perceived as significant by Native Americans adversely impacted by the higher level of permanent change to the landscape in the Little Rocky Mountains incurred under Alternative 5.

As described in Section 4.10.6.1, some non-Native Americans, for similar or other reasons, may also react negatively to the impacts of Alternative 5 on the local quality of life. However, these views probably would not affect the overall consensus within the non-Native American community that the extension of ZMI's mineral development activity would be of overall economic and social benefit in Malta, Zortman and Phillips County.

4.10.7.2 Cumulative Impacts

Under Alternative 5, reasonably foreseeable exploration activity to possibly expand ore reserves or further define existing reserves could involve the hiring of a contract drilling in crew of about 4 persons costing ZMI between $100,000 and $200,000 per year for 3 to 5 years, a small increment of employment and spending in comparison to proposed spending levels under the alternative. This would not materially change the magnitude or duration of any of the impacts identified for Alternative 5.

The cumulative socioeconomic impact of Alternative 5, summarized in terms of employment generated by ZMI's operations in the past and in the future, would be 8,196 job-years of full- and part-time employment in Phillips County, 309 job-years of employment in Blaine County, and 11,751 job years of employment in Montana as a whole.

The cumulative social effects under Alternative 5 would be essentially the same as those under Alternative 4. These were in Section 4.10.6.2, and are incorporated here by reference.

4.10.7.3 Unavoidable Adverse Impacts

The impact of Alternative 5 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. This impact would be unavoidable. All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 5 would be unavoidable, as well. Adverse impacts of closure are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.7.4 Short-term Use/Long-term Productivity

Under Alternative 5, the productivity of pre-existing and additional existing economic resources such as grazing land would be disturbed in exchange for mining, a significantly more intensive economic development. However, in the long run, assuming the success of reclamation procedures, pre-disturbance uses could be restored to long-term productivity.

4.10.7.5 Irreversible or Irretrievable Resource Commitments

In economic terms, no irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 5. Native Americans may view physical impacts upon cultural resource sites important to their lifestyle as an irreversible and irretrievable resource commitment associated with the alternative.

4.10.8 Impacts of Alternative 6

4.10.8.1 Impacts

Alternative 6 would approve expansion of both the Zortman and Landusky mines but impose agency-developed mitigation on the expansion and reclamation activities. The major modification to ZMI's expansion plans, as described under Alternative 4, would be to relocate the waste rock repository to the Ruby Flats just east of the Goslin Flats leach pad. No drainage would be restored to King Creek under Alternative 6.

Under Alternative 6, it is assumed mining would occur for only 5 years before closure activities begin. This is because the additional cost of moving waste rock to the repository at Ruby Flats would make it uneconomical to recover and process some ore at the Zortman mine. Implementation and the construction phase of Alternative 6 would be as described for other expansion alternatives. Alternative 6 would require high initial expenditures to construct of new facilities, including a larger system to process and move ore and waste rock to the Goslin Flats leach pad and the Ruby Flats repository. However, total expenditures over the life of the alternative would be lower under Alternative 6, as compared to Alternatives 4, 5, and 7 because less time would be devoted to mining and closure and reclamation would occur a year sooner. During the closure and reclamation cycle, employment and spending would be similar to that described for Alternative 4. The direct employment, payroll and expenditure associated with ZMI's continued operations under Alternative 6 are presented in Table 4.10-1 through Table 4.10-3.

During the extended mining period, Alternative 6 would sustain direct and indirect economic activity in the state of Montana, in Phillips County and, to a much lesser extent, in Blaine County. The additional employment and earnings generated as a result would be a significant benefit, especially when compared in magnitude to the effects of Alternatives 1 through 3.

Also, sustaining ZMI operations at current levels for 5 more years would have significant positive impacts on Phillips County and the communities of Malta and Zortman in terms of fiscal conditions, community resources, and social well-being among its residents. Cumulative positive effects also would be felt in Blaine County. However, they would be small, compared to existing conditions. Businesses elsewhere in the state of Montana would continue to be positively affected over the extended life of ZMI's operations, especially those in Billings and Helena which supply ZMI with goods and services. Property values would be supported at present levels in Phillips County and especially in the communities of Malta and Zortman. Consumers who buy electricity from the Big Flat Electric Cooperative would continue to benefit from the volume and demand-spreading discounts Big Flat earns from its supplier by having the mines as a customer. This effect would be concentrated in parts of Big Flat's service area that rely disproportionately on electric heat for home heating because they lack access to natural gas. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation. On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed (Eickerman 1993).

The State treasury would earn cumulative revenues, a significant beneficial impact. Economic effects on the Fort Belknap Indian Reservation would also be relatively small, if positive, and there would be no fiscal impact because no direct revenues are derived from the mine.

The extended mining phase of Alternative 6 also would sustain beneficial conditions in the social environment in Malta and Zortman, where mine employees and their families are positive contributors to, and an integral part of, local social structures. The impact of Alternative 6 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. Although some Native Americans residing on the reservation are employed by ZMI and would benefit economically from the additional years of employment and income, many Native Americans who oppose the mine and have expressed a high level of concern about its presence would continue to be adversely affected during the extended mining phase before closure activities begin and the mines ultimately are closed.

The impacts of closure under Alternative 6 would be similar to those described for Alternative 1 in Section 4.10.2. The only difference is that, for Alternative 6, the impacts would occur later than under Alternative 1. It is possible that by delaying closure under Alternative 6, the relative magnitude of the impacts may be somewhat different because conditions may change farther out in the future. However, this is not likely since population and employment projections available now for Phillips County indicate almost no growth is anticipated for the county through the year 2012. In Blaine County, where the available population and employment projections indicate some growth is anticipated through the year 2012, the relative impacts of closure would therefore be even smaller under Alternative 6 than under Alternative 1.

Table 4.10-8 summarizes the economic and fiscal impact impacts of Alternative 6 compared to the impacts of Alternatives 4, 5 and 7. Under Alternative 6, ZMI's operations from 1996 to 2012 would generate a cumulative total of 4,524 job-years of direct and secondary employment and $114.8 million in 1994 dollars of direct and secondary earnings within the state of Montana. The cumulative effect on state employment would be about 8 times the magnitude of Alternative 1. The statewide effects include a cumulative total of 3,173 job-years of employment and $87.4 million in 1994 dollars of earnings in Phillips County, about 7 times the employment effect of Alternative 1. During the same period, ZMI's operations would generate a cumulative total of 133 job-years of employment and $2.4 million in earnings in 1994 dollars for Blaine County, about 7 times the employment effect of Alternative 1. (A job-year is a full- or part-time job held for a year, on average.) Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.

Under Alternative 6, the short-term effects to economically-beneficial recreation resources would be similar to those of Alternative 4. However, locating both the heap leach and waste rock repository in the Goslin Flats area would increase the magnitude and intensity of indirect impacts to the quality of the recreation experience for users of the developed campgrounds, sightseers driving the roads, and recreationists accessing nearby lands. Therefore, Alternative 6 probably would slightly increase the adverse impact to the potential for recreation-based economic development in the short-term. The effect is likely to occur but probably would be quite small.

Under Alternative 6, the existing work force potentially would stay in place, and because there would be no significant change in employment level, no change would be expected in total community and school population, other than the aging and turnover consistent with the trends described in Section 3.10.

ZMI would employ contract crews for construction of new facilities, including a water treatment plant, crusher, conveyor, and leach pad, as well as contract crews for final reclamation. It is assumed Big Flat Electric Cooperative would employ a contracted crew for construction of a power line between the Zortman and Landusky mines. Contract employment would occur in 1996 and 1997 and in 2005 and 2006. Temporary housing accommodations would be available for contractor employees as described in section 4.10.6.1.

Local jurisdictions in Phillips County would accumulate additional tax revenues under Alternative 6. Revenue flows would be sustained for an additional 5 years, but revenues would decline rapidly after 2001 and would disappear entirely after the conclusion of all activity at the mine site in 2011.

ZMI's operations from 1996 to 2011 would generate cumulative total revenues of $2.4 million for Phillips County, $1.2 million for the Malta High School and Elementary School districts combined, $1.0 million for the Dodson High School district, and $680,000 for Landusky Elementary School, all in 1994 dollars (Table 4.10-8). The impact upon local jurisdictions of the decline and eventual loss of revenues would be essentially the same as under Alternative 4 and was described in Section 4.10.6.1.

The Phillips County Hard Rock Trust Reserve fund would potentially receive annual distributions from state Metal Mines License Tax receipts for an additional 5 years, and the funds would be available for distribution when mine employment declines to half the previous five-year average. A distribution from the Phillips County Hard Rock Trust Reserve would be limited in its ability to mitigate impacts to local governments and schools. The amount distributed would be relatively small and available only on a one-time basis, while fiscal problems faced by each jurisdiction would be long-term. The Phillips County Hard Rock Trust Reserve had a balance of about $1 million in 1994; under Alternative 6 the fund would accumulate an additional $480,000. According to the statutory formula (described in Section 4.10.6.1) all the affected school districts in Phillips County would proportionally share in at least an estimated total of about $490,000 while the remainder of the fund would be available for expenditure directly by Phillips County or for distribution by the County as grants and loans to other local government units. Local school districts would also receive about $16,000 annually per district in Metal Mines License Tax distributions for additional years of mining.

In 1994, the Zortman and Landusky mines paid about $765,000 in metal mines license taxes, 75 percent of which is retained by the State. Under Alternative 6, the state would accumulate an additional $3.6 million in metal mines license taxes, about 8 times the total collected under Alternative 1.

Under Alternative 6, costs for providing services would continue at current levels for most jurisdictions through 2002 or 2003. Facilities within the study area that presently are at capacity would continue to operate under some strain. These include Malta's water and wastewater utilities, schools in Malta, medical care and emergency-response providers in Phillips County, and schools at Hays and Lodgepole. Additional revenues accumulated during ZMI's additional 5 years of mining may provide sufficient fiscal resources to accomplish some improvements for the Phillips County providers. Schools at Hays and Lodgepole, however, would not benefit because the mine facilities are not taxable by the Hays-Lodgepole school district.

The social impacts of Alternative 6 would differ among the potentially affected groups within the study area. For residents of Phillips County and its communities, the mine would have a significant positive impact on social well-being. The primary effect on local residents would be due to sustaining the local economy at its current level and maintaining employment opportunities, personal income levels, and fiscal resources for 5 more years.

The secondary and cumulative repercussions of these effects would be felt as positive impacts on local social structures, facilities and services, and retail trade and service sectors in Malta and Zortman. Mine employees are among the highest wage earners in the communities where they live; for example, only 30 or so oil and gas workers in Phillips County earn at the same level. ZMI employees also would remain active in local churches, civic service and economic development organizations, volunteer public safety and emergency services, and youth recreation programs. ZMI also directly donate funds which help to sustain or enhance the activities of various educational, civic, and social organizations; this pattern potentially would continue. Traditional rural family values would continue to be sustained to some extent in Malta and Phillips County by ZMI's policy of hiring local youth both for seasonal and permanent work (Rust 1994, Boothe 1994; Ereaux 1994).

Facilities and services offered by local governments in Phillips County would continue to be offered at current levels. Additional revenue flows will allow reduction of debt in Malta (Ereaux 1994). Senior citizen programs, recreation programs, and population sensitive services, such as medical practices, would be sustained for at least another 5 years (Wambold 1994).

By sustaining the current population, Alternative 6 also would positively affect retail trade and service sectors in Malta, the main shopping center located in Phillips County. This would be the case because ZMI and its employees are a significant market for goods and services in Malta now (Boothe 1994).

The impact of Alternative 6 on the well-being of groups in Blaine County, such as farmers, ranchers, and townspeople, would be similar to those described for Phillips County. However, the effect would potentially be much less intense and much less widely felt because so many fewer residents of Blaine County depend on the mines as an economic generator.

The effect of Alternative 6 on the sense of social well-being of residents of the Fort Belknap Indian Reservation as a whole was described in Section 4.10.6.1, and that description is incorporated here by reference. Although some Native Americans residing on the reservation are employed by ZMI and would feel better off economically, Alternative 6, like Alternatives 4 and 5, would be viewed by many Native Americans as allowing a significant and generally adverse quality of life impact to persist and expand in extent over an additional 5 years. Under Alternative 6, the adverse impact to the social well-being of Native Americans may be slightly lower than under Alternative 4 because of the improved probability of reclamation success and potential to correct existing water quality problems over the long term. Although these positive effects would occur, they may not be significant to Native Americans adversely impacted by the higher level of permanent change to the landscape in the Little Rocky Mountains which would be incurred under Alternative 6.

4.10.8.2 Cumulative Impacts

Reasonably foreseeable mining and exploration activity would not materially change the magnitude or duration of any of the impacts identified for Alternative 6. The cumulative socioeconomic impact of Alternative 6, summarized in terms of employment generated by ZMI's operations in the past and in the future, would be 8,013 job-years of full- and part-time employment in Phillips County, 303 job-years of employment in Blaine County, and 11,454 job years of employment in Montana as a whole.

The cumulative social effects under Alternative 6 would be essentially the same as those under Alternative 4. These were in Section 4.10.6.2, and are incorporated here by reference.

4.10.8.3 Unavoidable Adverse Impacts

The impact of Alternative 6 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. This impact would be unavoidable. All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 6 would be unavoidable, as well. Adverse impacts of closure are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.8.4 Short-term Use/Long-term Productivity

Under Alternative 6, the productivity of pre-existing and additional existing economic resources such as grazing land would be disturbed in exchange for mining, a significantly more intensive economic development. However, in the long run, assuming the success of reclamation procedures, pre-disturbance uses could be restored to long-term productivity.

4.10.8.5 Irreversible or Irretrievable Resource Commitments

In economic terms, no irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 6. Native Americans may view physical impacts upon cultural resource sites important to their lifestyle as an irreversible and irretrievable resource commitment associated with the alternative.

4.10.9 Impacts of Alternative 7

4.10.9.1 Impacts

Alternative 7 would approve expansion of both the Zortman and Landusky mines but impose agency developed mitigation on the expansion and reclamation activities. In socioeconomic terms, Alternative 7 is similar to Alternative 4; however, there are differences that potentially affect socioeconomic impacts. A difference at the Zortman Mine is the fact that under Alternative 7, the proposed waste rock repository would be constructed on top of existing facilities. At the Landusky Mine, a modification of reclamation requirements would be for ZMI to remove rock fill from the head of King Creek and backfill the pits so that they freely drain into King Creek, a feature Alternative 7 shares with Alternative 5. The use of water balance reclamation covers at both mines to reduce or eliminate environmental impacts differentiates Alternative 7 from the reclamation cover types used in Alternatives 2 through 6.

Under Alternative 7, it is assumed mining would occur for 7 years before a transition is made and closure activities begin. Implementation of Alternative 7 could begin as soon as early 1996. Construction of new facilities, assumed to occur in 1996 and 1997, would require substantial capital outlays and employment of some construction contracting. Cumulative expenditures by ZMI would be higher under Alternative 7, as compared to Alternatives 4 through 6, mainly because of the modified reclamation requirements.

After construction but during the extended mining operations, which would last into the year 2002, ZMI would require levels of employment similar to those in the past and would expend similar levels of annual operating and working capital expenditures. Closure activities are assumed to begin in the year 2002 and last through 2012, with additional reclamation contracting occurring in 2006 and 2007. During the closure and reclamation cycle, employment and spending would be somewhat higher than in other alternatives. The direct employment, payroll and expenditure associated with ZMI's continued operations under Alternative 7 are presented in Table 4.10-1 through Table 4.10-3.

During the extended mining period, Alternative 7 would sustain direct and indirect economic activity in the State of Montana, in Phillips County and, to a much lesser extent, in Blaine County. The additional employment and earnings generated as a result would be a significant benefit, especially when compared in magnitude to the effects of Alternatives 1 through 3.

Also, sustaining ZMI operations at current levels for 7 more years would have significant positive impacts on Phillips County and the communities of Malta and Zortman in terms of fiscal conditions, community resources, and social well-being among its residents. Cumulative positive effects also would be felt in Blaine County, however, they would be small, compared to existing conditions. Businesses elsewhere in the State of Montana would continue to be positively affected over the extended life of ZMI's operations, especially those in Billings and Helena which supply ZMI with goods and services. Property values would be supported at present levels in Phillips County and especially in the communities of Malta and Zortman. Consumers who buy electricity from the Big Flat Electric Cooperative would continue to benefit from the volume and demand-spreading discounts Big Flat earns from its supplier by having the mines as a customer. This effect would be concentrated in parts of Big Flat's service area that rely disproportionately on electric heat for home heating because they lack access to natural gas. These areas are the rural area of Phillips County south of Malta and around Regina, rural areas around Turner and Hogeland within Blaine County, and the Fort Belknap Indian Reservation. On certain occasions, ZMI would allow employee wood gathering as long as all State and Federal guidelines are followed.

The State treasury would earn cumulative revenues, a significant beneficial impact. Economic effects on the Fort Belknap Indian Reservation would also be relatively small, if positive, and there would be no fiscal impact because no direct revenues are derived from the mine.

The extended mining phase of Alternative 7 also would sustain beneficial conditions in the social environment in Malta and Zortman, where mine employees and their families are positive contributors to, and an integral part of, local social structures. The impact of Alternative 7 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. Although some Native Americans residing on the reservation are employed by ZMI and would benefit economically from the additional years of employment and income, many Native Americans who oppose the mine and have expressed a high level of concern about its presence would continue to be adversely affected during the extended mining phase before closure activities begin and the mines ultimately are closed.

The impacts of closure under Alternative 7 would be similar to those described for Alternative 1 in Section 4.10.2. The only difference is that, for Alternative 7, the impacts would occur later than under Alternative 1. It is possible that by delaying closure under Alternative 7, the relative magnitude of the impacts may be somewhat different because conditions may change farther out in the future. However, this is not likely since population and employment projections available now for Phillips County indicate almost no growth is anticipated for the county through the year 2012. In Blaine County, where the available population and employment projections indicate some growth is anticipated through the year 2012, the relative impacts of closure would therefore be even smaller under Alternative 7 than under Alternative 1.

Table 4.10-8 summarizes the economic and fiscal impact impacts of Alternative 7 compared to the impacts of Alternatives 4 through 6. Under Alternative 7, ZMI's operations from 1996 to 2012 would generate a cumulative total of 5,156 job-years of direct and secondary employment and $130.6 million in 1994 dollars of direct and secondary earnings within the State of Montana. The cumulative effect on state employment would be about 9 times that of Alternative 1. The statewide effects include a cumulative total of 3,608 job-years of employment and $99.3 million in 1994 dollars of earnings in Phillips County, about 8 times the employment effect of Alternative 1. During the same period, ZMI's operations would generate a cumulative total of 133 job-years of employment and $2.7 million in earnings in 1994 dollars for Blaine County, about 7 times the employment effect of Alternative 1. (A job-year is a full- or part-time job held for a year, on average.) Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.

Under Alternative 7, the short-term effects to economically-beneficial recreation resources would be similar to those of Alternative 4. However, locating both the waste rock repository on top of facilities at the Zortman Mine and the use of water balance reclamation covers may improve the appearance of reclaimed areas in the long term, a beneficial effect for recreation users in the Little Rocky Mountains. Therefore, Alternative 7 may increase slightly the beneficial impact to recreation-based economic development potential in the long-term for areas surrounding the Little Rocky Mountains. The effect is likely to occur but probably would be quite small.

Under Alternative 7, the existing work force potentially would stay in place during the extended life of ZMI's operations, and because there would be no significant change in employment level, no change would be expected in total community and school population, other than the aging and turnover consistent with the trends described in Section 3.10.

ZMI would employ contract crews for construction of new facilities, including a water treatment plant, crusher, conveyor, and leach pad, as well as contract crews for final reclamation. It is assumed Big Flat Electric Cooperative would employ a contracted crew for construction of a power line between the Zortman and Landusky mines. Contract employment would occur in 1996 and 1997 and in 2006 and 2007. Temporary housing accommodations would be available for contractor employees as described in section 4.10.6.1.

Local jurisdictions in Phillips County would accumulate additional tax revenues under Alternative 7. Revenue flows would be sustained for an additional 7 years, but revenues would decline rapidly after 2001, and would disappear entirely after the conclusion of all activity at the mine site in 2012.

ZMI's operations from 1996 to 2012 would generate cumulative total revenues of $2.6 million for Phillips County, $1.2 million for the Malta High School and Elementary School districts combined, $1.1 million for the Dodson High School district, and $730,000 for Landusky Elementary School, all in 1994 dollars (Table 4.10-8). The impact upon local jurisdictions of the decline and eventual loss of direct tax revenue would be essentially the same as under Alternative 4. This impact was described in Section 4.10.6.1.

The Phillips County Hard Rock Trust Reserve would receive annual distributions from state Metal Mines License Tax receipts during the extended operations, and the funds would be available for distribution when mine employment declines to half the previous five-year average. A distribution from the Phillips County Hard Rock Trust Reserve would be limited in its ability to mitigate impacts to local governments and schools. The amount distributed would be relatively small and available only on a one-time basis, while fiscal problems faced by each jurisdiction would be long-term. The Phillips County Hard Rock Trust Reserve had a balance of about $1 million in 1994; under Alternative 7 the fund would accumulate an additional $570,000. According to the statutory formula (described in Section 4.10.6.1) all the affected school districts in Phillips County would proportionally share in at least an estimated total of about $530,000 while the remainder of the fund would be available for expenditure directly by Phillips County or for distribution by the County as grants and loans to other local government units. Local school districts would also receive about $16,000 annually per district in Metal Mines License Tax distributions for additional years of mining.

In 1994, the Zortman and Landusky mines paid about $765,000 in metal mines license taxes, 75 percent of which is retained by the State. Under Alternative 7, the state would accumulate an additional $4.3 million in metal mines license taxes, about 10 times the total collected under Alternative 1.

Under Alternative 7, costs for providing services would continue at current levels for most jurisdictions through 2003 or 2004. Facilities within the study area that presently are at capacity would continue to operate under some strain. These include Malta's water and wastewater utilities, schools in Malta, medical care and emergency-response providers in Phillips County, and schools at Hays and Lodgepole. Additional revenues accumulated during ZMI's additional 7 years of mining may provide sufficient fiscal resources to accomplish some improvements for the Phillips County providers. Schools at Hays and Lodgepole, however, would not benefit because the mine facilities are not taxable by the Hays-Lodgepole school district.

The social impacts of Alternative 7 would differ among the potentially affected groups within the study area. For residents of Phillips County and its communities, the mine would have a significant positive impact on social well-being. The primary effect on local residents would be due to sustaining the local economy at its current level and maintaining employment opportunities, personal income levels, and fiscal resources for 7 more years.

The secondary and cumulative repercussions of these effects would be felt as positive impacts on local social structures, facilities and services, and retail trade and service sectors in Malta and Zortman. Mine employees are among the highest wage earners in the communities where they live; for example, only 30 or so oil and gas workers in Phillips County earn at the same level. ZMI employees also would remain active in local churches, civic service and economic development organizations, volunteer public safety and emergency services, and youth recreation programs. ZMI also directly donate funds which help to sustain or enhance the activities of various educational, civic, and social organizations; this pattern potentially would continue. Traditional rural family values would continue to be sustained to some extent in Malta and Phillips County by ZMI's policy of hiring local youth both for seasonal and permanent work (Rust 1994, Boothe 1994; Ereaux 1994).

Facilities and services offered by local governments in Phillips County would continue to be offered at current levels. Additional revenue flows would allow reduction of debt in Malta (Ereaux 1994). Senior citizen programs, recreation programs, and population sensitive services, such as medical practices, would be sustained for at least another 7 years (Wambold 1994).

By sustaining the current population, Alternative 7 also would positively affect retail trade and service sectors in Malta, the main shopping center located in Phillips County. This would be the case because ZMI and its employees are a significant market for goods and services in Malta now (Boothe 1994).

The impact of Alternative 7 on the well-being of groups in Blaine County, such as farmers, ranchers, and townspeople, would be similar to those described for Phillips County. However, the effect would potentially be much less intense and much less widely felt because so many fewer residents of Blaine County depend on the mines as an economic generator.

The effect of Alternative 7 on the sense of social well-being of residents of the Fort Belknap Indian Reservation as a whole was described in Section 4.10.6.1, and that description is incorporated here by reference. Although some Native Americans residing on the reservation are employed by ZMI and would feel better off economically, Alternative 7, like Alternatives 4 through 6, would be viewed by many Native Americans as allowing a significant and generally adverse quality of life impact to persist and expand in extent over an additional 7 years. Under Alternative 7, the adverse impact to the social well-being of Native Americans may be slightly lower than under Alternative 4 because of the improved probability of reclamation success over the long term, the potential to correct existing water quality problems, and the potential to increase flows in King Creek. However, there may be a higher level of concern about the quality of water flowing into King Creek. Although these positive effects would occur, they may not be significant to Native Americans adversely impacted by the higher level of permanent change to the landscape in the Little Rocky Mountains which would be incurred under Alternative 7.

4.10.9.2 Cumulative Impacts

Reasonably foreseeable mining and exploration activity would not materially change the magnitude or duration of any of the impacts identified for Alternative 7. The cumulative socioeconomic impact of Alternative 7, summarized in terms of employment generated by ZMI's operations in the past and in the future, would be 8,448 job-years of full- and part-time employment in Phillips County, 303 job-years of employment in Blaine County, and 12,086 job years of employment in Montana as a whole. Impacts in Phillips and Blaine counties may be overstated, as described in Section 4.10.1.2.

The cumulative social effects under Alternative 7 would be essentially the same as those under Alternative 4. These were in Section 4.10.6.2, and are incorporated here by reference.

4.10.9.3 Unavoidable Adverse Impacts

The impact of Alternative 7 on the social environment on the Fort Belknap Indian Reservation, at least during the extended mining phase, would be significant and generally perceived as adverse. This impact would be unavoidable. All adverse impacts related to the closure and reclamation of the Zortman and Landusky mines under Alternative 7 would be unavoidable, as well. Adverse impacts of closure are loss of employment and earnings, loss of direct tax revenues, adverse impacts to community facilities and services, and adverse impacts to the social well-being of residents of Phillips County.

4.10.9.4 Short-term Use/Long-term Productivity

Under Alternative 7, the productivity of pre-existing and additional existing economic resources such as grazing land would be disturbed in exchange for mining, a significantly more intensive economic development. However, in the long run, assuming the success of reclamation procedures, pre-disturbance uses could be restored to long-term productivity.

4.10.9.5 Irreversible or Irretrievable Resource Commitments

In economic terms, no irreversible or irretrievable commitments of socioeconomic resources have been identified for Alternative 7. Native Americans may view physical impacts upon cultural resource sites important to their lifestyle as an irreversible and irretrievable resource commitment associated with the alternative.

4.11 TRANSPORTATION

4.11.1 Introduction and Methodology

The discussion of transportation-related impacts associated with the various Zortman/Landusky project alternatives focuses on three primary areas:

- Effects of vehicle traffic on local roads and highways, and associated concerns regarding accident potential and safety of local residents. Three types of vehicle trips are considered, including those generated by workers commuting to and from the Zortman and Landusky mines; truck trips associated with the hauling of reclamation materials; and truck trips associated with the hauling of hazardous materials, such as cyanide and diesel fuel. These vehicle trips will be considered according to (a) the context of traffic volumes on local and regional roads, (b) the likelihood that the number of accidents may change on those roads, and (c) the issue of the safety of local residents who live adjacent to those roads. In addition, internal mine truck traffic will be discussed due to potential impacts on wildlife species that use the project area.

  In assessing the significance of traffic-related impacts and assigning an impact level (high, medium, or low), traffic volumes experienced due to project activities from 1979 - 1994 mining activities, as well as those projected for the future under various project alternatives, will be compared with the actual capacities of the highways and local roads utilized. Based on the Transportation Research Board's Highway Capacity Manual, the project area highways are generally capable of supporting as many as 5,700 trips per day before driving conditions would become congested. If traffic volumes exceed this threshold, traffic congestion increases considerably. Similarly, the local roads used to access the communities of Zortman and Landusky and the mines would be capable of handling as many as 2,850 trips per day each or 356 trips per hour before experiencing traffic congestion. Project-induced exceedances of these capacities or thresholds would be considered to have a high negative impact on the study area transportation system. Project-induced traffic that ranges from 70 percent to 100 percent of these capacities would be rated as medium negative, impacts ranging from 1 to 70 percent of capacity would be rated as low negative, and where traffic would not increase at all above baseline conditions, impacts would be rated as neutral.

  With respect to accidents, actual numbers of accidents on study area highways will be compared between the period before mining (1970s) and during recent mining activities (1980s) to assess whether or not accidents and accident rates increased as a result of increased traffic due to mining. For potential future accident calculation, the accident rate experienced during recent mining activities (1980 - 1989) will be applied to projected future traffic under the various project alternatives to predict accident numbers. If the calculated number of accidents is greater than 50 percent of the annual average experienced during the recent mining phase, impacts would be rated as high negative. For increases of 25 - 50 percent, impacts would be rated medium negative, and for increases from 1 - 25 percent, impacts would be rated low negative.

- Potential effects of the project alternatives on vehicle and pedestrian access to various parts of the Little Rocky Mountains, including the areas currently being mined, Saddle Butte, and Goslin, Pony and Alder Gulches.
  In assessing the significance of access-related impacts and assigning an impact level (high, medium, or low), the extent of the area excluded from public access due to road closures will be compared between baseline (pre-1979) and the present and projected future mining eras. Where project activities result in closure of major areas in the southern Little Rocky Mountains or roads that are important for accessing large areas and these impacts can not be mitigated, the impact is rated as high negative. For impacts to large areas or where important road closures would occur, but mitigation could be applied (permitted access on occasions, alternative roads constructed), impacts would be rated as medium negative. For closures of small areas, or where road closures do not affect larger areas, or where alternative access roads are available, impacts would be rated as low negative.

- Transportation of hazardous materials to and from the mines, and risks associated with potential accidents and spills.
  According to the Montana Highway Patrol and Montana Department of Transportation, accident rates for hazardous material haul trips have not been calculated to date. Records on the number of accidents involving commercial vehicles hauling hazardous materials are available, however. As an example, there were a total of 14 accidents involving commercial vehicles hauling hazardous materials in 1993 in the entire State of Montana (Montana Highway Patrol 1994). Unfortunately, the State does not track the total number of hazardous material haul trips that are actually taking place each year and therefore can not calculate an accident rate (Montana Department of Transportation 1994). Based on the fact that only 14 accidents occurred in the entire State in 1993, and that there were likely to be hundreds of thousands of such haul trips (e.g., gasoline tankers supplying service stations statewide), one can assume the accident rate is very low in general. For the Zortman and Landusky mines, no hazardous material hauling accidents occurred from 1979 to 1994. For assessing potential future impacts, projected hazardous materials haul trips for all alternatives will be compared with the numbers utilized by the mines from 1979 to 1994.

4.11.2 Impacts From Mining, 1979 to Present

Impacts associated with recent mining activities are evaluated in comparison to the study area transportation network as it existed prior to 1979. General traffic volume and accident data were available from the Montana Department of Transportation and Montana Highway Patrol and were used for comparison of pre-mining conditions with conditions associated with recent mining operations.

Traffic

After commencement of permitted mining activities in 1979, traffic volumes on study area roads increased considerably (Table 3.11-1). Specifically, average daily traffic (ADT) volumes increased by 152 percent on U.S. Highway 191 between Malta and Zortman, 41 percent between Zortman and Lewistown, and 133 percent on Route 66 between Hays and Landusky from 1975 to 1980 (Montana Department of Transportation 1994, 1990, and 1991). These elevated traffic volumes have generally persisted throughout the past 15 years that mining has been carried out. Although this increase may be attributed to a variety of factors, much of it is likely to be associated with commuting mine workers that did not work in the project area prior to 1979. It is estimated that commuting mine workers added an average of approximately 100 roundtrips per day, virtually every day, to the transportation network from 1979 to 1994. Similarly, truck traffic also increased due to mining activities in the project area. It is estimated that roughly 12 truck roundtrips per day or up to 4,200 roundtrips per year were added to the transportation network for hauling of various mining-related supplies from 1979 to 1994.

In terms of assessing the significance of these traffic increases, it is important to consider the fact that traffic volumes on project area highways were very low relative to their actual capacity. In the context of this project, the traffic volume increases experienced from 1979 to 1994 were fairly large when compared with pre-mining conditions, but were small relative to the design capacity of the respective local roads and highways. In fact, over the 15 years that mining has occurred at the Zortman and Landusky mines, ADT values have never exceeded 1,000 for either U.S. Highway 191 or Route 66, the two highways that actually serve the mining area. Thus, even with mining-related traffic, these highways have operated at less than one-fifth of their capacity. Similarly, the local roads used to access the communities of Zortman and Landusky and the mines experienced traffic volumes far below their capacity values. Consequently, the increase in traffic volumes associated with recent mining activities is considered to have had a low negative impact on the transportation network in the study area.

Surprisingly, the number of accidents and accident rate on study area highways actually dropped after 1979, despite the increase in traffic volumes (Table 3.11-1). From 1972 to 1978, U.S. Highway 191 between Malta and Zortman experienced an average of 14 accidents per year, compared with 13 accidents per year from 1980 to 1989, despite a 153 percent increase in traffic volumes. Route 66 and U.S. Highway 2 also experienced reductions in accidents in the 1980s, despite similar increases in traffic volumes after mining commenced. In fact, the number of accidents per year dropped by 61 percent (from 13 to 5) on Route 66 and by 55 percent (from 31 to 14) on U.S. Highway 2. It is difficult to determine why this reduction in accidents occurred. Various factors not related to traffic volume, including weather severity, may have played a role in highway conditions and the number of accidents. Thus, it appears the increase in traffic related to mining in the project area had no impact on accident numbers or accident rates in the study area.

Public Access to the Little Rocky Mountains

One of the more pronounced impacts of mining operations at the Zortman and Landusky mines has been the closure of roads to the public that were historically used for access to the southern Little Rocky Mountains. Prior to 1979, public access and vehicle use of roads in the current mining areas were permitted and those areas were used for a variety of recreational and cultural purposes. Since 1979, the Zortman Mine Access Road, the Zortman to Landusky road, and the Landusky Mine access roads have been closed to the public for safety reasons. Similarly, Mission Canyon Road has been closed below the Landusky Mine, as has the road that extends up Alder Gulch near the Zortman Mine. Altogether, these road closures have had a high negative impact on the local transportation network as it relates to access to the southern Little Rocky Mountains because they have effectively excluded access to a considerable portion of the southern Little Rocky Mountains once available for public use. The specific impacts on recreation and cultural uses of the southern Little Rocky Mountains are described in Sections 4.7 and 4.12 respectively.

At present, public access to Saddle Butte, Goslin Gulch, and Pony Gulch is still available, although permission to cross private property on Goslin Flats is required.

Transportation of Hazardous Materials

As described in Section 3.11, very little transportation of hazardous materials in the local project area occurred prior to 1979. Commencement of mining activities in the Little Rocky Mountains resulted in the transport of large quantities of chemical reagents, motor vehicle fuels, and other regulated hazardous materials to both the Zortman and Landusky mines. Although production rates at the two mines varied from 1979 to 1994, it is estimated that approximately 4,200 truck trips (roundtrips) per year were required to supply the mines with the materials they needed. This transport of regulated hazardous materials created a risk of accidents and potential releases of hazardous materials. Fortunately, over the 15 year operating period, there were no reported accidents associated with the project involving the transport of hazardous materials.

4.11.3 Impacts From Alternative 1

Traffic

Under Alternative 1, reclamation would be quickly completed at the Zortman Mine (ending about 1998) and final mining, leaching, and reclamation would be completed at the Landusky Mine around the year 2000. Under projected employment conditions, this project scenario would result in roughly 95 commuter roundtrips per day in 1996 and would diminish once reclamation is completed (Table 4.11-1). The addition of 95 roundtrips per day would represent an increase above baseline (pre-1979) conditions, but a slight decrease in traffic relative to the 1979 to 1994 mining period (which averaged 100 roundtrips per day).

Similarly, truck traffic to the mines would also diminish as the productive life of the mines ends. Alternative 1 features the least intensive reclamation effort of all project alternatives considered. No truck trips associated with hauling of clay are envisioned as a result (Table 4.11-2).

Five truck trips per day or up to 1,775 (roundtrips) per year would be required for hazardous materials hauling. These materials would consist primarily of reagents required for final heap leaching at the mines. After heap leaching is completed, these trips would decrease and would consist primarily of gasoline and diesel fuel for heavy equipment engaged in reclamation activities (Table 4.11-3) (Figure 4.11-1).

Comparison of hazardous material hauling of 1,775 roundtrips per year, with an average of 4,200 roundtrips per year from 1979 to 1994 indicates that truck traffic would decrease relative to recent mining activities. As described in Section 4.11.2, the traffic volumes associated with mining operations would have a low negative impact on the transportation network in the study area due to the abundance of available road and highway capacity in the study area (Figure 4.11-2).

Internal mine traffic associated with completion of active mining of ore and hauling of waste rock would continue at the rate of 180,000 and 90,000 roundtrips per year (500 and 250 roundtrips daily) at the Landusky Mine, respectively until the end of 1995. Active mining ceased at the Zortman Mine in 1990.

TABLE 4.11-1

SCHEDULE OF COMMUTER TRIPS: ALTERNATIVES 1-7[1]

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Alternative 1	95	15	10	10	10	5	5	5	5	3	0	0	0	0	0	0	0
Alternative 2	95	55	10	10	15	5	5	5	5	3	0	0	0	0	0	0	0
Alternative 3	95	95	10	10	15	5	5	5	5	3	0	0	0	0	0	0	0
Alternative 4	115	135	120	120	120	120	95	95	60	15	20	20	5	5	5	5	5
Alternative 5	115	135	120	120	120	120	95	95	20	20	20	20	5	5	5	5	5
Alternative 6	115	135	120	120	120	95	95	95	20	20	20	5	5	5	5	5	0
Alternative 7	115	135	120	120	120	120	95	95	95	15	20	18	5	5	5	5	5

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[1] Commuter trips include both mines and were calculated based on projected employment over the life of the alternatives. Values given are roundtrips.

TABLE 4.11-2
SCHEDULE OF RECLAMATION TRUCK TRIPS[1]

Schedule of Reclamation Trips - Alternative 1

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Zortman Reclamation Trips - Complete																
Landusky Reclamation Trips - Complete																0

Schedule of Reclamation Trips - Alternative 2

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	R	R	R													
Zortman Clay Trips	1,300	1,750	1,750	(Through town)												4,800
Project Phase	L	L	L	L	R											
Landusky Clay Trips	1,000	1,000	1,500	2,800	4,000	(Through town)										10,300

Schedule of Reclamation Trips - Alternative 3

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	R	R	R	R												
Zortman Clay	1,400	2,000	2,000	2,000	(Through town)											7,400
Zortman Limestone	3,000	4,000	4,000	4,000	(Not through town)											15,000
Project Phase	L	L	L	L	R	R										
Landusky Clay	1,000	1,000	1,000	3,500	4,000	5,200	(Through town)									15,700
Landusky Limestone	3,000	3,000	3,000	6,000	8,000	9,000	(Not through town)									32,000

Project Phases: C = Construction; M = Mining; L = Leaching; R = Reclamation

TABLE 4.11-2 - SCHEDULE OF RECLAMATION TRUCK TRIPS[1]
(Continued)

Schedule of Reclamation Trips - Alternative 4[2]

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase - Zortman	C	C	M	M	M	M	M	L	L	R	R	R				
Zortman Mine Clay	100	100	100	100	0	0	800	800	800	800	2,000	2000				7,600
Carter Gulch Repos. Clay	100	100	300	300	300	300	300	300	300	400	450	450				3,600
Total/Year	200	200	400	400	300	300	1,100	1,100	1,100	1,200	2,450	2,450	(Through town)			11,200
Zortman Mine/Carter Gulch NAG	2,500	2,500	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	8,000	(Not through town)			58,000
Goslin Flat Clay	5,000	2,000	200	200	200	300	500	500	500	800	800	800	(Not through town)			11,800
Goslin Flat Limestone	1,000	1,000	500	500	500	500	500	500	500	3,100	3,100	3,100	(Not through town)			14,800
Project Phase - Landusky	M	L	L	L	L	R	R									
Landusky Clay	1,000	1,000	1,000	500	2,000	3,500	4,000	(Through town)								13,000
Landusky Limestone	0	0	0	0	0	350	350	(Not through town)								700
Landusky NAG	5,000	5,000	5,000	5,000	5,000	5,000	10,000	(Not through town)								40,000

Schedule of Reclamation Trips - Alternative 5

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase - Zortman	C	C	M	M	M	M	L	L	L	R	R	R				
Zortman Mine Clay	500	500	500	500	500	500	500	1,000	1,000	1,000	1,000	1,000				8,500
Alder Gulch LP Clay	3,000	3,000	0	0	0	0	0	500	600	1,000	1,000	1,000				10,100
Carter Gulch Repos. Clay	300	300	300	300	300	300	300	300	300	450	450	400				4,000
Total/Year	3,800	3,800	800	800	800	800	800	1,800	1,900	2,450	2,450	2,400	(Through town)			22,600
Zortman Limestone	0	0	0	0	0	0	0	0	0	4,800	5,000	5,000	(Not through town)			14,800
Zortman NAG	0	1,000	1,000	1,000	1,000	1,000	1,000	2,000	2,000	3,000	4,000	4,800	(Not through town)			21,800
Project Phase - Landusky	M	L	L	L	L	R	R									
Landusky Clay	1,000	1,000	1,000	2,300	2,600	3,800	4,000	(Through town)								15,700
Landusky Limestone	0	0	0	0	0	350	350	(Not through town)								700
Landusky NAG	3,000	3,500	3,500	3,500	3,500	5,000	10,000	(Not through town)								32,000

Project Phases: C = Construction; M = Mining; L = Leaching; R = Reclamation

TABLE 4.11-2 - SCHEDULE OF RECLAMATION TRUCK TRIPS[1]
(Continued)

Schedule of Reclamation Trips - Alternative 6[2]

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase - Zortman	C	C	M	M	M	M	M	L	L	R	R					
Zortman Mine Clay	500	500	500	500	500	500	500	500	1,000	1,500	2,000	(Through town)				8,500
Zortman Mine NAG	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	3,000	3,000	(Not through town)				15,000
Ruby Flats NAG	3,000	3,000	1,000	1,000	1,000	1,000	1,000	1,000	2,000	3,700	5,000	(Not through town)				22,700
Goslin Flat Limestone	1,000	1,000	500	500	500	500	1,000	1,500	1,500	3,400	3,400	(Not through town)				14,800
Goslin Flat Clay	5,000	2,000	0	0	0	0	0	0	0	200	200	(Not through town)				7,400
Ruby Flats Repos. Clay	300	300	300	300	300	300	300	400	450	750	750	(Not through town)				4,450
Project Phase - Landusky	M	L	L	L	L	R	R									
Landusky Clay	1,000	1,000	1,000	2,300	2,600	3,800	4,000									15,700
Landusky Limestone	0	0	0	0	0	350	350	(Not through town)								700
Landusky NAG	3,000	3,500	3,500	3,500	3,500	5,000	10,000	(Not through town)								32,000

Schedule of Reclamation Trips - Alternative 7[2]

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase - Zortman	C	C	M	M	M	M	M	L	L	R	R	R				
Zortman Mine Soil	0	0	2,000	2,000	2,000	2,000	2,000	2,000	3,000	5,000	5,000	5,500	(Through town)			30,500
Zortman Mine NAG	0	0	2,600	2,600	2,600	2,600	2,600	2,600	2,600	8,000	8,000	8,000	(Not through town)			42,200
Goslin Flat Clay	5,000	2,000	0	0	0	0	0	0	0	0	0	0	(Not through town)			7,000
Goslin Flat NAG	0	0	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,000	1,000	2,000	(Not through town)			13,100
Project Phase - Landusky	M	L	L	L	L	R	R									
Landusky Limestone	0	0	0	0	0	350	350	(Not through town)								700
Landusky NAG	2,000	5,000	5,000	5,000	5,000	8,000	12,000	(Not through town)								42,000

Project Phases: C = Construction; M = Mining; L = Leaching; R = Reclamation

TABLE 4.11-2 - SCHEDULE OF RECLAMATION TRUCK TRIPS[1]
(Concluded)

[1] Values given are roundtrips. Each roundtrip represents delivery of ore load of a reclamation material to its location of use and the return trip to the source location.

[2] NAG to be used at the Goslin Flat Leach Pad and Ruby Flats Waste Rock Repository (Alt. 6 only) would be transported by conveyor. Values given indicate internal mine truck trips required to haul from source to conveyor loading area.

Project Phases:

C = Construction of new facilities related to extension
M = Mining (includes concurrent leaching and reclamation activities)
L = Leaching (includes concurrent reclamation activities)
R = Reclamation (reclamation only)

TABLE 4.11-3[1]
HAZARDOUS MATERIAL HAUL TRIPS: ALTERNATIVES 1-7

Annual Hazardous Materials Trips - Alternative 1

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	R	R														
Zortman	275	275														550
Project Phase	L	L	L	L	R											
Landusky	1,500	1,500	1,500	1,500	475											6,475
												Alternative Total - Both Mines				7,025

Annual Hazardous Materials Trips - Alternative 2

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	R	R	R													
Zortman	275	275	275													825
Project Phase	L	L	L	L	R											
Landusky	1,500	1,500	1,500	1,500	475											6,475
												Alternative Total - Both Mines				7,300

Annual Hazardous Materials Trips - Alternative 3

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	R	R	R	R												
Zortman	275	275	275	275												1,100
Project Phase	L	L	L	L	R	R										
Landusky	1,500	1,500	1,500	1,500	475	475										6,950
												Alternative Total - Both Mines				8,050

Project Phases: C = Construction; M = Mining; L = Leaching; R = Reclamation

TABLE 4.11-3 - HAZARDOUS MATERIAL HAUL TRIPS: ALTERNATIVES 1-7
(Continued)

Annual Hazardous Materials Trips - Alternative 4

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	C	C	M	M	M	M	M	L	L	R	R	R				
Zortman	275	275	2,800	2,800	2,800	2,800	2,800	2,450	2,450	275	275	275				20,275
Project Phase - Landusk	M	L	L	L	L	R	R									
Landusky	1,700	1,500	1,500	1,500	1,500	475	475									8,650
											Alternative Total - Both Mines					28,925

Annual Hazardous Materials Trips - Alternative 5

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	C	C	M	M	M	M	L	L	L	R	R	R				
Zortman	275	275	2,800	2,800	2,800	2,800	2,450	2,450	2,450	275	275	275				19,925
Project Phase	M	L	L	L	L	R	R									
Landusky	1,700	1,500	1,500	1,500	1,500	475	475									8,650
											Alternative Total - Both Mines					28,575

Annual Hazardous Materials Trips - Alternative 6

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	C	C	M	M	M	M	M	L	L	R	R					
Zortman	275	275	2,800	2,800	2,800	2,800	2,800	2,450	2,450	275	275					20,000
Project Phase	M	L	L	L	L	R	R									
Landusky	1,700	1,500	1,500	1,500	1,500	475	475									8,650
											Alternative Total - Both Mines					28,650

Project Phases: C = Construction; M = Mining; L = Leaching; R = Reclamation

TABLE 4.11-3 - HAZARDOUS MATERIAL HAUL TRIPS: ALTERNATIVES 1-7
(Concluded)

Annual Hazardous Materials Trips - Alternative 7

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Project Phase	C	C	M	M	M	M	M	L	L	R	R	R				
Zortman	275	275	2,800	2,800	2,800	2,800	2,800	2,450	2,450	275	275	275				20,275
Project Phase	M	L	L	L	L	R	R									
Landusky	1,700	1,500	1,500	1,500	1,500	475	475									8,650
Alternative Total - Both Mines																28,925

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[1] Values given are roundtrips. Each roundtrip represents one loaded delivery to the mine and the empty return trip back to the point of origin.

Project Phases:

C = Construction of new facilities related to extension
M = Mining (includes concurrent leaching and reclamation activities)
L = Leaching (includes concurrent reclamation activities)
R = Reclamation (reclamation only)

Figure 4.11-1. Total Annual Truck Trips

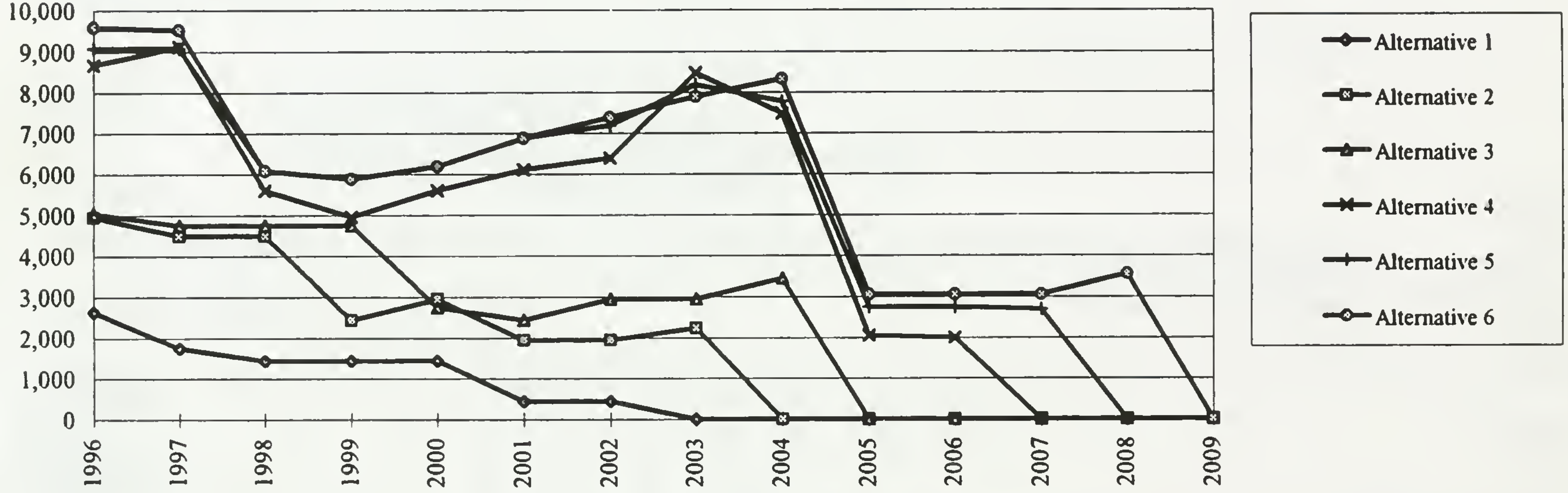
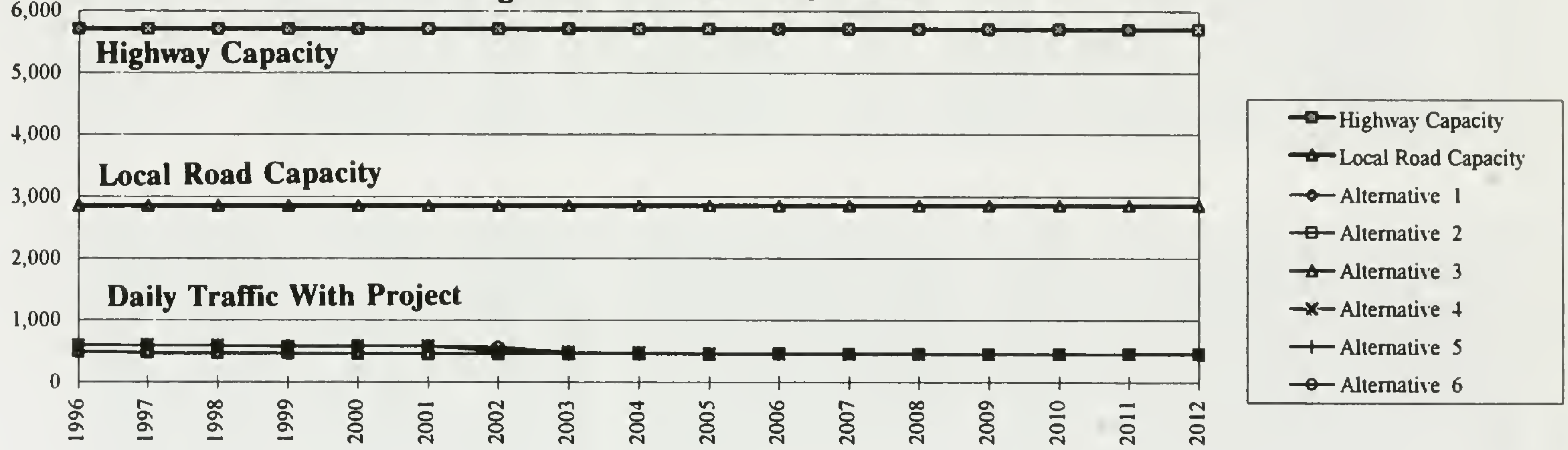


Figure 4.11-2 Total Daily Traffic



With respect to accidents, the addition of commuter and truck trips to the transportation system as a whole could result in 1.87 accidents per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be considered a low negative impact.

Residents of the communities of Zortman and Landusky and their pets would be somewhat vulnerable to accidents during commute hours as mine workers arrive or leave during shift changes. Similarly, truck traffic through those communities would also create a risk of accidents. This increased risk of accidents is considered to be a low negative impact on the communities, since truck traffic volumes would be very low.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels, resulting in a neutral impact over the long-term.

Public Access to the Little Rocky Mountains

With respect to public access to the southern Little Rocky Mountains, the No Action Alternative would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2000. After closure of the mines is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Thus, over the long-term, a neutral impact would be anticipated.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional five years under the No Action Alternative, with shipments tapering off after the mines go out of production, leaching of ore ceases, and reclamation is completed (around 2000). Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the maximum number of roundtrips per year (1,775) would be below the number utilized from 1979 to 1994 (4,200).

Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, the No Action Alternative would have a low negative impact on local residents. After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Thus, over the long-term, a neutral impact would be anticipated.

4.11.3.1 Cumulative Impacts

Impacts for both the Zortman and Landusky mines are described above for the life of the project under Alternative 1 and post-closure. Since there are no reasonably foreseeable developments associated with this alternative, no additional impacts have been identified for cumulative impacts discussion.

4.11.3.2 Unavoidable Adverse Impacts

Restriction of public access to the southern Little Rocky Mountains would be considered an unavoidable adverse impact. This impact could not be mitigated because, by their nature, mining operations are hazardous and incompatible with public activities, such as hiking or hunting. By necessity, public access must be restricted from mining areas. This impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around the year 2000).

4.11.3.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. Although a variety of impacts would be experienced under this alternative, they would be relatively short-term in nature as opposed to permanent. After final reclamation were completed, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.3.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project areas roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.11.4 Impacts From Alternative 2

Traffic

Under Alternative 2, reclamation efforts would require considerably more hauling of clay to both mines than previously described for Alternative 1. These additional reclamation activities would also increase commute roundtrips by mine workers to a small extent over the life of the alternative. Under projected employment conditions, this project scenario would result in roughly 95 commuter roundtrips per day in 1996 and would diminish as reclamation is completed (Table 4.11-1). The addition of 95 trips per day would represent an increase above baseline (pre-1979) conditions, but a decrease in traffic relative to the 1979 to 1994 mining period (which averaged 100 roundtrips per day).

At the Zortman Mine, reclamation would include clay capping of numerous facilities that would not be completed until approximately 1998. This clay capping would require a total of 4,800 truck trips (roundtrips) over the 3 year duration of the alternative (Table 4.11-2). Clay haul trips would be routed from the Seaford clay pit up Seven Mile Road through the community of Zortman and up the mine access road to the Zortman Mine. Clay hauling would be carried out by convoys of 9-15 Caterpillar 777 trucks hauling 50-85 tons of clay each. These convoys would be escorted by a lead car from the clay pit to the mine with convoy speeds reduced as they pass through town. It is estimated that 8-10 convoy roundtrips per day would be required over a period of up to 12 days from 1996 to 1998 under Alternative 2.

At the Landusky Mine, reclamation would feature more extensive clay capping than described under Alternative 1. This additional capping would require a total of 10,300 truck roundtrips over the 5 year duration of the alternative which would be completed around the end of 2000. These trips would extend from the Williams clay pit through the community of Landusky via Landusky Road. As described for the Zortman Mine, clay hauling would utilize Caterpillar 777 truck convoys escorted by a pilot car. For reclamation of the Landusky Mine, this transportation of clay would last up to 27 days during the peak year of reclamation (year 2000).

In addition, an estimated total of 7,300 truck trips would be required for hazardous materials (five roundtrips per day or up to 1,775 trips annually). These trips would primarily consist of reagents required for heap leaching at the Landusky Mine. After leaching is completed, these trips would decrease and would consist primarily of gasoline and diesel fuel for heavy equipment engaged in reclamation activities.

The combination of reclamation and hazardous material hauling would comprise up to 5,025 truck trips per year (up to 155 roundtrips daily), compared with an average of 4,200 truck trips per year from 1979 to 1994 (Figure 4.11-1). Despite this modest increase, traffic volumes under this alternative would still remain far below the capacity of the transportation system in the project area and would therefore have a low negative impact (Figure 4.11-2).

Internal mine traffic associated with active mining and waste rock hauling would be the same as described for Alternative 1 since no additional ore would be mined.

With respect to accidents, the addition of commuter and truck trips to the transportation system as a whole could result in 1.99 accidents per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be rated as a low negative impact.

Residents of the communities of Zortman and Landusky and their pets would be somewhat vulnerable to accidents during commute hours as mine workers arrive or leave during shift changes. Moreover, truck convoys passing through those communities would also create a risk of accidents. This increased risk of accidents associated with truck traffic (up to 150 roundtrips or 300 one-way trips through town per day) is considered to be a medium negative impact on the local communities, due to the large size and lack of maneuverability of haul trucks, the presence of residences adjacent to the haul roads and the presence of children and other pedestrians. The use of a lead car and reduction of speed through the communities should reduce the risk of accidents to some ext.

With respect to creation of higher risk accident locations, the addition of truck traffic for hauling of clay from the Seaford clay pit to the Zortman Mine would likely increase the risk of accidents at two locations. For the Zortman clay haul trips, the Seaford clay pit road intersects U.S. Highway 191 directly across from Seven Mile Road. Therefore, clay haul trucks would have to cross U.S. Highway 191 to access Seven Mile Road. Potential safety hazards could arise if clay haul convoys do not stop and/or look for approaching traffic on U.S. Highway 191. Similarly, travelers on the highway may not be aware that truck traffic would cross the highway on a regular basis.

In addition, the junction of Seven Mile Road and Bear Gulch Road could also become more hazardous with the addition of clay haul convoys because traffic destined for the town of Zortman and/or the mine merges there.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels, resulting in a neutral impact over the long-term.

Public Access to the Little Rocky Mountains

As described previously, Alternative 2 would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2000. After closure of the mines is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Over the long-term, impacts would be reduced to insignificant.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional five years, with shipments tapering off as reclamation is completed (around 2000). Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the maximum number of roundtrips per year (1,775) would be below the number utilized from 1979 to 1994 (4,200). Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, Alternative 2 would have a low negative impact on local residents. After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Thus, over the long-term, a neutral impact would be anticipated.

4.11.4.1 Cumulative Impacts

Impacts for both the Zortman and Landusky mines are described above for the life of the project under Alternative 2 and post-closure. Since there are no reasonably foreseeable developments associated with this alternative, no additional impacts have been identified for cumulative impacts discussion.

4.11.4.2 Unavoidable Adverse Impacts

As described previously for Alternative 1, restriction of public access to the southern Little Rocky Mountains would be considered an unavoidable adverse impact. This impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around 2000).

4.11.4.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. After final reclamation were completed, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.4.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project area roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.11.5 Impacts From Alternative 3

Traffic

This alternative would feature the most intensive reclamation efforts of any of the non-expansion alternatives. Consequently, the number of truck trips that would be generated to haul the required volume of clay is considerably larger than under Alternatives 1 or 2. Internal mine hauling of limestone for reclamation purposes would also be required. Under projected employment conditions, this project scenario would result in roughly 95 commuter roundtrips per day in 1996 and would diminish as reclamation is completed (Table 4.11-1). The addition of 95 trips per day would represent an increase above baseline (pre-1979) conditions, but a decrease in traffic relative to the 1979 to 1994 mining period (which averaged 100 roundtrips per day). These convoys would be escorted by a pilot car with convoy speeds reduced to 15 mph as they pass through town.

At the Zortman Mine, reclamation would include capping of numerous facilities that would not be completed until approximately 1999. This capping would require a total of 7,400 truck trips by clay haul convoys through the town of Zortman over the 4 year duration of the alternative (up to 150 roundtrips per day for up to 14 days per year) (Table 4.11-2).

At the Landusky Mine, additional capping would require a total of 15,700 truck trips by clay haul convoy through the town of Landusky over the six year duration of the alternative (up to 150 roundtrips per day for up to 35 days per year), which would be completed around the end of 2001. These trips would extend from the Williams clay pit through the community of Landusky as described previously.

In addition, an estimated total of 8,050 truck trips would be required for hauling hazardous materials (five trips per day or up to 1,775 trips annually). These trips would primarily consist of reagents required for heap leaching at the Landusky Mine. After leaching is completed, these trips would decrease and would consist primarily of gasoline and diesel fuel for heavy equipment engaged in reclamation activities.

The combination of reclamation trips and hazardous material trips would comprise up to 7,275 truck trips per year (up to 155 roundtrips daily), compared with an average of 4,200 trips per year from 1979 to 1994 (Figure 4.11-1). Despite this increase, traffic volumes under this alternative would still remain far below the capacity of the transportation system in the project area and would therefore have a low negative impact (Figure 4.11-2).

Internal mine traffic associated with active mining and waste rock hauling would be the same as described for Alternative 1, since no additional ore would be mined. The hauling of limestone for reclamation purposes would generate up to 4,000 additional truck trips per year at the Zortman Mine and 9,000 trips per year at the Landusky Mine. These trips would not impact the public transportation network, but could impact wildlife and other resources, such as air quality due to dust generation.

With respect to accidents, the addition of commuter and truck trips to the transportation system as a whole could result in 2.02 accident per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be rated as a low negative impact. However, the increased risk of accidents related to truck convoys (up to 150 roundtrips or 300 one-way trips through town per day) is considered to be a medium negative impact on the local communities, due to the large size and lack of maneuverability of haul trucks, the presence of residences adjacent to the haul roads and the presence of children and other pedestrians. The use of a lead car and reduction of speed to 15 mph through the communities should reduce the risk of accidents.

As described previously, the potential for increased accidents could arise from additional truck traffic associated with hauling of clay at certain locations. These locations include the junction of U.S. Highway 191 and Seven Mile Road/Seaford clay pit access road, and the intersection of Seven Mile Road and Bear Gulch Road.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels, resulting in a neutral impact over the long-term.

Public Access to the Little Rocky Mountains

Alternative 3 would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2001. Thus, this alternative would extend this impact an additional year, relative to Alternatives 1 and 2. After closure of the mines is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Over the long-term, an impact would be reduced to insignificant.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional six years with shipments tapering off as reclamation is completed (around the end of 2001). Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the maximum number of roundtrips per year (1,775) would be below the number utilized from 1979 to 1994 (4,200). Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, Alternative 3 would have a low negative impact on local residents. After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Over the long-term, impact would be reduced to insignificant.

4.11.5.1 Cumulative Impacts

Impacts for both the Zortman and Landusky mines are described above for the life of the project under Alternative 3 and post-closure. Since there are no reasonably foreseeable developments associated with this alternative, no additional impacts have been identified for cumulative impacts discussion.

4.11.5.2 Unavoidable Adverse Impacts

As described previously for Alternatives 1 and 2, restriction of public access to the southern Little Rocky Mountains would be considered a significant, unavoidable adverse impact. This impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around the end of 2001).

4.11.5.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. After final reclamation were completed, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.5.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project areas roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.11.6 Impacts From Alternative 4

Traffic

Under Alternative 4, the Company Proposed Action, the productive lives of the Zortman and Landusky mines would be extended beyond what is currently permitted. This extended period of ore production and related heap leaching would be followed by a period of fairly extensive reclamation activity. As a result, the number of commuter trips, reclamation haul trips, and hazardous material haul trips would all be considerably greater than under Alternatives 1, 2, and 3, which do not extend mine life.

Under projected employment conditions, this project scenario would result in as many as 135 commuter roundtrips per day in 1997 and would diminish as mining, leaching, and reclamation are completed (Table 4.11-1). The addition of 135 trips per day would represent both an increase above baseline (pre-1979) and the 1979 to 1994 mining period (which averaged 100 roundtrips per day). After approximately 2001, however, the number of commuter trips would drop below 1979 - 1994 levels.

At the Zortman Mine, reclamation would also include clay capping of numerous facilities associated with the proposed extension, including the expanded mine pit area, the Carter Gulch waste rock repository, and the Goslin Flats leach pad. Although considerable reclamation work would be carried out concurrently with mining, a great deal would occur after mining and leaching were completed. Thus, final reclamation would not be completed until approximately the end of 2007. Unlike the alternatives that would deny mine extensions, Alternative 4 would require the hauling of clay to Goslin Flats for construction and reclamation of the Goslin Flats leach pad.

Clay capping would require a total of 11,200 truck trips (roundtrips) through the community of Zortman over the 12 year duration of the alternative (up to 150 roundtrips per day for up to 17 days per year) for reclamation of the Zortman Mine and Carter Gulch waste rock repository (Table 4.11-2). For construction and reclamation of the Goslin Flats leach pad, clay haul trips would not pass through the community of Zortman (11,700 roundtrips), but would require use of Seven Mile Road. Any limestone that would be used in reclamation of the leach pad would be transported from the source to the conveyor by truck and transported to the leach pad by conveyor. Truck convoys would be escorted by a lead car and trips passing through town would be conducted at reduced speeds.

At the Landusky Mine, reclamation capping would require a total of 13,000 clay haul truck trips over the 7 year duration of the alternative (up to 150 roundtrips per day for up to 27 days), which would be completed around the end of 2002. These trips would extend from the Williams clay pit through the community of Landusky and would feature a lead car and reduced speeds through town. Clay haul trips through Landusky would likely be fewer because Alternative 4 uses a thinner clay layer than modified Reclamation Cover C.

An estimated total of 28,925 truck trips would be required for hazardous material hauling, which is more than three times as many trips through Zortman and Landusky as would be required under Alternatives 1, 2, or 3. Additional mining (ammonium nitrate), and associated heap leaching (lime, cyanide, etc), as well as increased reclamation material hauling (diesel, lubricants, etc.) are all responsible for this substantial increase in use of these materials and necessary haul trips. At the Zortman Mine, roughly 20,000 trips would be required over the 12 year life of the project (up to 8 roundtrips per day or 2,800 roundtrips annually through Zortman). For the Landusky Mine, roughly 8,050 trips would be required over the 7 year life of the project (up to 5 roundtrips per day or 1,700 roundtrips annually through Landusky).

The combination of reclamation and hazardous material hauling would comprise up to 4,700 truck trips per year for both mines (up to 165 roundtrips daily), compared with an average of 4,200 trips per year from 1979 to 1994 (Figure 4.11-1). Despite this modest increase, traffic volumes under this alternative would still remain far below the capacity of the transportation system in the project area and would therefore have a low negative impact (Figure 4.11-2).

With the extensions of mine life, the additional mining and associated hauling of ore to leach pads and waste rock to repositories or reclamation activities would generate considerable internal mine truck traffic. Future mining at the Zortman Mine would require approximately 240,000 truck trips per year (680 roundtrips daily) for hauling of ore from the mine pit complex to the crusher/conveyor loading area over a five year time frame. Hauling of waste rock would require an estimated 180,000 truck trips per year (500 roundtrips daily) over the same five year period. All potentially acid-generating waste rock would be hauled from the pit complex to the Carter Gulch waste rock repository, while the non-acid generating (NAG) waste would be stockpiled or hauled into reclamation activities by truck or conveyor (Goslin Flats leach pad). In addition, approximately 14,800 truck trips (roundtrips) would be required for hauling limestone from the LS-1 quarry to the Conveyor loading area for reclamation activities at the Goslin Flats leach pad. These truck trips would not pass through Zortman or affect public roads or highways.

At the Landusky Mine, the proposed mine life extension would last roughly one year and would feature the same volume of internal truck traffic over its duration as described in Alternative 1 (180,000 roundtrips per year or 500 per day for ore and 90,000 roundtrips per year or 250 per day for waste rock).

With respect to accidents, the addition of commuter and truck trips to the transportation system as a whole could result in 2.68 accidents per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be rated as a low negative impact.

Residents of the communities of Zortman and Landusky and their pets would be somewhat vulnerable to accidents during commute hours as mine workers arrive or leave during shift changes. Moreover, truck traffic through those communities would also create a risk of accidents due to clay haul convoys. This increased risk of accidents due to as many as 150 roundtrips or 300 one-way trips through town per day is considered to be a medium negative impact on the communities, due to the large size and lack of maneuverability of haul trucks, the presence of residences adjacent to the haul roads and the presence of children and other pedestrians. The use of a lead car and reduction of speed through the communities should reduce the risk of accidents.

As described previously, the potential for increased accidents at certain locations could arise from additional truck traffic associated with hauling of clay. These locations include the junction of U.S. Highway 191 and Seven Mile Road/Seaford clay pit access road, and the intersection of Seven Mile Road and Bear Gulch Road.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels resulting in a neutral impact over the long-term.

Public Access to the Little Rocky Mountains

Due to continued closure of the mining area portions of the Little Rocky Mountains and associated access roads, Alternative 4 would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2007.

In addition, Alternative 4 would also include construction and use of an overland conveyor for transportation of ore from the Zortman Mine to the Goslin Flats Heap leach pad. With few exceptions, access to the Little Rocky Mountains would generally be eliminated over the 11,000-foot length of the conveyor for pedestrians and vehicles approaching from the east, since the conveyor would have low clearance and would be fenced. Two important exceptions would be where the conveyor crosses Alder and Pony gulches. At these crossings, the conveyor would be constructed on bridge structures with sufficiently high clearance to allow passage of pedestrians and vehicles. Access across privately owned land to Goslin Gulch and Saddle Butte would no longer be available on the Goslin Gulch Road, since construction of the Goslin Flats Heap leach pad would physically block the road. Restriction of vehicle access to Goslin Gulch and pedestrian access to a much broader portion of the Little Rocky Mountains would be considered a low negative impact. This impact is rated as low because it would affect only a limited number of individuals who have historically had to obtain permission from the landowner/leaseholder to access Goslin Gulch from Goslin Flats. Since the terrain of the conveyor area is generally rugged and impassable for vehicles (except along existing roads), construction of the overland conveyor would not drastically limit vehicle access to the Little Rocky Mountains. As mentioned above, the roads that allow vehicle access to Pony and Alder gulches would not be affected by the conveyor. The only road that would be blocked off by the mine extension project would be Goslin Gulch Road.

Although the access impact associated specifically with the Goslin Flats leach pad and conveyor is rated as low, the combined impact of closure of the mining areas, their associated access roads, and the Goslin Flats/ Gulch area is high negative under this alternative.

After closure of the mines and reclamation is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Over the long-term, impact would be reduced to insignificant.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional 12 years with shipments tapering off as reclamation is completed (around the end of 2007). Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the number of hazardous material haul trips would be roughly the same as experienced from 1979 to 1994. Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, Alternative 4 would have a low negative impact on local residents.

For the Zortman operation, it is important to note that the majority of hazardous materials trips would terminate at the Goslin Flats leach pad/treatment plant for use in heap leaching. Only a fraction of the trips (e.g., diesel, ammonium nitrate) would pass through Zortman en route to the Zortman Mine. The risk of accidents and spills is lower under this alternative relative to Alternative 5, which would feature extended heap leaching in Upper Alder Gulch, thereby requiring that all hazardous materials trips pass through town and terminate at the mine.

After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Thus, over the long-term, a neutral impact would be anticipated.

4.11.6.1 Cumulative Impacts

As reasonably foreseeable actions, additional mining in Pony Gulch in the Zortman area and at the Landusky Mine would result in additional impacts, beyond those described for Alternative 4. To the extent mining is extended by these actions, traffic impacts similar to those described above would be extended as well. Commuters, hazardous material use and hauling, and reclamation material hauling would continue to add traffic to local and regional roads for the life of these actions. As described previously, this impact is low negative because local roads and regional highways would have adequate capacity to support this extended period of additional traffic, assuming traffic volumes are not substantially higher than described for Alternative 4. Reclamation activities at the Zortman Mine, the foreseeable Pony Gulch Mine, and the Landusky Mine that would require hauling by convoy through the local communities would result in a high negative impact on the community during the duration of hauling.

In addition, the reasonably foreseeable action at Pony Gulch would almost certainly require closure of Pony Gulch to the public for safety reasons. Closure of vehicle and pedestrian access to Pony Gulch would be considered a high negative impact, as recreational opportunities in and around Pony Gulch would be adversely affected for the life of the mine. The impacted is rated as high because Pony Gulch would be one of the few remaining access points for the southern Little Rocky Mountains under Alternative 4. Cumulatively, and with few exceptions, closure of the Pony Gulch access road would result in virtual elimination of vehicle access to the southern Little Rocky Mountains. Areas and roads closed to the public would remain closed until final reclamation is completed at some time in the future.

For the Zortman Mine, hazardous material hauling would be directed primarily to the Goslin Flats leach pad and processing plant for heap leaching activities. Additional mining at Landusky would require continued hauling of hazardous materials through the town of Landusky. As described previously, since the small risk of accidents and spills would remain along local and regional roads over the duration of this action, reasonably foreseeable mining at the Zortman and Landusky mines would have a low negative impact on local residents.

Exploration activities would also add commuter trips and may add a small number of hazardous materials trips (vehicle fuel for trucks, road grading, drill rigs, etc.). The addition of new exploration roads could have a positive impact on public access to the Little Rocky Mountains, however, assuming the roads are open to the public.

For the Landusky Mine, development of the Montana Gulch Limestone Quarry would create additional safety hazards as convoyed truck traffic up the Montana Gulch road would greatly increase the risk of accidents with recreational users of the Montana Gulch Campground. This convoyed truck traffic would also pass through the town of Landusky, thereby adding to the medium negative impact experienced due to clay haul convoys.

4.11.6.2 Unavoidable Adverse Impacts

As described previously, restriction of public access to the southern Little Rocky Mountains would be considered an unavoidable adverse impact. With the exception of new access restrictions near the conveyor and adjacent to Goslin Flats, this impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around the end of 2007).

4.11.6.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. After completion of final reclamation, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.6.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project areas roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.11.7 Impacts From Alternative 5

Traffic

Since this alternative also features extended mining activities, the number of commuter trips, reclamation haul trips, and hazardous material haul trips would all be considerably greater than under Alternatives 1, 2, and 3, which deny mine life extensions.

Under projected employment conditions, this project scenario would result in as many as 135 commuter roundtrips per day in 1997 and would diminish as mining, leaching, and reclamation are completed (Table 4.11-1). The addition of 135 trips per day would represent both an increase above baseline (pre-1979) and the 1979 to 1994 mining period (which averaged 100 roundtrips per day). After approximately 2001, however, the number of commuter trips would drop below 1979 - 1994 levels.

At the Zortman Mine, reclamation would also include capping of numerous facilities associated with the proposed extension, including the expanded mine pit area, the Carter Gulch waste rock repository, and the Upper Alder Gulch leach pad. Although considerable reclamation work would be carried out concurrently with mining, a great deal would occur after mining and leaching were completed. Thus, final reclamation would not be completed until approximately the end of 2007.

Transportation of clay to various facilities for construction and reclamation would require a total of roughly 22,600 truck trips (roundtrips) through the community of Zortman over the 12 year duration of the alternative (up to 150 roundtrips per day for up to 25 days) (Table 4.11-2). Since heap leaching would take place adjacent to the mine in Alder Gulch, instead of on Goslin Flats, all of the clay haul trips would have to pass through the town of Zortman. In addition, the more intensiveness of the reclamation effort required under this alternative also contributes to the substantial increase in clay haul trips through town required, relative to Alternative 4.

At the Landusky Mine, reclamation capping would require a total of 15,700 truck trips (roundtrips) over the 7 year duration of the alternative (up to 150 roundtrips per day for up to 27 days), which would be completed around the end of 2002. These trips would extend from the Williams clay pit through the community of Landusky. It is important to note that the clay volume and associated haul trips required through Landusky would be greater than described for Alternative 4 because of the use of a thicker clay cap on surfaces requiring Reclamation Cover C.

In addition, an estimated total of 28,575 truck trips would be required for hazardous material hauling. At the Zortman Mine, roughly 19,925 roundtrips would be required over the 12 year life of the project (up to 8 trips per day or 2,800 trips annually). For the Landusky Mine, roughly 8,650 roundtrips would be required over the 7 year life of the project (up to 5 roundtrips per day or 1,700 trips annually).

The combination of reclamation and hazardous material haul trips would comprise up to 7,725 truck trips through local communities per year (up to 165 roundtrips daily in 2002), compared with an average of 4,200 trips per year from 1979 to 1994 (Figure 4.11-1). Despite this increase, traffic volumes under this alternative would still remain far below the capacity of the transportation system in the project area and would therefore have a low negative impact (Figure 4.11-2).

Internal mine truck traffic associated with ore and waste rock hauling would be the same as described for Alternative 4 in terms of the number of trips, although ore would be hauled to the Upper Alder Gulch leach pad instead of the conveyor loading area.

With respect to accidents, the addition of commuter and truck trips to the transportation system as a whole could result in 2.86 accidents per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be rated as a low negative impact.

Residents of the communities of Zortman and Landusky and their pets would be somewhat vulnerable to accidents during commute hours as mine workers arrive or leave during shift changes. Moreover, truck convoys passing through those local communities would also create a risk of accidents. This increased risk of accidents due to as many as 150 roundtrips or 300 one-way trips through town per day is considered to be a medium negative impact on the communities, due to the large size and lack of maneuverability of haul trucks, the presence of residences adjacent to the haul roads and the presence of children and other pedestrians. The use of a lead car and reduction of speed to 15 mph through the communities should reduce the risk of accidents.

As described previously, the potential for increased accidents at certain locations could arise from additional truck traffic associated with hauling of clay. These locations include the junction of U.S. Highway 191 and Seven Mile Road/Seaford clay pit access road, and the intersection of Seven Mile Road and Bear Gulch Road.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels, resulting in a neutral impact over the long-term.

Public Access to the Little Rocky Mountains

Alternative 5 would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2007. An ore conveyor to Goslin Flats would not be utilized under this alternative. Thus, access-related impacts would remain confined to the same area that has historically (1979 - 1994) been impacted and would not expand. Use of the Upper Alder Gulch leach pad site would not increase the area of public closure, since Alder Gulch Road is already closed to the public roughly ¼ mile above its junction with Pony Gulch road.

After closure of the mines is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Over the long-term, impact would be reduced to insignificant.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional 12 years, with shipments tapering off as reclamation is completed (around the end of 2007). It is important to note that all hazardous material haul trips for the Zortman Mine would pass through the town of Zortman, compared with Alternatives 4, 6, and 7 where the majority of these trips would terminate at the Goslin Flats leach pad and not pass through town. Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the number of hazardous material haul trips would be roughly the same as experienced from 1979 to 1994. Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, Alternative 5 would have a low negative impact on local residents.

After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Over the long-term, impact would be reduced to insignificant.

4.11.7.1 Cumulative Impacts

Based on reasonably foreseeable actions described for this alternative, cumulative impacts would be similar to those described for Alternative 4. However, impacts associated with mining in Pony Gulch, use of a conveyor, and heap leaching on Goslin Flats would not occur.

4.11.7.2 Unavoidable Adverse Impacts

As described previously, restriction of public access to the southern Little Rocky Mountains would be considered an unavoidable adverse impact. This impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around the end of 2007).

4.11.7.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. After final reclamation were completed, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.7.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project areas roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.11.8 Impacts From Alternative 6

Alternative 6 would require realignment of a portion of Seven Mile Road due to construction of the Ruby Flats waste rock repository on the present road alignment. Re-routing of Seven Mile Road would require a 90 degree turn to the east at the south end of the repository. The road would then follow the southern and eastern edges of the repository and intersect with Bear Gulch Road near the Zortman airstrip (Figure 2.11-2). This modification is not expected to impact road capacity, traffic flow or safety, assuming new curves in the road are properly signed to alert drivers as they approach.

Traffic

As described for Alternatives 4 and 5, this alternative also features extended mining activities, and related increases in the number of commuter trips, reclamation haul trips, and hazardous material haul trips. Under projected employment conditions, this project scenario would result in as many as 135 commuter roundtrips per day in 1997 and would diminish as mining, leaching, and reclamation are completed (Table 4.11-1). The addition of 135 trips per day would represent both an increase above baseline (pre-1979) and the 1979 to 1994 mining period (which averaged 100 roundtrips per day). After approximately 2000, however, the number of commuter trips would drop below 1979 - 1994 levels.

At the Zortman Mine, reclamation would also include capping of numerous facilities associated with the proposed extension, including the expanded mine pit area, the Ruby Flats waste rock repository, and the Goslin Flats leach pad. Although considerable reclamation work would be carried out concurrently with mining, a great deal would occur after mining and leaching were completed. Thus, final reclamation would not be completed until approximately the end of 2006. Unlike the alternatives that would deny mine extensions or Alternative 5, Alternative 6 would require the hauling of clay to Goslin Flats for construction and reclamation of the Goslin Flats leach pad and Ruby Flats waste rock repository. NAG waste and limestone would be transported to Goslin Flats by conveyor.

Reclamation capping with clay would require a total of 8,500 truck trips in convoys through the community of Zortman over the 11 year duration of the alternative (up to 150 roundtrips per day for up to 14 days) (Table 4.11-2) for reclamation of the Zortman Mine. For reclamation of the Goslin Flats leach pad and Ruby Flats waste rock repository, clay haul trips would not pass through the community of Zortman, but would require use of Seven Mile Road (11,850 roundtrips).

At the Landusky Mine, additional capping would require a total of 15,700 truck trips over the 11 year duration of the alternative (up to 150 roundtrips per day for up to 27 days), which would be completed around the end of 2002. These trips would extend from the Williams clay pit through the community of Landusky.

In addition, an estimated total of 28,650 truck trips would be required for hazardous material hauling. At the Zortman Mine, nearly 20,000 roundtrips would be required over the 11 year life of the project (up to 8 roundtrips per day or 2,800 trips annually). For the Landusky Mine, roughly 8,650 roundtrips would be required over the 7 year life of the project (up to 5 roundtrips per day or 1,700 trips annually).

The combination of reclamation and hazardous material haul trips would comprise up to 7,775 truck trips per year (up to 165 roundtrips daily), compared with an average of 4,200 trips per year from 1979 to 1994 (Figure 4.11-1). Despite this increase, traffic volumes under this alternative would still remain far below the capacity of the transportation system in the project area and would therefore have a low negative impact (Figure 4.11-2).

Internal mine truck traffic associated with ore and waste rock hauling would be the same as described for Alternative 4 in terms of the number of trips, although waste rock would be hauled to the conveyor loading area instead of the Carter Gulch waste rock repository.

With respect to accidents, the addition of commuter and truck trips to the transportation system as a whole could result in 2.60 accidents per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be rated as a low negative impact.

Residents of the communities of Zortman and Landusky and their pets would be somewhat vulnerable to accidents during commute hours as mine workers arrive or leave during shift changes. Moreover, truck convoys passing through those communities would also create a risk of accidents. This increased risk of accidents due to as many as 150 roundtrips or 300 one-way trips through town per day is considered to be a high negative impact on the communities, due to the large size and lack of maneuverability of haul trucks, the presence of residences adjacent to the haul roads and the presence of children and other pedestrians. The use of a lead car and reduction of speed to 15 mph through the communities should reduce the risk of accidents.

As described previously, the potential for increased accidents at certain locations could arise from additional truck traffic associated with hauling of clay. These locations include the junction of U.S. Highway 191 and Seven Mile Road/Seaford clay pit access road, and the intersection of Seven Mile Road and Bear Gulch Road.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels, resulting in a neutral impact over the long-term.

Public Access to the Little Rocky Mountains

Due to continued closure of the mining area portions of the Little Rocky Mountains and associated access roads, Alternative 6 would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2006.

Alternative 6 would also include construction and use of an overland conveyor for transportation of ore, limestone, and NAG waste from the Zortman Mine to the Goslin Flats Heap leach pad and Ruby Flats waste rock repository. Impacts to access associated with the conveyor would be the same as those described for Alternative 4. With the addition of impacts to the Goslin Flats and conveyor areas, Alternative 6 (as well as Alternatives 4 and 7) represents the worst-case project scenario from an access impact standpoint because Alternatives 1 - 3 and 5 would not feature facilities on Goslin Flats and would not create any additional access impacts in that portion of the Little Rocky Mountains.

After closure of the mines and reclamation is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Over the long-term, impact would be reduced to insignificant.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional 11 years, with shipments tapering off as reclamation is completed (around the end of 2006). Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the number of hazardous material haul trips would be roughly the same as experienced from 1979 to 1994. Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, Alternative 6 would have a low negative impact on local residents.

For the Zortman operation, it is important to note that the majority of hazardous materials trips would terminate at the Goslin Flats leach pad/treatment plant for use in heap leaching. Only a fraction of the trips (e.g., diesel, ammonium nitrate) would pass through Zortman en route to the Zortman Mine. Therefore, the risk of accidents and spills is lower under this alternative, relative to Alternative 5, which would feature extended heap leaching in Upper Alder Gulch, thereby requiring that all hazardous materials trips pass through town and terminate at the mine.

After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Thus, over the long-term, a neutral impact would be anticipated.

4.11.8.1 Cumulative Impacts

Cumulative impacts would be the same as those described for Alternative 4.

4.11.8.2 Unavoidable Adverse Impacts

As described previously, restriction of public access to the southern Little Rocky Mountains would be considered an unavoidable adverse impact. With the exception of new access restrictions near the conveyor and adjacent to Goslin Flats, this impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around the end of 2006).

4.11.8.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. After final reclamation were completed, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.8.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project areas roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.11.9 Impacts From Alternative 7

Alternative 7 would be similar to Alternatives 4 and 6 because it would also feature a leach pad on Goslin Flats. Alternative 7 has two unique features that influence the number and type of truck trips: disposal of waste rock on the pit complex and more extensive use of soil as a reclamation cover.

Traffic

As described for Alternatives 4, 5, and 6, this alternative also features extended mining activities, and related increases in the number of commuter trips, reclamation haul trips, and hazardous material haul trips. Under projected employment conditions, this project scenario would result in as many as 128 commuter roundtrips per day in 1997 and would diminish as mining, leaching, and reclamation are completed (Table 4.11-1). The addition of 128 trips per day would represent both an increase above baseline (pre-1979) and the 1979 to 1994 mining period (which averaged 100 roundtrips per day). After approximately 2001, however, the number of commuter trips would drop below 1979 - 1994 levels.

At the Zortman Mine, reclamation would also include water balance capping of numerous facilities associated with the proposed extension, including the expanded mine pit area, the waste rock repository, and the Goslin Flats leach pad. Although considerable reclamation work would be carried out concurrently with mining, a great deal would occur after mining and leaching were completed. Thus, final reclamation would not be completed until approximately the end of 2007.

Reclamation capping would require a total of 30,500 convoyed truck trips (roundtrips) hauling soil through the community of Zortman over the 12 year duration of the alternative (up to 150 roundtrips per day for up to 37 days) (Table 4.11-2) for reclamation of the Zortman Mine pit complex and waste rock repository. For reclamation of the Goslin Flats leach pad, NAG waste would be transported from the mine by conveyor.

At the Landusky Mine, additional capping would not require clay. All reclamation materials required (NAG, soil, limestone) would be obtained at the mine or from the adjacent King Creek limestone quarry. Therefore, no truck trips through Landusky would be required for reclamation purposes.

In addition, an estimated total of 28,925 truck trips would be required for hazardous material hauling. At the Zortman Mine, nearly 20,275 trips would be required over the 12 year life of the project (up to 8 roundtrips per day or 2,800 trips annually). For the Landusky Mine, roughly 8,650 trips would be required over the 7 year life of the project (up to 5 roundtrips per day or 1,700 trips annually).

The combination of reclamation and hazardous material haul trips would comprise up to 10,000 truck trips per year (up to 165 daily), compared with an average of 4,200 trips per year from 1979 to 1994 (Figure 4.11-1). Despite this increase, traffic volumes under this alternative would still remain far below the capacity of the transportation system in the project area and would therefore have a low negative impact (Figure 4.11-2).

Internal mine truck traffic associated with ore and waste rock hauling would be the same as directed for Alternative 4 in terms of magnitude, although waste rock would be hauled to different areas in the pit complex for disposal instead of the Carter Gulch waste rock repository. In addition, approximately 13,100 truck trips of NAG waste would be destined for the conveyor loading area for transport to the Goslin Flats leach pad for reclamation purposes.

With respect to accidents, the addition of commuter and truck trips to the transportation system could result in 2.52 accidents per year, based on the 1980 - 1989 accident rates for the project area highways during the peak period of the project. This would be rated as a low negative impact.

Residents of the communities of Zortman and Landusky and their pets would be somewhat vulnerable to accidents during commute hours as mine workers arrive or leave during shift changes. Moreover, truck convoys passing through the town of Zortman would also create a risk of accidents. This increased risk of accidents due to as many as 150 roundtrips or 300 one-way trips through town per day is considered to be a medium negative impact on the community, due to the large size and lack of maneuverability of haul trucks, the presence of residences adjacent to the haul roads and the presence of children and other pedestrians. The use of a lead car and reduction of speed to 15 mph through the communities should reduce the risk of accidents.

As described previously, the potential for increased accidents at certain locations could arise from additional truck traffic associated with hauling of clay. These locations include the junctions of U.S. Highway 191 and Seven Mile Road/Seaford clay pit access road, and the intersection of Seven Mile Road and Bear Gulch Road.

After closure of the Zortman and Landusky mines is completed, traffic volumes would diminish to approximately baseline or historic levels, resulting in an insignificant impact over the long-term.

Public Access to the Little Rocky Mountains

Due to continued closure of the mining area portions of the Little Rocky Mountains and associated access roads, Alternative 7 would result in a continuation of the high negative impacts experienced from 1979 to 1994 over the short-term. Areas and roads closed to the public would remain closed until final reclamation is completed around the end of 2007.

In addition, Alternative 7 would also include construction and use of an overland conveyor for transportation of ore and NAG waste from the Zortman Mine to the Goslin Flats heap leach pad. Impacts to access associated with the conveyor would be the same as those described for Alternatives 4 and 6. With the addition of impacts to the Goslin Flats and conveyor areas, Alternative 7 (as well as Alternatives 4 and 6) represents the worst-case project scenario from an access impact standpoint because Alternatives 1 - 3 and 5 would not feature facilities on Goslin Flats and would not create any additional access impacts in that portion of the Little Rocky Mountains.

After closure of the mines and reclamation is completed, public access would be restored, and baseline conditions would once again be experienced with respect to transportation. Over the long-term, impact would be reduced to insignificant.

Transportation of Hazardous Materials

Transportation of hazardous materials would continue for an additional 12 years, with shipments tapering off as reclamation is completed (around the end of 2007). Historically, there have been no documented accidents involving trucks transporting hazardous materials to the Zortman and Landusky mines. Under this alternative, the number of hazardous material haul trips would be roughly the same as experienced from 1979 to 1994. Since the small risk of accidents and spills would remain along local and regional roads over the duration of this alternative, Alternative 7 would have a low negative impact on local residents.

For the Zortman operation, it is important to note that the majority of hazardous materials trips would terminate at the Goslin Flats leach pad/treatment plant for use in heap leaching. Only a fraction of the trips (e.g., diesel, ammonium nitrate) would pass through Zortman en route to the Zortman Mine. Therefore, the risk of accidents and spills is lower under this alternative, relative to Alternative 5, which would feature extended heap leaching in Upper Alder Gulch, thereby requiring that all hazardous materials trips pass through town and terminate at the mine.

After closure of the mines is completed, hazardous material haul trips would drop back to extremely low baseline levels. Over the long-term, impact would be reduced to insignificant.

4.11.9.1 Cumulative Impacts

Cumulative impacts would be the same as those described for Alternative 4.

4.11.9.2 Unavoidable Adverse Impacts

As described previously, restriction of public access to the southern Little Rocky Mountains would be considered an unavoidable adverse impact. With the exception of new access restrictions near the conveyor and adjacent to Goslin Flats, this impact would essentially be a continuation of an existing impact, dating back to 1979, until reclamation would be completed (around the end of 2007).

4.11.9.3 Short-Term Use/Long-Term Productivity

Short-term use of the project area for mining would not compromise the long-term productivity of the transportation network. After final reclamation were completed, the impacts would cease to occur and the study area would likely return to baseline conditions with respect to transportation.

4.11.9.4 Irreversible or Irretrievable Resource Commitments

With respect to transportation, this alternative would result in no irreversible or irretrievable resource commitments. Project areas roads and highways would continue to exist and be accessible as they were under baseline conditions prior to 1979.

4.12 CULTURAL RESOURCES

4.12.1 Methodology

Prehistoric and Historic Cultural Resources

Regulations at 36 CFR 800 are used as guidance for assessing effects to historic properties. Historic properties are those archaeological, historic, and ethnographic sites that are listed on or have been determined to be eligible for listing on the National Register of Historic Places (36 CFR 60.4). The BLM and SHPO consult to determine site eligibility; the Keeper of the National Register is consulted if there is disagreement.

Properties are impacted if the criteria that caused them to be determined eligible are affected. To be determined eligible, all sites must demonstrate integrity of their significant features. This includes integrity of location, setting, and feeling - if those features contribute to the site's significance.

For archaeological and historic sites that are determined eligible under criterion (d) of 36 CFR 60.4, impacts would include the loss of information (scientific data) that could add to our knowledge of Native American and Euro-American history. Impacts to historic sites or districts eligible under criterion (a) may include a change in the setting or a loss of feeling or association with the historic event. For traditional cultural properties, the loss of setting and feeling that were important aspects of the sites' significance may be as important as the physical impact.

Impacts to cultural properties can be direct or secondary. Direct impacts include destruction of the property or destruction of the features that contribute to the property's significance. Secondary impacts may include increased access to an area, increased site vandalism, and/or restricted access. General ways to mitigate impacts are discussed in the Memorandum of Agreement (Appendix E). Additional impacts have been addressed in a relative fashion in the following discussion.

Measures to mitigate effects on historic properties (National Register eligible) for all alternatives are being developed in a Memorandum of Agreement (MOA) that will be executed by the BLM, Montana State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (Advisory Council) (Appendix E). Other interested parties such as the Bureau of Indian Affairs, Zortman Mining, Inc., and the Fort Belknap Community Council have been invited to participate in the preparation of the MOA. Public meetings have been held to solicit public input. This MOA is being prepared in accordance with the requirements of 36 CFR 800 (see also Section 3.12.1).

Native American Cultural Resources

Project impacts were assigned for potential physical, visual, and aural (noise or sound) impacts to Native American cultural resources which represent contemporary or heritage significance. Heritage significance is a measure of the relative importance of a site or area to Native Americans, as measured by the level of concern expressed for particular cultural resources or classes of cultural resources.

No systematic data were collected to determine the level of contemporary or heritage significance of the inventoried sites or areas to Native Americans. On the other hand, the information provided in Deaver and Kooistra (1992)--which includes comments made by Native Americans at Fort Belknap during and after the public meetings at Lodgepole, the writer's considerable experience with similar kinds of analyses and, perhaps most notably, the fact that most of the inventoried sites are of a spiritual or religious nature--clearly indicate that all of these sites or areas should be assigned a high level of heritage significance. This measure is, therefore, a constant for the present analysis.

Physical impacts are those which would alter or otherwise affect the physical integrity of a site or area possessing heritage significance to Native Americans; visual impacts are those which would affect the view from or modify the visual integrity of a site or area possessing heritage significance to Native Americans; aural impacts are those which would affect the aural integrity of a site or area possessing heritage significance to Native Americans.

Impacts are commonly of a negative nature in that they produce a negative effect on the resource. However, an impact can also be positive, producing an effect which is beneficial to the resource. Reclamation efforts which improve the resource or the resource setting, for example, may have long-term positive effects.

Physical impacts involve actual ground or structure disturbance. Impact levels for physical impacts were determined by the distance between Native American sites or resources and existing or new mining activities as actual or high (0.0-0.2 miles), none or neutral (0.2+ miles), and in the special situations described below, as unknown.

In several instances, the actual location and extent of the resources identified in the Little Rocky Mountains study area are unknown. For example, literature sources and Native Americans have reported burial practices in the Little Rocky Mountains (LRM Burials in Table 4.12.1) but actual burial locations are either unknown or not reported. And while Coming Day's Route probably passed through or near the mining areas, the actual location of any cultural sites or other resources associated with this historic event are unknown. Impacts to these activities are, therefore, assigned as unknown. On the other hand, impacts are assigned to Little Rocky Mountains Resource Procurement activities since it can be safely assumed that many of the resources associated with this activity existed throughout the Little Rocky Mountains, including the Zortman and Landusky mining areas.

Visual impacts were measured from the highest elevation of a place used for vision questing (see discussion in Section 3.12) to the closest visible mining activity at the Zortman and Landusky mines. The viewshed was based primarily upon the visual analysis and simulations conducted for the Visual Resources Studies (Section 4.8). Other sources consulted for this determination included discussions with professionals who had visited the study area, and a non-computerized analysis of study area using USGS 7.5' topographic quadrangles and aerial photographs. Visual impact levels were determined by the distance between the ethnographic site and mining activities as high (0.0-3.0 miles), medium (3.0-6.0 miles), low (6.0-9.0 miles), no or neutral (9+ miles or not visible), or unknown impact. These levels were determined in consultation with the visual resources specialists.

Aural impacts (noise) emanating from sources such as blasting, use of machinery, and vehicular traffic, were also determined by distance between the ethnographic site and mining activities as high (0.0-2.0 miles), medium (2.0-4.0 miles), low (4.0-6.0 miles), no or neutral (6.0+ miles or not audible), or unknown impact. These levels were determined in consultation with the noise specialists.

Duration, or the anticipated length of time the impact would occur, and incidence, or the frequency of impact occurrence, are also significant factors in assessing impacts to Native American cultural resources. Duration and incidence of impact are discussed in evaluating project effects for each of the alternatives.

Considering the data limitations described in Section 3.12.3.2, the impact assessment is based upon a preliminary and incomplete sample of the sites and associated Native American values present in the Little Rocky Mountains TCP Historic District, and employs both quantitative and qualitative data. The analysis should not be considered as exhaustive. It is adequate, however, for the purposes of a general assessment of impacts to Native American cultural resources associated with the various alternatives.

By way of summary, the model used to assign impact levels to Native American resources is shown below.

IMPACT MODEL

Impact Type	Impact Level			
	High	Medium	Low	Neutral
Physical (P)	0.0-0.2 miles	NA	NA	0.2+ miles
Visual (V)	0.0-3.0 miles	3.0-6.0 miles	6.0-9.0 miles	9.0+ miles
Aural (A)	0.0-2.0 miles	2.0-4.0 miles	4.0-6.0 miles	6.0+ miles

4.12.2 Impacts from Mining-1979 to Present

Prehistoric and Historic Cultural Resources

Eight recorded historic sites have been directly impacted by mining operations since 1979. The following sites had been determined not eligible for the National Register of Historic Places: 24PH254, 24PH256, 24PH257, 24PH2184, 24PH2296, and 24PH2297. Eligibility had not been determined for site 24PH2774. The Ruby Mill and townsite (24PH255) was recorded in 1978 and determined to be not eligible at the time. Much of the townsite has since been destroyed; however, the mill remains standing and has since been determined eligible for the National Register. There may have been secondary impacts to the Ruby Mill (vandalism, blasting effects), but these are not documented. Additionally, since standards for consideration of historic sites for National Register eligibility have changed somewhat since 1979, some of the sites that were not afforded protection may have been considered eligible by 1994 standards. These sites include the Gold Bug Mine (24PH254), the August Mine (24PH256), the Little Ben Mine (24PH257) and all or parts of the Ruby townsite. Other mining-related sites such as portals, shafts, cabin foundations, "glory holes", adits, trash dumps, and other structures were recorded as isolated finds in 1978

(Hogan and Fredlund 1978). These too have been impacted or destroyed by mining activity since 1979. By 1994 standards, these resources would be recorded as sites and their National Register eligibility assessed. Additionally, mining activity since the 19th century has probably impacted unrecorded prehistoric sites.

Native American Cultural Resources

Existing impacts are displayed in Table 4.12-1. The purpose is to show existing impacts to the sample of 41 Native American sites identified from literature and other sources for the period of surface mining, from 1979 to 1994. These sites are all within the working boundaries of the TCP Historic District. Impacts from previous periods of mining within the Zortman and Landusky Project areas were existent prior to 1979 and carry over into the present period. Table 4.12-1 shows that the existing impacts for physical, visual, and aural impacts associated with the Zortman Mine site are all high, yielding an overall impact assessment of high. Similarly, the existing impacts for physical, visual, and aural impacts associated with the Landusky Mine site are all high, yielding an overall impact assessment of high. It follows that the combined existing impacts of both mining operations to Native American cultural resources are also high.

The impacts shown in Table 4.12-1 are all assumed to be negative and represent the existing condition, or threshold, for the assessment of each of the proposed alternatives which follows. It is important to note, however, that this threshold represents only a sample of the Native American cultural resources in the Little Rocky Mountains. Other considerations, such as the effects of the alternative mining plans on the larger TCP District and associated Native American values, are also factored into the assessment, albeit in a less quantitative manner.

In assessing the various alternatives, the effects of existing impacts must be taken into account. As noted in Section 3.12.3.6, prior to 1979, significant physical disturbance had occurred in Montana Gulch, Beaver Creek, and Pony Gulch and mill tailing had been deposited in King Creek, Alder Gulch, and Ruby Gulch. Since 1979, there has been additional disturbance to these areas and extensive new physical disturbance associated with Antoine Butte and Shell Butte (Zortman), and Gold Bug Butte and Mission Peak (Landusky). As shown in Table 4.12-1, existing visual and aural impacts are also significant, ranging from neutral to high, depending upon visibility and distance from mining activities.

Impacts to Native American cultural resources include impacts to the National Register eligible TCP Historic District, individual cultural properties identified within the District, and the associated traditional Native American values. As long as the mines continue to operate, these impacts remain a significant and serious issue for Native American traditionalists. This conclusion follows from the literature review (see Section 3.12.3); comments from tribal members presented at the public scoping meeting for the Zortman Mine Expansion EIS held in Lodgepole, Montana on April 15, 1993; and the sworn testimony of Virgil McConnell before the State of Montana (1990). All of this information supports the perception to traditionalists that more sites and areas would be rendered unavailable, unacceptable, or less desirable with the continuation of mining in the Little Rocky Mountains.

4.12.3 Impacts from Alternative 1

Under the No Action Alternative, there would be no expansion at either the Zortman or Landusky mines. Previously permitted operations and activities including ore leaching, facility reclamation, revegetation, and other closure activities would continue. Reclamation measures under this alternative may not be as effective as those proposed under the other alternatives.

Prehistoric and Historic Cultural Resources

There would be no additional impacts to significant archaeological or historic sites.

Native American Cultural Resources

For Alternative 1, the existing impacts are reduced from high to moderate for Native American cultural resources. This reduction from existing impact levels reflects not approving mine expansions, proposed reclamation measures, and mine closure, all of which should lead to the cessation of mining in the Little Rocky Mountains and reclamation of the land to its pre-mining state. As such, the provisions of Alternative 1 should eventually result in the preservation and protection of Native American cultural resources, and their use by the Native population for contemporary and traditional cultural practices. The impact level assigned also recognizes the observation that reclamation procedures proposed under this alternative are not fully protective of the environment.

TABLE 4.12-1

NATIVE AMERICAN CULTURAL RESOURCES IMPACT ASSESSMENT: EXISTING IMPACTS

			Visibility		Distance		Zortman			Landusky		
No.	Site Type (Primary)	Site Activity (Primary)	Zortman	Landusky	Zortman	Landusky	P	V	A	P	V	A
01.	Religion & Ritual	Vision Questing	yes	no	2.0	4.0	N	H	H	N	N	M
02.	Religion & Ritual	Vision Questing	no	yes	2.2	0.0	N	N	M	H	H	H
03.	Religion & Ritual	Vision Questing	yes	no	1.0	3.1	N	H	H	N	N	M
04.	Religion & Ritual	Fasting	yes	yes	2.7	1.7	N	H	M	N	H	H
05.	Religion & Ritual	Fasting	no	no	1.5	3.5	N	N	H	N	N	M
06.	Religion & Ritual	Vision Questing	yes	yes	2.2	3.1	N	H	M	N	M	M
07.	Religion & Ritual	Vision Questing	yes	yes	0.4	1.0	N	H	H	N	H	H
08.	Religion & Ritual	Vision Questing	yes	no	0.2	2.2	H	H	H	N	N	M
09.	Religion & Ritual	Vision Questing	yes	no	5.8	7.8	N	M	L	N	N	N
10.	Religion & Ritual	Vision Questing	no	yes	2.8	0.2	N	N	M	H	H	H
11.	Religion & Ritual	Vision Questing	no	yes	5.5	2.8	N	N	L	N	H	M
12.	Religion & Ritual	Fasting	no	yes	4.0	0.7	N	N	M	N	H	H
13.	Religion & Ritual	Vision Questing	yes	yes	4.4	2.7	N	M	L	N	H	M
14.	Religion & Ritual	Vision Questing	yes	no	3.4	5.7	N	M	M	N	N	L
15.	Religion & Ritual	Vision Questing	no	no	7.2	4.4	N	N	N	N	N	L
16.	Religion & Ritual	Vision Questing	no	no	4.0	6.0	N	N	M	N	N	L
17.	Religion & Ritual	Vision Questing	no	yes	7.4	4.0	N	N	N	N	M	M
18.	Religion & Ritual	Vision Questing	yes	no	7.8	9.6	N	L	N	N	N	N
19.	Religion & Ritual	Fasting	no	no	6.4	7.2	N	N	N	N	N	N
20.	Religion & Ritual	Vision Questing	no	yes	6.6	8.4	N	N	N	N	L	N
21.	Religion & Ritual	Offering Area	no	no	3.7	1.4	N	N	M	N	N	H
22.	Religion & Ritual	Fasting	no	yes	2.6	0.6	N	N	M	N	H	H
23.	Religion & Ritual	Vision Questing	yes	yes	3.4	3.3	N	M	M	N	M	M
24.	Religion & Ritual	Vision Questing	yes	no	3.9	3.8	N	M	M	N	N	M
25.	Religion & Ritual	Vision Questing	yes	no	1.2	3.0	N	H	H	N	N	M
26.	Rock Art	Prehistoric Site	no	no	2.3	2.6	N	N	M	N	N	M

Sheet 1 of 2

TABLE 4.12-1 - NATIVE AMERICAN CULTURAL RESOURCES IMPACT ASSESSMENT
(Concluded)

No.	Site Type (Primary)	Site Activity (Primary)	Visibility		Distance		Zortman			Landusky		
			Zortman	Landusky	Zortman	Landusky	P	V	A	P	V	A
27.	Rock Art	Prehistoric Site	no	no	2.4	2.3	N	N	M	N	N	M
28.	Rock Art	Prehistoric Site	no	no	3.2	2.3	N	N	M	N	N	M
29.	Rock Art	Prehistoric Site	no	no	2.3	2.7	N	N	M	N	N	M
30.	Burial	Burial	no	no	7.0	4.2	N	N	N	N	N	L
31.	LRM Burials	Burial	?	?	?	?	U	U	U	U	U	U
32.	Healing	Medicinal Spring	no	no	4.3	2.4	N	N	L	N	N	M
33.	Healing	Healing Waters	no	no	6.3	8.3	N	N	N	N	N	N
34.	Sundance	Sundance Site	no	no	4.3	3.3	N	N	L	N	N	M
35.	Sundance	Sundance Site	no	yes	3.2	1.8	N	N	M	N	H	H
36.	Resource Procurement	Fossil Gathering	no	no	3.4	5.4	N	N	M	N	N	L
37.	LRM Resource Procurement	Plant Gathering	yes	yes	0.0	0.0	H	H	H	H	H	H
38.	Historic Event	Historic Battle Site	no	no	4.9	2.8	N	N	L	N	N	M
39.	Historic Event	Coming Day's Route	?	?	?	?	U	U	U	U	U	U
40.	Pipe Offering	Flat Pipe Offering	no	no	7.0	4.2	N	N	N	N	N	L
41.	Powwow	Pow Wow Grounds	no	no	3.6	1.6	N	N	M	N	N	H
						Impact Score	3.00	2.53	2.03	3.00	2.61	2.12
						Impact Level	High	High	High	High	High	High
										IMPACT TOTALS		
										Zortman		High
										Landusky		High
										Combined Total		High

P = Physical Impact, V = Visual Impact, A = Aural Impact; H = High Impact, M = Moderate Impact, L = Low Impact, N = No Impact, U = Unknown Impact; High = 3, Moderate = 2, Low = 1.

To compute impact scores, the individual impact scores are summed and then divided by the number of individual impacts. Situations of No, Neutral, or Unknown impact are not used in computing impact scores. Low impacts are represented by a score of 0.0 - 1.0, Moderate impacts be a score of 1.0 - 2.0, and High impacts by a score of 2.0 - 3.0.

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4.12.3.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources

There would be no additional impact to the eight known historic sites and corresponding historic information already lost to mining operations.

Native American Cultural Resources

Under the No Action Alternative, existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure.

4.12.3.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

There would be no adverse impacts to known resources.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of physical disturbance to sacred places, such as Shell Butte (Zortman) and Gold Bug Butte (Landusky), are permanent and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with mine operation, reclamation, and closure, are also unavoidable under all the alternatives.

4.12.3.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources

Current and historic mining practices have disturbed cultural sites. Although the mine activities are relatively short-term, the impacts to cultural and historic sites are long-term or even permanent.

Native American Cultural Resources

Mining operations and related activities in the Little Rocky Mountains continue to have an adverse effect on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse effects lessen, thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by the Native populations. Alternatives 1 - 3, the no expansion alternatives, represent the least amount of time for this transition to take place.

4.12.3.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources

Although no additional sites would be committed, the existing impacts to cultural or historic sites are irreversible and irretrievable.

Native American Cultural Resources

The irreversible and irretrievable effects of mining operations would be limited largely to existing impacts and those associated with already permitted operations.

Some Native Americans have asserted that mining amounts to desecration, and reclamation cannot undo this damage. Still, one may assume that the Gros Ventre and Assiniboine would prefer reclamation over the continued mine operation or expansion. During the public scoping meeting at Lodgepole, for example, several tribal members mentioned the lack of effective reclamation and the need to enforce reclamation requirements.

4.12.4 Impacts from Alternative 2

Under this alternative, expansion of the Zortman and Landusky mines would not be approved although already permitted activities, including ore rinsing and leaching, would continue. Reclamation procedures currently in use would be modified to reduce the potential for acid rock drainage.

Prehistoric and Historic Cultural Resources

There would be no impacts to significant archaeological or historic sites.

Native American Cultural Resources

The impacts would be similar to Alternative 1, and for the same reasons, the existing impacts of high are reduced to moderate for Native American cultural resources under Alternative 2. This reduction from existing impact levels reflects not approving mine expansions, proposed reclamation measures, and mine closure, all of which should lead to the cessation of mining in the Little Rocky Mountains and reclamation of the land to its pre-mining state. As such, the provisions of Alternative 2 should eventually result in the preservation and protection of Native American cultural resources, and their use by the Native population for contemporary and traditional cultural practices. The impact level assigned also recognizes the observation that reclamation procedures proposed under this alternative are not fully protective of the environment.

4.12.4.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources

There would be no additional impact to the eight known historic sites and corresponding historic information already lost to mining operations.

Native American Cultural Resources

Under this alternative, existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure.

4.12.4.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

There would be no additional adverse impacts to known resources.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of physical disturbance to sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky), are permanent and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with existing mine operations, reclamation, and closure, are also unavoidable under all the alternatives.

4.12.4.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources

Current and historic mining practices have disturbed cultural sites. Although the mine activities are relatively short-term, the impacts to cultural and historic sites are long-term or even permanent.

Native American Cultural Resources

Mining operations and related activities in the Little Rocky Mountains continue to have an adverse effect on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse effects lessen, thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by the Native populations. Alternatives 1, 2, and 3, the no expansion alternatives, represent the least amount of time for this transition to take place.

4.12.4.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources

Although no additional sites would be committed, the existing impacts to cultural or historic sites are irreversible and irretrievable.

Native American Cultural Resources

The irreversible and irretrievable effects of mining operations would be limited largely to existing impacts and those associated with already permitted operations.

Some Native Americans have asserted that mining amounts to desecration, and reclamation cannot undo this damage. Still, one may assume that the Gros Ventre and Assiniboine would prefer reclamation over the continued mine operation or expansion. During the public meeting at Lodgepole, for example, several tribal members mentioned the lack of effective reclamation and the need to enforce reclamation requirements.

4.12.5 Impacts from Alternative 3

Under this alternative, expansion of the Zortman and Landusky mines would not be approved although already permitted activities, including ore leaching and rinsing, would continue. Reclamation procedures already in place would be modified to incorporate changes developed by the agencies to reduce environmental impacts and enhance the potential for reclamation success.

Prehistoric and Historic Cultural Resources

There would be no additional impacts to significant archaeological or historic sites.

Native American Cultural Resources

The impacts to Native American cultural resources under this alternative are similar to those identified for Alternatives 1 and 2, although the incorporation of more effective reclamation procedures developed by the agencies should result in more effective restoration of the heavily disturbed portions of the Little Rocky Mountains. As such, the existing impacts of high are reduced to low for Alternative 3 in recognition of these additional potentially favorable benefits to restoration of the Little Rocky Mountains. As with Alternatives 1 and 2, mining operations under Alternative 3 would continue at the same level until closure, and although reclamation activities are more extensive, the positive benefits to the resource base in the long run outweigh the resulting extension of impacts and time.

4.12.5.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources

There would be no additional impacts to the eight known historic sites and corresponding historic information already lost to mining operations.

Native American Cultural Resources

Under this alternative, existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure. Cumulative impacts also include the application of additional reclamation and remediation measures. Additional mining and exploration is not foreseeable and would, therefore, have no impact.

4.12.5.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

There would be no adverse impacts to known resources.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of physical disturbance to sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky), are permanent and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with mine operation, reclamation, and closure are also unavoidable under all the alternatives.

4.12.5.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources

Current and historic mining practices have disturbed cultural sites. Although the mine activities are relatively short-term, the impacts to cultural and historic sites are long-term or even permanent.

Native American Cultural Resources

Mining operations and related activities in the Little Rocky Mountains continue to have an adverse effect on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse effects lessen, thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by the Native populations. Alternatives 1, 2, and 3, the no expansion alternatives, represent the least amount of time for this transition to take place.

4.12.5.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources

Although no additional sites would be committed, the existing impacts to cultural or historic sites are irreversible and irretrievable.

Native American Cultural Resources

The irreversible and irretrievable effects of mining operations would be limited largely to existing impacts and those associated with already permitted operations.

Some Native Americans have asserted that mining amounts to desecration, and reclamation cannot undo this damage. Still, one may assume that the Gros Ventre and Assiniboine would prefer reclamation over the continued mine operation and expansion. During the public meeting at Lodgepole, for example, several tribal members mentioned the lack of effective reclamation and the need to enforce reclamation requirements.

4.12.6 Impacts from Alternative 4

The company proposed action (CPA) would permit extended operations at both the Zortman and Landusky mines along with implementation of modified reclamation plans. At the Zortman Mine this would include: lateral expansion and deepening of the pit complex to remove 80 million tons of ore, construction and operation of a heap leach facility at Goslin Flats, construction of an ore conveyor system through Alder Gulch to Goslin Flats, construction of a new waste rock repository in Carter Gulch, and development of a limestone source south of Green Mountain for uses associated with reclamation. At the Landusky Mine, activities would include deepening of the August pit and the South Gold Bug pit to extract 7.6 million additional tons of ore, expansion of the 87/91 leach pad capacity to

19.5 million tons, and development of a quarry in the King Creek drainage to mine limestone for use in reclamation.

Prehistoric and Historic Cultural Resources

The Alder Gulch Historic District, eligible under criteria (a) and (d) of 36 CFR 60.4, would be impacted by construction of the conveyor system. One site in the district (24PH2863, a lime kiln) would be directly impacted. The remainder of the sites that comprise the Alder Gulch Historic District would not be directly impacted by this alternative. However, the setting and feeling of the District would be changed with the construction and operation of the conveyor system. Direct impacts would be low negative, with mitigation measures. Duration would be permanent. Because the conveyor system does not impact the entire District, secondary impacts would also be low negative. Duration would be for life-of-mine, since reclamation includes removal of the conveyor.

One archaeological site (24PH2905) may be impacted in the land application area.

Native American Cultural Resources

Under this alternative, the existing high impacts would continue while additional activities and disturbance would increase overall impact levels. As a result, the impact level for Native American cultural resources remains high. At the Zortman Mine site, impacts to Shell and Antoine Buttes and the surrounding area would continue and accelerate with (a) increased ore extraction, (b) removal of the waste rock dump in Alder Gulch, (c) construction and operation of a new waste rock dump in Carter Gulch, and (d) the addition of new facilities. Construction and operation of the conveyor system in Alder Gulch and the leach pad in Goslin Flats would add new impacts to Soldier Butte and the surrounding area. At the Landusky Mine, impacts to Gold Bug Butte, Mission Peak, and the surrounding area would continue and accelerate with new ore extraction activities. Construction and operation of the limestone quarry in the King Creek drainage would add impact to the area and to Damon Hill. Many of the physical impacts are permanent and would remain post-reclamation.

4.12.6.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources

Implementation of this alternative would result in no additional impacts to prehistoric resources, but the cumulative effect and significance of impacts to prehistoric resources is not known since most disturbance was unrecorded.

Low, negative impacts from this alternative would contribute to the cumulative impact on certain historic sites. Of these, one site has been determined to be eligible for the National Register.

Mining in the Pony Gulch area would increase the impacts to the Alder Gulch Historic District. Eastward extension of the Goslin Flats leach pad could impact site 24PH2905, a stone circle site. The exploration could also impact previously unrecorded sites. Standard archaeological survey methods would be employed to locate significant sites prior to project development.

Native American Cultural Resources

Under this alternative, existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure as with the other alternatives discussed. The magnitude, intensity, incidence, and duration of impacts, however, would greatly increase over current conditions. The cumulative impact is approximately 100 plus years of significant disruption to Native American traditional cultural practices in portions of the Little Rocky Mountains.

All of the reasonably foreseeable activities would increase the magnitude, incidence, and duration of the impacts to Native American cultural resources.

4.12.6.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

Cultural resources have already been adversely impacted by mining activities. Under 36 CFR 800, adverse project effects can be mitigated. While there would be some loss of individual sites and a change in the setting of the Alder Gulch Historic District, Alternative 4 would not have an adverse effect on prehistoric and historic resources with the implementation of appropriate mitigation measures.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of physical disturbance to sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky), are permanent and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with mine operation, reclamation, and closure, are also unavoidable under all the alternatives. Unavoidable adverse impacts to the Little Rocky Mountains TCP District, individual cultural properties, and associated Native American values would greatly increase under Alternative 4.

4.12.6.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources
The loss of sites is a long-term impact. The loss of setting or feeling in the Alder Gulch Historic District is relatively short-term.

Native American Cultural Resources
Mining operations and related activities in the Little Rocky Mountains continue to have an adverse impact on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse impacts lessen, thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by the Native populations. Alternative 4 would significantly increase the amount of time for this transition to take place.

4.12.6.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources
Loss of archaeological sites is irreversible and irretrievable. Implementation of this alternative would require a minor additional commitment of resources when compared with the loss-to-date.

Native American Cultural Resources
Under this alternative, existing impacts would continue and new impacts would be added, so that the irreversible and irretrievable impacts to Native American cultural resources would increase. Locations of Native American activities have previously been irreversibly committed (e.g., Gold Bug Butte). This alternative would irreversibly commit additional undisturbed land.

4.12.7 Impacts from Alternative 5

With Alternative 5, the Zortman and Landusky mines would be expanded although at Zortman the heap leach facility would be constructed in Upper Alder Gulch instead of Goslin Flats and the conveyer system would not be built. At Landusky, the rock fill would be removed from the head of King Creek and the pits would be backfilled to a minimum elevation required to create a surface which would freely drain into King Creek.

Prehistoric and Historic Cultural Resources
Without the conveyor system through Alder Gulch and the leach pad at Goslin Flats, no historic or prehistoric sites would be impacted.

Native American Cultural Resources
As with Alternative 4, the existing high impacts would continue, while additional activities and disturbance would increase overall impact levels. As a result, the impact level for Native American cultural resources remains high. At the Zortman Mine site, impacts to Shell and Antoine Buttes and the surrounding area would continue and accelerate with increased ore extraction, removal of the waste rock dump in Alder Gulch, construction and operation of a new waste rock dump in Carter Gulch, and the addition of new facilities. Since construction and operation of the conveyor system in Alder Gulch and the leach pad in Goslin Flats would not take place, impacts to Soldier Butte and the surrounding area would be less than under Alternative 4, but Alternative 5 would not significantly reduce the overall impacts compared to Alternative 4. At the Landusky Mine, impacts to Gold Bug Butte, Mission Peak, and the surrounding area, would continue and accelerate with new ore extraction activities. Construction and operation of the limestone quarry in the King Creek drainage would add impacts to the Damon Hill area.

4.12.7.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources
Implementation of this alternative would result in no additional impacts to prehistoric resources, but the cumulative effect and significance of impacts to prehistoric resources is not known since most disturbance was unrecorded.

Low, negative impacts from this alternative would contribute to the cumulative impact on certain historic sites. Of these, one site has been determined to be eligible for the National Register.

Native American Cultural Resources
Existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure as with the other alternatives. The magnitude, intensity, incidence, and duration of impacts, however, would greatly increase over current conditions. The cumulative impact is

approximately 100 plus years of significant disruption to Native American traditional cultural practices in portions of the Little Rocky Mountains. The deletion of the conveyor system through Alder Gulch and the leach pad at Goslin Flats would lessen the overall cumulative impacts relative to Alternative 4.

All of the reasonably foreseeable activities would increase the magnitude, incidence, and duration of the impacts to Native American cultural resources.

4.12.7.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

There would be no adverse impacts due to implementation of Alternative 5.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of physical disturbance to sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky), are permanent and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with mine operation, reclamation, and closure are unavoidable under all the alternatives. Unavoidable adverse impacts to the Little Rockies TCP, individual cultural properties, and associated Native American values, however, would greatly increase under Alternative 5, although not to the degree associated with Alternative 4.

4.12.7.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources

There is no removal of resources under Alternative 5.

Native American Cultural Resources

Mining operations and related activities in the Little Rocky Mountains would continue to have an adverse effect on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse effects would lessen, thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by the Native populations. Alternative 5 would result in not only continuing and increased impacts to the resource base, but represents an increased period of time for this transition to take place.

4.12.7.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources

No resources would be committed under Alternative 5.

Native American Cultural Resources

Existing impacts would continue and new impacts would be added so that the irreversible and irretrievable impacts to Native American cultural resources would greatly increase. This increase would result from the continuation and expansion of existing activities, the addition of new activities, reclamation, and mine closure. Locations of Native American activities have previously been irreversibly committed (e.g., Gold Bug Butte). This alternative would irreversibly commit additional undisturbed land.

4.12.8 Impacts from Alternative 6

With Alternative 6, the Zortman and Landusky mine expansions would be approved although the waste rock facility would be located on Ruby Flats just east of the Goslin Flats heap leach pad. At Landusky, a drainage notch would be constructed between the August Pit and Montana Gulch to prevent runoff from the pits from flowing into the August tunnel.

Prehistoric and Historic Cultural Resources

Impacts to the Alder Gulch Historic District under this alternative would be similar to those outlined in Alternative 4. Additionally, the added disturbance on Ruby Flats could impact prehistoric sites 24PH2905 and 24PH3203. Site 24PH2905 may also be impacted by use of the land application area.

Native American Cultural Resources

As with the impacts associated with Alternatives 4 and 5, under Alternative 6, the existing high impacts would continue while additional activities and disturbance would increase overall impact levels. As a result, the impact level for Native American cultural resources remains high. At the Zortman Mine site, impacts to Shell and Antoine Buttes and the surrounding area would continue and accelerate with increased ore extraction, removal of the waste rock dump in Alder Gulch, and the addition of new facilities. Construction and operation of the conveyer system in Alder Gulch, the waste rock dump at Ruby Flats, and the leach pad in Goslin Flats would add new impacts to Soldier Butte and the surrounding area. At the Landusky Mine, impacts to Gold Bug Butte, Mission Peak, and the surrounding area, would continue and accelerate with new ore extraction activities. Construction and operation of the limestone quarry in the King Creek drainage would add impacts to the Damon Hill area.

4.12.8.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources

Under this alternative, two additional sites would be impacted on Ruby Flats, increasing the overall cumulative impact to prehistoric cultural resources. However impacts would still be low and negative since adverse effects could be mitigated according to 36 CFR 800. Cumulative impacts to historic sites are minor when compared to the current level of disturbance.

Low, negative impacts from this alternative would contribute to the cumulative impact on certain historic sites. Of these, one site has been determined to be eligible for the National Register.

Mining in the Pony Gulch area would increase the impacts to the Alder Gulch Historic District. Eastward extension of the Goslin Flats leach pad could impact site 24PH2905, a stone circle site. The exploration could also impact previously unrecorded sites. Standard archaeological survey methods would be employed to locate significant sites prior to project development.

Native American Cultural Resources

Existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure as with the other alternatives discussed. The magnitude, intensity, incidence, and duration of impacts, however, would greatly increase over current conditions. The cumulative impact is approximately 100 plus years of significant disruption to Native American traditional cultural practices in portions of the Little Rocky Mountains.

All of the reasonably foreseeable activities would increase the magnitude, incidence, and duration of the impacts to Native American cultural resources.

4.12.8.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

Under 36 CFR 800, adverse project effects can be mitigated. While there will be some loss of individual sites and a change in the setting of the Alder Gulch Historic District, approval of Alternative 6 would not, if appropriate mitigation measures are implemented, have an adverse effect on prehistoric and historic resources.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of physical disturbance to sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky), are permanent and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with mine operation, reclamation, and closure are unavoidable under all the alternatives. Unavoidable adverse impacts to the Little Rockies TCP, individual cultural properties, and associated Native American values, however, would greatly increase under this alternative.

4.12.8.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources

The loss of sites is a long-term impact. The loss of setting or feeling in the Alder Gulch Historic District is relatively short-term, lasting the life of the mine.

Native American Cultural Resources

Mining operations and related activities in the Little Rocky Mountains would continue to have an adverse effect on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse effects would lessen, thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by Native American populations. Alternative 6 would result in not only continuing and increased impacts to the resource base, but represents an increased period of time for this transition to take place.

4.12.8.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources

Loss of archaeological sites is an irreversible and irretrievable commitment. Implementation of this alternative would require a minor additional commitment of resources when compared with the loss of historic sites to date. Loss of the two prehistoric sites would be a greater loss, as no known sites have been lost to date. This is a greater loss than for Alternatives 4, 5, and 7.

Native American Cultural Resources

Existing impacts would continue and new impacts would be added so that the irreversible and irretrievable impacts to Native American cultural resources would greatly increase. This increase would result from the continuation and expansion of existing activities, the addition of new activities, the construction and operation of new facilities, reclamation, and mine closure. Locations of Native American activities have previously been irreversibly committed (e.g., Gold Bug Butte). This alternative would irreversibly commit additional undisturbed land.

4.12.9 Impacts from Alternative 7

Alternative 7 would permit mining extensions with agency mitigated expansion and reclamation at both Zortman and Landusky mines. The agencies developed Alternative 7 as a way to (1) reduce the amount of land disturbance associated with expanded mining activities, (2) reduce the potential for impacts to water resources, and (3) enhance reclamation opportunities on existing facilities. Many of the plans and facility designs for Alternative 7 are similar to or the same as those described for Alternative 4. At the Zortman Mine, the major difference is that the waste rock repository proposed for Alder Gulch in Alternative 4 would be replaced by construction of a waste rock repository on the top of existing facilities at the mine pit complex in Alternative 7. Expansion at the Landusky Mine would be similar to Alternative 5.

Prehistoric and Historic Cultural Resources

Impacts would be similar to those described in Section 4.12.6.

Native American Cultural Resources

Under this alternative, the existing high impacts would continue while additional activities and disturbance would increase overall impact levels. As a result, the impact level for Native American cultural resources remains high. At the Zortman Mine site, impacts to Shell and Antoine Buttes and the surrounding area would continue and accelerate with (a) increased ore extraction, (b) removal of the waste rock dump in Alder Gulch, (c) construction and operation of a new waste rock dump on existing facilities near the Zortman mine pit complex, and (d) the addition of new facilities. Construction and operation of the conveyer system in Alder Gulch and the leach pad in Goslin Flats would add new impacts to Soldier Butte and the surrounding area. At the Landusky Mine site, impacts to Gold Bug Butte, Mission Peak, and the surrounding area, would continue and accelerate with new ore extraction activities. Construction and operation of the limestone quarry in the King Creek drainage would add impact to the area and to Damon Hill.

4.12.9.1 Cumulative Impacts

Prehistoric and Historic Cultural Resources

Implementation of this alternative would result in no additional impacts to prehistoric resources, but the cumulative effect and significance of impacts to prehistoric resources is not known since most disturbance was unrecorded.

Low, negative impacts from this alternative would contribute to the cumulative impact on certain historic sites. Of these, one site has been determined to be eligible for the National Register.

Mining in the Pony Gulch area would increase the impacts to the Alder Gulch Historic District. Eastward extension of the Goslin Flats leach pad could impact site 24PH2905, a stone circle site. The exploration could also impact previously unrecorded sites. Standard archaeological survey methods would be employed to locate significant sites prior to project development.

Native American Cultural Resources

Under this alternative, existing impacts from past, present, and proposed future actions would continue through the period of mine operation, reclamation, and closure as with the other alternatives discussed. The magnitude, intensity, incidence, and duration of impacts, however, would greatly increase over current conditions. The cumulative impact is approximately 100 plus years of significant disruption to Native American traditional cultural practices in portions of the Little Rocky Mountains.

All of the reasonably foreseeable activities would increase the magnitude, incidence, and duration of the impacts to Native American cultural resources.

4.12.9.2 Unavoidable Adverse Impacts

Prehistoric and Historic Cultural Resources

Adverse impacts can be mitigated as described for Alternative 4 in Section 4.12.6.2.

Native American Cultural Resources

Previous impacts to Native American cultural resources, including high levels of disturbance to sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky) are permanent, and unavoidable under any of the alternatives. The physical, visual, and aural disturbance associated with mine operation, reclamation, and closure, are also unavoidable under all the alternatives. Unavoidable adverse impacts to the Little Rockies TCP District, individual cultural properties, and associated Native American values would increase under Alternative 7 (over the no expansion alternatives), similar to the increases noted for alternatives 4-6.

4.12.9.3 Short-Term Use/Long-Term Productivity

Prehistoric and Historic Cultural Resources

The loss of sites is a long-term impact. The loss of setting or feeling in the Alder Gulch Historic District is relatively short-term.

Native American Cultural Resources

Mining operations and related activities in the Little Rocky Mountains would continue to have an adverse effect on the use of Native American cultural resources for social, religious, and other cultural purposes. With the cessation of mining, reclamation, and closure activities, these adverse impacts would lessen thereby encouraging the use of Native American cultural resources in the Little Rocky Mountains by the Native populations. Similar to Alternatives 4-6 which also include mining extensions, this alternative would significantly increase the amount of time for this transition to take place.

4.12.9.4 Irreversible or Irretrievable Resource Commitments

Prehistoric and Historic Cultural Resources

Loss of archeological sites is irreversible and irretrievable. Implementation of this alternative would require a minor additional commitment of resources when compared with the loss-to-date.

Native American Cultural Resources

Under this alternative, existing impacts would continue and new impacts would be added so that the irreversible and irretrievable impacts to Native American cultural resources would also increase. This increase would result from the continuation and expansion of existing activities, the addition of new activities, the construction and operation of new facilities, reclamation, and mine closure. Locations of Native American activities have previously been irreversibly committed (e.g., Gold Bug Butte). This alternative would irreversibly commit additional undisturbed land, but less than Alternatives 4, 5, or 6.

Impacts Summary

All the alternatives represent relatively high and negative impacts to cultural resources. Relative to each other, however, some alternatives would create a greater impact. The following table shows these relative rankings based on impacts to prehistoric, historic, and traditional cultural properties.

Relative Impact Rankings

Alt.	Ranking (1 = most favorable)
1	2
2	2
3	1
4	4
5	3
6	4
7	4

Of all the alternatives, Alternative 3 is the most favorable due to no additional expansion, and improved reclamation measures. The other two no-expansion alternatives are ranked second for their reclamation.

Of the mine expansion alternatives, Alternative 5 is most favorable due to lower impacts to historic and prehistoric sites. The other three expansion alternatives are all ranked approximately equal due to their anticipated levels of disturbance to prehistoric, historic and traditional cultural properties.

4.13 AREAS OF CRITICAL ENVIRONMENTAL CONCERN (ACEC)

Five areas within or in close proximity of the Little Rocky Mountains have been nominated or designated as ACECs. These areas include Azure Cave and prairie dog towns within the 7km Complex that have been designated ACECs by the BLM. The BLM has received nominations for the following areas: Little Rocky Mountains, Saddle Butte, and Old Scraggy Peak. The following sections summarize potential impacts to each of these existing and nominated ACECs.

4.13.1 Methodology

ACECs are areas with special designation by the BLM based on the relevance and importance of certain resource values. These areas were evaluated based on impacts of each alternative on the specific resources that lead to nomination or designation as an ACEC. Impacts are rated as high or low, positive or negative, based on several factors including:

- Analysis of specific resources presented in previous sections of this Draft EIS;
- Consultations with local, state and federal agencies and resource experts such as Bat Conservation International; and
- Proximity of the ACEC to proposed activity or disturbance.

Factors taken into consideration during the rating process include evaluation of direct and indirect impacts and whether impacts would be of short-term (life of mine) or long-term duration.

4.13.2 Impacts to Azure Cave

Azure Cave was designated as an ACEC based on its significant vertebrate biology, particularly hibernating bats, and geologic values such as the abundance of spelothems.

4.13.2.1 Impacts from Mining-1979 to Present

No direct impacts to Azure Cave have occurred as a result of mining. Indirect impacts to bats that may have occurred include noise from mining operations, summer and foraging habitat disturbance and mortality from drinking cyanide solution. No indirect impacts can be demonstrated with available data. A 1978 survey of Azure Cave found 530 hibernating bats (Chester et al. 1979). A survey of the cave in March 1993 found approximately 250-300 hibernating bats (Butts 1993). This apparent decline in bat numbers could be related to discrepancies in counting methods, the extent of the cave area surveyed, or other factors; however, habitat loss or disturbance may be contributing to the actual decline (Taylor 1994). Similar declines in bat populations have been documented in a number of bat species nationwide. The most common reasons cited are loss of secure roosting sites through cave destruction, unplanned recreational use of caves, abandoned mine closures, loss of late seral stage forest as roosting sites, and loss of foraging habitat (Tuttle and Taylor in press).

4.13.2.2 Impacts

Impacts to hibernating bats in Azure Cave are detailed in Section 4.5. No alternative would have direct impacts on the cave or hibernating bats. However, several indirect impacts could occur including noise, mortality from consumption of cyanide solutions, and destruction of riparian foraging areas.

Mining and reclamation activities under all alternatives would be more than 0.7 miles from Azure Cave and would produce audible noise at the cave between 57 and 66 dBA, or roughly the noise produced by a urban residential area. These levels would be further attenuated by the cave structure and hibernating bats would not be significantly impacted by noise levels produced under any alternative (Taylor 1994). Noise produced by mining activities would be short-term in duration and would be virtually eliminated after final reclamation.

Evaluation of mine blasting using Particle Velocity versus Square Root Scale Distance equations indicated that blasting associated with alternatives 4 through 7 would not create noticeable vibration at Azure Cave (W-C 1995).

Under the reasonably foreseeable future actions for Alternatives 4, 6, and 7, blasting could occur at Pony

Gulch, approximately 4,000 feet from the cave, and would produce vibration barely perceptible by humans and well within acceptable levels. Vibration from blasting under all alternatives would be too low to cause any damage to cave geologic feature and limestone formations. Variables used in calculations included:

- Average number of holes per blast - 500
- Average number of shots per week - 2.5
- Number of holes shot per delay - 20
- Pounds of explosives shot per delay - 5,000 lbs ANFO
- Delay period - 100 msec between delays

Past and present mining are not known to have adversely impacted biologic and geologic resources of Azure Cave. No spelothems or limestone formations have been broken and apparent declines in the number of hibernating bats may be explained by natural fluctuations and nationwide declines in bat populations. Cumulative impacts of past and present mining and reasonably foreseeable future actions, specifically under Alternatives 4, 6 and 7, could produce significant impacts to bats using Azure Cave. Mining in Pony Gulch would locate blasting, processing, and machinery disturbance within 4,000 feet of the cave. However, calculations of noise levels from mining activities at Pony Gulch would be approximately 64 dBA at Azure Cave. This noise level is equivalent to levels of urban residential areas where bats are commonly found and would not create a significant impact to hibernating bats (see Section 4.5). Noise levels from Pony Gulch would be further attenuated by an intervening hill and Lodgepole pine forest. The cumulative effects of noise and habitat loss, particularly in riparian and mature douglas fir along Alder, Carter, and Pony Gulches could have a moderate adverse impact on summer breeding bats and indirectly on hibernating bats in Azure Cave (Taylor 1994).

All impacts to Azure Cave resources would be short-term in nature and could be mitigated.

4.13.3 Impacts to Prairie Dog 7km Complex

Prairie dog towns within the 7km Complex were designated as an ACEC based on its significant biological resources, primarily the density of prairie dog towns and prairie wildlife species. The endangered black-footed ferret has been recently reintroduced into this complex, elevating the biological significance of this area.

4.13.3.1 Impacts from Mining-1979 to Present

The Prairie Dog 7km complex is more than 8 miles south of the Little Rocky Mountains, and previous mining activities have not impacted the ACEC.

4.13.3.2 Impacts

No impacts would occur to the Prairie Dog 7km complex under any alternative because the nearest prairie dog town is approximately 8 miles south of proposed mining activity.

4.13.4 Impacts to the Little Rocky Mountains

The entire Little Rocky Mountains have been nominated for consideration as an ACEC because of Native American cultural and historic values.

4.13.4.1 Impacts from Mining-1979 to Present

Impacts from recent mining (1979 to present) to Native American cultural resources have been significant and include physical, visual, and aural impacts (refer to Section 4.12). Previous impacts to ethnographic cultural resources include actual physical removal of parts of sacred places such as Shell Butte (Zortman) and Gold Bug Butte (Landusky).

4.13.4.2 Impacts

Cultural resources evaluated in Section 4.12 of this Draft EIS and illustrated in Table 4.12-2 describe additional impacts as low under Alternative 3, moderate under Alternatives 1 and 2, and high under Alternatives 4, 5, 6, and 7.

Impacts for Alternative 1 through 3 reflect a reduction from existing impact levels due to mine closure and proposed reclamation measures. Alternatives 1, 2, and 3 would allow continued use of ethnographic cultural resources by the Native American population for contemporary and traditional cultural practices and would not affect potential ACEC designation.

Impacts to cultural resources common to Alternatives 4-7 would not change the relevance and importance of the Little Rocky Mountains and, hence, its nomination as an ACEC. It would impact contemporary practices in some areas of the range for the duration of the mining and reclamation activities.

4.13.5 Impacts to Saddle Butte

The entire Saddle Butte area has been nominated for consideration as an ACEC, due to its unique vegetation community.

4.13.5.1 Impacts from Mining-1979 to Present

Saddle Butte is approximately 2 miles from the nearest mining activity and there have been no direct impacts from mining from 1979 to present.

4.13.5.2 Impacts

The nomination of Saddle Butte as an ACEC was based on the presence of a rare savannah community, classified as *Pseudotsuga menziesii/Andropogon scoparius*. Recent surveys conducted in the summer of 1994 by Steve Cooper of the MNHP indicated that this species association was not a community, but rather a seral type that will likely disappear in a short period (Cooper 1994).

The ACEC nomination is approximately 2 miles south of existing and proposed mining activity under Alternatives 1, 2, 3, and 5. Because of this distance, vegetation would not be significantly impacted. Saddle Butte is located directly west of the proposed Goslin Flats heap leach pad and thus would be most impacted by Alternatives 4, 6 and 7, particularly the diversion ditches around the leach pad; however, the *Pseudotsuga menziesii/Andropogon scoparius* community would not be directly impacted by disturbance. Therefore, no impacts from any alternative would affect potential ACEC designation.

4.13.6 Impacts to Old Scraggy Peak

Old Scraggy Peak has been nominated as an ACEC, based on Native American cultural and historic values.

4.13.6.1 Impacts from Mining-1979 to Present

According to Section 4.12 of this Draft EIS, impacts from mining 1979 to present on Native American cultural resources, including Old Scraggy Peak, have been significant through limited to visual and aural impacts; no direct disturbance has occurred.

4.13.6.2 Impacts

Impacts would be similar to those described for the Little Rocky Mountains. Impacts would consist of visual and aural impacts of mining at the Zortman Mine and would be greatest under Alternatives 4 through 7 and least for Alternative 1 through 3. However, no impacts from any alternative would affect ACEC designation.

4.14 HAZARDOUS MATERIALS

4.14.1 Introduction and Methodology

Potential environmental impacts associated with the use, storage, and disposal of hazardous materials at the Zortman and Landusky mines are associated with (1) normal or routine uses of hazardous materials and disposal practices and (2) accidental or uncontrolled releases of hazardous materials into the environment.

Key factors in the determination of impact significance include the severity of potential spills or releases in terms of magnitude and toxicity of the material as well as the opportunity for immediate response and effective cleanup. High negative or significant environmental impacts could result from:

- Massive spills or releases that are too large to be readily contained,
- spills of materials that are acutely toxic to people, vegetation, and wildlife in low concentrations,
- spills that occur in locations or situations that prevent immediate response and effective cleanup,
- normal or routine mining activities that involve hazardous materials that cause significant degradation of natural resources, and
- uncertain or ineffective reclamation or cleanup of a facility or material with potentially toxic or hazardous characteristics, unless effective mitigation is available.

All of these situations could be considered to have high negative impacts because of the potential for contamination of natural resources and the potential for harm to human health of on-site workers, local residents, and recreationists. Spills, releases, or routine mining activities would be rated as having low negative impacts if they involve small, easily contained quantities of materials, or where the material in question is not acutely toxic in low concentrations, or where cleanup is immediate and effective.

The following sections describe the potential hazards associated with hazardous material use at the mines, including toxicity characteristics and potential for exposure, known impacts from use of these materials from 1979 to the present, and potential impacts that could arise from each of the project alternatives.

4.14.2 Toxic Hazard Characteristics and Potential Exposure to Hazardous Material Used at the Zortman and Landusky Mines

Important considerations in evaluating the significance of a release, spill, or intended use of a hazardous material include the toxic characteristics, as well as the physical and chemical properties of the material, and potential exposure of receptors (workers, area residents, wildlife). The toxic effects of hazardous materials used in the project area vary considerably by material. Exposure to certain materials could cause severe injury or immediate death in low concentrations, while other materials are considerably less toxic, even in large doses or concentrations. The physical and chemical properties of these materials can also influence how they might behave when spilled or released into the environment. The following is a description of the toxic hazards associated with each hazardous material used at the Zortman and Landusky mines. Most of this information was derived from Material Safety Data Sheets (MSDS) available in project files and the Zortman and Landusky Operating Plans.

Gasoline is used to power light vehicles at the Zortman and Landusky operations. Benzene, one of the components of gasoline, can potentially cause leukemia and is toxic to the blood and blood-forming tissues. Gasoline contains petroleum hydrocarbons, which can irritate the eyes, skin, and lungs with prolonged exposure. Overexposure may cause weakness, headache, nausea, confusion, blurred vision, drowsiness, and other nervous system effects. Greater exposure may cause dizziness, slurred speech, flushed face, unconsciousness, and convulsions. In addition, gasoline is highly flammable and can explode if it reacts with oxidizing agents. Exposure to gasoline would most likely occur to mine workers during fueling or maintenance of mine vehicles. It is also possible that spilled gasoline could contaminate surface or groundwater. This would be unlikely, however, since gasoline is stored on a containment pad and spills of gasoline would be contained and cleaned up promptly by mine staff. Domestic water wells in the towns of Landusky and Zortman are located at considerable distances from the mines and contamination with gasoline is extremely unlikely, even if a discharge to the groundwater occurred at a storage or refueling location.

Diesel fuel is used in large quantities during mining to fuel heavy equipment. Diesel can cause irritation of the skin, eyes, and lungs due to inhalation or direct exposure. Extreme overexposure or aspiration into the lungs may cause lung damage and/or death. Overexposure may cause weakness, headache, nausea, confusion, blurred vision, drowsiness, and other nervous system effects. Greater exposure may cause dizziness, slurred speech, flushed face, unconsciousness, and convulsions. Naphthalene, an ingredient in diesel fuel, can irritate the eyes, skin and lungs. Prolonged exposure can also be toxic to the eyes, liver, kidneys, and blood. Given that diesel is a petroleum hydrocarbon, it is highly flammable and will ignite if exposed to heat or ignition source, and may explode if it reacts with oxidizing agents. Potential exposure to diesel is greatest for mine workers. Other types of exposures that could be experienced are the same as described for gasoline.

Oil and Lubricants would be used by light and heavy mine equipment and to some extent in drilling and other activities. In general, these materials are not acutely toxic, unless exposure is extreme. Exposure to these materials may cause minor skin or eye irritation. Prolonged exposure to waste oil has caused skin cancer in animal tests. Oils and lubricants are insoluble in water and are flammable at high temperatures. Potential exposure to oil and lubricants is most likely for mine workers during vehicle maintenance. Oil and lubricants are stored on a containment pad to minimize potential soil and groundwater contamination.

Antifreeze is also used by mine vehicles and is comprised primarily of ethylene glycol. Routes of exposure can include inhalation, ingestion, absorption, skin contact, and eye contact. Some of the effects of exposure to ethylene glycol by inhalation include headache, nausea, vomiting, dizziness, drowsiness, irritation of the respiratory tract, and loss of consciousness. Ingestion may cause nausea, vomiting, headaches, dizziness, and gastrointestinal irritation. Ingestion may be fatal. Liquid may be irritating to skin and eyes. Skin absorption may be harmful. Chronic effects of overexposure may include damage to kidneys, liver, lungs, blood, or central nervous system. Ethylene glycol is not considered carcinogenic. In terms of its physical properties, ethylene glycol is soluble in water and has a flash point of 232 degrees Fahrenheit in its pure form. It is a slightly viscous liquid with a mild odor. Potential exposure is most likely for mine workers during vehicle maintenance. Ethylene glycol spills can be of concern because of its toxicity, as wildlife and stock or domestic animals may not be able to detect its potential hazard. It is not uncommon for animals to die because of ethylene glycol ingestion. As described for gasoline, diesel, and lubricants, antifreeze is stored on a concrete containment pad to minimize the potential for soil or groundwater contamination.

Ammonium Nitrate is used for blasting when combined with fuel oil (ANFO). Routes of potential exposure include inhalation and ingestion. Dust inhalation may cause tightness and chest pain, coughing, and difficulty in breathing. Contact with skin or eyes may cause irritation. Ingestion may cause headache, nausea, vomiting, gastrointestinal irritation, unconsciousness, and convulsions. If released into the environment due to accidental spill or as a residue from blasting, ammonium nitrate can degrade water quality by raising nitrate levels and stimulating growth or algae and other aquatic plants. Elevated nitrate levels can also cause health effects in human populations and wildlife if contaminated water is consumed and high nitrate levels are present. Domestic water wells are located relatively far from the mining areas and potentially contaminated streams. Human consumption is therefore unlikely.

In addition, ammonium nitrate is highly reactive with various materials as it is a strong oxidizer. Contact with other materials may cause fire or explosion. In terms of its physical properties, ammonium nitrate is slightly soluble in water, is odorless and has the appearance of transparent white crystals or white granules. Fire or explosion of pure ammonium nitrate is the most important hazard associated with this material.

Sodium Cyanide is used for extraction of precious metals from ore and is by far the most toxic material used at the Zortman and Landusky mines. It is extremely poisonous and can cause immediate death if swallowed or inhaled in sufficient quantities. Routes of potential exposure can include inhalation, ingestion, absorption, skin contact, and eye contact. Some of the effects of exposure to sodium cyanide include headache, nausea, vomiting, dizziness, weakness, rapid ineffective breathing, low blood pressure, loss of consciousness, convulsions, or death. Contact with skin or eyes may cause severe irritation or burns. Organs that are affected by exposure to sodium cyanide include the cardiovascular system, the central nervous system, liver, kidneys, and skin.

Sodium cyanide is also hazardous because it is highly reactive. Contact with water or acidic conditions liberates poisonous hydrogen cyanide gas. In terms of its physical properties, sodium cyanide is slightly soluble in water. It has the appearance of white granules and is odorless.

Even in low concentrations, spilled or released cyanide could seriously harm wildlife or human populations, should water resources become contaminated and subsequently consumed. Surface water resources are used by area wildlife, while human consumption is limited to groundwater extracted from wells near the towns of Zortman and Landusky.

Lime is used primarily for pH control in cyanide solutions. Given its alkalinity, contact with lime can cause skin, eye, nose and throat irritation. Exposure to concentrated lime would be generally limited to mine workers. Release via surface or groundwater could harm vegetation or wildlife, depending on the concentration of the lime in solution.

Hydrochloric Acid is also extremely hazardous. It can cause severe burns and may be fatal if swallowed or inhaled. Hydrochloric acid can cause damage to the respiratory system if vapors are inhaled.

Hydrochloric acid is soluble in water and has the appearance of a clear to slightly yellow, pungent fuming liquid. Hydrochloric acid is also hazardous because it is highly corrosive and reacts with metals and other materials to emit explosive hydrogen gas or hydrogen chloride gas. Hydrochloric acid is used in limited quantities in process circuit lines. Should this material be spilled, it could cause serious harm to mine workers, wildlife, or vegetation if contacted prior to dilution by precipitation or surface water.

Sodium Hydroxide is also extremely hazardous. It can cause severe burns and may be fatal if swallowed or inhaled. Sodium hydroxide can cause severe damage to the respiratory system if vapors or mists are inhaled.

Sodium hydroxide is soluble in water and has the appearance of a clear, odorless liquid. As described for hydrochloric acid, this material could cause serious harm to mine workers, wildlife, or vegetation if exposed to undiluted spilled material. Since it is only used in the refinery and is stored in a double contained tank, the only opportunities for a spill would be during transportation or from a leak in the pipeline from the storage tank to the refinery.

Hydrogen Peroxide is also considered extremely hazardous due its potential for causing severe burns and its oxidizing properties. Effects of exposure to hydrogen peroxide include severe irritation of the skin, severe irritation of the respiratory tract if inhaled, burning of the eyes and blindness if contacted. Ingestion may be irritating to the esophagus and stomach and may cause sudden distension.

Hydrogen peroxide is highly unstable and a strong oxidizer. Contact with various materials, such as combustibles and strong reducing agents may cause fire or explosion. Hydrogen peroxide is soluble in water and has the appearance of a clear, odorless liquid. Since this material is rarely used at all, and is stored in a double walled tank, the likelihood of release and exposure is extremely low. If accidentally released and not cleaned up effectively, hydrogen peroxide could harm vegetation or wildlife if exposed.

Calcium Hypochlorite is considered extremely hazardous due to its potential for causing severe burns and its oxidizing properties. Effects of exposure to calcium hypochlorite include ulcers, discoloration, excema, irritation, and burns when skin or eyes are contacted. Inhalation of dust is irritating and can be severely damaging to respiratory passages and lungs. Ingestion may cause severe burning of mouth and stomach and may be fatal.

In addition, calcium hypochlorite is a strong oxidizer. Contact with various materials, such as water, combustibles and strong reducing agents may cause fire or explosion or generate poisonous hydrogen chloride gas. Calcium hypochlorite is slightly soluble in water. It has the appearance of a white powder with a strong chlorine-like odor. Since this material is rarely used at all, and is stored on containment, the likelihood of release and exposure is very low. If accidentally released and not cleaned up effectively, calcium hypochlorite could harm vegetation or wildlife if exposed.

Powdered Zinc is used in the Merrill-Crowe process for extracting precious metals from process solutions at the Landusky Mine. It is hazardous primarily because of its strong reaction when exposed to air. In terms of health effects of exposure, inhalation of dust may irritate the upper respiratory tract, cause headache, coughing, dizziness or difficulty in breathing. Prolonged exposure may cause dermatitis. Ingestion of zinc powder may cause nausea, vomiting, headaches, dizziness, and gastrointestinal irritation.

Zinc powder dust may become flammable or explosive when mixed with air, especially when damp. It also reacts with water, strong bases, strong acids, oxidizing agents, and alkali metals. It can be an explosion hazard, especially when heated or exposed to an ignition source. Zinc powder is highly insoluble in water and has the appearance of a bluish-gray metal powder with no odor. Since zinc powder is used at only one location and is stored on a lined leach pad, the potential for spill and release into the environment is low. If spilled during transfer or handling, this material would be cleaned up immediately and effectively by mine staff to prevent reaction with air and subsequent fire or explosion.

4.14.3 Impacts From Mining (Pre-1979)

As described in Section 3.14.2, historic mining operations in the project area utilized both mercury and cyanide for gold extraction. Mills were located within the Ruby and Alder Gulch drainages in the Zortman area, and within the King Creek and Montana Gulch drainages in the Landusky area. Other hazardous materials such as gasoline and diesel may have also been used by historic mining operations. Review of water quality records for the various drainages in the project area, as well as newspaper articles, publications describing the history of mining in the Little Rocky Mountains, and other information sources revealed no evidence that significant dumping, accidental spills or releases of hazardous materials occurred prior to 1979. Although spills or releases of hazardous materials may have occurred in the past, no evidence of such occurrences remained in 1979. Water quality data from the 1977-1978 period showed no detections of cyanide or other hazardous materials in any of the project area drainages.

4.14.4 Impacts From Mining 1979 to Present

Two types of general impacts relating to hazardous materials have occurred at the Zortman and Landusky mines during the period of recent mining activity. First, several cyanide heap leach pads and waste rock dumps have residual hazardous materials and wastes present in them that can not be completely removed, detoxified, or cleaned up. Second, accidental releases or spills of cyanide solution and petroleum hydrocarbons have occurred in the past, as described in Section 3.14.4. In general, these spills were responded to and corrective measures were taken, although not always in a timely enough fashion to prevent environmental degradation. Also, residual contamination may remain over the long-term.

Routine mining operations in recent years have included the use of cyanide solution for heap leaching on several heap leach pads and process circuits at both the Zortman and Landusky mines. Although these cyanide solutions are neutralized and heap leach pads are rinsed at the end of their useful lives, residual cyanide may remain present in the pads over the long term due to blind-offs (zones inaccessible to solution movement due to settling or accumulation of fines) and/or preferential flow patterns that prevent uniform and complete removal of cyanide from the leach pad ore mass. Studies conducted during 1990 indicate the potential for retained cyanide in heaps after rinsing to be minimal (Schafer 1991). Similarly, various chemical reagents used to control the chemistry of cyanide solutions or maintain pumps, pipelines, and spray lines (e.g., anti-scalants) have also been applied to the heap leach pads, which may retain these materials if rinsing is not completely effective. Various wastes disposed of specifically on the Zortman 89 pad, such as laboratory rinses, fume scrubber runoff, reagent residues from dumped reagent containers, and water treatment plant metal hydroxide sludge (2,000 tons per year) may also persist in the leach pad to the extent rinsing does not remove or detoxify them. In the case of metal hydroxide sludge, there is also the potential that acid rock drainage that could form within the leach pad in the future could remobilize these metals.

Blasting of ore and waste rock in the mine pits is accomplished using ANFO, which is a mixture of ammonium nitrate and fuel oil (diesel). After blasting, ore and waste rock are hauled by truck and deposited on the leach pads and waste rock dumps, respectively. Blasting with ANFO can leave residual nitrates on the ore and waste rock. Residual nitrates can degrade water quality if they are dissolved within the waste rock dumps or reclaimed leach pads in leachate and are released into the environment. Nitrates in surface water can stimulate the growth of undesirable algae and other aquatic plants, and at higher concentrations, can cause health problems in human populations and wildlife. As described in Section 3.2 and 4.2, elevated nitrate levels have been observed in drainages in the study area. It is quite possible that these elevated levels are due to runoff of nitrate residues present in waste rock and possibly reclaimed (and perforated) leach pads.

Reclamation of heap leach pads and waste rock dumps at the Zortman and Landusky mines would include reclamation covers that should substantially reduce the amount of infiltration that would occur, thereby reducing the amount of leachate generated. This subject will be discussed further in subsequent sections.

It is possible that residual metals, cyanide compounds, nitrates, and other chemicals could be released from reclaimed leach pads and waste rock dumps into surface and groundwater resources via the perforations or leaks in their liners. However, leachate monitoring, capture, and control measures should prevent release of these materials to surface water bodies and the environment. Residual cyanide compounds may break down within the leach pads on their own, despite less than 100 percent effective rinsing. This breakdown would occur more quickly if the pH of residual solution or leachate is neutral or acidic, since cyanide can only persist in alkaline conditions (pH greater than 9). Given the potential for the formation of acid rock drainage in spent ore within the leach pads, residual cyanide within the pads may be neutralized before draining out of the facility. Of course, acidic conditions could also increase the mobilization of metals in the leachate.

Another waste disposal practice used by the Zortman and Landusky mines is land application disposal (LAD) of neutralized cyanide solution. Solutions disposed in this manner must have cyanide concentrations at or below 0.22 mg/l WAD. In general, solutions are sprayed on the surface, and soil in the LAD area adsorb and attenuate metals and cyanide. Emergency LAD at the Zortman Mine was carried out on Carter Butte to the south of the 84 leach pad between October 1986 and June 1987, in response to unusually high precipitation received at the mine site and the related generation of considerable excess solution in the leach pads. The solution was neutralized with calcium hypochlorite before LAD. Approximately 20 million gallons of neutralized solution were disposed on 17 acres of LAD area. Although LAD is an accepted and permitted practice, and soils are tested for attenuation capacity before LAD is permitted, treated cyanide solution was detected in surface and alluvial groundwater in Alder Gulch because steep slopes and high application rates caused the solution to run off the LAD area into the gulch. During the emergency LAD, total cyanide levels in Alder Gulch peaked at 0.48 mg/l and diminished thereafter. Cyanide levels remained in exceedance of the state aquatic life standard (.0054 mg/l) almost continuously for the five years following emergency LAD. It is likely that the low aquatic species density and diversity in Lower Alder Gulch can be attributed at least in part to cyanide contamination, however, this has not been confirmed.

No other routine mining operations or activities have been identified that would result in the release of hazardous materials into the environment. Based on review of available reports and documents and other information provided by ZMI, potentially hazardous materials or wastes have not been disposed on waste rock dumps, in mine pits, or elsewhere at the mine sites or office complex.

The vast majority of hazardous materials used at the Zortman and Landusky mines were completely consumed, with no waste products generated, or eventually degraded with no apparent significant environmental impact. Examples of such consumption include gasoline and diesel fuel, which were combusted in mine vehicles; lime, which is non-hazardous when diluted in process solutions; and cyanide, the overwhelming majority of which is degraded in contained facilities through dilution (rinsing) and other natural processes. A few examples of residual hazardous wastes remain, including waste oil and lubricants, spent citrus-based solvents, and cupels and slag from the assay lab and refinery. These wastes are disposed in accordance with state and federal regulations at approved facilities.

A second source of impact related to hazardous material use has resulted from accidental spills or releases of cyanide solution from heap leaching facilities. As described in Section 3.14, six accidental spills or releases of cyanide solution occurred between 1982 and 1993 (two at the Zortman Mine, four at Landusky). One release from the Zortman Mine (on November 1, 1982) contaminated the water supply system for the town of Zortman, which was replaced by another source. Another release from the Zortman Mine (October 1987) entered Ruby Gulch and was neutralized to a large extent with calcium hypochlorite, although concentrations of cyanide remained in Ruby Gulch in the following years (.018-0.44 mg/l) that exceeded the state aquatic life standard (.0054 mg/l). Accidental releases of cyanide solution from the Landusky Mine have similarly impacted Mill and Montana gulches. Both of these gulches suffered cyanide contamination that exceeded aquatic life standards at various times between 1982 and 1994 (up to 0.12 mg/l in Mill Gulch and up to 0.14 mg/l in Montana Gulch). In addition, two releases of cyanide solution at the Landusky Mine (July 1992, September 1993) have contaminated water near the processing plant and one process pond. At least one of these spills may have exceeded several thousand gallons. Although pumping of this groundwater was initiated, it is unlikely all of the cyanide solution can be recovered. Given the high toxicity of cyanide, and the inability of mine personnel to completely clean up these spills, these incidents were rated as having high negative impacts, though no domestic water supply or surface waters were affected. As mentioned previously, given the instability of cyanide, it is possible that accidentally spilled cyanide solutions may degrade quickly and naturally and that water resources may not be impacted over the long-term or offsite. However, since the timing and extent of this degradation cannot be predicted with certainty, the high negative impact rating remains.

As mentioned in Section 3.14, a release of petroleum hydrocarbons occurred at the Zortman Mine in

September 1991. This release was effectively cleaned up to the satisfaction of the Montana Department of Health and Environmental Sciences. Since this spill was cleaned up with minimal impact to the environment, this incident had no impact.

No other spills or releases have been reported by ZMI from past mining activities. It is possible that leaks or spills may have occurred that were undetected. No information is available to deny or confirm this possibility. As described in Chapter 3.14, virtually all hazardous materials and wastes are stored on containment facilities or above concrete surfaces, where complete and effective clean up of spills can be achieved. Given that no information on additional spills or accidents has been reported, that virtually all hazardous materials and wastes are stored on containment structures or surfaces, and that mine personnel are trained in spill response and containment and are expected to follow that training, no additional impacts relating to spills or releases of hazardous materials have been identified at the Zortman and Landusky mines.

4.14.5 Impacts From Alternative 1

Alternative 1 would involve little additional mining or heap leaching in the future as remaining permitted ore at the Landusky Mine would be exhausted within about a year. Since all permitted ore at the Zortman Mine was exhausted in 1990, no additional mining would occur at the Zortman operation under this alternative. Continued mining for another year at Landusky, along with associated heap leaching of that ore, as well as final reclamation that would take place at both mines would require continued use of the various hazardous materials until final reclamation is completed. For the Zortman Mine, use of hazardous materials would continue until about the end of 1997. For the Landusky Mine, use would continue until the end of 2000.

Under Alternative 1, no new leach pads, waste rock dumps or repositories, or other relevant facilities would be constructed. Thus, the locations of hazardous material use, handling, and storage would generally be the same as described for the 1979 to present timeframe (refer to Sections 3.14 and 4.14.4).

In terms of routine mining activities and waste disposal practices, impacts under Alternative 1 would be similar to those described for recent mining. Cyanide heap leaching would continue for an additional three to four years at the Landusky Mine on the 87/91 and 91 leach pads, while rinsing and reclamation of the other inactive leach pads would proceed. For the Zortman Mine, final rinsing and reclamation of the 89 leach pad would occur. To date, 20 million tons of ore have been loaded on the leach pads at the Zortman Mine. At Landusky, 107 million tons have been loaded to date.

At the Zortman Mine, no new ore would be loaded onto leach pads and no additional heap leaching would occur, but disposal of lab rinses, fume scrubber runoff, crushed reagent containers, and water treatment plant sludge would continue in the 89 leach pad for an additional two years, until reclamation of that facility around late 1997 or 1998. After that, treatment plant sludge would be deposited in a lined holding pond that would be capped after treatment plant closure. Lab rinses, scrubber runoff and reagent containers would not be generated after mine closure. As described in Section 4.14.4, residual cyanide solution and other compounds may remain in all of the leach pads due to incomplete rinsing. Similarly, residual nitrates from blasting may remain in the leach pads and waste dumps. As for the 89 leach pad, continued disposal of treatment plant sludge, lab rinses, fume scrubber runoff, and reagent containers would contribute additional opportunity for long-term contamination of the ore mass contained in the leach pad, should final rinsing be ineffective at completely removing, neutralizing, or at least substantially diluting those materials.

The continued active heap leaching at the Landusky Mine on the 87/91 and 91 leach pads would increase the ore mass that may contain residual cyanide solutions and other hazardous materials/reagents. As described previously, geochemical testing of spent ore has indicated that generation of acid rock drainage is likely within the reclaimed leach pads. Assuming this occurs, it is possible that residual cyanide solution would be neutralized by acidic leachate as these materials drain and mix within the leach pads. Conversely, residual cyanide solution, which is alkaline, could neutralize some of the acid rock drainage as well. In general, as described in Section 4.2.1.3, anticipated water quality from leach pads would include alkaline pHs (with residual cyanide present) in the immediate short-term after reclamation, followed by increased acidity over time as remnant sulfides react, thereby neutralizing residual cyanide in leachate.

The extent that residual hazardous materials within the leach pads and waste rock dumps mobilize and escape into the environment via surface water and groundwater transport would depend on the effectiveness of reclamation capping and water capture and treatment. Effective reclamation capping would minimize infiltration of water that could liberate and/or react with hazardous materials and form contaminated leachate.

Effective water capture and treatment would minimize the opportunity for contaminated leachate from impacting water resources downstream of the mine sites. A thorough evaluation of reclamation capping and water capture and treatment measures has been presented in Section 4.2. Based on that evaluation, reclamation covers under Alternative 1 would have minimal effect on reducing infiltration and would not improve water quality above present levels. Water capture and treatment would likely have to continue in the long-term. To the extent leachate from reclaimed facilities contains residual hazardous materials or compounds, the discharge of that leachate is considered to have a negative impact. Capture and treatment of contaminated leachate would mitigate impacts downstream, however.

Another routine or normal waste disposal practice under this alternative would be the land application disposal (LAD) of neutralized cyanide solution. LAD would most likely occur at the end of mine life, assuming no emergency LADs would be required. For the Zortman Mine, LAD would occur on Goslin Flats. For the Landusky Mine, LAD would occur on the southeast side of Gold Bug Butte. The Gold Bug Butte location has been permitted for LAD, based on baseline soil data and evaluations of the ability of soil in the LAD area to attenuate cyanide and metals. Assuming LAD is performed properly, neutralized cyanide solution and metals should not impact soil or water resources. If performed improperly, LAD would negatively impact soil and water resources because cyanide and/or metals concentrations would not be effectively attenuated by the soil. Improper LAD can occur if neutralization of cyanide prior to application is ineffective (solution applied to soil has a high cyanide concentration that soil cannot attenuate) and/or application of solution occurs at excessive rates (which could result in runoff of solution into adjacent surface water resources). Under such conditions, vegetation would be lost and/or would fail to reestablish after LAD and wildlife could be lost if exposed to toxic levels of cyanide and/or metals in soil or surface water.

With respect to spills or accidental releases of hazardous materials in the future, the environmental impacts of such a release would depend on which materials are released, the quantity released, and where the release were to occur and the nature and timing of the response. Potential releases could range from a 10 gallon spill of diesel fuel in the fueling area that is immediately and effectively cleaned up, to a catastrophic release of 50,000 gallons of cyanide solution into a surface water drainage. In general, the hazardous materials of greatest concern would be liquid fuels and cyanide. Liquid fuels such as gasoline and diesel are used and stored in large quantities. Cyanide is of concern because it is highly toxic, used in large quantities, has a wide distribution of use at the mine sites (leach pads, ponds, pipelines, process plants), and problems have occurred with spills or accidental releases of cyanide solution in the past.

Diesel fuel and gasoline would continue to be used extensively at the Zortman and Landusky mines as heavy equipment would be used for transportation of ore and waste rock at the Landusky Mine, hauling of reclamation materials, and final capping and grading during reclamation of both mines. As many as 2.6 million gallons of diesel fuel per year would be used at the Landusky Mine alone over the remaining life of this alternative. If spilled or accidentally released, diesel or gasoline could kill vegetation if released in a vegetated area (e.g., truck crashes into forest, overturns and spills fuel), impact surface water quality, and harm aquatic organisms (if spilled into a creek), impact groundwater resources, and/or ignite and cause a fire that either burns mine facilities or causes a forest or grass fire.

Cyanide and cyanide solutions have been and continue to be used in large quantities at both mines, although the Zortman operation is in the process of final rinsing and neutralization of its stock of solution. Not only is cyanide an important concern because of its extreme toxicity, its use is widely distributed at the mine sites in various heap leach pads, solution ponds, and treatment plants, with associated networks of pipelines connecting these facilities. Unlike other hazardous materials, which are stored and used in limited locations, the number and size of facilities containing cyanide solution are extensive, thereby increasing the number of locations where spills or releases could occur. Potential releases in the future could occur as a result of failure of a facility, such as a leak in a leach pad or pond liner, or bursting of a solution pipeline on an unlined surface. In addition, accidental spills or releases could occur as the result of human error, such as the draining of a spray line on an unlined surface. If spilled or accidentally released, cyanide solutions could cause wildlife mortality, impact surface water quality, harm aquatic organisms (if spilled into a creek), or impact groundwater resources. The release of hydrogen cyanide gas would be of greatest concern to mine workers responding to the spill, since the locations where spills could occur are generally removed from populated areas offsite and rapid dilution in air would likely occur.

As described in Section 3.14, gasoline and diesel fuel are stored on-site in aboveground tanks on containment structures. Cyanide and cyanide solutions are generally stored in or on lined heap leach pads or solution ponds to minimize the potential for release into the environment. In addition, mine personnel are trained in emergency response and spill containment practices. For potential future spills of solution that would enter a surface water drainage, ZMI's Cyanide Spill Contingency Plan calls for temporarily damming the affected drainage with earth or impermeable liner, and collection and pumping of the solution back to contained facilities, such as contingency ponds or leach pads. Downstream surface and groundwater monitoring sites would be sampled and analyzed for possible cyanide contamination to confirm that the spill had been contained and impacts minimized. For spills or releases to groundwater, pump back operations would be initiated and recovered solution would be routed to contained facilities. If recovery is incomplete, or migration of contamination is suspected, additional wells would be drilled to facilitate recovery of solution or injection of neutralization solutions, and monitoring of groundwater conditions. The combination of contained storage and emergency preparedness would minimize the chance of an accidental spill or release. Nevertheless, given that spills have occurred in the past at these mines and other cyanide leach gold mines, the probability of such a release in the future is not zero. Depending on the material released, the quantity released, and the location of the release and the response, the magnitude of the associated impacts may vary and could be high and negative. Since the potential impacts associated with accidental spills or releases of hazardous materials vary considerably and cannot be predicted with certainty, no impact rating assigned.

Other hazardous materials used at the Zortman and Landusky mines such as hydrochloric acid, sodium hydroxide, and calcium hypochlorite are also hazardous. Because of the relatively limited quantities used of these compounds, the limited distribution of use (e.g. refinery only), and substantial containment provided at storage locations the likelihood of a release to the environment is considerably smaller, and these materials are of less concern.

4.14.5.1 Cumulative Impacts

Cumulative impacts associated with past and current use of hazardous materials at the Zortman and Landusky mines under Alternative 1 would be essentially the same as described in Section 4.14.5 and would consist of:

- Potential generation of hazardous leachate from spent ore heaps within decommissioned leach pads at both mines. Residual cyanide solution, as well as other process chemicals may remain in the ore heaps due to ineffective rinsing and neutralization over the long-term. Approximately 20 million tons of spent ore would remain within decommissioned leach pads at the Zortman Mine, and 115 million tons would remain in leach pads at the Landusky Mine. Potential infiltration into these heaps could contact and mobilize these residual hazardous compounds, which could then be released into the soil and water resources through perforations in leach pad liners. Contamination of water resources with hazardous materials could negatively impact vegetation and wildlife, should contaminated water in creeks or springs be consumed, as well as livestock and human populations should wells or other domestic water supplies be affected. However, capture and treatment of contaminated water would eliminate these impacts.

- Land application disposal (LAD) of cyanide solution in the past contaminated water resources in Alder Gulch. Future LAD under Alternative 1 could also negatively impact soil and water resources in the Goslin Flats area. Impacts could arise from ineffective neutralization of cyanide prior to application and application of solution at excessive rates, which could result in runoff of solution into Goslin Gulch.

- At least six separate spills or accidental releases of cyanide solution have occurred since 1979. As a result, cyanide has been detected in surface and groundwater resources in Ruby and Alder Gulches below the Zortman Mine and in Mill and Montana Gulches below the Landusky Mine. Past cyanide contamination in Alder Gulch has been significant enough to warrant closure and replacement of the town of Zortman's water supply.

4.14.5.2 Unavoidable Adverse Impacts

Past spills or releases of cyanide solutions that have contaminated surface and groundwater resources may prove difficult, if not infeasible to remediate. Although natural processes may degrade spilled cyanide solution over time, it is unclear whether or not this natural degradation would occur before contamination migrates offsite. Efforts to neutralize and/or pump groundwater contaminated with cyanide solution have had limited success to date. Future accidental spills or releases of cyanide solutions could increase this impact, if such releases were similarly difficult to treat, capture, or otherwise neutralize.

Potential future contamination of water resources from leach pads and waste rock dumps draining hazardous leachate would only be avoidable through implementation of long-term monitoring, collection, and treatment of drainage/leachate.

4.14.5.3 Short-term Use/Long-term Productivity

The generation of leachate from reclaimed leach pads that contains residual cyanide, metals, and other reagents could cause long-term negative impacts to surface and ground water resources, vegetation and wildlife downstream of the permit area. Mitigation in the form of monitoring, capture, and treatment of contaminated water would be required.

4.14.5.4 Irreversible or Irretrievable Resource Commitments

The use of hazardous materials or reagents that are made from non-renewable resources, such as gasoline and diesel fuel, would constitute an irreversible and irretrievable loss of those resource commitments.

4.14.6 Impacts From Alternative 2

Alternative 2 would involve no additional mining as described for Alternative 1. The primary difference for Alternative 2 relates to the reclamation measures. Since more intensive reclamation covers would be used, the effectiveness of reclamation as it relates to potential hazardous materials impacts would differ to some extent. In addition, since this alternative would include hauling and placement of clay for reclamation, the use/consumption of diesel fuel, gasoline, oil and lubricants, and antifreeze would increase.

Under Alternative 2, no new leach pads, waste rock dumps or repositories, or other relevant facilities would be constructed. Thus, the locations of hazardous material use, handling, and storage would be the same as described for the 1979 to present timeframe (refer to Sections 3.14 and 4.14.4).

In terms of routine mining activities and waste disposal practices, the potential for residual hazardous materials in reclaimed leach pads and waste rock repositories to react with infiltrating water and leave the facility would be reduced to some extent by more intensive reclamation covers that include a clay layer on facilities identified by ZMI to have acid generating potential. Based on infiltration modeling described in Section 4.2.4, over the short-term, reduced infiltration should reduce the amount of leachate potentially containing hazardous materials, but over the longer term, as the integrity of the clay cap is degraded, infiltration would increase and leachate generation would be similar to that experienced for Alternative 1. Aside from short term reduction of leachate formation, impacts associated with Alternative 2 would the same as described for Alternative 1 and long-term water capture and treatment may be required to mitigate downstream impacts.

LAD would likely occur at the end of mine life. For the Zortman Mine, LAD would probably occur on Goslin Flats. For the Landusky Mine, LAD would occur on the southeast side of Gold Bug Butte. Neutralized cyanide solution and metals would not impact soil or water resources. Improper LAD can occur if neutralization of cyanide prior to application is ineffective (solution applied to soil has a high cyanide concentration that soil cannot attenuate) and/or application of solution occurs at excessive rates (which could result in runoff of solution into adjacent surface water resources). Under such conditions, vegetation would be lost and/or would fail to reestablish after LAD and wildlife could be lost if exposed to toxic levels of cyanide and/or metals in soil or surface water.

With respect to spills or accidental releases of hazardous materials, the environmental impacts of such a release would depend on which materials are released, the quantity released, and where the release would occur. As described for Alternative 1, the hazardous materials of greatest concern would be vehicle fuels and cyanide solution. Since diesel fuel and gasoline would be used in greater quantities under Alternative 2 due to more intensive reclamation capping, the potential for an accidental release is increased to some extent. The potential impacts associated with a spill or release of cyanide solution would be the same as described for Alternative 1, since the quantity and locations of use would be the same.

4.14.6.1 Cumulative Impacts

Cumulative impacts associated with past and current use of hazardous materials at the Zortman and Landusky mines under Alternative 2 would generally be the same as described for Alternative 1 since no new mining would be carried out and the potential sources of contamination (leach pads, LAD, potential for spills before mine closure) would essentially be the same. The primary difference would relate to the use of a clay cap for reclamation of various mine facilities. As described in Section 4.14.6, the proposed clay cap is expected to reduce infiltration and subsequent generation of leachate from leach pads over the short term. However, the cap is expected to degrade over time and lose its effectiveness and, subsequently, the generation of leachate is expected to be similar to that expected for Alternative 1.

4.14.6.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative 1.

4.14.6.3 Short-term Use/Long-term Productivity

Short-term use versus long-term productivity would be the same as described for Alternative 1.

4.14.6.4 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable resource commitments would be the same as described for Alternative 1.

4.14.7 Impacts From Alternative 3

The primary difference for Alternative 3 relates to the agency mitigated reclamation measures. Since more intensive reclamation covers would be used, relative to Alternatives 1 or 2, the effectiveness of reclamation as it relates to potential hazardous materials impacts would increase to a considerable extent. In addition, since this alternative would include hauling and placement of considerably more clay for reclamation, the use/consumption of diesel fuel, gasoline, oil and lubricants, and antifreeze would increase, relative to Alternatives 1 or 2.

The locations of hazardous material use, handling, and storage would be the same as described for the 1979 to present timeframe (refer to Sections 3.14 and 4.14.4).

In terms of routine mining activities and waste disposal practices, the potential for residual hazardous materials in reclaimed leach pads and waste rock repositories to react with infiltrating water and leave the facility would be reduced to a large extent by more intensive reclamation capping that includes both clay and capillary break layers on virtually all mine facilities. Based on infiltration modeling described in Section 4.2.5, the reclamation covers would be most effective at minimizing infiltration, and therefore, potential generation of leachate contaminated with hazardous materials. In addition, leach pad liners would not be perforated until water quality management objectives have been met for a period of ten years. The combination of more effective reclamation capping, along with extensive leachate monitoring of water quality for leach pads, would greatly reduce the potential for release of contaminated leachate in the future.

LAD would likely occur at the end of mine life. For the Zortman Mine, LAD would probably occur on Goslin Flats. For the Landusky Mine, LAD would occur on the southeast side of Gold Bug Butte. Neutralized cyanide solution and metals would not impact soil or water resources. Improper LAD can occur if neutralization of cyanide prior to application is ineffective (solution applied to soil has a high cyanide concentration that soil cannot attenuate) and/or application of solution occurs at excessive rates (which could result in runoff of solution into adjacent surface water resources). Under such conditions, vegetation would be lost and/or would fail to reestablish after LAD and wildlife could be lost if exposed to toxic levels of cyanide and/or metals in soil or surface water.

With respect to spills or accidental releases of hazardous materials, the environmental impacts of such a release would depend on which materials are released, the quantity released, and where the release would occur and the response. As described for Alternatives 1 and 2, the hazardous materials of greatest concern would be vehicle fuels and cyanide solution. Since diesel fuel and gasoline would be used in greater quantities under Alternative 2 due to even more intensive reclamation, the potential for an accidental release is increased to some extent. The potential impacts associated with a spill or release of cyanide solution would be the same as described for Alternative 1, since the quantity and locations of use would be the same.

A comprehensive Environmental Site Assessment would minimize the risk of long-term contamination of soil and water resources. Any contaminated soil and/or groundwater would then be remediated to applicable State and Federal standards to prevent migration of contamination offsite and impacts on the environment.

4.14.7.1 Cumulative Impacts

Impacts for both the Zortman and Landusky mines are described above for the life of the project under Alternative 3 and post-closure. Since there are no reasonably foreseeable future actions associated with this alternative, no additional impacts have been identified for cumulative impacts discussion.

4.14.7.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative 1.

4.14.7.3 Short-term Use/Long-term Productivity

Short-term use versus long-term productivity would be the same as described for Alternative 1.

4.14.7.4 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable resource commitments would be the same as described for Alternative 1.

4.14.8 Impacts From Alternative 4

Continued mining at the Zortman and Landusky operations, along with associated heap leaching of ore, and extensive reclamation that would take place at both mines would require continued use of numerous hazardous materials (described in Section 3.14) until final reclamation was completed around the end of 2007 at Zortman and 2002 at Landusky. Anticipated annual usage of hazardous materials under this alternative is presented in Section 2.8.

At the Zortman Mine, proposed heap leaching of ore would be carried out exclusively at the Goslin Flats leach pad, which would be constructed in support of the mine expansion. A related feature of this alternative is the relocation of the entire cyanide solution circuit and related hazardous materials to Goslin Flats adjacent to the leach pad. Aside from cyanide solution, lime, hydrochloric acid, sodium hydroxide, anti scalants, calcium hypochlorite and hydrogen peroxide would all be stored and used at the Goslin Flats leach pad and processing plant complex almost exclusively after final rinsing of the Zortman 89 pad and removal of cyanide solution from the Zortman process ponds are completed (around 1998). Reclamation of the older leach pads and process-related facilities (ponds, pipelines, Merrill-Crowe Plant, etc.) at the Zortman Mine would be carried out over the first few years of this alternative. With a few exceptions (vehicle fuels, ammonium nitrate), this relocation of heap leaching and metal extraction activities shifts the focus of where hazardous materials-related impacts (routine or accidental) may occur to Goslin Flats.

At the Landusky Mine, solution ponds and processing plants would remain at the same locations. Thus, the locations of use, storage, and handling of hazardous materials would not change. Additional mining would merely continue existing hazardous material use, both in terms of location and quantity for about one year.

In terms of routine mining activities and waste disposal practices, new mining and heap leach activities at the Zortman Mine would proceed for approximately seven years after construction of the Goslin Flats leach pad, conveyor, and Carter Gulch waste rock repository were completed. The 89 leach pad would be rinsed and reclaimed, along with the other leach pads at the Zortman Mine. New heap leaching activities at Goslin Flats would involve the treatment of 80 million tons of ore with cyanide solutions. After reclamation of the 89 leach pad is completed, metal hydroxide water treatment plant sludge (2,000 tons per year) would be disposed of on the new leach pad, along with laboratory rinses, fume scrubber runoff, and possibly crushed reagent containers. At Landusky, the addition of approximately 7.6 million tons of new ore on the 87/91 and 91 leach pads would prolong the use of cyanide solution until about the end of the year 2000 and would increase the mass of material that could become contaminated with residual cyanide solution and other reagents.

As described for Alternatives 1 through 3, residual cyanide solution, metals, and other reagents may remain in the leach pad ore mass even after rinsing is carried out due to blind-offs or preferential flow patterns that can limit effective rinsing of the ore mass. In general, it is important to note that rinsing is considered to be an adequate means of neutralizing and detoxifying heap leach pads in most cases, and the likelihood of significant retention of cyanide solution and other hazardous materials is low. The potential for presence of residual hazardous materials in the leach pad must be considered after rinsing, however, given that rinsing is not always completely effective and the impacts of the generation and release of hazardous leachate into the environment could be high and negative.

Geochemical testing of spent ore has indicated that generation of acid rock drainage is likely within the reclaimed leach pads. Assuming this occurs, it is likely that residual cyanide solution would be neutralized by acidic leachate as these materials drain and mix within the leach pads. Conversely, residual cyanide solution, which is alkaline, could neutralize some of the acid rock drainage as well. In general, as described in Section

4.2.1.3, anticipated water quality from leach pads would include alkaline pHs (with residual cyanide potentially present) in the short-term after reclamation, followed by increased acidity over time as remnant sulfides react, thereby neutralizing residual cyanide in leachate. Although cyanide would be neutralized by acid rock drainage in the leachate, other hazardous materials, such as acid rinses and metal sludges would remain and could become even more soluble or mobile.

The extent that residual hazardous materials within the leach pads and waste rock repositories mobilize and escape into the environment via surface water and groundwater transport would depend on the effectiveness of reclamation capping and water capture and treatment. Effective reclamation capping would minimize infiltration of water that could liberate and/or react with hazardous materials and form contaminated leachate. A thorough evaluation of reclamation capping and water capture and treatment measures has been presented in Section 4.2. Based on that evaluation, reclamation covers under Alternative 4 would have less than the desired effect at reducing infiltration into the lead pads. As a result, infiltration may over time react with or mobilize residual hazardous materials and generate contaminated leachate. To the extent leachate from the reclaimed leach pads contains residual hazardous materials or compounds, the discharge of that leachate is considered to have a negative impact. Capture and treatment of contaminated leachate would mitigate impacts to receiving waters, however.

Impacts from generation of contaminated leachate could occur at the older Zortman leach pads, at the Goslin Flats leach pad, and at the waste rock repositories along with any of the leach pads or waste rock repositories at the Landusky Mine. Since Alternative 4 would increase the number of leach pads and waste rock repositories, increase the volume of ore that could become contaminated with cyanide or hazardous material residues, and introduces this impact to a new location (Goslin Flats), the magnitude and distribution of this potential impact would be greater than described for Alternatives 1 through 3.

LAD would occur at the end of mine life. For the Zortman Mine, LAD would occur on Goslin Flats. For the Landusky Mine, LAD would occur on the southeast side of Gold Bug Butte. Evaluations of the ability of soil in the LAD area to attenuate cyanide and metals has been completed. Neutralized cyanide solution and metals should not impact soil, water resources, vegetation, or wildlife. Improper LAD can occur if neutralization of cyanide prior to application is ineffective (solution applied to soil has a high cyanide concentration that soil cannot attenuate) and/or application of solution occurs at excessive rates (which could result in runoff of solution into adjacent surface water resources). Under such conditions, vegetation would be lost and/or would fail to reestablish after LAD and wildlife could be lost if exposed to toxic levels of cyanide and/or metals in soil or surface water.

Diesel fuel and gasoline would continue to be used extensively at the Zortman and Landusky mines as heavy equipment would be utilized for transportation of ore and waste rock, hauling of reclamation materials, and final capping and grading during reclamation of both mines. As many as 1.4 and 2.6 million gallons of diesel fuel per year would be used at the Zortman and Landusky mines, respectively. If spilled or accidentally released, diesel or gasoline could kill vegetation if released in a vegetated area (e.g., truck crashes into forest, overturns and spills its fuel), impact surface water quality and harm aquatic organisms (if spilled into a creek), impact groundwater resources if a spill migrates into the ground, and ignite and cause a fire that either burns mine facilities or causes a forest or grass fire. At the Zortman Mine, the vast majority of fuel consumption would be in the pit complex, crusher area, and waste rock repository as opposed to Goslin Flats.

The release of hydrogen cyanide gas would be of greatest concern to mine workers responding to the spill, since the locations where spills could occur are generally removed from populated areas offsite and rapid dilution in air would likely occur.

As described in Section 3.14, gasoline and diesel fuel are stored on-site in above ground tanks on containment structures. Cyanide and cyanide solutions are generally stored in or on lined heap leach pads or solution ponds to minimize the potential for release into the environment. In addition, mine personnel are trained in emergency response and spill containment practices. For potential future spills of solution that would enter a surface water drainage, ZMI's Cyanide Spill Contingency Plan calls for temporarily damming the affected drainage with earth or impermeable liner, and collection and pumping of the solution back to contained facilities, such as contingency ponds or leach pads. Downstream surface and groundwater monitoring sites would be sampled and analyzed for possible cyanide contamination to confirm that the spill had been contained and impacts minimized. For spills or releases to groundwater, pump back operations would be initiated and recovered solution would be routed to contained facilities. If recovery is incomplete, or migration of contamination is suspected, additional wells would be drilled to facilitate recovery of solution or injection of neutralization solutions, and monitoring of groundwater conditions. The combination of contained storage and emergency preparedness should minimize the chance of an accidental spill or release. Nevertheless, given that spills have occurred in the past, the probability of such a release in the future is not zero. Depending on the material released, the quantity released, and the location of the release and the response, the magnitude of the associated impacts may vary and could be high and negative. Since the potential impacts associated with accidental spills or releases of hazardous materials vary considerably and cannot be predicted with certainty, no impact rating has been assigned.

The potential for spills or release of cyanide solution would be included in the Goslin Flats area.

At the Landusky Mine, cyanide solution would be stored and used in the same locations as has occurred in the past. Therefore, potential spills or releases could impact the same general area as described in Alternatives 1 through 3. The extension of mine life would extend the use of cyanide solution for about another year, thereby extending the period of risk that an accident or release could occur.

Other hazardous materials used at the Zortman and Landusky mines such as hydrochloric acid, sodium hydroxide, and calcium hypochlorite are also hazardous, yet, because of the relatively limited quantities used, the limited distribution of use (e.g. refinery only), and substantial containment provided at storage locations, these materials are of less concern because the likelihood of a release to the environment is considerably smaller.

4.14.8.1 Cumulative Impacts

Zortman Mine - Cumulative impacts would consist of the combination of impacts from 1979 to the present, the proposed activities under Alternative 4, and impacts from reasonably foreseeable future actions. Impacts from 1979 to present and Alternative 4 were discussed previously. For reasonably foreseeable future actions, the additional mining of 2 million tons of ore in Pony Gulch as an addition to the Zortman Mine would extend active mining for only another four months. The additional 2 million tons of ore would also be leached on the Goslin Flats leach pad, thereby increasing the total mass of ore that could contain residual cyanide solution and other hazardous materials by about 2 percent. Additional heap leaching at the Goslin Flat leach pad would be extended an additional four months, thereby extending the period that an accidental spill or release of cyanide solution or other hazardous material could occur. Active mining in the Pony Gulch area, extraction of limestone from the ridge above Zortman or enlargement of the Green Mountain Limestone Quarry, and exploration activities would involve the use heavy equipment and the associated risk of a fuel spill.

Landusky Mine - Reasonably foreseeable mining of an additional 12.2 million tons of ore would extend the life of the Landusky Mine and the period of hazardous material usage (and associated risk of spill or release) for an additional two years. Heap leaching at a new leach pad would add a new facility loaded with spent ore that could contain residues of hazardous materials which could generate contaminated leachate. If an older leach pad were off-loaded and its spent ore backfilled in a pit, the spent ore could be a source of hazardous material residue and contaminated leachate could be generated within the backfilled pit. As described for the leach pads, the potential generation of contaminated leachate could be minimized through effective reclamation capping, and capture and treatment of leachate, if necessary. Continued active mining at Landusky, extraction of limestone from the Montana Gulch Limestone Quarry, and exploration activities would involve the use heavy equipment and the associated risk of a fuel spill.

The use of a water treatment plant at Landusky would result in the generation of metal hydroxide sludge in undetermined quantities. As is the case for the Zortman plant, this sludge would likely disposed of in a leach pad and would thereby add material that could react with acidic leachate to mobilize metals. Effective reclamation capping of that leach pad would limit infiltration and potential mobilization of metals, although capture and treatment of leachate may be required.

In summary, the addition of reasonably foreseeable future actions would essentially extend the period of use of hazardous materials and the period that an accidental spill or release could occur. Reasonably foreseeable future actions would increase the volume of spent ore that could contain hazardous material residues and thereby increase the amount and sources of contaminated leachate (possible new leach pad at Landusky), should reclamation capping be ineffective.

4.14.8.2 Unavoidable Adverse Impacts

Past spills or releases of cyanide solutions that have contaminated surface and groundwater resources may prove difficult, if not infeasible to remediate. Although natural processes may degrade spilled cyanide solution over time, it is unclear whether or not this natural degradation would occur before contamination were migrate offsite. Efforts to neutralize and/or pump groundwater contaminated with cyanide solution have had limited success to date. Future accidental spills or releases of cyanide solutions could increase this impact, if such releases were similarly difficult to treat, capture, or otherwise neutralize.

Potential future contamination of water resources from leach pads and waste rock repositories draining hazardous leachate would only be avoidable through implementation of long-term monitoring, collection, and treatment of drainage/leachate, should reclamation capping prove ineffective.

4.14.8.3 Short-term Use/Long-term Productivity

The generation of leachate from reclaimed leach pads that contains residual cyanide, metals, and other reagents that could result from mining in the study area over the short-term could cause long-term negative impacts to water resources, vegetation and wildlife downstream of the permit area in numerous drainages without mitigation in the form of monitoring, capture, and treatment of contaminated water.

4.14.8.4 Irreversible or Irretrievable Resource Commitments

The use of hazardous materials or reagents that are made from non-renewable resources, such as gasoline and diesel fuel, would constitute an irreversible and irretrievable loss of those resource commitment.

4.14.9 Impacts From Alternative 5

Use of hazardous materials would continue at both mines until final reclamation were completed around the end of 2007 at Zortman and the end of 2002 at Landusky. Anticipated annual usage of hazardous materials would be about the same as Alternative 4 and is described in Section 2.8.

At the Zortman Mine, all heap leaching of new ore would be carried out at the Upper Alder Gulch Leach Pad, with the rest of the cyanide solution circuit remaining in its current place. As a result, the storage, handling and use of hazardous materials related to heap leaching would occur in the same location as before, with exception of the leach pad. At the Landusky Mine, the use, storage, and handling of hazardous materials would be the same as described or Alternative 4.

In terms of routine mining activities and waste disposal practices, new mining and heap leach activities at the Zortman Mine would proceed for approximately seven years after construction of the Upper Alder Gulch leach pad and Carter Gulch waste rock repository were completed. After reclamation of the 89 leach pad, metal hydroxide water treatment plant sludge, laboratory rinses, fume scrubber runoff and crushed reagent containers would be disposed on the new leach pad.

As described for Alternative 4, residual cyanide solution and other hazardous materials may remain in the leach pad ore mass even after rinsing is carried out. Although rinsing is generally considered effective, a low potential exists for residual contaminants to remain present in all of the leach pads at the Zortman and Landusky mines. Depending on whether or not acid rock drainage may form in leachate produced in these leach pads, residual cyanide solution may be neutralized within the heaps before the leachate were to drain out of the facilities. Although the generation of acid rock drainage in the heaps could neutralize residual cyanide, its presence could accelerate the mobilization of metals and other hazardous compounds. Residual nitrates from blasting may also be present in leach pads and waste rock repositories. It is difficult at this time to predict which reactions would occur in the facilities and what contaminants would be present in their leachates.

Under Alternative 5, reclamation of leach pads and waste rock repositories would be more intensive and is likely to be more effective than under Alternative 4 (refer to Section 4.2). In addition, monitoring of leachate contamination would occur prior to perforation of leach pad liners. As described for Alternative 3, after rinsing, leachate in all of the leach pads would have to meet water quality objectives for 10 years before liner perforation could be performed. The combination of more effective reclamation covers, along with extensive leachate monitoring and water quality objective compliance for leach pads should greatly reduce the potential for release of contaminated leachate in the future, relative to Alternative 4.

Land application disposal of neutralized cyanide solution would occur at the end of mine life as described under Alternative 4. Assuming land application disposal is performed properly, there should be no impact on the environment.

With respect to accidental spills or releases of hazardous materials, potential impacts and materials of greatest concern would be the same as described for Alternative 4. For potential spills or releases of cyanide solutions into the environment, the nature, risk, and duration of period that solution would be used would be the same as described for Alternative 4, although the location of use would change for the Zortman Mine. At Zortman, all heap leaching of ore would occur at Upper Alder Gulch, as opposed to Goslin Flats. As a result, if a spill or release were to occur, potential impacts would be experienced in Alder Gulch, Alder Spur, and Ruby Gulch, rather than on Goslin Flats. Additional mining would increase the duration that cyanide solutions would be used and thereby extend the period of risk that a spill or release could occur.

A comprehensive Environmental Site Assessment would minimize the risk of long-term contamination of soil and water resources. Any contaminated soil and/or groundwater would be remediated to applicable State and Federal standards to prevent migration of contamination offsite and impacts on the environment.

An annual Environmental Audit would assure that spill containment systems work properly, that leak detection systems are in proper working order, and that spill prevention and response planning can be realistically implemented.

4.14.9.1 Cumulative Impacts

Cumulative impacts would consist of the combination of impacts from 1979 to the present, the proposed activities under Alternative 5, and impacts from reasonably foreseeable future actions. Impacts from 1979 to present and Alternative 5 were discussed previously. For reasonably foreseeable future actions at the Zortman Mine, extraction of limestone from the ridge above Zortman or enlargement of the Green Mountain Limestone Quarry, and exploration activities would involve the use heavy equipment and the associated risk of a fuel spill. Reasonably foreseeable future actions and cumulative impacts at the Landusky Mine would be the same as described for Alternative 4.

4.14.9.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative 4.

4.14.9.3 Short-term Use/Long-term Productivity

Short-term use versus long-term productivity would be the same as described for Alternative 4.

4.14.9.4 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable resource commitments would be the same as described for Alternative 4.

4.14.10 Impacts From Alternative 6

The relocation of the waste rock repository to Ruby Flats instead of Carter Gulch is the primary feature of this alternative. Changing the location of the waste rock repository would shift the location of potential impact from Carter Gulch to Ruby Flats.

Routine mining activities associated with the use and disposal of hazardous materials would generally be the same as described for Alternative 4. For the Zortman Mine, all heap leaching and related solution handling (ponds, processing) would be at the Goslin Flats Leach Pad. Use of vehicle fuels, oil and lubricants, antifreeze, and ammonium nitrate (for blasting) would continue to be at the pit complex primarily. All new waste rock disposal would be at Ruby Flats. As described previously, from a hazardous materials standpoint, the primary concern with waste rock repositories relates to residual nitrates from blasting. Routine mining activities related to hazardous material use and disposal at the Landusky Mine would be the same as described for Alternative 4.

With respect to potential impacts from routine mining activities and waste disposal practices, the potential for residual hazardous materials in reclaimed leach pads and waste rock repositories to react with infiltrating water and leave the facility would be reduced to a large extent by more intensive reclamation covers. Based on infiltration modeling, the reclamation covers for this alternative should be more effective at minimizing infiltration than under Alternative 4. As a result, the potential for generation of contaminated leachate would be reduced. In addition, and as described for Alternatives 3 and 5, leach pad liners would not be perforated until water quality management objectives have been met for 10 years. The combination of more effective reclamation covers, along with extensive leachate monitoring for leach pads, should greatly reduce the potential for release of contaminated leachate in the future.

With respect to accidental spills or releases of hazardous materials, potential impacts, locations of impacts and materials of greatest concern would be virtually the same as described for Alternative 4. Since all new heap leaching, cyanide solution storage and processing would take place at Goslin Flats, the risk of future accidental spills or releases of cyanide solution is greatest on Goslin Flats, as opposed to the older Zortman Mine leach pads or process area. Heap leaching activities and related impacts at the Landusky Mine would be the same as described for Alternative 4. Extended mine lives would increase the duration that cyanide solution would be used and thereby extend the period of risk that a spill or release could occur.

A comprehensive Environmental Site Assessment would minimize the risk of long-term contamination of soil and water resources. Any contaminated soil and/or groundwater would be remediated to applicable State and Federal standards to prevent migration of contamination offsite and impacts on the environment.

An annual Environmental Audit would assure that spill containment systems work properly, that leak detection systems are in proper working order, and that spill prevention and response planning can be realistically implemented.

4.14.10.1 Cumulative Impacts

Cumulative impacts would be the same as described for Alternative 4.

4.14.10.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative 4.

4.14.10.3 Short-term Use/Long-term Productivity

Short-term use versus long-term productivity would be the same as described for Alternative 4.

4.14.10.4 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable resource commitments would be the same as described for Alternative 4.

4.14.11 Impacts From Alternative 7

The relocation of the waste rock repository to the existing mine disturbance area instead of Carter Gulch is one of the primary features of this alternative. Changing the location of the waste repository would shift the location of potential impact from Carter Gulch to the existing mine area.

Routine mining activities associated with the use and disposal of hazardous materials would generally be the same as described for Alternative 4. For the Zortman Mine, heap leaching and related solution handling (ponds, processing) would be at the Goslin Flats leach pad. Use of vehicle fuels, oil and lubricants, antifreeze, and ammonium nitrate (for blasting) would continue to be at the pit complex primarily. Routine mining activities related to hazardous material use and disposal at the Landusky Mine would be the same as described for Alternative 4.

With respect to potential impacts from routine mining activities and waste disposal practices, the potential for residual hazardous materials in reclaimed leach pads and waste rock repositories to react with infiltrating water and leave the facility would be reduced to a large extent by the water balance reclamation covers. Based on infiltration modeling, the reclamation covers for this alternative should be more effective at minimizing infiltration than under Alternatives 4, 5 or 6 (refer to Section 4.2.8.6). As a result, the potential for generation of contaminated leachate should be reduced to the largest extent under this alternative. In addition, leach pad liners would not be perforated until water quality management objectives have been met for 10 years. The combination of more effective reclamation capping, along with extensive leachate monitoring for leach pads, should greatly reduce the potential for release of contaminated leachate in the future.

With respect to accidental spills or releases of hazardous materials, potential impacts, locations of impacts and materials of greatest concern would be virtually the same as described for Alternative 4. Since all new heap leaching, cyanide solution storage and processing would take place at Goslin Flats, the risk of future accidental spills or releases of cyanide solution is greatest on Goslin Flats, as opposed to the older Zortman Mine leach pads or process area. Heap leaching activities and related impacts at the Landusky Mine would be the same as described for Alternative 4. Extended mine lives would increase the duration that cyanide solution would be used and thereby extend the period of risk that a spill or release could occur.

A comprehensive Environmental Site Assessment would minimize the risk of long-term contamination of soil and water resources. Any contaminated soil and/or groundwater would be remediated to applicable State and Federal standards to prevent migration of contamination offsite and impacts on the environment.

An annual Environmental Audit would assure that spill containment systems work properly, that leak detection systems are in proper working order, and that spill prevention and response planning can be realistically implemented.

4.14.11.1 Cumulative Impacts

Cumulative impacts would be the same as described for Alternative 4.

4.14.11.2 Unavoidable Adverse Impacts

Unavoidable adverse impacts would be the same as described for Alternative 4.

4.14.11.3 Short-term Use/Long-term Productivity

Short-term use versus long-term productivity would be the same as described for Alternative 4.

4.14.11.4 Irreversible or Irretrievable Resource Commitments

Irreversible or irretrievable resource commitments would be the same as described for Alternative 4.

CHAPTER 5.0

CONSULTATION AND COORDINATION

5.1 PUBLIC INVOLVEMENT

A Notice of Intent, formally announcing the beginning of the EIS process, was published in the Federal Register in November 1992. The public has been informed of and involved in the EIS process through Federal Register Notices, news releases, direct mailings, and public meetings.

Public scoping meetings were held in the following communities to identify concerns related to the mine life extensions of the Zortman and Landusky mines:

- Dodson, December 15, 1992 (approximately 26 people attended),
- Malta, December 16, 1992 (approximately 39 people attended),
- Hays, December 17, 1992 (approximately 27 people attended), and
- Lodgepole, April 15, 1993 (approximately 30 people attended in the afternoon meeting and 75 people attended the evening meeting).

The following is a list summarizing the concerns/issues identified by the public which have been addressed in this document:

- Water quality and water supply
- Acid rock drainage
- Wildlife protection and mortalities
- Protection of vegetation and wetlands
- Potential impacts to cultural resources
- Soil characteristics and reclamation issues
- Impacts to geology
- Noise and air quality issues
- Socioeconomic concerns
- Recreational issues and concerns
- Visual and aesthetic impacts and concerns
- Concerns regarding land use and recreation
- Safety hazards from transportation of hazardous materials
- Risks to human health
- Engineering concerns and potential impacts to human health and environment
- Environmental policy and planning issues
- Concerns for possible alternatives to the proposed action

5.2 CONSULTATION

Agencies and organizations contacted and consulted during development of this Draft EIS include:

Bat Conservation International
Montana Air Quality Division
Montana Water Quality Division
Montana Department of Fish, Wildlife and Parks
Montana Department of Transportation
Montana Natural Heritage Program
United States Army Corps of Engineers
United States Bureau of Indian Affairs
United States Environmental Protection Agency - Region VIII
United States Fish and Wildlife Service

5.3 DISTRIBUTION LIST

The following is a list of organizations, agencies, and individuals to whom this Draft EIS or the Draft EIS Executive Summary has been distributed.

County Commissioners
Blaine County
Phillips County

State of Montana
Bureau of Mines and Geology
Department of Commerce
Department of Environmental Quality
Department of Fish, Wildlife and Parks
Department of Natural Resources and Conservation
Environmental Quality Council
Governor's Office
Montana State Library
State Historic Preservation Office

Congressional
Honorable Max Baucus
Honorable Conrad Burns
Honorable Pat Williams

Federal
Army Corps of Engineers
Bureau of Indian Affairs
Bureau of Mines
Bureau of Reclamation
Department of Energy
Environmental Protection Agency

- Fish and Wildlife Service
- Geological Survey
- Mineral Management Service
- National Park Service
- Office of Environmental Policy and Compliance

Fort Belknap Councils, Departments, and Committees
- Fort Belknap Community Council
- Fort Belknap Fish and Wildlife
- Fort Belknap Indian Community
- Fort Belknap Planning Department

Libraries
- Harlem Public Library
- Havre City Library
- Lewistown City Library
- Montana Tech Library
- Phillips County Public Library

Organizations
- American Wildlands
- Greater Yellowstone Coalition
- Indian Law Clinic
- Indian Law Resource Center
- Land and Water Fund
- Mineral Policy Center
- Montana Environmental Information Center
- Montana Mining Association
- Montana Wilderness Association
- National Wildlife Federation
- Nature Conservancy, The
- Phillips County Economic Growth Council
- Red Thunder, Inc.
- Square Butte Grazing Association
- Western Environmental Law Center
- Wilderness Society, The
- Wildlands Studies and Information Center
- Zortman Water Users Association

Businesses
- Billings Gazette
- Great Falls Tribune
- KEMC
- KMMR Radio
- KOJM-KPQX
- Marble Law Office
- Pegasus Gold Corporation
- Phillips County News
- Zortman Mining, Inc.

Individuals
- Joe Azure
- Russell and Julia Cebulski
- Mark DeHarm
- Valborg Freyholtz
- Kathy Gallagher
- Bob Goltern
- James R. Green
- Chris Grove
- Catherine and Bill Halver
- Louis Kirkaldie
- Ted Lange
- Rose Main
- Peter Mali
- Virgil McConnell
- Robin McCulloch
- Grace Nesbit
- Cleo Phillips
- Glen A. Phillips
- Paul Robinson
- Dave Roemer
- James J. Shive
- Ross Simser
- Arlo Skari
- Richard Thieltges
- Jeff White
- Ali Zaid
- Paul Zogg

5.4 LIST OF PREPARERS

The Zortman and Landusky Mine Life Extensions and Reclamation Plan Modification Draft EIS was written and produced by an interdisciplinary team composed of the Bureau of Land Management (BLM), Montana Department of Environmental Quality (DEQ), a third-party consulting firm, Woodward-Clyde Consultants (W-C), working under the direction of the two agencies. BLM, DSL, and W-C personnel involved in the production of the Draft EIS, their responsibilities and qualifications are listed below.

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CHAPTER 6.0

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CHAPTER 7.0

GLOSSARY

ADIT - A nearly horizontal passage, driven from the surface, by which a mine may be entered, ventilated, and dewatered.

AFFECTED ENVIRONMENT - The biological and physical environment that will or may be changed by actions proposed and the relationship of people to that environment.

ALLUVIAL - Pertaining to material or processes associated with transportation or deposition by running water.

ALLUVIUM - Soil and rock that is deposited by flowing water.

ALTERNATIVE - A combination of management prescriptions applied in specific amounts and locations to achieve a desired management emphasis as expressed in goals and objectives. One of the several policies, plans, or projects proposed for decision making. An alternative need not substitute for another in all respects.

AMBIENT - Surrounding, existing.

ANALYTE - A compound determined by an analysis.

AQUITARD - A rock unit with relatively low permeability that retards the flow of water.

AREA OF CRITICAL ENVIRONMENTAL CONCERN (ACEC) - An area where special attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values; fish and wildlife resources; or other natural systems or processes; or to protect life and safety from natural hazards.

BENTHIC - Pertaining to the bottom of a body of water.

BERM - A horizontal bench left in an exposed slope to increase slope stability and provide a place for sloughing material to collect.

BEST MANAGEMENT PRACTICES (BMPs) - Practices determined by the State of Montana to be the most effective and practicable means of preventing or reducing the amount of water pollution generated by non-point sources, to meet water quality goals.

BIG GAME - Those species of large mammals normally managed as a sport hunting resource.

BIOLOGICAL ASSESSMENT - An evaluation conducted on federal projects requiring an environmental impact statement in accordance with the Endangered Species Act. The purpose of the assessment is to determine whether the proposed action is likely to affect an endangered, threatened, or candidate species.

BORE HOLE - A drill hole from the surface to an orebody.

COLLUVIUM - Fragments of rock carried and deposited by gravity.

CONTACT METAMORPHISM - The process by which rocks surrounding an igneous intrusion are changed in appearance and composition by the heat, pressure, and chemicals emanating from that intrusion.

COUNCIL ON ENVIRONMENTAL QUALITY - An advisory council to the President established by the National Environmental Policy Act (NEPA) of 1969. It reviews Federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

CULTURAL RESOURCES - Remains of human activity, occupation, or endeavor as reflected in sites, buildings, artifacts, ruins, etc.

DEWATERING - The act of removing water.

DRILL SEEDING - A mechanical method for planting seed in soil.

ENDANGERED SPECIES - Any plant or animal species which is in danger of extinction throughout all or a significant portion of its range. (Endangered Species Act of 1973).

ENVIRONMENTAL ASSESSMENT - A concise public document for which a Federal or State agency is responsible that serves to:

(1) Briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact.
(2) Aid an agency's compliance with the National or Montana Environmental Policy Act (NEPA or MEPA) when no environmental impact statement is necessary.
(3) Facilitate preparation of an environmental impact statement when one is necessary.

ENVIRONMENTAL IMPACT STATEMENT (EIS) - A detailed, written statement as required by Section 102(2)(c) of the National Environmental Policy Act of 1969.

EROSION - The group of processes whereby earthy or rocky material is worn away by natural sources such as wind, water, or ice and removed from any part of the earth's surface.

FELSIC - Pertaining to or composed dominantly of silica-rich minerals such as feldspar; typically forming light-colored rocks.

FLOODPLAIN - The lowland and relatively flat areas adjoining inland and coastal waters. A 100-year floodplain is that area subject to a one percent or greater chance of flooding in any given year.

FLOTATION AGENT - Any of a number of chemical agents used in the separation of ore minerals by the froth flotation process.

FORAGE - Vegetation used for food by wildlife, particularly big game wildlife and livestock.

FORB - Any herbaceous plant other than a grass, especially one growing in a field or meadow.

FREEBOARD - The distance from surface of a pond to top of a dam.

GAINING STREAM - A stream that gains water as flow proceeds downstream. Water is gained from groundwater inflow and/or tributary streams.

GLACIAL DEPOSIT - Any rock material, such as boulders, till, gravel, sand, or clay, transported by a glacier and deposited by or from ice or by or in the water derived from the melting of the ice.

GNEISS - A coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate.

HYDRAULIC CONDUCTIVITY - A measure of the ease with which water moves through soil or rock; permeability.

HYDRIC SOIL - Soil which is wet long enough to periodically produce anaerobic conditions, thereby influencing the growth of plants.

HYDROPHYTIC - Water-loving; ability to grow in water or saturated soil.

HYDROSEEDING - Distributing seed in a spray of water. Mulch and fertilizer may be added to the spray.

INDICATOR SPECIES - Species of fish, wildlife, or plants which reflect ecological changes caused by land management activities.

INTRUDE - To forcefully invade and displace pre-existing rocks. Molten rock can inject itself into surrounding rocks due to high temperatures and pressures.

JOINT - Fracture in rock, generally more or less vertical or transverse.

LOSING STREAM - A stream that loses water as flow proceeds downstream. Typically, water loss is via infiltration into the ground and evaporation.

MACROINVERTEBRATE - Animals without backbones that are visible without a microscope; insects.

MAFIC - Pertaining to or composed dominantly of the magnesian rock-forming silicates; said of some igneous rocks and their constituent minerals. Contrasted with felsic.

MANAGEMENT UNIT - Geographic areas, not necessarily contiguous, which have common management direction consistent with the BLM allocations.

MAXIMUM CREDIBLE EARTHQUAKE - The largest rationally conceivable earthquake that could occur in a particular area.

MAXIMUM PROBABLE FLOOD - The flood event that could cause the highest expected river stage.

METAMORPHOSE - To change into a different physical form.

MINERAL LODE CLAIM - A claim for possession of land in the public domain (especially national forests) containing minerals under the Mining Law of 1872.

MINERALIZATION - The process by which a valuable mineral or minerals are introduced into a rock resulting in a potential or actual ore deposit.

MITIGATION - Actions to avoid, minimize, reduce, eliminate, replace, or rectify the impact of a management practice.

ORE-GRADE - When minerals are found in sufficient concentration to warrant extraction by mining, the mineralized area is considered an ore deposit. Ore is mineral that can be extracted from the ground at a profit. Grade is a term used to define the amount of concentration of a mineral in rock, and is usually expressed in units of metal per ton of rock or in percentage.

PACKER - A compressible cylinder of rubber and metal that is placed in or outside a well to plug or seal the well at a specific point.

PEAK FLOW - The greatest flow attained during the melting of the winter snowpack.

PERIPHYTON - Microscopic organisms attached to and growing on the bottom of a waterway or on submerged objects.

PERMEABILITY - The capacity for transmitting a fluid; depends on the size and shape of the pores, the size and shape of their interconnections, and the extent of the latter. It is measured by the rate at which a fluid of standard viscosity can move a given distance through a given interval of time.

PICTOGRAPH - Any conventionalized representation of an object.

PIEZOMETER - A well, generally of small diameter, that is used to measure the elevation of the water table.

POTENTIOMETRIC SURFACE - The surface or level to which water will rise in a well. The water table is a particular potentiometric surface for an unconfined aquifer.

PROPOSED ACTION - In terms of NEPA or MEPA, the project, activity, or action that a Proponent intends to implement or undertake and which is the subject of an environmental analysis.

REAGENT - A substance used in a chemical reaction to detect, measure, examine, or produce other substances.

RECORD OF DECISION (ROD) - A document separate from but associated with an environmental impact statement that publicly and officially discloses the responsible official's decision on the proposed action.

RIPARIAN - Situated on or pertaining to the bank of a river, stream, or other body of water. Normally used to refer to the plants of all types that grow along or around springs.

ROADLESS AREA - That area which is absent of roads which have been improved and maintained by mechanical means to ensure relatively regular and continuous use, and is bounded by a road, the edge of a right-of-way, other land ownership, or a significant imprint of man.

SCOPING - A term used to identify the process for determining the scope of issues related to a proposed action and for identifying significant issues to be addressed.

SEDIMENTARY - Rock formed of sediment, especially: (1) Clastic rocks, as, conglomerate, sandstone, and shales, formed of fragments of other rock transported from their sources and deposited in water. (2) Rocks formed by precipitation from solution, as rock salt and gypsum, or from secretions of organisms, as most limestone.

SEISMIC - Of, or produced by, earthquakes.

SHAFT - A vertical excavation of limited area compared with its depth, located alongside or through an orebody for access.

SHEAR ZONE - A zone in which shearing has occurred on a large scale so that the rock is crushed and brecciated.

SIGNIFICANT - As used in NEPA, requires consideration of both context and intensity. Context means that the significance of an action must be analyzed in several contexts such as society as a whole, and the affected region, interests, and locality. Intensity refers to the severity of impacts (40 CFR 1508.27).

SOIL PRODUCTIVITY - The capacity of a soil to produce a specific crop such as fiber and forage, under defined levels of management. It is generally dependent on available soil moisture and nutrients and length of growing season.

SUBSIDENCE - The sinking of a large part of the earth's crust.

TAILING - Second grade or waste material derived when raw material is screened or processed.

TALUS - A collection of fallen disintegrated material which has formed a slope at the foot of a steeper declivity.

TECTONIC - Of, pertaining to, or designating the rock structure and external forms resulting from the deformation of the earth's crust.

THREATENED SPECIES - Any species of plant or animal which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

TRANSMISSIVITY - The rate at which water is transmitted through a unit width of aquifer under a hydraulic gradient.

UNNECESSARY OR UNDUE DEGRADATION - Surface disturbance greater than what would normally result when an activity is being accomplished by a prudent operator in usual, customary, and proficient operations of similar character and taking into consideration the effects of operations on other resources and land uses, including those resources and uses outside the area of operations.

VISUAL ABSORPTION CAPABILITY (VAC) - The relative ability of a landscape to accept management practices without affecting its visual characteristic. The capability to absorb visual change. A prediction of how difficult it will be for a landscape to meet recommended VQOs.

VISUAL QUALITY OBJECTIVES (VQO) - Descriptions of a different degree of alteration of the natural landscape based upon the importance of aesthetics.

WETLAND - Lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface.

INDEX

APPENDIX A

SUMMARY OF THE WATER QUALITY IMPROVEMENT PLAN

1.0 INTRODUCTION

Water quality associated with discharges from existing or expanded mine facilities is a major issue identified during EIS scoping. This appendix summarizes the technical approaches of a plan to improve water quality. The Water Quality Improvement Plan is an agency mitigation that would be required by the DEQ's HRB (Hard Rock Bureau) and the BLM. The plan has been derived by BLM and HRB from water quality improvement measures proposed by ZMI, and after consultation with EPA and the Montana Water Quality Division.

The BLM has determined that implementation of the Water Quality Improvement Plan is needed for existing or expanded mining to prevent unnecessary or undue degradation of federal lands as required by the Federal Land Policy and Management Act (FLPMA). Similarly, DEQ-HRB has determined that measures in the Improvement Plan are needed to achieve comparable stability and utility of mined lands with adjacent lands as required by the Montana Metal Mine Reclamation Act (MMRA).

On a parallel track with the mitigation efforts of DEQ-HRB and BLM, are the enforcement efforts of EPA and the Montana DEQ's Water Quality Division (WQD). The United States, for and on behalf of EPA, and the State of Montana, for and on behalf of the Montana Department of Environmental Quality (formerly the Montana Department of Health and Environmental Sciences), have filed civil lawsuits against ZMI and its parent corporation, Pegasus Gold Corporation, with regard to discharges of mining wastewaters at the Zortman and Landusky mines allegedly in violation of the Federal Clean Water Act and the State of Montana Water Quality Act. The United States and the State of Montana seek, among other things, injunctive relief to bring the Zortman and Landusky mines into compliance with Federal and State law. EPA and the State of Montana are likely to require that any compliance plan incorporate the major technical components described in this appendix. However, it must be noted that the measures described in this appendix, and required by BLM and HRB, may not address all the technical concerns of the parties involved in the civil lawsuits. Additional, alternate or supplemental measures, beyond those required by BLM and HRB, may result from settlement or litigation. The more restrictive (protective) measures would ultimately be required.

1.1 RELATION TO DRAFT EIS ALTERNATIVES

The facility construction and monitoring requirements summarized in this appendix, while based on the existing mine facilities, are actions common to all alternatives in this Draft EIS. Should one of the mine expansion alternatives be selected, the water control, capture and treatment structures would be built to accommodate any new or expanded mine facilities.

This summary emphasizes:

- Water quality objectives of the Improvement Plan;
- Construction of water management facilities and practices for achieving water quality objectives;
- Monitoring requirements and other data collection activities; and,
- Schedule for constructing water management facilities and implementing monitoring practices.

1.2 IMPROVEMENT PLAN OBJECTIVES

The objectives of this Water Quality Improvement Plan are to prevent unnecessary or undue degradation of federal lands as required by the FLPMA and to achieve comparable stability and utility of mined lands with adjacent lands as required by the MMRA. Measures to improve and maintain water quality are an integral part of compliance with these acts.

To achieve the above objectives, work must be performed by ZMI to attain interim compliance at the Zortman and Landusky mine sites with the effluent guidelines for ore mining and dressing BAT (Best Available Technology Economically Achievable, 40 CFR 440) water quality standards and final compliance with Montana Pollution Discharge Elimination System (MPDES) water quality effluent limits, and the Clean Water Act, in accordance with a specific schedule. The work required would fall into three general categories:

- Water management and treatment practices for improving water quality;
- Water quality monitoring; and
- Determination of pre-ZMI mining water quality and collection of data in support of water quality permit effluent limits.

1.3 REQUIRED ENGINEERING DESIGNS AND WORK PLANS

Upon approval by the regulatory agencies of the overall plans and concepts in the Water Quality Improvement Plan detailed engineering plans for each drainage must be prepared by ZMI. Detailed work plans must also be prepared that include:

- Sampling and Analysis Plans for Water Quality Monitoring of Water Management Facilities and Practices;
- Storm Water Management Plan for Zortman and Landusky Mine Sites; and
- Work Plans Supporting MPDES Permit Development for the Zortman and Landusky Mine Site Drainages.

2.0 WATER MANAGEMENT PLAN

Based on the hydrogeologic conditions at the Zortman and Landusky mine sites (see Chapter 3), the Water Management Plan provides a basis for segregating various waters, and identifying which waters could be managed with sediment and erosion control practices and which waters would require capture and treatment.

2.1 WATER MANAGEMENT ZONES

Waters at the mine sites are to be classified based on the source of the water, the materials contacted by water as it flows through the mine sites, and the quality of the water as it is discharged from the mine sites. By classifying the various types of waters at the mine sites, the following benefits would be achieved:

- Areas which contribute to each drainage diversion/discharge are delineated.
- Areas producing poor quality discharge (mine drainage) are delineated from areas of relatively good quality discharge (storm water).
- Water quality management requirements which best fit each water classification are identified.

EPA regulations define threecategories of surface water at mine sites: (1) process water; (2) mine drainage; and (3) storm water. Waters within ZMI's mine permit areas would be classified within one of these three types of water management zones, or as "unclassified". These proposed water management zones are shown in detail in Figure A-1 (Zortman mine site) and Figure A-2 (Landusky mine site) of the Summary Report (Hydrometrics Inc. 1995) available from BLM or DSL.

2.2 WATER BALANCE

Quantification of each of the water "inputs" to a system and the "outputs" from the system, and any change in storage within the system is a process referred to as a water balance. For purposes of the Water Management Plan, available hydrologic data were used to complete a water balance for each Zortman and Landusky mine site drainage. The water balance is presented for an annual time period, and therefore assumes no change in stored water within each drainage. Since the water balance uses annually averaged input and output values, the water balance does not affect the design capacity of water management facilities proposed in this plan. Instead, the design capacity is based on short intense storm events such as the 10-year 24-hour storm.

The results of the water balance are shown in Table A-1 (average year), Table A-2 (dry year) and Table A-3 (wet year). As these tables indicate, groundwater outflow from each basin is highly variable depending on hydrologic conditions. This indicates that estimates of groundwater discharge are fairly sensitive to variations in precipitation, evapotranspiration and surface runoff estimates. For example, during an average year, precipitation estimates in Ruby Gulch vary by 20 million gallons (from 120 to 140 million gallons), surface runoff estimates vary by 13 million gallons (from 1.1 to 14 million gallons) and evapotranspiration estimates vary by 20 million gallons (from 100 to 120 million gallons). However, groundwater varies over a range of 39 million gallons--a substantially larger range than the other hydrologic variables in the water balance.

Also, note that use of a water balance equation predicts a net inflow of groundwater to some basins for some hydrological scenarios. Since the drainage basin boundaries have been selected to correspond to topographic boundaries, the water balance illustrated in Tables A-1 through A-3 assumes that the basin boundaries are groundwater boundaries and there is no groundwater transfer between drainages.

3.0 WATER QUALITY IMPROVEMENT PLAN

The proposed facilities and practices are based on site specific conditions in each drainage. Figures and tables identifying each discharge and the associated water management practice(s) follow the text.

The water management practices are established technologies to reduce or eliminate the discharge of impacted water. When fully implemented, the water management practices would improve water quality in affected drainages with the performance criteria of achieving compliance with final permit effluent limits. Improvements in water quality would be monitored in accordance with the procedures in Section 4.

While site specific plans vary, the generalized plan for improving water quality is to:

- Segregate good quality water originating in storm water management zones from poor quality water originating in mine drainage zones or seeps;
- Treat surface water runoff in storm water management zones through Best Management Practices (BMPs);
- Apply BMPs in mine drainage water management zones where appropriate to augment mine drainage water capture and treatment facilities by reducing sedimentation in capture systems; and
- Capture all poor quality surface water and alluvial groundwater from mine drainage or stormwater management zones and treat this water in order to meet applicable water quality standards.

3.1 WATER QUALITY IMPROVEMENT OBJECTIVES

The goal is for ZMI to achieve compliance with the Montana Water Quality Act as soon as possible, preventing unnecessary or undue degradation. If the water management practice and facilities proposed in this plan do not achieve the required water quality objectives, ZMI would be required to immediately identify the source of the deficiency and modify the existing water management practices and facilities or develop additional water management practices and facilities to be constructed.

The Water Quality Division would issue a Montana Pollution Discharge Elimination System (MPDES) permit to ZMI. The MPDES permit may contain a compliance schedule and establish interim and final discharge limitations.

3.2 WATER CAPTURE AND TREATMENT

Poor quality water (both surface runoff and groundwater flow) would be collected using capture systems that vary depending on site-specific conditions, and consist of one or more of the following:

- Lined capture pond(s)
- Recovery well(s)
- Interceptor trench(s)
- Sump(s)

The facilities and water management practices are to be designed to capture and treat runoff from at least a 10-year 24-hour rainfall event, or seepage from a 100-year storm event, wherever the terrain accommodates such a facility. Figure A shows a general plan view and cross section of the water capture systems which are to be used downgradient of mine waste units.

The quality of surface water and groundwater downgradient of the most downgradient water management facility in each drainage would be monitored in accordance with requirements summarized in Section 4.0. In the event that water quality associated with a discharge, bypass or upset, of a water management facility does not comply with anticipated MPDES effluent limits at the discharge monitoring point, ZMI would implement corrective measures for achieving additional water quality improvements. Such measures would include additional capture and treatment facilities, additional BMPs, or other management or treatment practices. Monitoring the effectiveness of the capture and treatment facilities and having the opportunity to modify and improve the design is an inherent part of the design process that would be used to improve water quality.

Water treatment would be conducted at the Zortman water treatment plant (an actively operating lime precipitation plant) and discharged to Ruby Gulch. A new water treatment plant would be constructed at the Landusky Mine in the Montana Gulch area.

3.3 DRAINAGE SPECIFIC DISCHARGES & WATER MANAGEMENT FACILITIES AND PRACTICES

Current and future potential discharges of water from the existing mine sites are shown on Figures A-1 through A-7. For each of the discharges a water management facility or practice would be required by the agencies. These practices and facilities are summarized in Tables A-4 through A-10.

4.0 REQUIREMENTS FOR MONITORING WATER QUALITY IMPROVEMENT

As the water management practices are implemented, ZMI is required to collect water quality data. Monitoring is to be performed at discharge points and downstream of water management facilities and practices (This monitoring is in addition to the mine-wide water resources monitoring program). The purpose of the monitoring is to:

- Determine the effectiveness of capture and treatment facilities;
- Determine the effectiveness of BMPs; and
- Document compliance with interim and final effluent limits.

4.1 DATA COLLECTION REQUIREMENTS

Detailed procedures related to sample collection, laboratory testing, data quality, or data management and evaluation would be contained in a sampling and analysis plan to be developed by ZMI. The framework for monitoring is to establish the effectiveness of the water quality improvement measures and includes the following:

- Monitoring at surface water discharge points, groundwater monitoring sites, and ambient monitoring sites.
- Monitoring of capture system effectiveness (both surface water and groundwater).
- At least three samples per year of storm water discharge monitoring points during runoff events when the occur.
- Daily monitoring of mine drainage discharge monitoring points during periods of capture system discharge.
- Frequency of flow measurements or continuous flow measurements.

Parameters to be monitored for in storm water would include:

pH
Specific Conductivity
Oil and Grease (visual for sheen)
Flow (surface water only)
Total Suspended Solids
Total Dissolved Solids
Total Settleable Solids
Alkalinity as $CaCO_3$
Acidity (if Ph is <6.0)
Total Ammonia as N
Sulfate
Nitrate plus Nitrite
Cyanide - WAD*
TR Arsenic
TR Cadmium
TR Chromium
TR Copper
TR Lead
TR Manganese
TR Zinc

TR = Total Recoverable
* Total and free cyanide also will be tested for when WAD cyanide concentrations exceed 0.2 mg/l.

The parameters likely to be monitored for at mine drainage and ambient monitoring points include:

pH
Specific Conductivity
Oil and Grease (visual for sheen)
Water Levels (wells only)
Flow (surface water only)
Total Suspended Solids
Total Dissolved Solids
Total Settleable Solids
Alkalinity as $CaCO_3$
Acidity (if pH is < 6.0)
Total Ammonia as N
Total Petroleum Hydrocarbons
Hardness as $CaCO_3$
Iron**
Redox Potential (wells only)
Sulfate
Nitrate plus Nitrite
Cyanide - WAD*

Arsenic**
Cadmium**
Chromium**
Copper**
Lead**
Manganese**
Mercury**
Mercury**
Nickel**
Selenium**
Zinc**

* Total and free cyanide also will be tested for when WAD cyanide concentrations exceed 0.2 mg/l.

** Surface water sites to be monitored for both dissolved and total recoverable metals, and groundwater sites to be monitored for dissolved metals.

Testing at mine drainage monitoring sites would include whole effluent toxicity testing.

In the event that additional water management facilities or practices are required in the drainages, water quality monitoring is to be performed downgradient of the most downgradient water management facility or practice within that drainage. "Zones" have been identified to indicate the drainage areas wherein monitoring sites may be re-established as necessary to remain downgradient of the most downgradient water management facility or practice within a drainage. Ambient monitoring stations are located at the downgradient end of the Zones to establish a consistent reference point for evaluating water quality improvements.

4.2 MONITORING DATA REPORTING

All point source effluent monitoring data would be mailed or delivered to the DEQ by the 28th day of the month following the completed reporting period (calendar month).

All ambient monitoring data would be submitted no later than 45 days after the completion the previous calendar quarter. Annual summary reports and narratives must be submitted 90 days after completion of the calendar year.

5.0 IMPLEMENTATION SCHEDULE

More than one year is necessary for full scale engineering design review and construction of water quality improvement facilities and practices for all drainages. To ensure that progress is made to stabilize and/or improve water quality in each drainage in 1995 and 1996, interim runoff management practices plus effluent capture and treatment measures are in effect. Construction and monitoring activities from July 1995 through August 1995 are detailed in the Order for Compliance issued by the DEQ's Water Quality Division on July 11, 1995. Additional interim requirements have been prepared by BLM and HRB to improve water quality until the Water Quality Improvement Plan can be finalized and approved.

Once the EIS process is completed, and the Water Quality Improvement Plan is approved, ZMI would be required to have submitted detailed drainage specific plans to BLM and HRB within one year. Contingent upon obtaining the necessary regulatory approvals in a timely manner, ZMI would be required to complete the initial phase of construction in all drainages during 1997. Any additional construction that may be necessary after a review of the effectiveness of the water management structures would be completed by December 31, 1999.

TABLE A-1

WATER BALANCE AND ESTIMATED GROUNDWATER OUTFLOW DURING AN AVERAGE YEAR ZORTMAN AND LANDUSKY MINES

(million gallons, unless otherwise noted)

DRAINAGE	AREA	ESTIMATED VOLUME OF ANNUAL PRECIPITATION[1]		ESTIMATED VOLUME OF ANNUAL RUNOFF[2]		ESTIMATED VOLUME OF ANNUAL EVAPOTRANSPIRATION[3]		ESTIMATED VOLUME OF ANNUAL GROUNDWATER OUTFLOW[4]	
	(SQ. MI.)	MIN	MAX	MIN	MAX	MIN	MAX	MIN[5]	MAX[6]
Ruby Gulch	0.39	120	140	1.1	14.0	100	120	0	39.0
Alder Spur	0.15	44	55	0.30	7.0	39	47	0	16.0
Carter Gulch	0.10	30	36	0.19	5.5	26	31	0	9.8
Montana Gulch	0.89	260	320	3.4	25.0	230	280	0	87.0
Sullivan Park	0.11	32	40	0.21	5.8	29	35	0	11.0
Mill Gulch	0.42	120	150	1.2	15.0	110	130	0	39.0
King Creek	0.073	22	27	0.12	4.4	19	22	0	7.9

Notes:

[1] Based on an estimate of 17 to 21 inches of precipitation derived from measured precipitation of the NWS and BLM weather stations near Zortman.

[2] Based on methods in USGS Water Resources Investigation 84-4143.

[3] Based on an estimate of 15 to 18 inches of evapotranspiration from the MSU MAPS database.

[4] Groundwater outflow estimated by using a water balance equation of the form GW = P - S - ET where GW is the annual volume of groundwater from a basin, P is the estimated annual volume of precipitation falling on a basin, S is the annual volume of surface runoff from a basin and ET is the annual volume of evapotranspiration from a basin.

[5] Minimum values of groundwater result from a combination of minimum precipitation with maximum runoff and evapotranspiration. If this combination results in a negative number, groundwater outflow was estimated to be zero because no groundwater is assumed to be transferred across basin boundaries.

[6] Maximum values of groundwater result from a combination of maximum precipitation with minimum runoff and evapotranspiration.

Source: Hydrometrics 1995.

TABLE A-2

WATER BALANCE AND ESTIMATED GROUNDWATER OUTFLOW DURING A DRY YEAR ZORTMAN AND LANDUSKY MINES

(million gallons, unless otherwise noted)

	AREA	ESTIMATED VOLUME OF ANNUAL PRECIPITATION[1]		ESTIMATED VOLUME OF ANNUAL RUNOFF[2]		ESTIMATED VOLUME OF ANNUAL EVAPO-TRANSPIRATION[3]		ESTIMATED VOLUME OF ANNUAL GROUNDWATER OUTFLOW[4]	
DRAINAGE	(SQ. MI.)	MIN	MAX	MIN	MAX	MIN	MAX	MIN[5]	MAX[6]
Ruby Gulch	0.39	81	110	0.55	7.0	75	88	0	34.0
Alder Spur	0.15	31	42	0.15	3.5	29	34	0	13.0
Carter Gulch	0.10	21	28	0.095	2.8	19	23	0	8.9
Montana Gulch	0.89	190	250	1.7	12.0	170	200	0	78.0
Sullivan Park	0.11	23	30	0.10	2.9	21	25	0	9.0
Mill Gulch	0.42	88	117	0.6	7.5	80	94	0	36.0
King Creek	0.073	15	20	0.06	2.2	14	16	0	5.9

Notes:

[1] Based on an estimate of 12 to 16 inches of precipitation derived from measured precipitation of the NWS and BLM weather stations near Zortman.

[2] Based on methods in USGS Water Resources Investigation 84-4143.

[3] Based on an estimate of 11 to 13 inches of evapotranspiration from the MSU MAPS database.

[4] Groundwater outflow estimated by using a water balance equation of the form GW = P - S - ET where GW is the annual volume of groundwater from a basin, P is the estimated annual volume of precipitation falling on a basin, S is the annual volume of surface runoff from a basin and ET is the annual volume of evapotranspiration from a basin.

[5] Minimum values of groundwater result from a combination of minimum precipitation with maximum runoff and evapotranspiration. If this combination results in a negative number, groundwater outflow was estimated to be zero because no groundwater is assumed to be transferred across basin boundaries.

[6] Maximum values of groundwater result from a combination of maximum precipitation with minimum runoff and evapotranspiration.

Source: Hydrometrics 1995.

TABLE A-3

WATER BALANCE AND ESTIMATED GROUNDWATER OUTFLOW DURING A WET YEAR - ZORTMAN AND LANDUSKY MINES

(million gallons, unless otherwise noted)

	AREA	ESTIMATED VOLUME OF ANNUAL PRECIPITATION[1]		ESTIMATED VOLUME OF ANNUAL RUNOFF[2]		ESTIMATED VOLUME OF ANNUAL EVAPO-TRANSPIRATION[3]		ESTIMATED VOLUME OF ANNUAL GROUNDWATER OUTFLOW[4]	
DRAINAGE	(SQ. MI.)	MIN	MAX	MIN	MAX	MIN	MAX	MIN[5]	MAX[6]
Ruby Gulch	0.39	150	180	2.2	28.0	130	150	0	47.0
Alder Spur	0.15	57	68	0.60	14.0	50	57	0	17.0
Carter Gulch	0.10	38	45	0.38	11.0	33	38	0	12.0
Montana Gulch	0.89	340	400	6.8	50.0	29	340	0	100.0
Sullivan Park	0.11	43	50	0.42	11.6	38	43	0	12.0
Mill Gulch	0.42	160	190	2.4	30.0	14	160	0	47.0
King Creek	0.073	28	33	0.24	8.8	24	28	0	8.8

Notes:

[1] Based on an estimate of 22 to 26 inches of precipitation derived from measured precipitation of the NWS and BLM weather stations near Zortman.

[2] Based on methods in USGS Water Resources Investigation 84-4143.

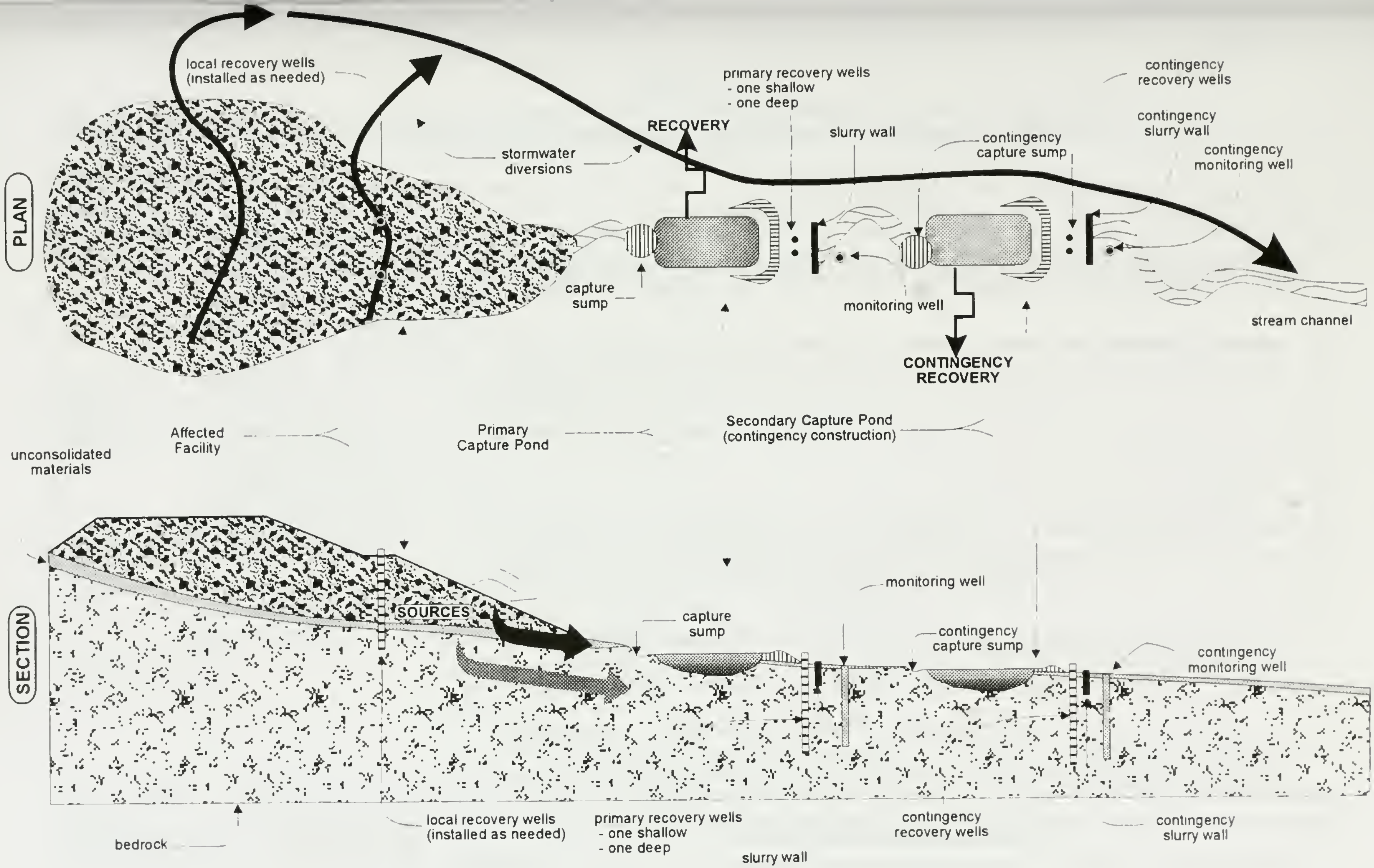
[3] Based on an estimate of 19 to 22 inches of evapotranspiration from the MSU MAPS database.

[4] Groundwater outflow estimated by using a water balance equation of the form $GW = P - S - ET$ where GW is the annual volume of groundwater from a basin, P is the estimated annual volume of precipitation falling on a basin, S is the annual volume of surface runoff from a basin and ET is the annual volume of evapotranspiration from a basin.

[5] Minimum values of groundwater result from a combination of minimum precipitation with maximum runoff and evapotranspiration. If this combination results in a negative number, groundwater outflow was estimated to be zero because no groundwater is assumed to be transferred across basin boundaries.

[6] Maximum values of groundwater result from a combination of maximum precipitation with minimum runoff and evapotranspiration.

Source: Hydrometrics 1995.



Schematic of Capture System

(not to scale)

FIG. A

Charles W. Russell Ph.D
10 August 1998

TABLE A-4

WATER MANAGEMENT PRACTICES FOR RUBY GULCH

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Seepage along downstream face of buttress for 85/86 Pad.	Construction of lined ponds to capture seepage and storm runoff water from mine-related facilities. Two ponds proposed in this basin are shown on Figure A-1. Final design, based on bedrock suitability and other terrain features, may result in other configurations. Based on the preliminary design criteria, the combined pond volume required in this drainage is at most 25 acre-feet. If conditions are suitable, slurry cut-off walls would be constructed adjacent to the capture ponds to collect seepage. Recovery wells may also be completed to supplement the capture system. This alluvial groundwater capture system would be completed in the fill material from the static water level down to bedrock. Captured water would be pumped to the Zortman water treatment plant.
Mine Drainage	Discharge is runoff from actively used process and staging areas, and runoff from roads in the upper mine area.	Construct improved drainage ditches to convey mine water runoff to the upper storage pond. Reclaim active areas to minimize sediment erosion and sediment accumulation in the capture pond.
Unclassified Water	Runoff from the east side of Ruby Gulch.	Enlarge and improve existing ditch and construct additional ditch to release water downstream of the lower proposed capture pond.
Storm Water[1]	Runoff from the west side of Ruby Gulch presently released into the storm water sediment pond.	Improve existing ditch. Redesign storm water sedimentation pond overflow to pipe water across road and into Ruby Gulch. Reconstruct eroded areas and revegetate inactive areas within water management zone.
Mine Drainage	Potential overflow of the proposed downstream capture pond.	Mine drainage water in excess of the design event may be released to Ruby Creek through a spillway.

* (Hydrometrics 1995)

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[1] For all discharges in these Tables A-4 through A-10 labeled "storm water" it should be noted that a final determination as to whether the discharge is storm water" or "mine drainage" has not been made. It is assumed that this discharge would be of good quality based on the area it drains. If this assumption is incorrect, this discharge would be collected and treated.

TABLE A-5

WATER MANAGEMENT PRACTICES FOR ALDER SPUR

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Discharge is the seep below the contingency pond and for possible contingency pond overflow.	Construction of a lined capture pond in Alder Spur to capture seepage and potential contingency pond overflow. Calculations indicate the required capture pond volume would be about 10 acre-feet (when storm water runoff is included). Captured water would be pumped to the Zortman water treatment plant. Recovery wells would not be constructed below this pond, since there is no alluvium in the drainage at the present proposed location for the capture pond.
Mine Drainage	Potential overflow of the proposed capture pond.	Mine drainage water in excess of the design event may be released to Alder Spur.
Storm Water	Runoff from the reclaimed buttress for the 83 and 84 Pads.	Optimal drainage ditches would be constructed to convey storm water runoff from reclaimed buttresses and undisturbed hillsides around the capture pond. However, the steep terrain in the Gulch will not likely be suitable for such drains, and the capture pond would therefore be sized to contain storm water runoff.
Storm Water	Drain west of 84 Pad.	An improved drain and dispersion facility would be constructed.
Unclassified Water	Runoff from access roads and unimpacted areas east of the contingency pond.	BMPs would be used to control erosion. If feasible, one or more ditches may be constructed to transport surface water around the proposed capture pond; thereby reducing the volume of water requiring treatment. Steep canyon walls may make diversion ditches difficult to construct.

* (Hydrometrics 1995)

TABLE A-6

WATER MANAGEMENT PRACTICES FOR CARTER GULCH

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	A seep at the base of the Alder Gulch Waste Repository.	To improve collection of seepage water, a series of recovery wells would be installed within the waste repository in Carter Gulch. This would allow capture and transport of impacted water prior to its release at the toe of the waste repository. Additionally, an improved capture system near the toe of the Alder Gulch waste repository would be evaluated for the collection of impacted water. However, there is very limited area to construct a capture system between the discharge and its confluence with the west fork of Carter Gulch. The effectiveness and feasibility of both options must be determined prior to final design and construction. The existing waste rock dump in Carter Gulch would be removed under alternatives 3, 4 through 7. No recovery wells are proposed downgradient of the surface water capture system, since little alluvium exists in the drainage at this location. All captured water would be pumped to the water treatment plant.
Mine Drainage	Potential overflow of the proposed capture system.	Mine drainage water in excess of the design event may be released to Carter Gulch. The design of this capture system would provide a mechanism for reducing the amount of suspended material in the discharge.
Storm Water	Runoff diverted west from Alder Gulch Waste Repository drainage benches and access roads.	No improvements to the existing discharges are planned, unless the road is expanded to permit construction equipment access to the bottom of the waste repository. In this case, the drains and release points would be redesigned to accommodate larger flows, and other BMPs would be used to reduce erosion. These water management practices are addressed under ZMI's reclamation plan.
Storm Water	Runoff from access road around the Alabama pits.	An improved mechanism for releasing water at the dispersion point is proposed to reduce erosion.

TABLE A-6 - WATER MANAGEMENT PRACTICES FOR CARTER GULCH
(Concluded)

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Storm Water	Runoff diverted south from Alder Gulch Waste Repository drainage benches proposed sump.	To further reduce infiltration of surface water into the Alder Gulch Waste Repository, additional drainage benches with underlying layers of impervious material would be constructed on the face of the waste rock repository. Runoff from these benches would be collected in drainage ditches and discharged to Carter Gulch downstream of the mine facilities. The lined drainage benches should significantly reduce the volume of impacted water requiring capture. A sump also will be constructed to improve the capture of storm water in the gully located on the east side of the waste repository.
Storm Water	Runoff diverted south from the lower most Alder Gulch Waste Repository drainage bench.	An additional drainage bench would be constructed at the proposed location of the recovery wells. A drain and dispersion point would be constructed to transport this water down Carter Gulch, below the proposed capture system.
Storm Water	Runoff from the ridge road between Zortman and Landusky mine sites.	Minor improvements to the road drainage system and dispersion point facilities are proposed to reduce erosion.

* (Hydrometrics 1995)

TABLE A-7

WATER MANAGEMENT PRACTICES FOR SULLIVAN PARK

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Seepage at the toe of the buttress.	The contingency pond, constructed with a hypalon liner, would be used to capture seepage. A slurry wall would be used to capture shallow groundwater flow. All captured water would be pumped to the Landusky water treatment plant or returned to process circuit. Water may be released to the Sullivan Park drainage when storm events exceed the design capacity of the capture pond. Release would occur from a spillway. Some settling of suspended solids would occur prior to release.
Mine Drainage	Potential release from the existing contingency pond.	To provide additional storage to contain runoff from large storm events, an additional lined capture pond may be constructed downstream of the present capture system. Due to the very steep and difficult terrain in the Sullivan Park drainage, the capture pond may be located just upstream of the confluence with Rock Creek where the drainage begins to widen. Water in this downstream capture pond would be pumped to the upstream capture pond. No recovery wells are proposed downgradient of the lowest capture system, since little alluvium exists in the drainage at this location.
Storm Water	Runoff from the road east of the 91 Pad.	BMPs, including check dams in the roadside ditch, would be used to control erosion.
Storm Water	Runoff from the dike which is transported in the proposed drain on the east side of the dike.	Reclamation of the buttress would be conducted in accordance with plans approved by the DEQ and the BLM. The reclamation would be completed, using BMPs to control erosion. A drain would be constructed along the east side of the buttress to reduce erosion and divert surface water received from the dike and unimpacted areas southeast of the dike past the upper proposed capture pond.
Storm Water	Runoff from roads and eroded areas west of Sullivan Park.	BMPs would be applied to reduce erosion and improve the stability of steep slopes.

* (Hydrometrics 1995)

TABLE A-8

WATER MANAGEMENT PRACTICES FOR MILL GULCH

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Seep at the toe of the Mill Gulch Waste Repository.	An additional lined capture pond and groundwater capture system would be constructed below the contingency pond to capture impacted seepage. All captured water would be pumped to a water treatment plant. If feasible, captured water would be routed to the Zortman Water Treatment Plant; however, an additional treatment plant would be built for the Landusky mine site. Some water may also be returned to the process circuit, when additional water is required.
Mine Drainage	Potential contingency pond overflow.	The capture pond described for discharge would be appropriately sized to contain possible overflow from the contingency pond.
Mine Drainage	Potential overflow of the proposed capture pond.	Mine drainage may be released to Mill Gulch when storm events exceed the design capacity. Release would occur using a stand pipe in the pond, which would allow settling of suspended solids prior to release.
Storm Water	Runoff from the Mill Gulch Waste Repository.	The waste repository in Mill Gulch would be capped to reduce the amount of infiltration from storm water, which presently increases the volume of impacted seepage. Diversion ditches would be constructed to collect and discharge storm water to a dispersion point downstream of the proposed capture pond. Capping the waste repository would reduce the exposure of waste rock to water and possibly oxygen with resulting improvements in pH and sulfate concentrations in the seepage water.
Storm Water	Runoff from unimpacted areas.	No improvements are developed for this unimpacted area. The proposed capture pond would be sized to contain surface flow from this area. Alternately, a drain diverting the water around the capture pond may be proposed in the final engineering plans for Mill Gulch.
Storm Water	Runoff from access road and unimpacted areas northwest of the contingency pond.	BMPs would be applied to reduce erosion and improve the stability of steep slopes. An improved drain would be constructed along the road that would release storm water downstream of the capture pond.
Storm Water	Runoff from road and unimpacted areas around the Gold Bug Butte LAD site.	Areas of erosion along the road would be mitigated using BMPs. No improvements to the existing drain are necessary.

TABLE A-8 - PROPOSED WATER MANAGEMENT PRACTICES FOR MILL GULCH
(Concluded)

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Storm Water	Runoff from the 80, 81, 82, 84 Pad complex.	When reclamation of the 80, 81, 82, and 84 Pads is complete, drains would be constructed to route storm water runoff from these reclaimed pads into the west fork of Mill Gulch.
Storm Water	Dispersion point in west fork of Mill Gulch.	A lined drain system would be constructed to capture water from the two previously described storm water areas. The drain also may serve the Gold Bug pit area upon completion of reclamation of the pit area.
Storm Water	Landusky process and staging area.	No drains or other BMPs are developed for this area. No signs of erosion have been observed, likely because slopes receiving runoff are well vegetated.

* (Hydrometrics 1995)

TABLE A-9

WATER MANAGEMENT PRACTICES FOR MONTANA GULCH

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Seep from the August Drain tunnel at the toe of the Montana Gulch Waste Repository.	A lined capture pond would be constructed below the Montana Gulch Waste Repository to capture impacted seepage, and to capture storm water runoff from surrounding areas which drain toward the proposed pond. Capturing the water from the August Drain Tunnel before it is transported beneath the 85-86 Pad would prevent mixing with storm water from the storm water basin located west of the 85-86 Pad (SW-MT5). Reclamation capping of the August Pit floor and rerouting of potential recharge under alternatives 4, 5, 6, and 7 would reduce the volume of discharge from the August Drain tunnel. All captured water would be pumped to the Landusky water treatment plant. In situ lime precipitation may be tried as an alternative to treatment at a water treatment plant.
Storm Water	The existing drain along the northwest side of the Montana Gulch Waste Repository.	Minor modifications are proposed for this discharge, including check dams in the drain to reduce water flow rates and sediment erosion.
Mine Drainage	Flow from the August Drain Tunnel and runoff from storm water west of the Montana Gulch Waste Repository, which combines in underdrains beneath the 85-86 pad.	With the completion of the proposed capture pond described for mine drainage from the August drain tunnel, this discharge will consist entirely of storm water. The water management objective at this point would be to ensure separation of this water from other discharges. The existing drain which diverts water around the aeration pond would be enlarged to contain storm water runoff during large storm events. A new drain would be constructed which permits storm water to bypass the 85-86 Pad along the west side of the 85-86 Pad. However, approximately a 50 foot deep cut into a steep mountainside would be needed to allow the water to drain naturally along the edge of the pad.

TABLE A-9 - PROPOSED WATER MANAGEMENT PRACTICES FOR MONTANA GULCH
(Continued)

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Storm Water	Runoff from the 85-86 Pad buttress and adjacent unimpacted areas.	BMPs and/or drains would be used to prevent storm water from discharging to the contingency/aeration pond.
Mine Drainage	Discharge is the Gold Bug historic adit, and the release of water from the contingency/aeration pond which receives water from the Gold Bug Adit.	The existing aeration pond would be enlarged to contain runoff during storm events, or an additional lined capture pond would be constructed downstream of the aeration pond. The capture pond would contain both Gold Bug Adit releases, and surface water runoff from mine drainage areas. Additionally, BMPs would be used to improve the stability of steep slopes and reduce the amount of silt which is contained in the surface water runoff from the mine drainage areas. Mine drainage captured in this pond would be routed to the Landusky water treatment plant.
Storm Water	Release from drain north of the 83 Pad.	A drain would be constructed to route storm water into Montana Gulch. BMPs would be used to improve the stability of steep slopes and reduce the amount of silt which is contained in the runoff.
Mine Drainage	Potential overflow from the proposed capture pond.	Water may be discharged to Montana Gulch during storm events which exceed the design capacity of the pond. The quality of water during releases may be mitigated by the settling of suspended solids prior to release. Alternatively, wetlands or other treatment alternatives may be employed to treat discharges. However, the feasibility of such treatment alternatives must be ascertained.g

TABLE A-9 - PROPOSED WATER MANAGEMENT PRACTICES FOR MONTANA GULCH
(Concluded)

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Discharge is a seep at the toe of the 83 Pad buttress, and the potential overflow of the existing contingency pond, both of which presently are captured by the clay-lined pond located downstream.	An improved and enlarged lined capture pond would be constructed to further reduce the potential for pond overflow during large storm events and to improve the capture of seepage. An additional alluvial groundwater recovery system would be constructed to capture alluvial groundwater downgradient of the capture pond. Mine drainage captured in this pond would be routed to a water treatment plant (either the Zortman plant or a new Landusky plant). Some water may also be recycled into the process water circuit when additional make-up water is necessary.
Mine Drainage	Potential pond overflow of the existing (and future) capture pond.	Water may be discharged to Montana Gulch during storm events which exceed the design capacity of the pond. Because the pond is intended to primarily capture groundwater seepage, the storm water runoff would be routed around the pond, the potential for pond overflow is lower than for other proposed capture ponds.
Storm Water	Runoff from the reclaimed buttress to the 83 Pad.	BMPs would be applied to reduce erosion and improve the stability of steep slopes. An improved drain would be constructed along the road that would release storm water from reclaimed buttresses and adjacent ponds roads downstream of the capture pond.

* (Hydrometrics 1995)

TABLE A-10

WATER MANAGEMENT PRACTICES FOR KING CREEK

DISCHARGE	DESCRIPTION*	WATER MANAGEMENT PRACTICE
Mine Drainage	Seep at the head of King Creek drainage.	A sump would also be constructed to collect seepage. This water would be pumped to the water treatment plant or back into the process water circuit.
Storm Water	Runoff from the reclaimed slopes surrounding the north end of the Montana Gulch Waste Repository and the Landusky pit areas.	The northern section of the Montana Gulch Waste Repository was recently resloped and capped to reduce water infiltration. Alternatives 5 and 7 would route storm water that recharges groundwater in the mine pit areas into King Creek as runoff. BMPs would be applied to reduce erosion and improve the stability of steep slopes.
Storm Water	Runoff from the access road into King Creek.	A drain would be constructed along the road to control the flow and release of storm water. Also, BMPs would be applied to reduce erosion and improve the stability of steep slopes.
Mine Drainage	Potential pond overflow of the sedimentation pond.	No changes are proposed for this discharge other than source control of mine drainage to improve water quality.

* (Hydrometrics 1995)

LEGEND

Leach Pad	
Waste Repository, Buttress, or Dike Face	
Basin with Interior Drainage	
ZL-143 ●	Present Groundwater Monitoring Well
Z-1 ▲	Present Surface Water Monitoring Location
	Dispersion Point
	Capture Point
555	Seep Release
	Storm Water Release
595	Pond Overflow Release
BMP	General Area of Application of Best Management Practices
	General Flow Direction
	Drain System (Unlined)
	Drain System (on Bedrock)
	Drain System (Lined)
	Contingency Pond
	Storm Water Sediment Pond
	Process Pond
	Capture Pond
	Proposed Compliance Zone

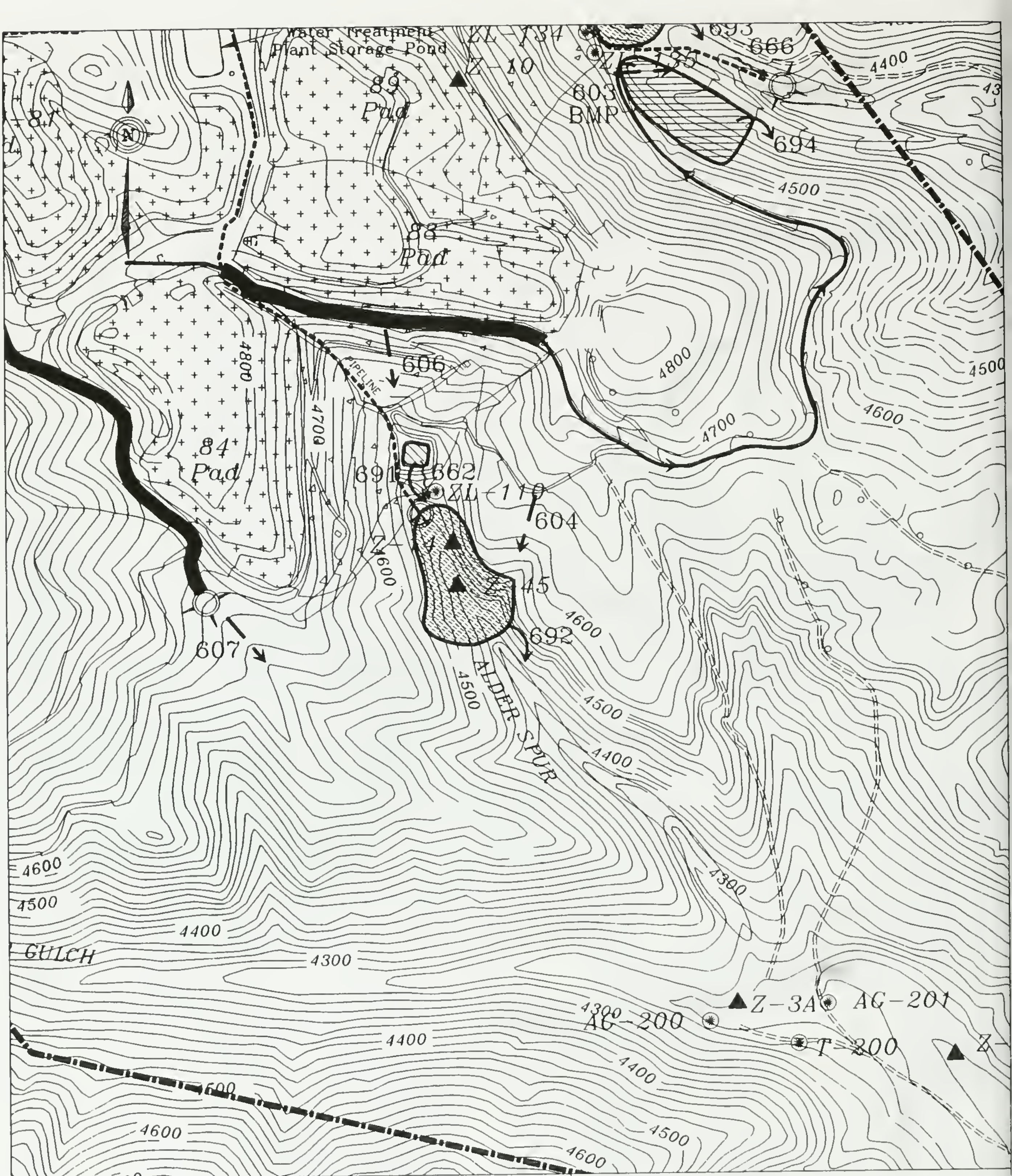
Zortman Mining Inc.

PROPOSED WATER MANAGEMENT
FACILITIES AND PRACTICES

FIGURE A-1

RUBY GULCH AREA
ZORTMAN MINE SITE

ORG DATE:	REV DATE:		FILENAME: 54-RUBY.DWG
7 JUNE 95			SCALE 1"=500'



LEGEND

- Leach Pad
- Waste Repository, Buttress, or Dike Face
- Basin with Interior Drainage
- ZL-143 ● Present Groundwater Monitoring Well
- Z-1 ▲ Present Surface Water Monitoring Location
- Dispersion Point
- ⊕ Capture Point
- 555 Seep Release
- Storm Water Release
- 595 Pond Overflow Release
- BMP General Area of Application of Best Management Practices
- General Flow Direction
- Drain System (Unlined)
- Drain System (on Bedrock)
- Drain System (Lined)
- Contingency Pond
- Storm Water Sediment Pond
- Process Pond
- Capture Pond
- Proposed Compliance Zone

Zortman Mining Inc.

PROPOSED WATER MANAGEMENT
FACILITIES AND PRACTICES

FIGURE A-2

ALDER SPUR AREA
ZORTMAN MINE SITE

ORG DATE:	REV DATE:		FILENAME: 54-SPUR.DWG
7 JUNE 95			SCALE 1"=500'

LEGEND

⁘	Leach Pad
⁘	Waste Repository, Buttress, or Dike Face
▨	Basin with Interior Drainage
ZL-143 ●	Present Groundwater Monitoring Well
Z-1 ▲	Present Surface Water Monitoring Location
⌖	Dispersion Point
⊕	Capture Point
555 →	Seep Release
→	Storm Water Release
595 ↰	Pond Overflow Release
BMP	General Area of Application of Best Management Practices
→	General Flow Direction
～	Drain System (Unlined)
～	Drain System (on Bedrock)
━	Drain System (Lined)
▨	Contingency Pond
⬭	Storm Water Sediment Pond
▨	Process Pond
▨	Capture Pond
⬭	Proposed Compliance Zone

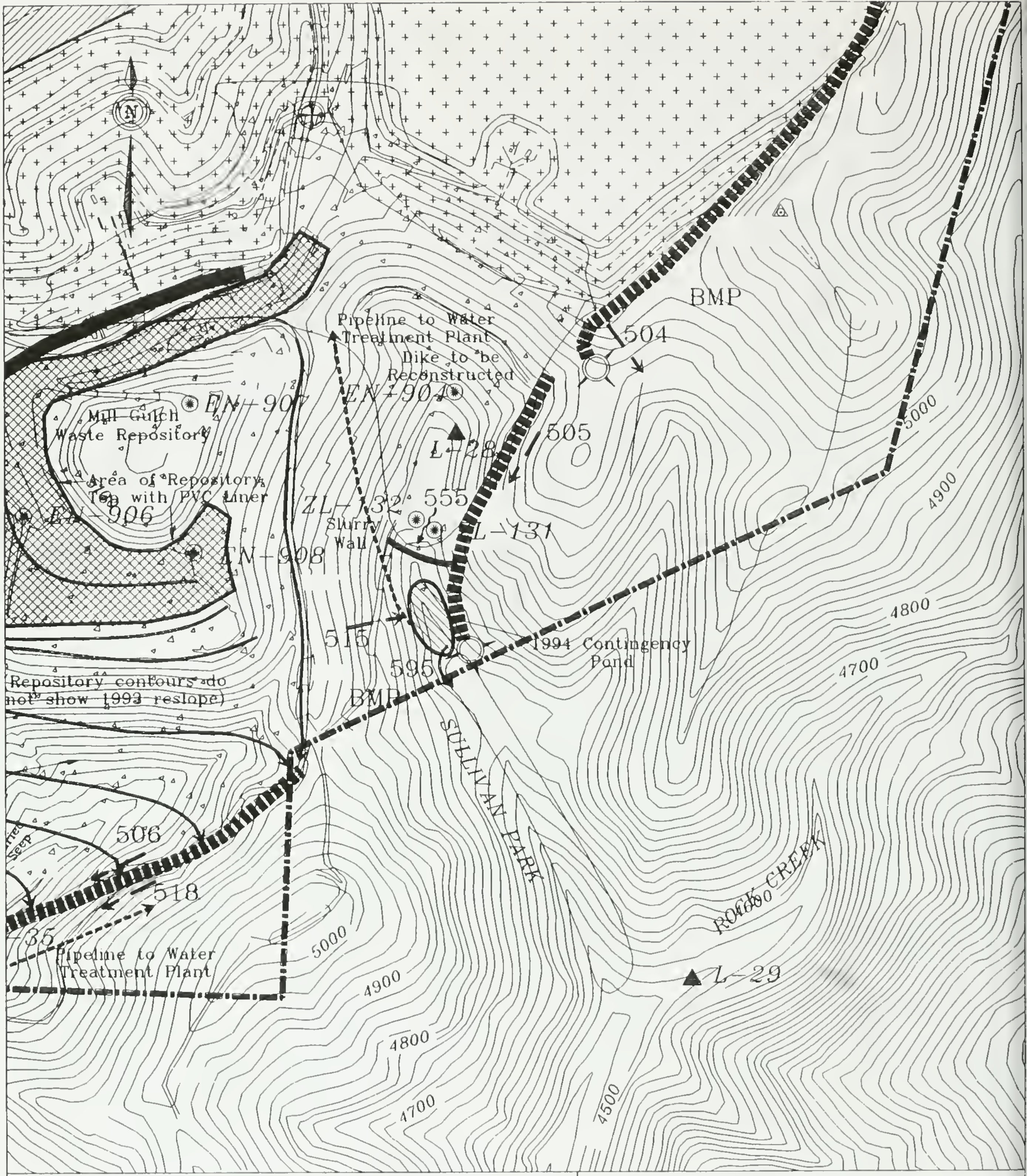
Zortman Mining Inc.

PROPOSED WATER MANAGEMENT
FACILITIES AND PRACTICES

FIGURE A-3

CARTER GULCH AREA
ZORTMAN MINE SITE

ORG DATE:	REV DATE:		FILENAME: 54-CARTER.DWG
7 JUNE 95			SCALE 1"=500'



LEGEND

⁘	Leach Pad
▨	Waste Repository, Buttress, or Dike Face
▨	Basin with Interior Drainage
ZL-143 ●	Present Groundwater Monitoring Well
Z-1 ▲	Present Surface Water Monitoring Location
⊖	Dispersion Point
⊕	Capture Point
555 →	Seep Release
→	Storm Water Release
595 ↩	Pond Overflow Release
BMP	General Area of Application of Best Management Practices
→	General Flow Direction
~	Drain System (Unlined)
▮▮▮	Drain System (on Bedrock)
▬	Drain System (Lined)
▨	Contingency Pond
▭	Storm Water Sediment Pond
▨	Process Pond
▨	Capture Pond
○	Proposed Compliance Zone

Zortman Mining Inc.

PROPOSED WATER MANAGEMENT
FACILITIES AND PRACTICES

FIGURE A-4

SULLIVAN PARK AREA
LANDUSKY MINE SITE

ORG DATE:	REV DATE:		FILENAME: 55-PARK.DWG
7 JUNE 95			SCALE 1"=500'

LEGEND

	Leach Pad
	Waste Repository, Buttress, or Dike Face
	Basin with Interior Drainage
ZL-143 ●	Present Groundwater Monitoring Well
Z-1 ▲	Present Surface Water Monitoring Location
	Dispersion Point
⊕	Capture Point
555 →	Seep Release
→	Storm Water Release
595	Pond Overflow Release
BMP	General Area of Application of Best Management Practices
→	General Flow Direction
	Drain System (Unlined)
	Drain System (on Bedrock)
	Drain System (Lined)
	Contingency Pond
	Storm Water Sediment Pond
	Process Pond
	Capture Pond
	Proposed Compliance Zone

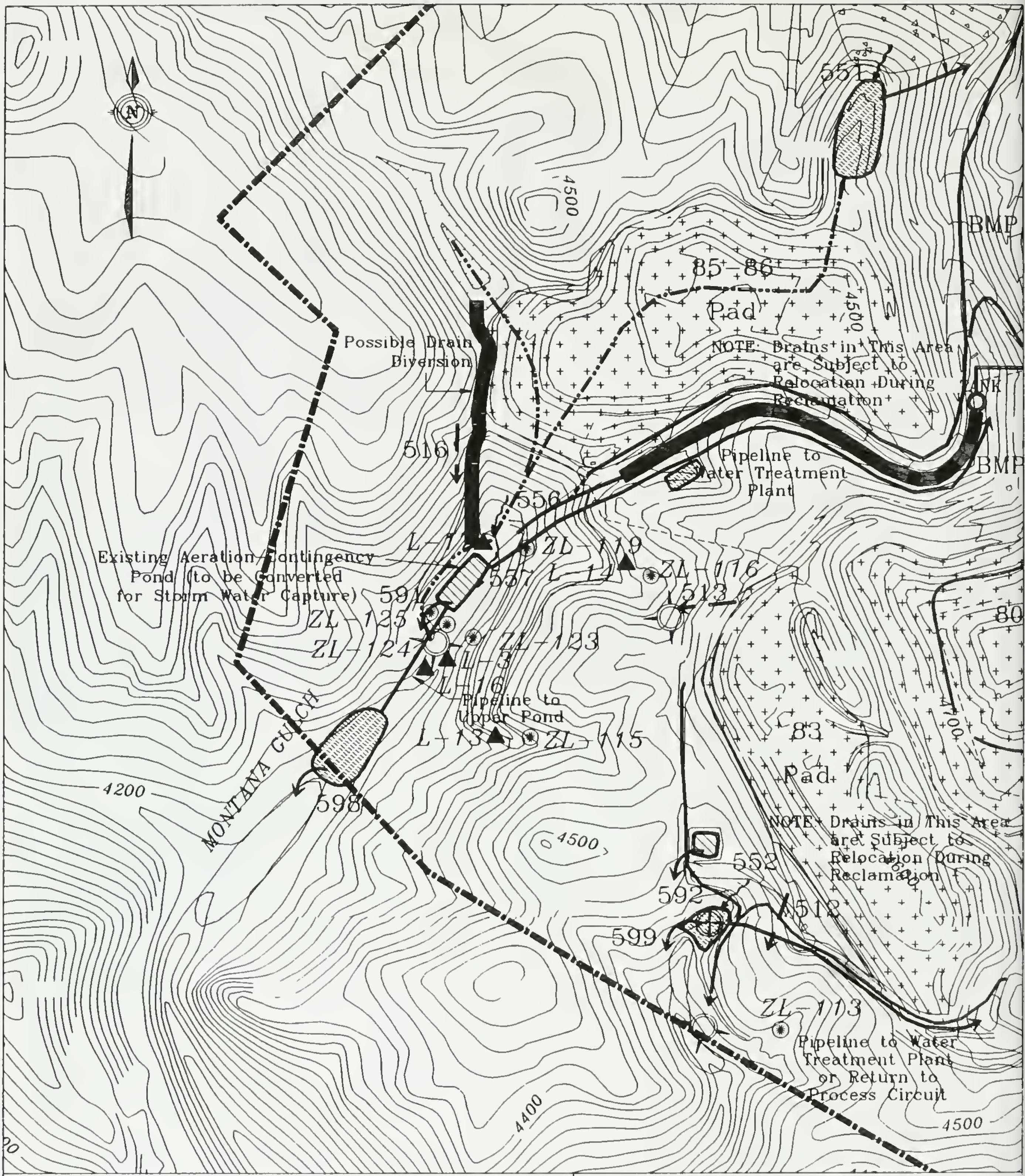
Zortman Mining Inc.

PROPOSED WATER MANAGEMENT
FACILITIES AND PRACTICES

FIGURE A-5

MILL GULCH AREA
LANDUSKY MINE SITE

ORG DATE:	REV DATE:		FILENAME: 55-MILL.DWG
7 JUNE 95			SCALE 1"=500'



LEGEND

- Leach Pad
- Waste Repository, Buttress, or Dike Face
- Basin with Interior Drainage
- ZL-143 ● Present Groundwater Monitoring Well
- Z-1 ▲ Present Surface Water Monitoring Location
- Dispersion Point
- ⊕ Capture Point
- 555 Seep Release
- → Storm Water Release
- 595 Pond Overflow Release
- BMP General Area of Application of Best Management Practices
- → General Flow Direction
- Drain System (Unlined)
- Drain System (on Bedrock)
- Drain System (Lined)
- Contingency Pond
- Storm Water Sediment Pond
- Process Pond
- Capture Pond
- Proposed Compliance Zone

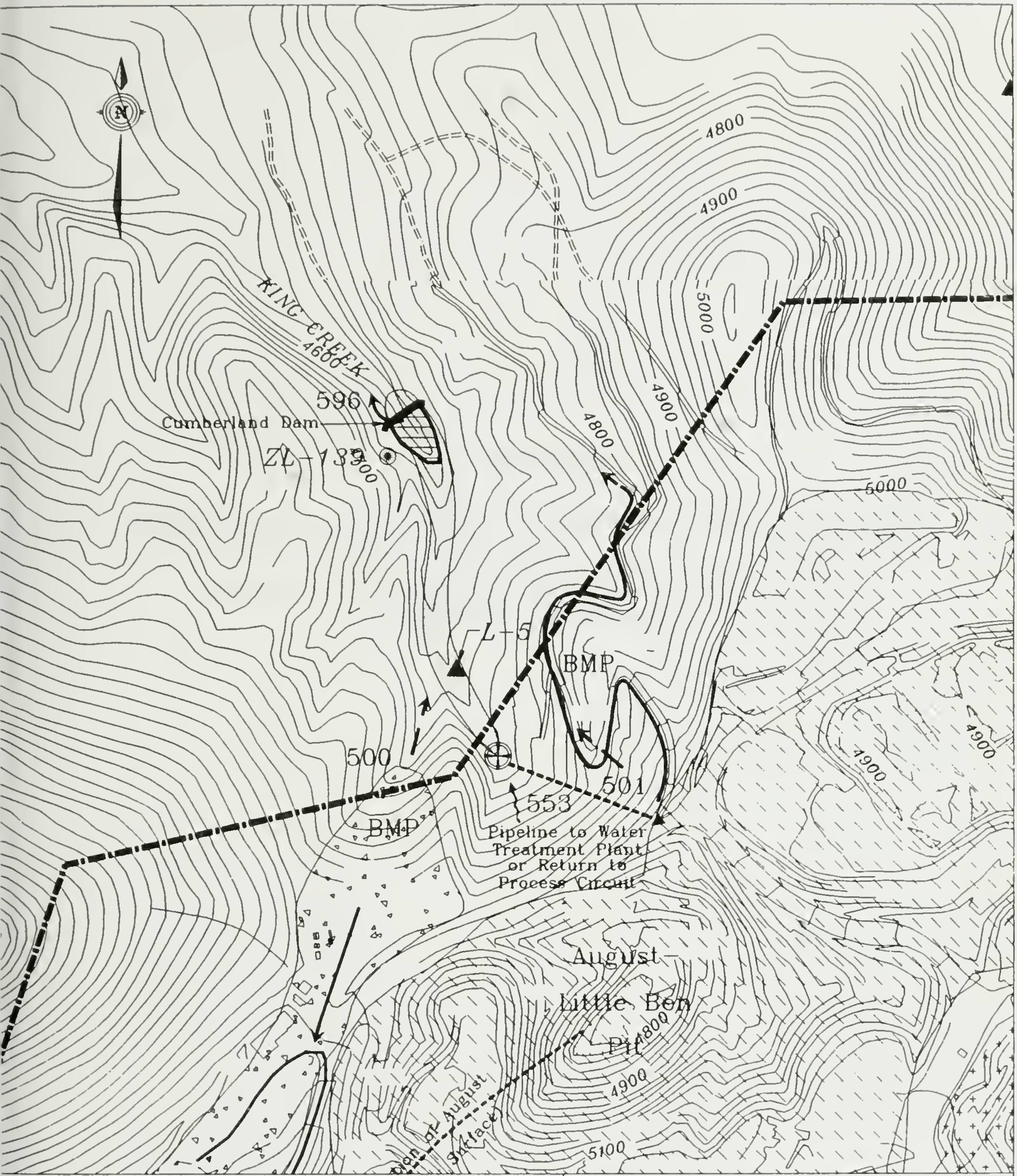
Zortman Mining Inc.

PROPOSED WATER MANAGEMENT
FACILITIES AND PRACTICES

FIGURE A-6

MONTANA GULCH AREA
LANDUSKY MINE SITE

ORG DATE:	REV DATE:		FILENAME: 55-MT.DWG
7 JUNE 95			SCALE 1"=500'



LEGEND

- Leach Pad
- Waste Repository, Buttress, or Dike Face
- Basin with Interior Drainage
- ZL-143 ● Present Groundwater Monitoring Well
- Z-1 ▲ Present Surface Water Monitoring Location
- Dispersion Point
- ⊕ Capture Point
- 555 Seep Release
- Storm Water Release
- 595 Pond Overflow Release
- BMP General Area of Application of Best Management Practices
- General Flow Direction
- Drain System (Unlined)
- Drain System (on Bedrock)
- Drain System (Lined)
- Contingency Pond
- Storm Water Sediment Pond
- Process Pond
- Capture Pond
- Proposed Compliance Zone

Zortman Mining Inc.

PROPOSED WATER MANAGEMENT FACILITIES AND PRACTICES

FIGURE A-7

KING CREEK AREA
LANDUSKY MINE SITE

ORG DATE:	REV DATE:		FILENAME: 55-KING.DWG
7 JUNE 95			SCALE 1"=500'

APPENDIX B

PRELIMINARY CLEAN WATER ACT SECTION 404(b)(1) SHOWING AND IMPACTS TO WETLAND FUNCTIONS AND VALUES ZORTMAN MINING, INC.

PRELIMINARY CLEAN WATER ACT SECTION 404(b)(1) SHOWING

CONTENTS

LIST OF TABLES

PRELIMINARY SECTION 404(b)(1) SHOWING
ZORTMAN MINING INC.
Zortman Mine and Landusky Mine Expansion and Reclamation Project

This document represents the Montana Department of State Land's and the U.S. Bureau of Land Management's (Agencies) opinion on how the preferred alternative complies with the requirements of the 404(b)(1) guidelines. This showing is not intended to represent the Corps of Engineers' conclusions or its final 404(b)(1) evaluation. This showing is provided to solicit public input, comments, and foster increased public awareness and participation in the Environmental Impact Statement (EIS) process.

1.0 SUBPART A - GENERAL INTRODUCTION

The 404(b)(1) Guidelines (40 Code of Federal Regulations [CFR] 230) are the substantive criteria used in evaluating discharges of dredged or fill material in waters of the U.S. under Section 404 of the Clean Water Act, and are applicable to all Section 404 permit decisions. Fundamental to these guidelines is the precept that dredged or fill material should not be discharged into an aquatic ecosystem unless it can be demonstrated that such discharges would not have unacceptable, adverse impacts either individually or in combination with known or probable impacts of other activities affecting the ecosystems of concern.

Subpart B of the guidelines outlines restrictions imposed on all discharges, the factual determinations required by the guidelines and specifications for a determination of compliance or noncompliance with the guidelines.

> Section 230.10(a) states no discharge of dredged or fill material shall be permitted, except as provided under Section 404(b)(2) of the Clean Water Act, if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.
>
> Section 203.10(b) establishes three conditions, applicable to inland waters, which must be satisfied to make a finding that a proposed discharge complies with the guidelines. No discharge of dredged or fill material shall be permitted if it:
>
> > a) Violates applicable state water quality standards;
> >
> > b) Violates any applicable toxic effluent standard or prohibition under Section 307
> > of the Clean Water Act; or
> >
> > c) Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, or results in likelihood of the destruction or adverse modification of a habitat which is determined to be a critical habitat.
>
> Section 230.10(c) provides that no discharge of dredged or fill material shall be permitted if it will cause or contribute to significant degradation of the waters of the U.S., except as provided under Section 404(b)(2).
>
> Section 230.10(d) prohibits the discharge of dredged or fill material, except as provided under Section 404(b)(2) of the Clean Water Act, unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.

Section 230.11 requires the permitting authority to determine in writing the potential short-term or long-term effect of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment in light of subparts C-F. The determinations of effects of each proposed discharge shall include the following:

a) Physical substrate determinations;

b) Water circulation, fluctuation, and salinity determinations;

c) Suspended particulate and turbidity determinations;

d) Contaminant determinations;

e) Aquatic ecosystem and organism determinations;

f) Proposed disposal site determinations;

g) Determination of cumulative effects on the aquatic ecosystem; and

h) Determination of secondary effects on the aquatic ecosystem.

Subparts C through F list the potential impacts on the physical and chemical characteristics of the aquatic ecosystem; the potential impacts on the biological characteristics of the aquatic ecosystem; the potential impacts on special aquatic sites; and the potential effects on human use characteristics to be considered in making the factual determinations and the findings of compliance or noncompliance in Subpart B. Subpart G sets forth evaluation and testing procedures to obtain information necessary to reach the determinations in Subpart B. Subpart H lists actions to be undertaken to minimize the adverse effects of discharges of dredged or fill material.

This Section 404(b)(1) evaluation includes a description of the proposed discharge of fill material to be evaluated under Section 404 of the Clean Water Act and an analysis of the discharge according to the requirements of Subparts B through H. For this evaluation, primary effects are equated with direct impacts and secondary effects are equated with indirect impacts. Construction-related impacts are considered direct. Indirect impacts can occur at some distance from the project site or can be associated with actions that occur after the project is operational.

Additionally, the Corps of Engineers Regulations (33 CFR 320.4a[2]i-iii) require consideration of the relative extent of the public and private need; when there are unresolved conflicts as to resource use; and the extent and permanence of the beneficial or detrimental effect of the proposed structure or work on the public and private uses to which the area is suited.

1.1 Project description — Zortman Mining Inc. — Zortman and Landusky Mines Expansion Project

Zortman Mining Inc. (ZMI) requests permission to place fill material in various waters of the U.S. and associated wetlands in conjunction with the ZMI mine expansion and reclamation project. ZMI currently has two active gold mines nearby: the Zortman Mine and the Landusky Mine. The two mines are located in the Little Rocky Mountains in southwestern Phillips County, Montana. The current mining projects were permitted by Montana Department of State Lands (DSL) in 1979 under operating permits number 00095 (Landusky mine) and number 00096 (Zortman mine). ZMI has received numerous amendments to these operating permits between August 1, 1979 and August 23, 1989. These amendments are summarized in tables in Section 1 of the Draft EIS. ZMI's current areas of operations include the Landusky permitted area of 730 acres with 487 acres disturbed, and the Zortman permitted area of 961 acres with 401 acres disturbed.

At the Zortman Mine, the expansion and reclamation project proposes to mine an additional 80 million tons of ore and 60 million tons of waste rock. At this projected mining rate of 21 to 28 million tons per year, the expansion would allow for an additional 5 to 8 years of mining. Under the preferred mine expansion alternative (Alternative 7), an additional 769 acres would be disturbed for a total disturbance 1,170 acres at the Zortman mine. Under Alternatives 4, 5, 6, and 7, the Landusky mine expansion and reclamation project proposes to mine an additional 7.6 million tons of ore and 7 million tons of waste rock. No additional surface areas would be disturbed directly from mining. However, 72.4 additional acres would be disturbed at Landusky to provide for a land application support area, one or more limestone quarries, and other reclamation access and drainage construction activities.

ZMI would continue to use open-pit mining and heap-leach mineral processing to extract gold and silver from ore. The primary facilities and activities of the proposed mine expansion and reclamation project alternatives that involve surface disturbances and have direct or indirect impacts to waters of the U.S. and wetlands are:

- Construction of a heap-leach pad at Goslin Flat (Alternatives 4, 6, and 7) or Upper Alder Gulch (Alternative 5)
- Construction of a ore handling area at Goslin Flat (Alternatives 4, 6, and 7) or near the mine (Alternative 5)
- Construction of a conveyor system for ore transport (Alternatives 4, 6, and 7)
- Construction of a new waste rock repository in Carter Gulch (Alternatives 4 and 5), at the Ruby terrace (Alternative 6), or at the Zortman pit complex (Alternative 7)
- Removal of the existing Alder Gulch waste rock dump (Alternatives 4, 5, 6, and 7)
- relocate the Zortman to Landusky access road, power line and pipeline, upgrading of haul roads, and construct a new topsoil stockpile.

The Goslin Flats heap leach pad and ore handling area (Alternatives 4 and 7) would cover approximately 290 acres located primarily along the lower portion of Goslin Gulch, an ephemeral tributary to Ruby Creek. Geomorphically, the pad site is located on the first pediment stream terrace surface of Goslin Gulch. The proposed pad would be approximately 5,200 feet long and 1,800 feet wide and would have sufficient capacity to contain the present anticipated reserves of 80 million tons of ore. Ore would be stacked in 25-foot lifts to a maximum depth of approximately 200 feet. Prior to pad construction, the Goslin Flat location would be used to salvage approximately 1 million cubic yards of cover soil for use in reclaiming disturbed areas. Cover soil salvage volumes were based on salvaging up to 3 feet of soil over the 250-acre site.

The proposed overland conveyor system would connect the open pit operations to the heap leach facilities at Goslin Flat. The conveyor would be about 12,000 feet long with an elevation drop of about

1,000 feet. Construction of a maintenance road and fence, along some sections of the conveyor, would create an average 50-foot wide disturbance along the conveyor route.

Removing the existing Alder Gulch waste rock dump would involve relocating approximately 3.4 million tons of material from the current repository to the proposed Goslin Flat heap leach pad. The existing Alder Gulch waste rock is seeping poor-quality water from the toe of the dump; removing this material should reduce impacts to the drainage.

In 1991, a comprehensive delineation and inventory of waters of the U.S. and wetlands was prepared for ZMI by Western Technology and Engineering, Inc. with assistance by Hydrometrics, Inc. (Zortman Mining Inc. 1995). No comprehensive inventory of waters of the U.S. and wetlands was conducted prior to 1991. The 1991 inventory (Zortman Mining Inc. 1995) was completed as part of a draft Predischarge Notification (PDN) Nationwide Permit No. 26 application to the Corps of Engineers. Results of the 1991 inventory were used to help assess the direct and indirect impacts to waters of the U.S. and wetlands associated with past, current, and proposed mining activities associated with on-going mining and the proposed ZMI mine expansion and reclamation project.

Potential acreage of waters of the U.S. and wetlands affected by direct placement of fill materials before 1991 have been estimated and inferred using a series of aerial photographs and topographic maps of the mines dating from December 17, 1981 to July 1994. Acreage was estimated based on chronological scaled aerial photographs, reviews of available vegetation, hydrology, and soil inventories since 1977, and other assumptions based on best professional judgement. To be conservative, potential acreage for waters of the U.S. extending through historic disturbances were included. Before 1991, it is estimated, about 4.23 acres of waters of the U.S. (2.99 acres at Landusky and 1.24 acres at Zortman) and less that 0.1 acre of wetlands have been directly affected by mining at the Zortman and Landusky mines (Gallagher 1995).

In additional to the directly affected acres, waters of the U.S. and wetlands have been indirectly disturbed by existing mining mainly through increased sediments in surface runoff, acid rock drainage, leach pad leakage, and noise. The proposed mine expansion and reclamation project will most likely create additional indirect impacts, primarily through the same processes and through construction of water capture facilities downstream of the waste rock and leach pad piles. Other indirect impacts have resulted from constructing diversion ditches around the waste rock and leach pad facilities and by the placement of rock blankets in some receiving streams. Indirect impacts have not been accurately quantified for the existing and proposed mine disturbances. However, the total ephemeral and intermittent stream lengths for the impacted drainageways have been calculated and will be provided in a future deliverable. Calculated stream lengths were estimated based on the waters of the U.S. delineations provide in the draft PDN Nationwide Permit No. 26 application (Zortman Mining Inc. 1995).

For the 1991 inventory, waters of the U.S. and wetlands were identified and delineated at the Zortman and Landusky mines based on technical criteria presented in both the 1987 wetland manual (Environmental Laboratory 1987) and 1989 wetland manual (Federal Interagency Committee for Wetlands Delineation [FICWD] 1989). Identification and delineation activities used both off-site and on-site methods described in Part IV of the 1987 and 1989 wetland manuals. Most of the preliminary identifications were performed off-site because detailed vegetation, soils, and hydrology baseline inventories were available. Most of the on-site survey work was conducted using the 1989 manual since its use was considered most valid at the time of the field work. Supplemental information was necessary for accurate delineations and included on-site evaluations of wetland hydrology, hydric soils, and hydrophytic vegetation, and measuring widths of hydrophytic zones along drainages. National Wetland Inventory (NWI) maps were not available for the project area.

Results of the Waters of the U.S and wetlands inventory are presented on four individual large-format map sheets attached to the draft PDN permit application (Zortman Mining Inc. 1995). Due to the relatively small size of the delineated waters of the U.S. and narrow wetland areas compared to the large mine permit area, the delineated areas are not visually readable on standard-format maps. Acreage for the waters of the U.S. and wetlands have been totaled only for the areas affected by the various mining alternatives. The acreage totals by mine alternatives are presented in Table 1. The Corps of Engineers conducted a site inspection on June 14 and 15, 1995 and its determinations based on that inspection are undergoing review.

Waters of the U.S. and wetlands within the proposed mine project area were recognized as providing several important functions and values. Waters of the U.S. and wetland functions and values were assessed using a modified evaluation approach adapted from the Wetland Evaluation Technique of Adamus et al. (1991). In addition, best professional judgement based upon the best available literature information was also used in this assessment. Overall ratings of the existing wetland functions and values will be provided in a future deliverable.

A mitigation plan has been drafted that would create about 1.79 acres of wetland to compensate for the direct loss of about 1.06 acres of wetlands and indirect loss to another 0.48 acres of wetlands. The total 1.54 impacted acres are associated with the construction of the Goslin Flats heap leach pad and ore processing facility. This mitigation plan is described in the draft PDN permit application (Zortman Mining Inc. 1995). In addition to loss of wetlands, an estimated 2.08 to 3.01 acres of waters of the U.S. would be directly impacted by placement of fill under the various expansion project action alternatives. Alternative 7, the preferred alternative, would result in direct impacts to 2.51 acres of waters of the U.S. and 1.06 acres of wetlands. As stated above, approximately 4.23 acres of waters of the U.S. have previously been filled by mining activities. In total, an estimated 6.74 acres of waters of the U.S. will be directly affected by past and proposed mining activities. Mitigation efforts to offset adverse impacts to these waters of the U.S. have not been formally introduced but would likely be required by the Corps of Engineers before its recommendation to issue a permit.

Additional information on impacts and mitigation for waters of the U.S. and wetland resources are contained in Sections 2.0 and 4.0 of the draft EIS. Proposed mining and reclamation plans for the proposed ZMI mine expansion and reclamation project are detailed in the Application for Amendment to Operating Permit No. 00096, Volume 5, submitted to the Montana DSL (Zortman Mining Inc. 1993).

1.2 Description of filling activities associated with the ZMI mine project

The existing Zortman and Landusky mine operations have previously caused direct impacts to approximately 4.23 acres of existing waters of the U.S. and less than 0.1 acre of wetland through the placement of fill material in these areas. The ZMI mine expansion and reclamation project would result in additional direct impacts to 2.51 acres of waters of the U.S. and up to 1.06 acres of wetlands, depending on the mine alternative selected (see Table 1).

Construction and operation of the proposed Goslin Flat heap leach pad and ore handling facility will account for about 1.6 of the total 2.51 acres of directly affected waters of the U.S. Other proposed mine facilities that would require placement of fill materials in the remaining 0.9 acres of waters of the U.S. are the construction of the waste rock repository, access roads, haul roads to Landusky and the limestone quarries, pipe line and powerline, and the conveyor corridor. The entire 1.06 acres of directly affected wetlands are associated with the Goslin Flat leach pad area.

The type and quantity of fill materials that have been placed in existing waters of the U.S. or are proposed for placement in waters of the U.S. and wetlands are provided in Table A-1 of the draft PDN permit application (Zortman Mining Inc. 1995). At the Goslin Flat, waters of the U.S. and wetlands would be disturbed at the beginning of the expansion project and would receive fill materials continuously throughout the 5 to 8 year life of the pad. As much as 0.87 million cubic yards (1.3 million tons) of ore may be placed directly on top of the approximate 1.63 acres of waters of the U.S. and 1.06 acres of wetlands located under the proposed Goslin Flats leach pad area. The remaining 0.88 acres of waters of the U.S. proposed to receive fill materials would receive a combined total of 855 cubic yards (1,282 tons).

Conventional earth-moving equipment, such as front-end loaders, dump trucks, bulldozers, and rubber-tired scrapers, would be used to place fill materials in all waters of the U.S. and wetlands except the Goslin Flat heap leach pad. The conveyor and stacker system would be used for placing the ore and relocated Alder Gulch waste rock to the Goslin Flat heap leach pad.

2.0 SUBPART B - COMPLIANCE WITH THE GUIDELINES

2.1 Section 230.10 - Restrictions on the discharge

2.1.1 Section 230.10(a): Practicable alternative analysis

Seven mining alternatives, described and analyzed in the draft EIS, were developed in response to environmental issues and concerns outlined in Table 1-4 of the draft EIS. Chapter 2 of the draft EIS describes the development, evaluation, and selection of the project alternatives. Section 2.4 presents the summary descriptions of the mine alternatives. The affected acreage of waters of the U.S. and wetlands for each of the seven mining alternatives is shown in Table 1.

Because waters of the U.S. and wetlands will be affected by the proposed mine expansion, the protection and mitigation of these waters of the U.S. and wetlands must be considered in the EIS analysis. The Section 404 program prohibits placement of fill material if there are practicable alternatives that are less damaging to the aquatic environment or if the placement of fill would result in significant degradation of our nation's waters. Basic informational needs required to evaluate waters of the U.S. and wetlands for this project relate to the following four categories: (1) characterization, (2) functional assessment, (3) impact assessment, and (4) mitigation. The mitigation requirements are based on the acres, type, and functional quality of the existing and impacted waters of the U.S. and wetlands. The mitigation plan is necessary to evaluate the avoidance, minimization, and compensation efforts. When compensation is required, additional information is necessary to evaluate which of the three types of compensation (creation, restoration, or enhancement) may be most applicable for the site.

Under Alternatives 1, 2, and 3, the no-action and two mine expansion not approved alternatives, the agencies would not approve expansion of the Zortman and Landusky Mines, although mine activities already permitted, including ore leaching and rinsing, would continue. The existing Zortman and

Landusky mines (1977 to 1991) have already placed fill in about 4.23 acres of waters of the U.S. (3.0 acres at Landusky and 1.24 acres at Zortman) and less that 0.1 acre of wetlands (Gallagher 1995). Mitigation measures will be required to address these previous filling activities. Primary differences among these three alternatives relate to the mitigated reclamation procedures, specifically the amount of slope reduction, backfilling, and reclamation covers required.

Alternative 4, proposed by the company, consists of expanded mine operations at both Zortman and Landusky Mines and implementation of modified reclamation plans. Mine facilities and activities that would have direct and indirect impacts to waters of the U.S. and wetlands are the: (1) Goslin Flat heap-leach pad and ore handling area; (2) overland conveyor system; (3) relocation of the existing Alder Gulch waste rock dump; (4) construction of a new waste rock repository in Carter Gulch; and (5) construction of a new section of the Zortman to Landusky access road. This expansion alternative would affect approximately 3 acres of waters of the U.S. and 1.06 acres of wetlands by direct placement of fill.

Alternative 5 would allow expansion of both the Zortman and Landusky Mines but would require major modifications to the expansion and reclamation plans. The major modification would relocate the Goslin Flat leach pad facility to an Upper Alder Gulch site as a means to mitigate for visual, noise, and wildlife impacts. The conveyor system would not be needed. The Upper Alder Gulch leach pad would physically cover approximately 180 acres. However, a total area of approximately 308 acres would be affected when including the area enclosed by the surface water diversion canals necessary to divert the natural flows around the leaching facility to Alder Gulch below. This expansion alternative would directly affect approximately 2.1 acres of waters of the U.S. and less than 0.1 acre of wetlands through direct placement of fill. Additional indirect impacts, particularly to waters of the U.S. in Alder Gulch, are estimated to occur.

Alternative 6 would allow expansion of both the Zortman and Landusky Mines but would require a major modification by locating the waste rock facility on the Ruby Terrace just east of the proposed Goslin Flat heap leach pad. This alternative was developed partly because it would be easier to construct the repository on Ruby Terrace than in the Carter Gulch. In addition, the conveyor system could be used to transport both ore and waste rock. The Ruby Terrace waste rock repository would encompass approximately 203 acres and would stand approximately 300 feet high when full. The Goslin Flat heap leach pad and ore handling area would cover approximately 290 acres and would be approximately 5,200 feet long, 1,800 feet wide, and 200 feet high. This expansion alternative would affect approximately 2.2 acres of waters of the U.S. and 1.06 acre of wetlands through direct placement of fill materials. Additional indirect impacts may be associated with rerouting the 7-mile road and constructing diversion channels around the Ruby Terrace waste rock repository.

Alternative 7 would allow expansion of both the Zortman and Landusky Mines but would require a major modification by locating the waste rock repository on top of the existing disturbance at the Zortman Pit Complex. This alternative was developed primarily to reduce the amount of land disturbance, reduce potential impacts to water resources, and enhance reclamation opportunities on existing facilities. Many of the reclamation and mitigation details for Alternative 7 are similar to, or the same as, those for Alternative 4. The conveyor system would be used to transport ore to the Goslin Flat ore handling and leach pad facility. This expansion alternative would affect approximately 2.51 acres of waters of the U.S. and 1.06 acre of wetlands through direct placement of fill materials. Compared to Alternative 4, Alternative 7 would result in 0.5 fewer acres of filled waters of the U.S.

Several other reasonable alternatives were evaluated based on engineering, environmental, and economic factors. These alternatives were developed and considered primarily regarding their potential for a waste rock storage facility and an ore heap leaching facility. Selection criteria used to identify potential waste rock and heap leach facilities included (1) sufficient capacity to hold 80 million cubic yards, (2) geotechnical conditions, and (3) minimization of seepage potential. Detailed discussions of these alternatives considered and eliminated are presented in Section 2.3 of the draft EIS.

2.1.2 Section 230.10(b) - Discharge compliance with guidelines

The Section 404(b)(1) guidelines Section 230.10(b) require that no discharge shall be authorized if it:

1. Causes or contributes to any violation of applicable water quality standards.
2. Violates any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act.
3. Jeopardizes the continued existence of species listed as threatened or endangered under the Endangered Species Act (ESA) of 1973, as amended, or results in likelihood of the destruction or adverse modification of critical habitat under the ESA of 1973.

Placement of fill materials in waters of the U.S. and wetlands for construction and operation of facilities associated with this mine expansion and reclamation project has been evaluated under the following:

State water quality standards: The Montana Department of Health and Environmental Sciences (DHES), Water Quality Division provides Section 401 certification pursuant to state rules (Administrative Rules of Montana [ARM] 16.20.1701 et seq.). The Montana DHES will review this placement of fill material and will make a determination for violations of applicable state water quality standards. Montana DHES will not make its final ruling until ZMI submits a Water Management Plan for the Zortman and Landusky Mines. The Corps of Engineers cannot complete its final 404(b)(1) evaluation until the Section 401 certification is completed. Any conditions to the 401 certification will be conditions of the Section 404 permit. A Section 401 certification does not constitute a relinquishment of Montana DHES Water Quality Division's authority, or any subsequent alterations or additions thereto, nor does if fulfill or waive any other local, state, or federal regulations.

Toxic effluent standard or prohibition: Documentation of the potential for acid rock drainage from fill materials resulting from this project is contained in the draft EIS. Determination of compliance with Section 307 of the Clean Water Act is encompassed in the Montana DHES review. Section 307 requires review of the project in light of the possible introduction of toxic pollutants. As indicated above, water quality certification pursuant to Section 401 of the Clean Water Act will be required. All conditions identified in the Section 401 certification will be included as conditions should the 404(b)(1) evaluation result in a recommendation to issue a permit.

Threatened or endangered species: Impacts to threatened or endangered species were addressed in the draft EIS and are addressed elsewhere in this evaluation. To comply with the Endangered Species Act, a biological assessment will be prepared to evaluate the potential effects on threatened and endangered species that may be present in the project area. The U.S. Fish and Wildlife Service (USFWS) will review the biological assessment and render a biological opinion. If the USFWS determines that the preferred alternative may jeopardize the continued existence of a species, it may offer a reasonable and prudent alternative that would, if implemented, preclude jeopardy. ZMI must successfully meet the requirements of this section of the 404(b)(1) guidelines in order for the 404(b)(1) evaluation to result in a recommendation to issue a permit. The applicant realizes failure to meet the requirements of this section will result in a recommendation of denial.

2.1.3 Section 230.10(c) - Degradation of waters of the U.S.

Project impacts that would cause or contribute to significant degradation of waters of the U.S. are addressed throughout this document and in the draft EIS. The recommendation to issue a permit will be based on the assessment of existing impacts to previously disturbed waters of the U.S. and the potential impacts resulting from the mine expansion and reclamation project.

The existing Zortman and Landusky Mines (1977 to 1991) have already placed fill in about 4.23 acres of waters of the U.S. (2.99 acres at Landusky and 1.24 acres at Zortman) and less that 0.1 acre of wetlands (Gallagher 1995). Mitigation plans for these previously disturbed waters of the U.S. will be required in order to address the overall degradation of waters of the U.S. associated with the Zortman and Landusky mines. Proposed wetland mitigation plans were submitted in the draft PDN permit application (Zortman Mining Inc. 1995). In order to conclude that the ZMI mine expansion and reclamation project will not cause or contribute to additional degradation of Waters of the U.S, ZMI must successfully meet the requirements of this section of the 404(b)(1) guidelines.

Section 230.10(c) of the guidelines prohibits the discharge of dredge or fill material that will cause or contribute to significant degradation of waters of the U.S. Findings of significant degradation must be based on factual determinations, evaluations, and testing. Title 33 CFR Part 320.4(b)1-3 also states that the unnecessary alteration or destruction of wetlands should be discouraged as contrary to the public interest.

From a national perspective, the degradation or destruction of wetlands, and other special aquatic sites, is considered to be the most severe environmental impact covered by the 404(b)(1) guidelines. Wetlands perform various functions that are vital to the integrity of the wetland system and contribute to the overall quality of the nation's waters. Examples of these wetland functions are groundwater recharge and discharge, sediment stabilization, sediment/toxicant retention, production export, and nutrient removal/transformation. Other wetland functions considered important to the public interest and that serve significant biological functions are the providing of: general habitat (nesting, spawning, rearing, and resting sites); aquatic diversity and abundance; wildlife diversity and abundance; recreation; and uniqueness in nature or scarcity in the region.

ZMI completed a comprehensive identification and delineation of waters of the U.S. and wetlands for the Zortman and Landusky Mines in 1991 with technical assistance from Western Technology and Engineering Inc. and Hydrometrics, Inc. (Zortman Mining Inc. 1995). Nearly all waters of the U.S. and wetland areas within the inventory boundary were characterized and delineated. Wetlands were mapped using topographic base maps and enlarged color aerial photographs. The Corps of Engineers conducted a site inspection on June 14 and 15, 1995 and its determinations based on that inspection are undergoing review.

Waters of the U.S. and wetlands within the proposed mine project area were recognized as providing several important functions and values. Waters of the U.S. and wetland functions and values were assessed using a modified evaluation approach adapted from the Wetland Evaluation Technique (WET 2.0) of Adamus et al. (1987). In addition, best professional judgement based upon the best available literature information was also used in this assessment. A overall rating summary of these functions and values will be provided in the future.

The cumulative impacts from the existing 4.23 acres of disturbed waters of the U.S. together with the additional impacts from the mine expansion approval alternatives (Alternatives 4, 5, 6, and 7), would decrease the amount of waters of the U.S. and wetlands and their ecological functions. Hydrologic support (groundwater discharge), floodflow alteration, sediment stabilization, water purification, and aquatic and wildlife diversity and abundance are considered to be the most important functions of the waters of the U.S. and wetlands. Development of the Goslin Flat heap leach pad and ore processing facility would remove more than 300 acres of natural watershed in the Goslin Gulch drainage. The capture of surface water by the Goslin Flats facility could reduce the frequency and duration of saturation, inundation, and ponding of water for some portion of the waters of the U.S. and wetlands downgradient. Additionally, a failure in the water treatment collection system may affect surface and groundwater quality and affect additional downgradient waters of the U.S. and wetlands (see Section 2.0 of the draft EIS).

2.1.4 Section 230.10(d) - Appropriate and practicable steps to minimize potential adverse impacts of the discharges on the aquatic ecosystem

The primary steps to minimize potential adverse impacts to waters of the U.S. and wetlands pertain to locating the mine features and facilities to maximize wetland avoidance. The two major facility components were the waste rock storage area and the ore heap leaching facility. Locations for these facilities were considered and evaluated based on engineering, environmental, and economic factors. Eight waste rock repository locations were considered: (1) Upper Ruby Gulch, (2) Lower Ruby Gulch, (3) total backfill of Zortman or Landusky pits, (4) partial backfill of Zortman or Landusky pits, (5) Goslin Flat, (6) Ruby Terrace, (7) Lodgepole Creek, and (8) Zortman Mine Complex. Six heap leach area locations were considered: (1) Ruby Gulch, (2) Upper Alder Gulch, (3) Placement of ore onto existing leach pads, (5) placement of ore into existing pits, and (6) Goslin Flat.

These facility locations were evaluated based partially on their ability to avoid waters of the U.S. and wetlands. However, other environmental factors were also considered. The inclusive environmental evaluations considered potential impacts to air, water, and soil, with consideration of subsequent impacts to vegetation, wildlife, and human health. Alternatives 4, 5, 6, and 7, the four mine expansion action alternatives, would directly fill 2.08 to 3.01 acres of waters of the U.S. Alternative 7, the preferred alternative, would result in directly filling 2.51 acres of waters of the U.S. Approximately 4.23 acres of waters of the U.S. have previously been filled by mining activities. In total, an estimated 6.74 acres of waters of the U.S. will be directly filled with materials by past and proposed mining activities. Mitigation efforts to offset adverse impacts from these previously filled waters of the U.S. have not been formally introduced but would likely be required by the Corps of Engineers prior to its recommendation to issue a permit.

The facility locations were evaluated in light of the significant issues described in Section 2.2 of the draft EIS. Facility locations that were considered acceptable and retained for analysis in this EIS generally received acceptable engineering and environment ratings. Facility locations were considered unacceptable if the engineering design was infeasible, they failed to be protective of the environment, or were considered uneconomical. The significant issues most pertinent to the facility locations were:

(1) Water Quality — possible additional adverse water quality impacts after the mine expansion and reclamation project was complete

(2) Acid Rock Drainage — proposed mine expansion and reclamation project would develop sulfide ore and create possible additional adverse water quality impacts

(3) Goslin Flat heap leach pad — concerns about storage and potential leakage, visual impacts, access restrictions, effectiveness of heap neutralization prior to closure, heap stability, adequate solution storage and flood diversion, quality of construction, acid rock drainage (ARD) potential, and hazards to wildlife

(4) Carter Gulch waste rock dump — concerns about waste characterization, waste handling, waste modification, acid rock drainage, dump stability, and reclamation and monitoring of dump performance.

Project impacts that would affect wetlands or waters of the U.S. are addressed in the following text, in accordance with the 404(b)(1) guidelines. Appropriate and practicable steps have been developed to minimize potential adverse impacts to Waters of the U.S and wetlands. In the event a Section 404 permit is approved and issued, these steps, including permit conditions and best management practices, will be incorporated into the Section 404 permit to ensure the project complies with this part of the guidelines. In addition, ZMI has proposed wetland mitigation to offset adverse impacts, which is described in the following section.

Wetland Mitigation Plan

ZMI has identified a possible wetland mitigation area in its draft PDN permit application (Zortman Mining Inc. 1995). The proposed acreage and schedule for creating wetlands in a tributary to Ruby Creek are shown in Table 2. ZMI plans to create about 1.79 acres of wetland to compensate for the direct loss of about 1.06 acres of wetlands and indirect loss of another 0.48 acres of wetlands associated with the construction of the Goslin Flat heap leach pad. The wetland mitigation site is near the proposed filled wetlands. ZMI has not formally presented a mitigation plan to compensate for past and proposed impacts to waters of the U.S. Approximately 6.74 acres of waters of the U.S. will be directly filled with materials by past and proposed mining activities.

The wetland mitigation site would be developed on a tributary to Ruby Creek, in an area owned by ZMI. The mitigation site is within one-half mile of the proposed Goslin Flat heap leach pad and ore handling facility. The tributary to Ruby Gulch currently contains about 0.6 acres of wetland and portions of the tributary not delineated as wetland will be used to create wetlands. If mitigation is successful, the created wetland should provide functions similar to those affected by the Goslin Flat heap leach pad facility. However, the heap leach facility is located only 500 to 2,000 feet away. Noise, lighting, and other disturbances from the heap leach facility may reduce the functional capacity of the mitigated wetland for habitat diversity for wildlife and aquatic species for the life of the mine expansion and reclamation project.

The wetland mitigation site would consist of a series of seven linear wetlands created along the tributary to Ruby Gulch. Establishment of wetland hydrology would rely on flow barriers or dikes and a clay liner to increase retention of surface runoff and duration of soil saturation and inundation. The seven retention dikes would be between 60 and 190 feet long with a maximum height of 6 feet. Each dike would have a spillway designed to allow for high flows during runoff and severe precipitation. A clay liner with a hydraulic conductivity of 0.01 inches per hour would be placed in the impoundment area and on the upstream face of the dike to reduce water loss. Native clay materials would be available from ZMI's clay pits.

Hydric soils from the affected wetland areas of Goslin Flat would be salvaged and directly respread on the mitigation sites to provide increased organic matter and a plant materials source. All disturbed areas within the mitigation sites would be broadcast seeded with a wetland revegetation mixture and containerized root stock, plugs, or rooted cuttings mechanically planted. The pond areas would be covered with an erosion control blanket up to the high water line. Reseeded areas above the high water line would be mulched or covered with an erosion control blanket.

The wetland mitigation will coincide with construction of the Goslin Flat heap leach facility. This timing will allow for the direct haul of hydric soils salvaged from the affected wetlands, concurrent mitigation, and a greater selection of construction equipment. The primary wetland functions to be reestablished at the wetland mitigation sites would be to reduce sediment transport, increase aquatic and wildlife habitat diversity and abundance, and attenuate peak flows.

2.2 Section 230.11 - Factual determinations

The potential adverse impacts of placing fill material on the physical, chemical, and biological components of the waters of the U.S. and wetland ecosystems have been evaluated. Mitigation efforts to offset adverse impacts have been considered for impacts to wetlands in this 404(b)(1) evaluation and in the draft EIS. No formal mitigation efforts by ZMI to offset past and proposed adverse impacts to waters of the U.S. have been proposed. Determination of these impacts has included the following:

2.2.1 Section 230.11(a) Physical substrate determinations

The proposed Goslin Flat heap leach pad and ore handling facility will account for about 1.6 of the total 2.51 acres of directly affected waters of the U.S. Other proposed mine facilities that would require placement of fill materials in the remaining 0.9 acres of waters of the U.S. are the construction of the waste rock repository, access roads, haul roads to Landusky and the limestone quarries, pipe line and powerline, and the conveyor corridor. The entire 1.06 acres of directly affected wetlands are associated with the Goslin Flat facility.

Before construction begins, soils under the Goslin Flat facility will be salvaged for use in reclaiming disturbed areas. An estimated 1 million cubic yards of cover soil can be salvaged based on an average depth of 3 feet over the 250-acre site. Hydric soils from under the Goslin Flat facility will be salvaged separately and respread on the nearby mitigation site. Soils from the other 0.9 acres of waters of the U.S. may have limited soil salvage potential due to excessive coarse fragment content and the steep slopes.

The physical and mineralogical composition of the waste rock and ore materials will be variable but quite different than the substrate (parent) materials in Goslin Flat. The parent materials for the Goslin Flat soils are primarily of sedimentary origin, but include alluvial, colluvial, and remnant glacial till deposits. The lithologies of the waste rock and ore deposits are metamorphic and igneous formed by the igneous intrusion. Detailed information on the geology and soils resources is presented in Section 3 of the draft EIS.

Geochemical testing has been performed on hundreds of samples of ore, waste rock, spent ore, and other local rock types at both Zortman and Landusky. Tests indicate that most of the Zortman ore and waste materials have a negative net neutralizing potential (NNP) and have the potential to generate acid. ZMI currently sorts waste rock materials with a total sulfur content less than 0.2 percent and defines this material as nonacid-generating waste. However, supplemental testing has shown these low total sulfur wastes have negative NNP and should not be considered truly nonacid- generating waste. Detailed results of waste rock and ore geochemical analyses are provided in Section 3 of the draft EIS.

2.2.2 Section 230.11(b) Water circulation, fluctuation and salinity determinations

As described in this evaluation (See 4.4 Section 230.23), water circulation and fluctuation would be altered in Goslin Gulch by the capture of surface water by the 290-acre Goslin Flat heap leach pad and ore handling facility and the surface water diversion around the facility. The placement of waste rock fill materials in small narrow waters of the U.S. tributaries below the Zortman pit complex will have limited impacts on circulation and fluctuations of Alder Gulch and Ruby Gulch waters. Salinity levels are not expected to change.

2.2.3 Section 230.11(c) Suspended particulate/turbidity determinations

Placement of fill materials and associated construction activities in Goslin Flat and the small tributaries to the Alder and Ruby Gulch drainages would increase sediment contributions to waters of the U.S. and wetlands. Soil erosion and transport would occur primarily during construction activities and prior to waste rock reclamation and revegetation. Potential soil losses for all mine alternatives have been estimated using the revised Universal Soil Loss Equation (RUSLE) and are presented in Appendix E. Estimated short-term soil losses (1-3 years) for steeper slopes range from 0.8 to 1.2 tons per acre per year. Long-term soil losses (3-5 years) are estimated at 0.1 to 0.3 tons per acre per year. Inclusion of Montana DHES Section 401 permit conditions, as well as other conditions to control sedimentation and turbidity, will help to minimize soil erosion and its potential negative impacts on aquatic organisms. Erosion control measures are described in ZMI's mine expansion permit application. These measures primarily involve mechanical practices, such as the use of mulching and erosion control blankets, surface water diversions to control runoff and sedimentation, and revegetation practices to provide a stabilizing cover.

2.2.4 Section 230.11(d) Contaminant determinations

See Section 7.0 - Evaluation and Testing (Sections 230.60 and 230.61).

2.2.5 Section 230.11(e) Aquatic ecosystem and organism determinations

The ZMI mine expansion and reclamation project will directly affect aquatic organisms by the placement of fill materials in 2.51 acres of waters of the U.S. and 1.06 acres of wetlands. Approximately 4.23 acres of waters of the U.S. have previously been filled by mining activities. In total, an estimated 6.74 acres of waters of the U.S. and 1.06 acres of wetlands will be directly filled with materials by past and proposed mining activities. Fisheries habitat in the project area is very limited. Drainages that will receive the main impacts from the mine expansion and reclamation project (Alder Gulch, Carter Gulch, Goslin Gulch, and Ruby Gulch) have intermittent flows and do no support fisheries. The Corps of

Engineers will require mitigation efforts, or attach special conditions to the Section 404 permit, to offset adverse impacts from previously filled waters of the U.S.

Past mining activities have created indirect impacts to waters of the U.S. and wetland areas throughout the Zortman and Landusky mines. These indirect impacts have resulted primarily from increased soil erosion and the accumulation of suspended solids and sediments in receiving streams. Indirect impacts associated with the proposed mine expansion and reclamation project would occur mainly in the areas immediately below the waste rock piles and below the Goslin Flat heap leach and ore processing facility.

Six species of bats have been documented to use Azure Cave. This cave may be the northernmost hibernaculum in the Pacific Northwest (Chester et al. 1979). This cave supports hibernating bats because it provides stable temperature and humidity ranges and possibly a moderate airflow (Freeman 1984). The bats probably use the Goslin Flat waters of the U.S. and wetlands for insect foraging and for their water supply.

Other organisms that inhabit the areas to be filled will compete for existence in surrounding areas which contain similar habitat. It is the Agencies' opinion that with appropriate mitigation measures for the bats, the mine expansion and reclamation project should not significantly affect the aquatic ecosystem or organisms associated with those ecosystems.

2.2.6 Section 230.11(f) Proposed disposal site determinations

As previously stated, the Montana DHES Water Quality Division provides Section 401 certification pursuant to Section 401 of the Clean Water Act. The Montana DHES will review this placement of fill material and will make a determination for violations of applicable state water quality standards. Section 404 permits, issued by the Corps of Engineers, require Section 401 certification.

The Goslin Flat heap leach pad and ore processing facility would account for about 1.6 of the total 2.51 acres of directly filled waters of the U.S. Other mine facilities that would require placement of fill materials in an additional 0.9 acres of waters of the U.S. are the construction of the Zortman Pit Complex waste rock repository, access roads, roads to Landusky and the limestone quarries, and the pipe line, powerline, and conveyor corridors. The entire 1.06 acres of wetlands to be filled are associated with the Goslin Flat facility.

2.2.7 Section 230.11(g) Determination of cumulative impacts on the aquatic ecosystem

An analysis of cumulative impacts is contained in Chapter 4 of the draft EIS for each resource area. Cumulative impacts are the collective effects for the project when considered in conjunction with other past, present, and reasonably foreseeable activities. Cumulative impacts for the ZMI mine expansion and reclamation project include: (1) historic mining disturbances in Montana Gulch, Beaver Creek, Pony Gulch, and the Hawkeye Mine, plus mill tailings in King Creek, Alder Gulch, and Ruby Gulch; (2) impacts from 1979 through 1994, including the previously filled 4.23 acres of waters of the U.S. and 0.1 acres of wetlands; (3) impacts resulting from implementing the mine alternative; and (4) reasonable foreseeable future actions, including a 2-million ton Pony Gulch mine, expansion of the Goslin Flat leach pad, development of new limestone sources, and construction of passive water treatment systems.

The cumulative impacts from these past, present, and reasonably foreseeable activities may decrease the amount of waters of the U.S. and wetlands and their ecological functions. The most important functions of the existing wetlands is their role in providing hydrologic support (groundwater discharge), floodflow alteration, sediment stabilization, water purification, and aquatic and wildlife diversity and abundance. Developing the Goslin Flat leach pad and ore processing facility would remove more than 290 acres of natural watershed in the Goslin Gulch drainage. The capture of surface water by the facility may reduce the frequency and duration of saturation, inundation, and ponding of water for some wetlands downgradient. Additionally, a failure in the water treatment collection system may affect surface and groundwater quality and affect additional downgradient waters of the U.S. and wetlands.

A large, 482-acre land application disposal (LAD) area has been identified for use near the Goslin Flat facility. The LAD would be used in the event that emergency land application of solutions is required, and during closure activities. Effluents disposed of at the LAD area would be neutralized and have cyanide concentrations at or below 0.22 milligrams per liter (mg/L) (as determined by the weak-acid dissociable [WAD] cyanide analytical test). Disposal activities would not occur within 100 feet of the county road and within 200 feet of the drainages. The LAD area is proposed for both sides of the tributary designated as the wetland mitigation site.

2.2.8 Section 230.11(h) Determination of secondary effects on the aquatic ecosystem

Secondary effects on the aquatic ecosystem from the ZMI mine expansion and reclamation project activities will result from an increased surface runoff and sedimentation from cleared areas and the face of the waste rock dumps, increased total suspended solids, total dissolved solids, and metal concentrations in water resources, and reduced surface water flows from the surface water capture by the Goslin Flat facility. The effects of this loss of habitat would be short-term and not significant if mitigation successfully replaces this aquatic habitat.

2.3 Section 230.12 Findings of compliance or noncompliance with the restrictions on discharge

Based on the Agencies' opinion, data contained in the draft EIS, the determinations of the preceding section, and the remainder of this evaluation, placement of fill materials in waters of the U.S. and wetlands would comply with the requirements of the Section 404 guidelines. Fill materials would be placed in waters of the U.S. and wetlands at the Goslin Flat facility, waste rock repository, roads to Landusky and the limestone quarries, pipe line, powerline, and conveyor corridors. Compliance with the Section 404 guidelines is assumed to include implementing appropriate and practicable permit conditions to minimize any adverse effects of the discharge to the aquatic ecosystem.

3.0 SUBPART C - POTENTIAL IMPACTS ON THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

Potential impacts from the placement of fill from the ZMI mine expansion and reclamation project on the physical, chemical, and biological components of the aquatic environment have been evaluated. Mitigation efforts to offset adverse impacts and the mitigation ratios have not been selected. Additional mitigation may be considered in the final evaluation after detailed engineering designs and drawings have been reviewed and approved. Determination of these impacts include the following.

3.1 Section 230.20 Physical substrate determinations

The placement of ore and some waste rock at the Goslin Flat heap leach facility will ultimately create a 200-foot-high pad that covers approximately 250 acres in the Goslin Gulch drainage. The facility would account for about 1.63 of the total 2.51 acres of directly filled waters of the U.S. and the entire 1.06 acres of filled wetlands. Other mine facilities that would require placement of fill materials in the additional 0.88 acres of waters of the U.S. are the construction of the Zortman Pit complex waste rock repository, access roads, roads to Landusky and the limestone quarries, and the pipe line, powerline, and conveyor corridors. Surface soil materials will be salvaged from the Goslin Flat facility and used for reclamation purposes. Hydric soils from the Goslin Flat pad area will be salvaged for use at the wetland mitigation site. Site-specific soil information is presented in Section 3 of the draft EIS.

3.2 Section 230.21 Suspended particulates/turbidity

An increase in the suspended solids, dissolved solids, and metals in the waters of the U.S. and waters flowing through the delineated wetlands will occur during construction. Erosion control measures are described in the ZMI mine expansion permit application. These measures primarily involve mechanical practices, such as the use of mulching and erosion control blankets; surface water diversions to control runoff and sedimentation; and revegetation practices to provide a stabilizing cover. Fisheries habitat in the project area is very limited; intermittent flows do not support fisheries.

3.3 Section 230.22 Water clarity, nutrients, environmental characteristics and values (chemistry)

The placement of fill material in waters of the U.S. and wetlands will alter water characteristics. During construction activities, changes in light penetration and water clarity could be reduced in downgradient waters due to increases in suspended solids. Total dissolved solids concentrations may also increase. Inclusion of Montana DHES Water Quality Division's Section 401 permit conditions, as well as other conditions, will minimize these impacts.

3.4 Section 230.23 Current patterns and water circulation

The placement of fill and diversion of surface water at the Goslin Flat heap leach pad and ore processing facility will modify surface water patterns, particularly at the point of discharge below the facility. The more than 300-acre facility will also capture surface water that will become part of the process flows rather than the natural flows. Placing waste rock fill materials in the small narrow channels within the mining complex will entirely fill these drainages and disperse the natural flows through the fill materials. Sound engineering and erosion control practices will help to minimize the impacts.

3.5 Section 230.24 Normal water fluctuations

The placement of fill and diversion of surface water at the Goslin Flat heap leach pad and ore processing facility may modify normal water fluctuations in the Goslin Gulch drainage by reducing peak flows by the capture of surface water. The heap leach facility includes more that 300 acres and so would have a sizeable affect on this small drainage. Goslin Gulch contains at least three alluvial springs that account for approximately 5 to 10 gallon per minute flows for short reaches below their sources. Potential decreases in surface and shallow groundwater flows (springs) may affect approximately one acre of wetland downgradient from the Goslin Flat facility. Vegetative species that are more tolerant of drier sites may replace species requiring moist site conditions along certain short reaches of Goslin Gulch.

Construction and placement of fill materials associated with the pipe line, powerline, conveyor, and access road corridors will modify normal water fluctuations in certain small drainages by partially filling these drainages. Sound engineering and erosion control practices will help to minimize the impacts.

3.6 Section 230.25 Salinity gradients

The ZMI mine expansion and reclamation project is not expected to have any impact or effect on salinity gradients because the fill materials are nonsaline and the waters of the U.S. and wetlands have freshwater sources.

4.0 SUBPART D - POTENTIAL IMPACTS ON BIOLOGICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

4.1 Section 230.30 Threatened and endangered species

Numerous wildlife studies have been conducted within the Zortman mining area (Farmer 1977; Scow 1978, 1979, 1983; WESTECH 1985, 1986, 1989). Reports on the bats and other wildlife found in Azure Cave have been prepared by Chester et al. (1979) and Butts (1993). The responsibility for wildlife habitat management in and around the Zortman mine rests with the Montana Department of Fish, Wildlife, and Parks (MDFWP); U.S. Bureau of Land Management (BLM); and U.S. Fish and Wildlife Service (USFWS). Additional information on threatened and endangered species is presented in Sections 2, 3, and 4 of the draft EIS.

A list of wildlife species of concern that may occur on or near the project site is presented in Table 3.5-1 of the draft EIS. Of these species, four (bald eagle, peregrine falcon, piping plover, and black-footed ferret) are listed as endangered. Ten other species (ferruginous hawk, mountain plover, burrowing owl, loggerhead shrike, Baird's sparrow, Townsend's big-eared bat, northern long-eared myotis, fringed myotis, long-legged myotis, and western small footed myotis) are considered candidate species that may be suitable for listing, but sufficient data are lacking on a national level to do so at this time. The USFWS will make recommendations to mitigate adverse effects to threatened and endangered species and other wildlife species of concern that may include measures in addition to those discussed in the draft EIS. Of particular interest is mitigation for the loss of open water (stock ponds) along Goslin Gulch. These stock ponds are considered to be important bat habitat for the Azure Cave populations because they probably supply some of the insects and water supply requirements for up to six bat and myotis species. The USFWS will issue a formal notification before the final EIS is released.

4.2 Section 230.31 Fish, crustaceans, mollusks, and other aquatic organisms in the aquatic food web

The small intermittent drainages in the Zortman and Landusky mine areas do not support many types or numbers of fish. Brook trout inhabit Beaver, Lodgepole, and Little Peoples Creeks, and can be found in ponds along Rock Creek. Rainbow trout occur in Little Peoples Creek. Flows in other drainages in the project area, including Alder Gulch and Montana Gulch, are intermittent and thus do not support a fishery. An inventory conducted by the MDFWP of fish populations in reservoirs and perennial flowing streams below Zortman and Landusky found populations of flat-headed minnows, long-nose dace, white sucker, northern redbelly dace, brook sickleback, northern pike, and perch. Additional information on fish is presented in Sections 2, 3, and 4 of the draft EIS.

Placement of fill materials associated with the ZMI mine expansion and reclamation project would not affect fish populations within the Zortman and Landusky mine areas. Downstream water quality may be affected if capture and treatment systems fail. Altered drainages have exhibited elevated chemical constituents on specific occasions downstream as far as the towns of Zortman and Landusky.

4.3. Section 230.32 Other wildlife

Shrub and grassland habitat used by terrestrial wildlife species, such as pronghorn antelope, in the areas near the Goslin Flat heap leach pad and ore handling facility would be affected by the mine expansion and reclamation project. The 1.63 acres of waters of the U.S. and 1.06 acres of wetland in the Goslin Flat area are probably used as a water supply for some terrestrial wildlife species. As mentioned above, the open water (stock ponds) along Goslin Gulch are considered important bat habitat. Developing additional open water areas and associated wetlands will be needed to mitigate the loss of this habitat by the construction of the Goslin Flat facility.

The construction and operation of the conveyor belt system may disturb big game and upland game birds for the life of the mine. Recommended mitigation will include designed wildlife overpasses and underpasses along important corridors, such as gulches and draws.

Responsibility for wildlife habitat management in and around the Zortman mine rests with the MDFWP, BLM, and USFWS. Additional information on wildlife and fisheries is presented in Sections 2, 3, and 4 of the draft EIS.

5.0 SUBPART E - POTENTIAL IMPACTS ON SPECIAL AQUATIC SITES

As discussed previously, this mine expansion and reclamation project would result in the placement of fill to waters of the U.S. and wetlands. The physical, chemical, and biological integrity of the aquatic ecosystem would be modified as described in the draft EIS and below.

5.1 Section 230.40 Sanctuaries and refuges

There are no sanctuaries or wildlife refuges in the project area that would be disturbed by the project.

5.2 Section 230.41 Wetlands

Approximately 1.06 acres of wetlands will be directly altered by fill materials from the Goslin Flat heap leach pad and ore processing facility. Wetland impacts are discussed in more detail in Section 4 of the draft EIS and in the draft PDN permit application (Zortman Mining Inc. 1995). A formal wetland mitigation plan will need to be submitted in compliance with Section 404(b)(1) of the Clean Water Act. The mitigation plan should provide for the mitigation of and compensation for the unavoidable loss and potential diminishment of the wetland functions and values associated with development of the proposed mine expansion and reclamation project.

ZMI has identified a possible wetland mitigation site and plans to create about 1.79 acres of wetland to compensate for the direct loss of about 1.06 acres of wetlands and indirect loss of another 0.48 acres of wetlands associated with the construction of the Goslin Flat heap leach pad. The wetland mitigation site is located on a tributary to Ruby Creek near the proposed filled wetlands.

5.3 Section 230.42 Mud flats

There are currently no mud flats at the project site.

5.4 Section 230.43 Vegetated shallows

There are currently no vegetated shallows at the project site.

5.5 Section 230.44 Coral reefs

There are no coral reefs associated with this project.

5.6 Section 230.45 Riffle and pool complexes

There are no riffle and pool complexes associated with this project.

6.0 SUBPART F - POTENTIAL EFFECT ON HUMAN USE CHARACTERISTICS

6.1 Section 230.50 Municipal and private water supplies

The project will not have any effect on municipal or private water supplies. ZMI has stated that diversion and capture systems would be constructed to collect waters affected by the mine and prevent deterioration of water quality in drainages not already contaminated. Captured seepage water would be pumped to the Zortman water treatment plant for treatment and release into Ruby Gulch.

6.2 Section 230.51 Recreational and commercial fisheries

Public lands in the vicinity of the Zortman and Landusky mines provide multiple use recreational opportunities, including hiking, horseback riding, mountain biking, all-terrain vehicle use, wildlife/bird watching, caving, climbing, and hunting. Construction of the Goslin Flat heap leach pad may create direct impacts to recreational users through an increase in visual, noise, and traffic impacts. Construction and operation of the conveyor system may also impact recreational users and hunters by the restriction of access to Goslin Gulch and along the length of the conveyor. The project area does not support a commercial fishery. Recreational users do fish the lower sections of Rock Creek, south of the Little Rocky Mountains.

6.3 Section 230.52 Water related recreation

The project will not have any effect or impact on water-related recreational uses.

6.4 Section 230.53 Aesthetics

The project will have an impact on the visual resources (viewshed) of the Little Rocky Mountains, particularly during construction, operation, and, from some vantage points, after reclamation. The primary mine facilities that will affect aesthetics and visual resources are the Goslin Flat heap leach pad and the overland conveyor. Visual impacts from the Goslin Flat heap leach pad will include strong form and color contrasts created by the large, 200-foot-high pad facility. Night lighting at the Goslin Flat facility will also be visible for miles around. The overland conveyor system will pass through generally undisturbed forested areas, creating a linear feature in the landscape that will be visible from several roads in the area and from Saddle Butte and Old Scraggy Peak. Some impacts will be long term, such as the landscape change caused by the Goslin Flat pad. Most other impacts will disappear after project completion with revegetation and reclamation activities.

6.5 Section 230.54 Parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves

No parks, national monuments, or other sites are located directed within the mine's project area. The Charles M. Russell National Wildlife Refuge is located approximately 15 miles south of the Zortman Mine and Landusky Mine site. The Fort Belknap Indian Reservation is located approximately 2.5 miles north of the project area and includes the Pow Wow grounds. Nearly the entire Zortman mine is located in an area BLM has defined as an Area of Potential Effect for cultural properties. Two groups of vision quest sites have been recommended as eligible for nomination to the National Register as Traditional Cultural Properties. These are the Eagle Child Mountain District and the Beaver Mountain Vision Quest Sites. Azure Cave is adjacent to the project area and has been designated an Area of Critical Environmental Concern by the BLM.

7.0 SUBPART G - EVALUATION AND TESTING

7.1 Section 230.60 General evaluation of dredged or fill material

Ore and some waste rock will be placed at the Goslin Flat heap leach facility and will ultimately create a 200-foot-high pad that covers approximately 250 acres. The leach pad will contain a liner system consisting of approximately 12 inches of compacted clay overlain by a 30-mil polyvinyl chloride (PVC) geomembrane. The facility will account for about 1.6 of the total 2.51 acres of directly filled waters of the U.S. and the entire 1.06 acres of filled wetlands.

The Goslin Flat heap leach facility operations will include leaching ore stacked on the pad, collecting pregnant solution at the bottom of the pad, transferring the pregnant solution to ponds, extracting the metals, and storing the barren solution for reapplication. As designed, all processing solutions will be stored within the Goslin Flat heap leach facility, which includes storage within the heap, in sumps, behind dikes, and in the surface ponds. The pad would be designed to accommodate excess process solution that would accumulate during a 6-inch, 24-hour storm with a pump shutdown of 36 hours.

The Goslin Flat heap leach pad facility will be constructed primarily with ore. However, some waste rock materials from the existing Alder Gulch waste rock dump will be relocated to the Goslin Flat facility. The physical and mineralogical composition of the waste rock and ore materials will be variable.

The waste rock and ore deposits are primarily metamorphic and igneous rocks formed by the igneous intrusion. Detailed information on the geology and soils resources are presented in Section 3 of the draft EIS.

Fill materials associated with construction of the powerline, pipe line, and access road and conveyor corridors would be natural borrow materials from cut and fill operations and nearby disturbances. Waste rock would be used to fill the small narrow channels within the mining complex. The waste rock fill may have a negative NNP and cannot be considered as truly nonacid-generating.

7.2 Section 230.61 Chemical, biological, and physical evaluation and testing

Chemical characteristics of ZMI's waste rock are presented in Section 3 of the draft EIS. Geochemical testing has been performed on hundreds of samples of ore, waste rock, spent ore, and other local rock types collected from both the Zortman and Landusky sites. Tests indicate that most of the Zortman ore and waste materials have a negative NNP and have the potential to generate acid. ZMI currently sorts waste rock materials with a total sulfur content less than 0.2 percent and defines this material as nonacid-generating waste. However, supplemental testing has shown these low total sulfur wastes have negative NNP and should not be considered truly nonacid-generating waste.

ARD is generated from pit walls and waste rock piles at the Zortman and Landusky mines. Data indicate that all of the major drainages show some degree of impact from mining-related activities. Geochemical analyses have indicated that ore and waste rock generated by the mine expansion and reclamation project will be acid generating. Sorting the waste rock based on its percent sulfur and NNP, and isolating it within the center of the repository, will help to minimize ARD from the new waste rock dumps.

8.0 SUBPART H - ACTIONS TO MINIMIZE ADVERSE EFFECTS

Project impacts that would affect waters of the U.S. and wetlands are addressed in this showing, in accordance with Section 404(b)(1) guidelines. Appropriate and practicable steps to minimize potential adverse impacts on the aquatic ecosystem have been developed and are addressed in Section 2.1.4 of this showing and in the alternatives analyses in Section 4 of the draft EIS. Waters of the U.S. and wetlands will be affected by ZMI's mine expansion and reclamation project (see Table 1).

Approximately 4.23 acres of waters of the U.S. and 0.1 acres of wetlands have previously been filled by mining activities. Alternatives 1, 2, and 3 would not fill any additional waters of the U.S. or wetlands. Alternatives 4, 5, 6, and 7 would directly fill an estimated 2.08 to 3.01 acres of waters of the U.S. and 1.06 acres of wetlands. Alternative 7, the preferred alternative, would result in direct impacts to 2.51 acres of waters of the U.S. and 1.06 acres of wetlands. Combining past and potential mining disturbances, an estimated 6.74 acres of waters of the U.S. and 1.06 acres of wetlands would be directly filled with materials.

A preliminary wetland mitigation plan has been prepared by ZMI in its draft PDN permit application (Zortman Mining Inc. 1995). Mitigation efforts to offset adverse impacts from previously filled and proposed disturbances to waters of the U.S. have not been formally introduced. The Corps of Engineers will likely request a draft waters of the U.S. mitigation plan before it will release a recommendation to issue a permit. The wetland mitigation plan is summarized above in Section 2.1.4 of this draft showing.

8.1 Section 230.70 Actions concerning the location of the discharge

The primary action used to minimize impacts to waters of the U.S. and wetlands was the location selected for the waste rock storage area and the ore heap leaching facility. Eight waste rock repository locations and six heap leach area locations were considered. These facility locations were evaluated based partially on their ability to avoid waters of the U.S. and wetlands. However, other environmental factors, such as the potential impacts to air, water, and soil, and their subsequent impacts to the vegetation, wildlife, and human health were also considered as part of the overall environmental assessment.

8.2 Section 230.71 Actions concerning the material to be discharged

Limited actions are available that can affect the physical or geochemical nature of the ore and waste rock materials placed in the waste rock dump and heap leach pad. To help minimize problems with ARD, ZMI proposes to continue sorting the waste rock based on its sulfur content and NNP. Waste rock materials with high sulfur contents and thus high probabilities for generating ARD would be isolated within the center areas of the waste rock repository. Diversion and capture systems would be constructed to allow capture of mine-contaminated waters and prevent past and future deterioration of water quality in the major drainages in the project area. The possible need to capture and treat contaminated waters in perpetuity is discussed in the draft EIS.

8.3 Section 230.72 Actions controlling the material after discharge

ZMI would implement a mine plan that includes reclamation of areas disturbed by past and proposed mine activities. The reclamation plan describes ZMI's proposed methods to recreate a land configuration compatible with the watershed, re-establish an appropriate vegetative cover, restore habitat for grazing livestock and wildlife, and re-establish the aesthetic environment.

Approximately 2.8 million cubic yards of nonacid forming waste rock materials would be used for reclamation, primarily as a capillary break. After detoxifying the Goslin Flat leach pad, the slopes would be reduced to about a 2.5 to 1 slope (2.5 feet horizontal to 1 foot vertical). The uppermost surface of the pad would be left roughly contoured to create a variable skyline and some microhabitat areas. A water balance reclamation cover would be applied to all pad surfaces and the areas revegetated with native prairie grasses, forbs, and shrubs. Reclamation activities for the other mining facilities, including the waste rock dumps, plant sites, and support facilities, are described in detail in ZMI permit application amendment (Zortman Mining Inc. 1993).

8.4 Section 230.73 Actions affecting the method of dispersion

Fill materials would be placed in waters of the U.S. and wetlands using conventional mining equipment and a conveyor system. The Goslin Flat heap leach pad facility would be designed to contain the ore, waste rock, and process solutions and prevent their dispersion or migration out of the heap leach facility. The leach pad would contain a liner system consisting of approximately 12 inches of compacted clay overlain by a 30-mil PVC geomembrane.

8.5 Section 230.74 Actions related to technology

The ore materials, relocated waste rock, and limestone used for reclamation would all be transported to the Goslin Flat facility using an overland conveyor system. The conveyor system would include dust suppression measures. ZMI is considering some form of passive water treatment, possibly involving constructed wetlands. Using of a water balance reclamation cover instead of a water barrier reclamation cover is considered to better limit downward migration of water into the waste zone and be more effective on steeper slopes.

Hydric soils will be salvaged from the wetlands under the Goslin Flat leach pad facility and directly respread on the wetland mitigation sites to provide increased organic matter and a plant materials source. A clay liner would be used to reduce deep percolation of water at the wetland mitigation sites.

8.6 Section 230.75 Actions affecting plant and animal populations

All plant populations under the Goslin Flat heap leach pad area will be lost, and animal populations will be displaced or lost as a result of construction activities. Reclamation activities will, when complete, replace some of the lost habitat and provide space for the reestablishment of some of the lost plant and animal populations. In addition, in the event a Section 404 permit is approved and issued, permit conditions and additional mitigation measures may be incorporated to ensure the project complies with Section 230.10(d) of the guidelines. ZMI has proposed wetland mitigation to offset adverse impacts and provide reasonable mitigation for the loss of approximately 1.54 acres of wetland. Mitigation efforts to offset adverse impacts from previously filled and proposed disturbances to waters of the U.S. have not been formally introduced.

8.7 Section 230.76 Actions affecting human use

The Goslin Flat heap leach pad facility site was selected because it appears to be the least damaging to the aquatic ecosystem of the leach pad alternatives. Although the leach pad structure will have a permanent negative effect on the visual aesthetics of the area, reclamation activities during project completion and revegetation of the disturbed surfaces will minimize the overall visual impact. The completed project is not expected to increase human activities in the area that are incompatible with current use patterns. The placement of the fill is not expected to affect any public water supply intake.

ARD is now and can be expected to continue to be generated from pit walls and waste rock piles at the Zortman and Landusky mines. Data indicate that all of the major drainages show some degree of impact from mining-related activities. Geochemical analyses have indicated that ore and waste rock generated by the mine expansion and reclamation project will be acid generating. Sorting the waste rock based on its percent sulfur and NNP, and isolating it within the center of the repository, will help to minimize ARD from the new waste rock dumps. If the Corps of Engineers recommends a permit, the Corps may attach permit conditions requiring ZMI to develop a contingency operational plan for unanticipated increases in ARD.

8.8 Section 230.77 Other actions

The planned reclamation, including some slope reduction and revegetation of the disturbed surfaces for the Goslin Flat heap leach facility, will help to minimize the adverse environmental impacts from this facility. The draft wetland mitigation proposed and probable mitigation for the waters of the

U.S. would offset some of the impacts caused by placing fill materials in Goslin Gulch and the other drainages within the mine site.

9.0 PRELIMINARY CONCLUSIONS

The proposed ZMI mine expansion and reclamation project has been reviewed against the Section 404(b)(1) guidelines and the Montana Department of State Lands and U.S. Bureau of Land Management have concluded the mining project will result in impacts to circulation and fluctuation patterns, substrate, suspended particulates/turbidity, water quality, and aquatic ecosystem functions. Several of these impacts will be permanent and long-term, while others will occur primarily during the construction period and will be short-term. Cumulative effects from previous mining activities and other related activities will be evaluated and considered before making the final permitting decision.

In the Corps of Engineers review of the project, all the alternatives considered in the final EIS will be reviewed and evaluated to determine if there is a least damaging practicable alternative that could be permitted. Public interest factors, input from other state and federal agencies, and the proposed mitigation measures will also be considered by the Corps of Engineers in the evaluation process before making a final permitting determination.

At the earliest, a final Section 404 permit evaluation cannot be made by the Corps of Engineers until 30 days after the final EIS is published. However, based on the size and complexity of this project, the required detailed evaluation, and the preparation of required supporting documentation, the Corps of Engineers final Section 404 permit evaluation will most likely not be issued until several months after the final EIS is published.

TABLE 1
Affected Acreage of Waters of the U.S. and Wetlands by Mining Alternatives

Mining Alternative		Wetland Acres		Waters of the U.S. Acres		Total Wetland and Waters of the U.S. Acres (Existing + Proposed)
		Existing	Proposed	Existing	Proposed	
Alternative 1	No Action - Permitted Operations and Reclamation	0.03	0.00	4.23	0.00	4.26
Alternative 2	Mine Expansion Not Approved - Company Proposed Reclamation	0.03	0.00	4.23	0.00	4.26
Alternative 3	Mine Expansion Not Approved - Agency-Mitigated Reclamation	0.03	0.00	4.23	0.00	4.26
Alternative 4	Company Proposed Expansion and Reclamation	0.03	1.06	4.23	3.01	8.33
Alternative 5	Agency-Mitigated Expansion and Reclamation with Proposed Goslin Flat Leach Pad Located in Upper Alder Gulch	0.03	1.06	4.23	2.08	7.40
Alternative 6	Agency-Mitigated Expansion and Reclamation with Proposed Carter Gulch Waste Rock Dump Located on Ruby Terrace	0.03	1.06	4.23	2.21	7.53
Alternative 7	Agency-Mitigated Expansion and Reclamation with Waste Rock Repository Located on Existing Mine Facilities Rather Than in Carter Gulch	0.30	1.06	4.23	2.51	7.83

TABLE 2
Proposed Acreage and Schedule for Created Wetlands in Ruby Creek Tributary

WETLAND MITIGATION SITE	ACRES	YEAR COMPLETED
A	0.16	1
B	0.28	1
C	0.09	1
D	0.28	1
E	0.38	1
F	0.35	1
G	0.25	1
TOTAL WETLAND MITIGATION	**1.79**	

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IMPACTS TO WETLAND FUNCTIONS AND VALUES
ZORTMAN MINING, INC.

The following assessment was prepared by OEA Research, Inc. and represents a preliminary judgement of the potential changes to the wetland functions and values resulting from the various project actions. This evaluation is currently under review and will be finalized. Refer to Table 3.4-2 for a summary of the existing functions and values. Impacts are presented for each project facility/component and generalized by drainage. No impacts anticipated for Beaver Creek. Figure B-1 locates the wetland site numbers identified in the text.

A. GOSLIN GULCH LEACH PAD AND ASSOCIATED FACILITIES AREAS (ALTERNATIVES 4, 6 AND 7)

Subdrainage(s) that would be affected: Goslin Gulch and Lower Ruby Gulch. Wetland sites that occur: 1, 2, 3, 4, 5a, 5b, 5c, 6, 7, 8, 9 (Figure B-1).

Baseline (Pre-1979)
Ranching activities such as grazing, fencing, jeep roads, drainage crossings, local channel alterations, including stockpond and spring development.

1979-present
Similar to baseline with some additional activities such as exploration/site characterization for proposed ZMI expansion resulting in some minor sporadic increases in disturbance.

Potential changes to functions and values provided:

Hydrologic Support (Groundwater Discharge and/or Recharge)	no change
Floodflow Alteration	no change
Sediment Stabilization/Erosion Control	minor/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	no change
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	no change
Wildlife Diversity/Abundance (Breeding)	minor/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	minor/neg
Uniqueness/Heritage/ Recreation	no change

Potential
Wetland sites that may be affected: 1, 2, 3, 4, 5a, 5b, 5c, 6, 7. Sites 8 and 9 would not likely be affected.

Direct fill: 1.01 ac
Loss of all functions and values at wetland sites 1, 2, 3, 4 and portions at 5a. Two springs would be lost. Beneficial use (two stockwater ponds which are probably used by Azure Cave bats for watering) would be lost. Some waterfowl breeding habitat would be lost.

Indirect: ~0.8 ac
Sites 5a (downstream portion), 5b, 5c, 6, 7
Sediment inputs; leach pad leakage (CN, metals); possible groundwater and/or surface water changes due to diversions, loss of infiltration under pad area that could decrease spring flow and drop water table; noise and other disturbances; overall type of wetlands would not substantially change i.e. Palustrine system with sedge dominance types; but loss of open water provided by ponds would occur;

Potential changes to functions and values provided:

Hydrologic Support (Groundwater Discharge and/or Recharge)	major/neg
Floodflow Alteration	moderate/neg
Sediment Stabilization/ Erosion Control	minor/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	no change
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	negligible
Wildlife Diversity/Abundance (Breeding, Migration)	moderate/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	major/neg
Uniqueness/Heritage/ Recreation	no change

B. WETLAND MITIGATION SITE (ALTERNATIVES 4, 6 AND 7)

Subdrainage(s) that would be affected: Side Tributary A to Ruby Gulch. Wetland sites that occur: 9

Baseline (Pre-1979)
Ranching activities such as grazing, fencing, jeep roads, drainage crossings, local channel alterations, including spring development; county road crossing.

1979-present
Similar to baseline with some additional activities such as site characterization for wetland mitigation site, rural home development, local airstrip activity resulting in minor periodic to continuous increases in disturbance.

Potential changes to functions and values provided:

Hydrologic Support (Groundwater Discharge and/or Recharge)	no change
Floodflow Alteration	no change
Sediment Stabilization/Erosion Control	negligible/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/Transform)	no change
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	no change
Wildlife Diversity/Abundance (Breeding)	no change
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/Recreation	no change

Potential
Wetland sites that may be affected: 9

Direct fill: none; no direct impacts on functions and values provided.

Indirect: none
Construction of 2 low dike systems above the existing wetland system would not likely affect groundwater function since existing wetlands are primarily sustained by a spring.

C. RUBY TERRACE/GOSLIN FLAT ALTERNATE WASTE ROCK REPOSITORY (ALTERNATIVE 6)

Subdrainage(s) that would be affected: Lower Ruby Gulch including side tributary A and Camp Creek.

Baseline (Pre-1979)
Ranching activities such as grazing, fencing, jeep roads, drainage crossings, local channel alterations, including stockpond and spring development.

1979-present
Similar to baseline with some additional activities such as site characterization for alternate facility, rural home development, local airstrip activity resulting in minor periodic to continuous increases in disturbance.

Potential changes to wetland functions and values provided:

Ruby Tributary A

Hydrologic Support (Groundwater Discharge and/or Recharge)	no change
Floodflow Alteration	no change
Sediment Stabilization/Erosion Control	negligible/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/Transform)	no change
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	no change
Wildlife Diversity/Abundance (Breeding)	no change
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/Recreation	no change

Camp Creek

Hydrologic Support (Groundwater Discharge and/or Recharge)	no change
Floodflow Alteration	no change
Sediment Stabilization/Erosion Control	minor/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/Transform)	no change
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	no change
Wildlife Diversity/Abundance (Breeding, migration)	negligible/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/Recreation	no change

Potential
Wetland sites that occur: 1, 2, 3, 4, 5a, 5b, 5c, 6, 7, 8, 9, 12, 13, 14. Wetland sites that would likely be affected: 9, 12, 13, 14

Direct fill: none; no direct impacts on functions and values provided.

Indirect: 0.59 acres in Ruby tributary A; ≤ 3 acres in Camp Creek
Sediment inputs; ARD; possible groundwater and/or surface water changes due to diversions, loss of infiltration under repository that could decrease spring

flow and drop water table in both Camp Creek and Ruby Tributary A; noise and other disturbances; changes would likely be more noticeable in Ruby tributary A than in Camp Creek. The southern edge of the repository is placed at the head (spring source) for the wetland.

Potential changes to functions and values provided:

<u>Ruby Tributary A</u>

Hydrologic Support (Groundwater Discharge and/or Recharge)	moderate-major/neg
Floodflow Alteration	minor/neg
Sediment Stabilization/ Erosion Control	major/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	major/neg
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	minor/neg
Wildlife Diversity/Abundance (Breeding)	minor/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/ Recreation	no change

<u>Camp Creek</u>

Hydrologic Support (Groundwater Discharge and/or Recharge)	moderate-major/neg
Floodflow Alteration	minor/neg
Sediment Stabilization/ Erosion Control	minor/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	no change
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	minor/neg
Wildlife Diversity/Abundance	negligible/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/ Recreation	no change

D. <u>LAND APPLICATION DISPOSAL (ALTERNATIVES 4, 5, 6, AND 7</u>

Subdrainage(s) that would be affected: Lower Ruby Gulch, Side Tributary A to Ruby Gulch, Goslin Gulch, Lower Alder Gulch, Camp Creek. Wetland sites that occur: 1, 2, 3, 4, 5a, 5b, 5c, 6, 7, 8, 9, 12, 13, 14

Baseline (Pre-1979)

Ranching activities such as grazing, fencing, jeep roads, drainage crossings, local channel alterations, including stockpond and spring development.

1979-present

Similar to baseline with some additional activities such as site characterization for alternate facility, rural home development, local airstrip activity resulting in minor periodic to continuous increases in disturbance.

Potential

Wetland sites that occur: 1, 2, 3, 4, 5a, 5b, 5c, 6, 7, 8, 9, 12, 13, 14. Wetland sites that would likely be affected: 9, 12, 13, 14

<u>Direct fill</u>: no fill; other direct impacts may occur to Ruby Tributary A i.e. runoff, spray drift.

<u>Indirect</u>: 0.59 acres in Ruby tributary A; ≤ 3 acres in Camp Creek.

Sediment inputs; assume LAD waters would not percolate below biologically active soils; disturbance and habitat effectiveness changes; assume impacts from proposed Goslin Leach Pad would occur so no indirect impacts to Goslin Gulch or lower Ruby wetlands anticipated; no wetlands in lower Alder Gulch therefore no impacts.

Potential changes to functions and values provided:

<u>Ruby Tributary A</u>

Hydrologic Support (Groundwater Discharge and/or Recharge)	negligible/neg
Floodflow Alteration	no change
Sediment Stabilization/ Erosion Control	minor/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	minor/neg
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	minor/neg
Wildlife Diversity/Abundance	minor-major/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	unknown
Uniqueness/Heritage/ Recreation	no change

Camp Creek

Hydrologic Support (Groundwater Discharge and/or Recharge)	negligible/neg
Floodflow Alteration	no change
Sediment Stabilization/ Erosion Control	minor/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	minor/neg
Production Export/Food Chain Support	no change
Aquatic Diversity/Abundance	negligible/neg
Wildlife Diversity/Abundance	minor/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/ Recreation	no change

E. RUBY PONDS

Subdrainage(s) that would be affected: Upper Ruby Gulch; Wetland sites that occur: 10, 11. No wetlands would be affected because sites 10 and 11 are in side drainage to Upper Ruby Gulch that are not affected by current or proposed activities.

F. CARTER GULCH WASTE ROCK REPOSITORY (ALTERNATIVES 4 AND 5)

Subdrainage(s) that would be affected: Upper Alder Gulch. Wetland sites that occur: 15, 16

Baseline (Pre-1979)
Mining, roads (along and within main stem channel and on slope to access Hawkeye Mine), concrete dam to create ponded water source for Hawkeye Mine; no water quality (ARD) impacts identified from past mining; drainage crossings, local channel alterations (blasting); natural erosion form steep slopes in uppermost portion of Alder Gulch produces sporadic sediment delivery to live waters. Alder Gulch goes dry below Zortman - looks like flow rarely reaches Ruby Gulch (Alder's original confluence with Ruby was altered and channelized so that Alder G technically is tributary to Goslin Gulch).

1979-present
Similar to baseline with addition of impacts from Alder Gulch waste rock dump (ARD) in Alder and Carter Spurs and 1986-87 LAD (cyanide) in Alder Spur; measures have been taken to improve water quality; impacts have been generally attenuating since 1991; no impacts have been observed at lower sampling station (Z-16). Current mining has no impacts on identified wetlands.

Potential
Wetland sites that occur: 15, 16. Wetland sites that would likely be affected: none

Direct fill: no fill; no other direct impacts because wetlands are upstream of the zone of influence.

Indirect: none; currently Ruby Gulch does not provide surface discharge to lower Ruby below Zortman

G. ALDER GULCH ALTERNATE LEACH PAD (ALTERNATIVE 5)

Subdrainage(s) that would be affected: Upper Alder Gulch. Wetland sites that occur: 15, 16

Baseline (Pre-1979)
Mining, roads (along and within main stem channel and on slope to access Hawkeye Mine), concrete dam to create ponded water source for Hawkeye Mine (?) - this area (wetland site 16) is filled with sediments and appears to be drying out; no water quality (ARD) impacts identified from past mining; drainage crossings, local channel alterations (blasting?); natural erosion form steep slopes in uppermost portion of Alder Gulch produces sporadic sediment delivery to live waters. Alder Gulch goes dry below Zortman - looks like flow rarely reaches Ruby Gulch (Alder's original confluence with Ruby was altered and channelized so that Alder G. technically is tributary to Goslin Gulch).

1979-present
Similar to baseline with addition of impacts from Alder Gulch waste rock dump (ARD) in Alder and Carter Spurs and 1986-87 LAD (cyanide) in Alder Spur; measures have been taken to improve water quality; impacts have been generally attenuating since 1991; no impacts have been observed at lower sampling station (Z-16). Current mining has no impacts on identified wetlands.

Potential
Wetland sites that occur: 15, 16. Wetland sites that would likely be affected: 15, 16

Direct fill: 0.02 ac
Loss of all functions and values (wetland site 15)

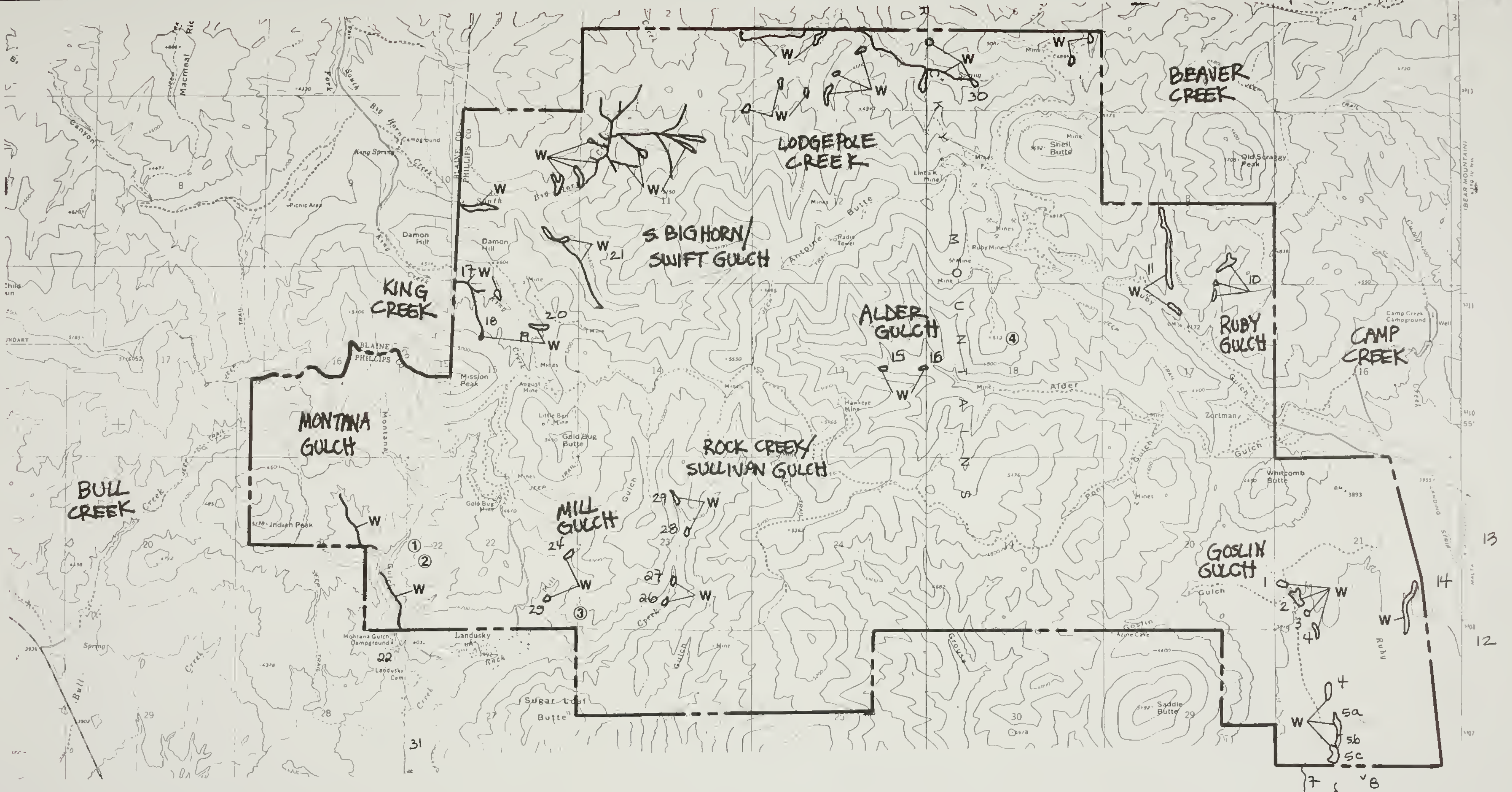
Indirect: 0.24 ac

Sediment inputs; leach pad leakage (CN, metals); possible groundwater and/or surface water changes due to diversions, loss of infiltration under pad area that could decrease spring flow and drop water table; noise and other disturbances; (wetland site 16)

Potential changes to functions and values provided:

<u>Upper Alder Gulch</u>

Hydrologic Support (Groundwater Discharge and/or Recharge)	no change
Floodflow Alteration	moderate/neg
Sediment Stabilization/ Erosion Control	major/neg
Water Purification (Sed. Transport/Toxicant Reduct; Nutrient Removal/ Transform)	major/neg
Production Export/Food Chain Support	moderate/neg
Aquatic Diversity/Abundance	major/neg
Wildlife Diversity/Abundance	minor/neg
Threatened, Endangered, or Sensitive (TES) Species Habitat	no change
Uniqueness/Heritage/ Recreation	no change



LEGEND

W WETLAND

\# Wetland site numbers for functions and values assessment (OEA Research, Inc.)

① PONDEROSA PINE/BEARBERRY ASSOCIATION

② PONDEROSA PINE/BEARBERRY ASSOCIATION

③ PONDEROSA PINE/BEARBERRY ASSOCIATION

④ PONDEROSA PINE/BEARBERRY ASSOCIATION

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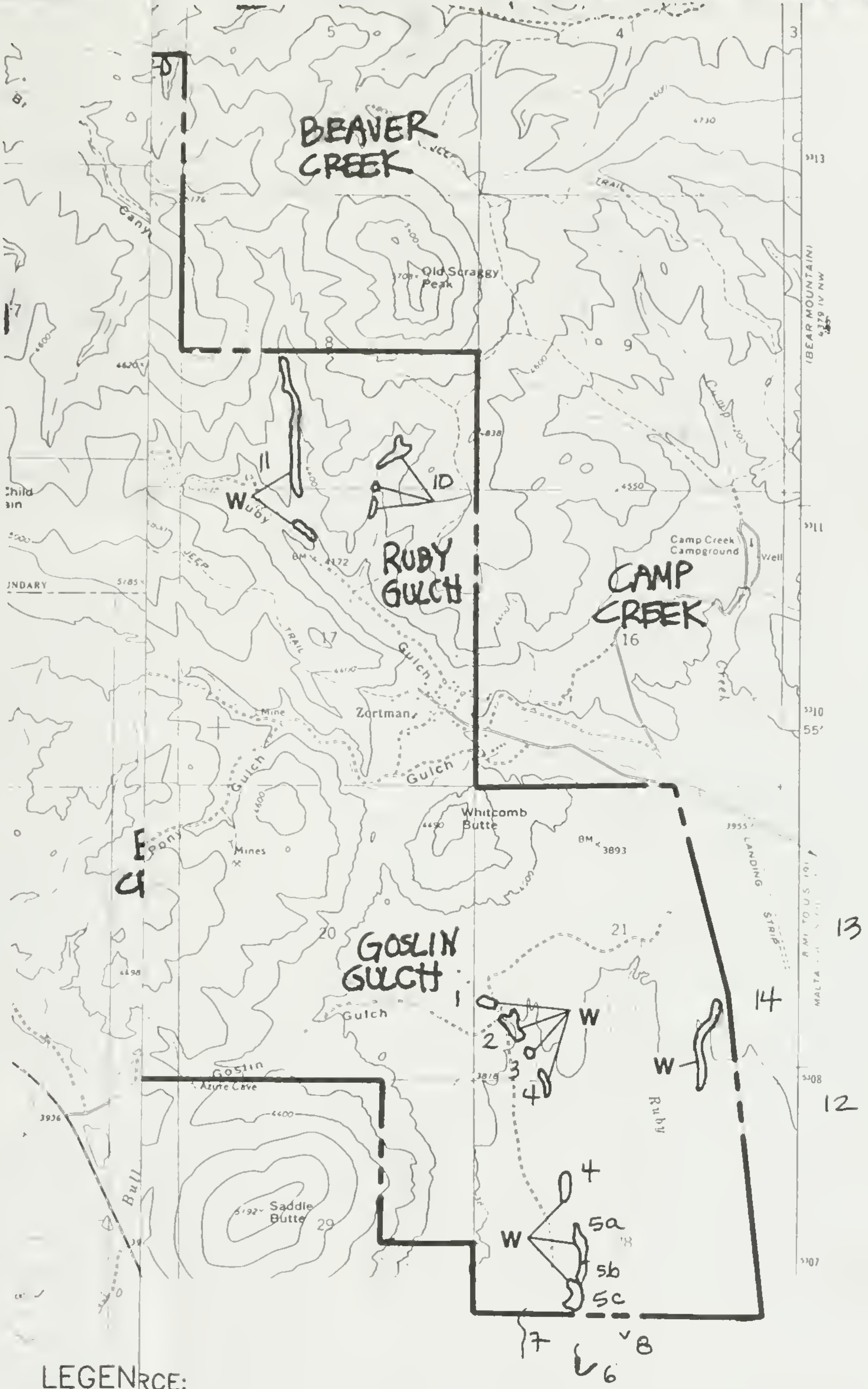
SOURCE:
BASE MAP TAKEN FROM 7.5 MINUTE QUADRANGLE MAPS TITLED: HAYS, MONTANA AND ZORTMAN, MONTANA. WETLAND LOCATIONS TAKEN FROM CULWELL et al. 1992.

JURISDICTIONAL WETLANDS AND SPECIES OF SPECIAL CONCERN

ZORTMAN/LANDUSKY MINES EIS

FIG. B-1

Woodward-Clyde Consultants



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JURISDICTIONAL WETLANDS AND SPECIES OF SPECIAL CONCERN

ZORTMAN/LANDUSKY MINES EIS

FIG. B-1

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APPENDIX C

BIOLOGICAL ASSESSMENT
MINE LIFE EXTENSIONS AND REVISED RECLAMATION PLANS FOR THE ZORTMAN AND LANDUSKY MINES

1.0 INTRODUCTION

This biological assessment of threatened and endangered wildlife species evaluates impacts associated with mine expansion and reclamation proposals which are described in this Draft Environmental Impact Statement (EIS). This biological assessment is in response to the requirements of section 7(c) of the Endangered Species Act (ESA).

The location of the mine expansions is in the Little Rocky Mountains of north central Montana (Figures 1-1 to 1-4 of the Draft EIS). Zortman Mining, Inc. (ZMI) has two active gold mines in close proximity within the Little Rocky Mountains. The Zortman Mine is located in portions of Sections 7, 12, 17, and 18, Township 25N, Range 25E, Montana Principal Meridian (MPM). The Landusky Mine is west of the Zortman Mine in portions of Sections 14, 15, 22, and 23, Township 25N, Range 24E, MPM. Both are near the southern boundary of the Fort Belknap Indian Reservation in the southwest corner of Phillips County. The towns of Hays and Lodgepole are located in the southern portion of the Reservation, just to the north of the mountains. The town of Landusky is in the southwest portion of the Little Rocky Mountains about 0.5 miles south of the Landusky Mine. The town of Zortman is about 1 mile south of the Zortman Mine on the southern edge of the Little Rocky Mountains.

The present mining disturbance is 401 acres at the Zortman Mine and 814 acres at the Landusky Mine. The mine expansion activities would increase the areas of disturbance at the both Zortman and Landusky mines by varying amounts under each alternative as described in Chapter 2 of the Draft EIS.

This Draft EIS addresses impacts from the seven alternatives to both private and public lands. The Draft EIS provides a comprehensive analysis of impacts to the public land and resources administered by BLM.

There are seven alternatives analyzed in the Draft EIS. Alternative 1 is No Action; Alternative 2 is Mine Expansions Not Approved and Company Proposed Reclamation; Alternative 3 is Mine Expansion Not Approved and Agency Mitigated Reclamation; Alternative 4 is the Company Proposed Expansion and Reclamation; Alternative 5 is Agency Mitigated Expansion and Reclamation with the Goslin Flats leach pad located in Upper Alder Gulch rather than on Goslin Flats; Alternative 6 is the Agency Mitigated Expansion and Reclamation with waste rock repository located on Ruby Flats rather than in Carter Gulch and Alternative 7 is the Agency Mitigated Expansion and Reclamation with waste rock repository located on top of, and adjacent to existing mine facilities rather than in Carter Gulch.

2.0 AFFECTED SPECIES

According to a letter from the U. S. Fish and Wildlife Service (USFWS) dated December 8, 1992, the threatened and endangered (T&E) species listed on Table D-1 may be present in the project area.

An updated list of threatened and endangered species was requested and received on October 28, 1994. There were no changes to the above listed species.

A description of the occurrence of these species can be found in the section 3.5.1.1.1 Threatened and Endangered Species in the Draft EIS. A summary of that information follows:

Bald eagles are fairly common migrants to eastern Montana. They occur throughout Phillips County following the fall and spring waterfowl migration. Wintering eagles have been observed primarily along major rivers (Milk and Missouri) where open water provides fish and/or waterfowl as food sources. However, bald eagle observations are rare in the Little Rocky Mountains. There are no known bald eagle nests or essential habitat in the Little Rocky Mountains and large open water bodies that could provide nearby nesting or foraging habitat do not exist.

Peregrine falcons have been an occasional spring and fall migrant to Phillips County. No historical nesting site are known to occur in the Little Rocky Mountains. However, DeLap (1962) reported breeding peregrine falcons in the Little Rocky Mountains in 1962, but did not report the location of the nest. Potential nesting sites are present in the Little Rocky Mountains. Prairie falcons and golden eagles now occupy the potential peregrine falcon nesting sites in the Little Rocky Mountains.

Approximately, 200 black-tailed prairie dog towns occur in Phillips County. Most of these towns form a large complex ideal for a black-footed ferret reintroduction. This 7km Complex is known as the North Central Montana (NCM) Complex. The NCM complex has been identified by the Montana Department of Fish, Wildlife and Parks (MDFWP) and USFWS as Montana's best reintroduction area. This area ranks as one of the three best ferret reintroduction areas in the United States. Black-footed ferrets were re-introduced into Phillips County in the fall of 1994. However, the reintroduction occurred about 35 air miles southeast of the Little Rocky Mountains. The closest prairie dog town to the Little Rocky Mountains is over 10 miles away.

The piping plover was listed (January 10, 1986) as threatened in eastern Montana. No sightings have been made within the Little Rocky Mountains or on BLM administered land in the area. However, an intensive inventory has not been completed as yet. This species could be a resident, occurring on lake shorelines or on gravel bars or sandy beaches along major rivers. Sightings and nesting of the piping plover has occurred at Fort Peck and Nelson Reservoirs within the area.

3.0 ISSUE ANALYSIS

This analysis discusses the Preferred Alternative identified in Chapter 2, Section 2.11 of the Draft EIS. The summary is as follows: Alternative 7 would allow expansion of both the Zortman and Landusky mines but impose agency-developed mitigation on the expansion and reclamation activities. The major modification to ZMI's expansion plans would be at the Zortman Mine, where the proposed waste rock repository would be constructed on top of existing facilities at the mine. Based upon a preliminary design for a waste rock cap and pit contour at the Zortman Mine site, the agencies developed this alternative as a way to reduce the amount of surface disturbance associated with expanded mining activities, reduce the potential for impacts to water resources and enhance reclamation opportunities on existing facilities. This alternative would also reduce the amount of reclamation materials by concentrating disturbed areas. Water balance reclamation covers, as opposed to the barrier covers described in the first six alternatives, would be used to promote revegetation and improve wildlife habitat. A significant modification at the Landusky Mine would include reclamation requirements to remove rock fill from the head of King Creek and backfill the pits to a minimum elevation required to create a surface which would freely drain into King Creek. Additional sources of backfill such as the 85/86 leach pad and the Montana Gulch waste rock dump, may also be required to reach the desired Landusky Mine pit floor elevation. Other agency-developed mitigating measures designed to reduce or eliminate environmental impacts are incorporated into this alternative.

The *black-footed ferret* would not be impacted by the expansion of the mines under Alternative 7.

Decision - No Effect

Rationale - There is no habitat for the ferret within 10 miles of the mine site. Therefore, there would be no impact to the black-footed ferret. If a ferret would ever get to the mine site it would be out of its habitat and would be caught and relocated back into ferret habitat

The *bald eagle* would not be impacted by the expansion of the mines under Alternative 7.

Decision - No Effect

Rationale - There is no designated critical habitat for the bald eagle in the Little Rocky Mountains. Any open water associated with the mining that contains toxic concentrations of captured acid rock drainage (ARD) or cyanide process solutions associated with the leaching activities would be fenced and netted to protect birds from these solutions.

The *piping plover* would not be impacted by the expansion of the mines under Alternative 7.

Decision - No Effect

Rationale - There is no designated critical habitat for the piping plover in the Little Rocky Mountains. A plover was sited in a gravel pit in western Montana however, there is little or no gravel in or near these pits. Any open water associated with the mining that contains toxic concentrations of captured ARD or cyanide process solutions associated with the leaching activities would be fenced and netted to protect birds from these solutions.

The *peregrine falcon* would not be impacted by the expansion of the mines under Alternative 7.

Decision - Positive May Effect

Rationale - There is no designated critical habitat for the peregrine falcon in the Little Rocky Mountains. Any open water associated with the mining that contains toxic concentrations of captured ARD or cyanide process solutions associated with the leaching activities would be fenced and netted to protect birds from these solutions. Also, at the end of mine life as final reclamation is performed, an evaluation would be done to see if the high walls could be used to hack peregrine falcons.

TABLE C-1

THREATENED AND ENDANGERED SPECIES POTENTIALLY PRESENT IN PROJECT AREA

LISTED SPECIES	STATUS	EXPECTED OCCURRENCE
Bald Eagle *Haliaeetus leucocephalus*	Endangered	Year-round resident, winter resident, migrant
Peregrine falcon *Falco peregrinus*	Endangered	Summer resident, migrant
Black-footed ferret *Mustela nigripes*	Endangered	Potential resident in prairie dog (*Clomys*) towns
Piping plover *Charadrius melodus*	Threatened	Summer resident, nesting

PROPOSED SPECIES	STATUS	EXPECTED OCCURRENCE
None		

Source: U.S. Department of the Interior, Fish and Wildlife Service, December 8, 1992 and October 28, 1994

APPENDIX D

PHOTO SIMULATION INDEX

Figure	Viewpoint	View Direction	View Distance (miles)	Location/Alternative Shown[1]
D-1	Hwy 191/Dry Fork Rd.	N	--	Existing Condition
D-2	Hwy 191/Dry Fork Rd.	N	5	Zortman/Alt. 4
D-3	Hwy 191/Dry Fork Rd.	N	5	Zortman/Alt. 6
D-4	Ricker Butte	WNW	--	Existing Condition
D-5	Ricker Butte	WNW	7.4	Zortman/Alt. 4
D-6	Ricker Butte	WNW	7.4	Zortman/Alt. 5
D-7	Ricker Butte	WNW	7.4	Zortman/Alt. 6
D-8	Beaver Mountain	S	--	Existing Condition
D-9	Beaver Mountain	S	4.2	Zortman/Alt. 6
D-10	Beaver Mountain	SSW	--	Existing Condition
D-11	Beaver Mountain	SSW	2.4	Zortman/Alt. 5
D-12	Old Scraggy Peak	S	--	Existing Condition
D-13	Old Scraggy Peak	S	3.2	Zortman/Alt. 4
D-14	Old Scraggy Peak	S	3.2	Zortman/Alt. 6
D-15	Old Scraggy Peak	W	--	Existing Condition
D-16	Old Scraggy Peak	W	1.6	Zortman/Alt. 4
D-17	Old Scraggy Peak	W	1.6	Zortman/Alt. 5
D-18	Old Scraggy Peak	W	1.6	Zortman/Alt. 7[2]
D-19	Old Scraggy Peak	W	1.6	Zortman/Alt. 7
D-20	Saddle Butte	N	--	Existing Condition
D-21	Saddle Butte	N	2.9	Zortman/Alt. 4
D-22	Saddle Butte	N	2.9	Zortman/Alt. 5
D-23	Saddle Butte	N	2.9	Zortman/Alt. 7[2]
D-24	Saddle Butte	N	2.9	Zortman/Alt. 7
D-25	Saddle Butte	E	--	Existing Condition
D-26	Saddle Butte	E	1	Zortman/Alt. 4[2]
D-27	Saddle Butte	E	1	Zortman/Alt. 4

APPENDIX D
(Concluded)

Figure	Viewpoint	View Direction	View Distance (miles)	Location/Alternative Shown[1]
D-28	Saddle Butte	E	1	Zortman/Alt. 6
D-29	Bear Gulch Road	W	--	Existing Condition
D-30	Bear Gulch Road	W	2.6	Zortman/Alt. 5
D-31	Bear Gulch Road	W	.2	Zortman/Alt. 6
D-32	Bear Gulch Road	SW	--	Existing Condition
D-33	Bear Gulch Road	SW	1	Zortman/Alt. 4
D-34	Bear Gulch Road	SW	.1	Zortman/Alt. 6
D-35	Thornhill Butte	N	--	Existing Condition
D-36	Thornhill Butte	N	5.1	Landusky/Alt. 4
D-37	Pow Wow Grounds	SSE	2.1	Existing Condition
D-38	Pow Wow Grounds	SSE	2.1	Landusky/Alt. 4
D-39	Hwy 66/Landusky turnoff	N	--	Existing Condition
D-40	Hwy 66/Landusky turnoff	N	4.5	Landusky/Alt. 4
D-41	Mission Peak	E	--	Existing Condition
D-42	Mission Peak	E	.3	Landusky/Alt. 4[2]
D-43	Mission Peak	E	.3	Landusky/Alt. 4

[1] Photographic simulations show the various alternatives after final reclamation, unless noted otherwise.

[2] Shows alternative during operations at full build-out.

FIGURE D-1 VIEWPOINT: HWY 191/DRY CREEK RD. VIEW: EXISTING CONDITION

FIGURE D-2 VIEWPOINT: HWY 191/DRY CREEK RD. VIEW: ZORTMAN/ALT. 4

FIGURE D-3 VIEWPOINT: HWY 191/DRY FORK RD. VIEW: ZORTMAN/ALT. 6

FIGURE D-4 VIEWPOINT: RICKER BUTTE VIEW: EXISTING CONDITION

FIGURE D-5 VIEWPOINT: RICKER BUTTE VIEW: ZORTMAN/ALT. 4

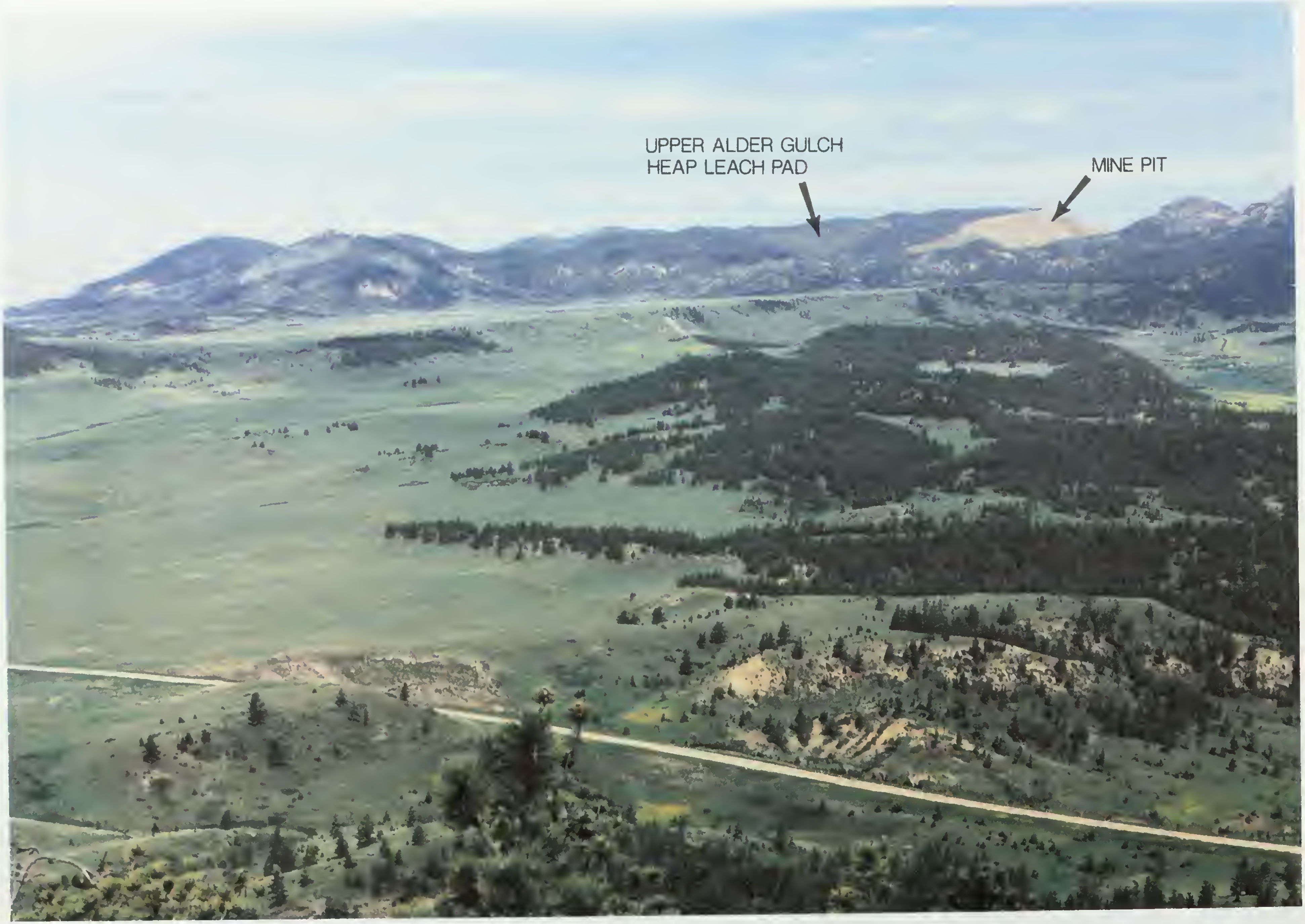


FIGURE D-6 VIEWPOINT: RICKER BUTTE VIEW: ZORTMAN/ALT. 7

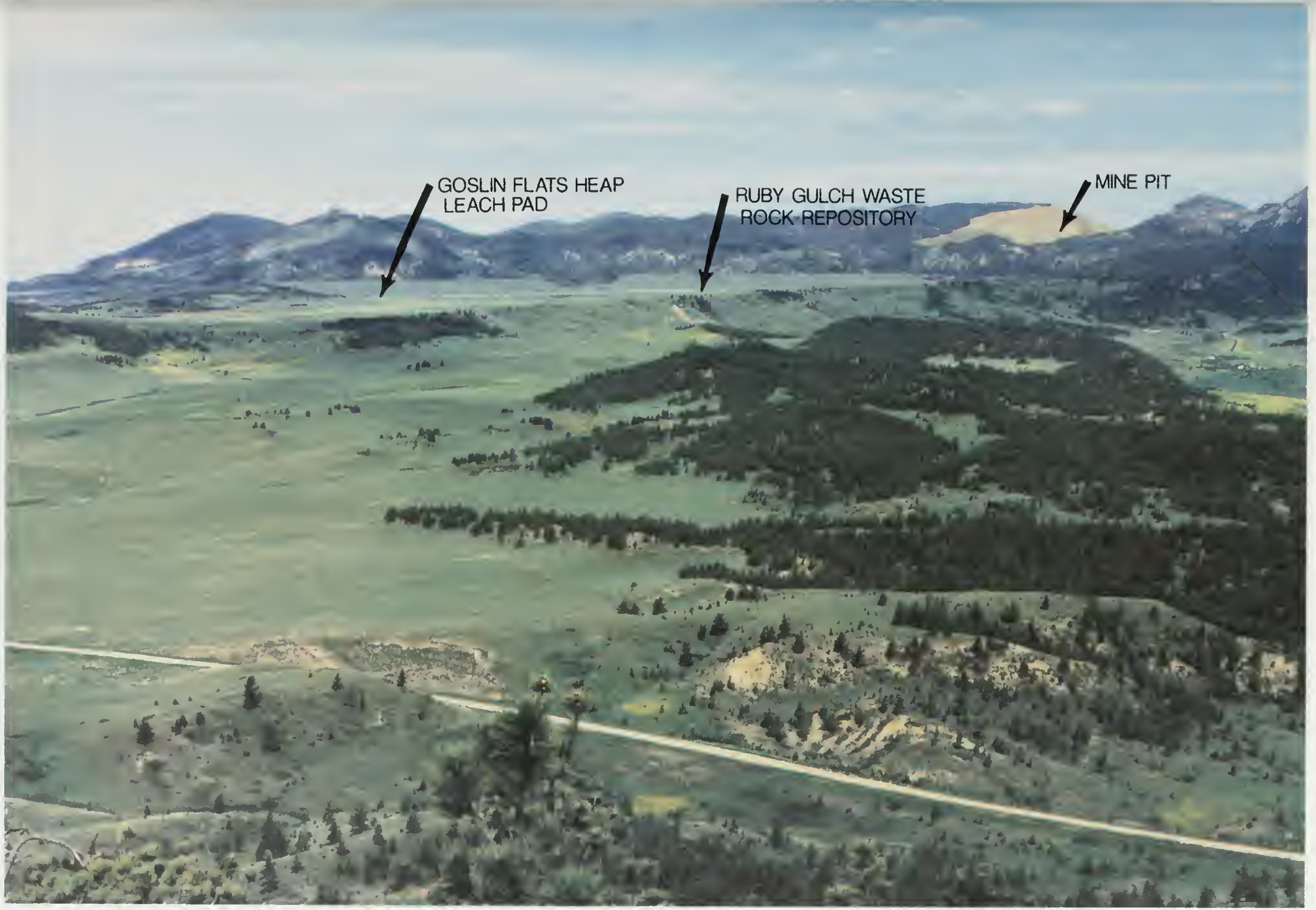


FIGURE D-7 VIEWPOINT: RICKER BUTTE VIEW: ZORTMAN/ALT. 6

FIGURE D-8 VIEWPOINT: BEAVER MOUNTAIN VIEW: EXISTING CONDITION

FIGURE D-9 VIEWPOINT: BEAVER MOUNTAIN VIEW: ZORTMAN/ALT. 6

FIGURE D-10 VIEWPOINT: BEAVER MOUNTAIN VIEW: EXISTING CONDITION

FIGURE D-11 VIEWPOINT: BEAVER MOUNTAIN VIEW: ZORTMAN/ALT. 5

FIGURE D-12 VIEWPOINT: OLD SCRAGGY PEAK VIEW: EXISTING CONDITION

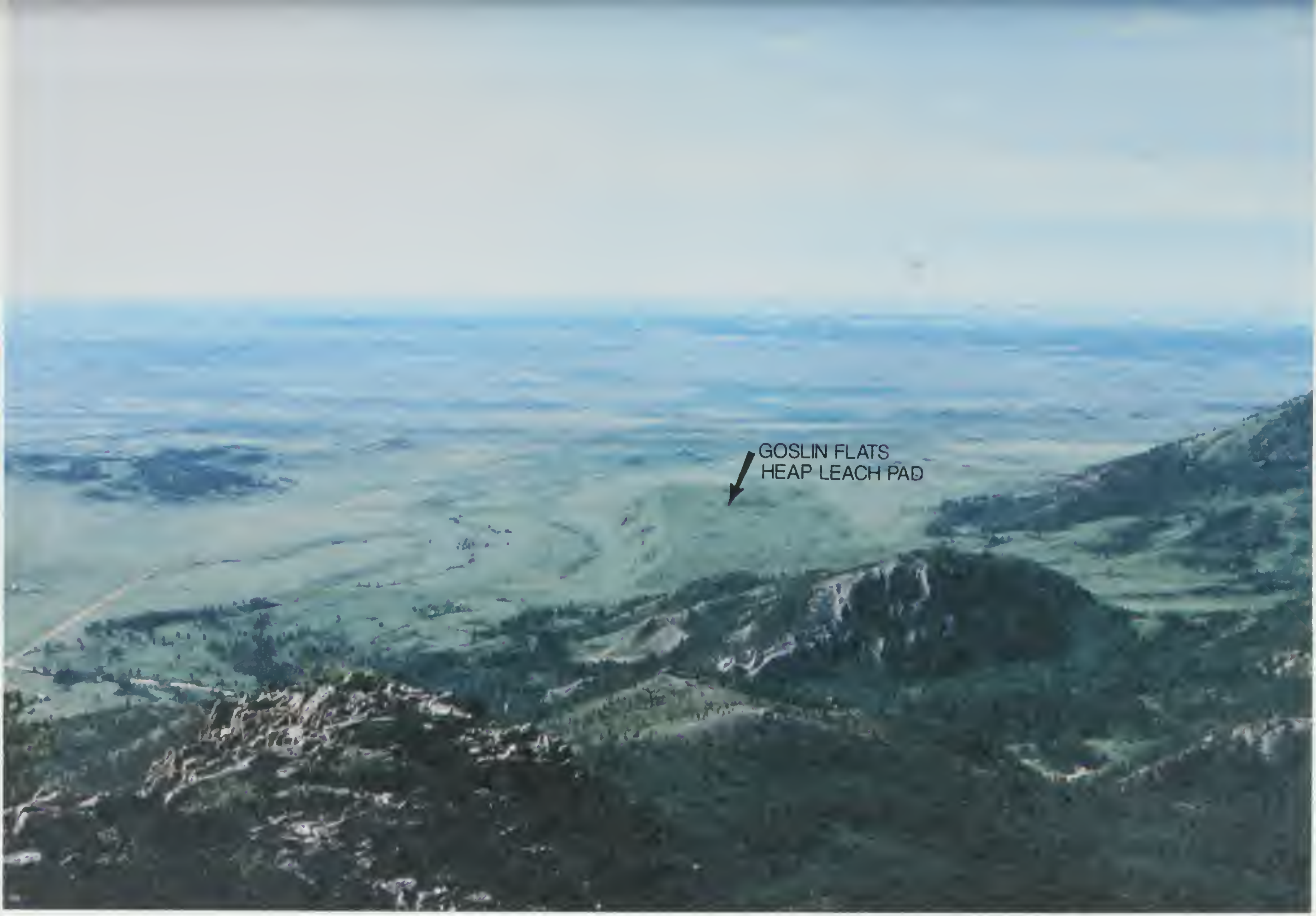


FIGURE D-13 VIEWPOINT: OLD SCRAGGY PEAK VIEW: ZORTMAN/ALT 4

FIGURE D-14 VIEWPOINT: OLD SCRAGGY PEAK VIEW: ZORTMAN/ALT. 6

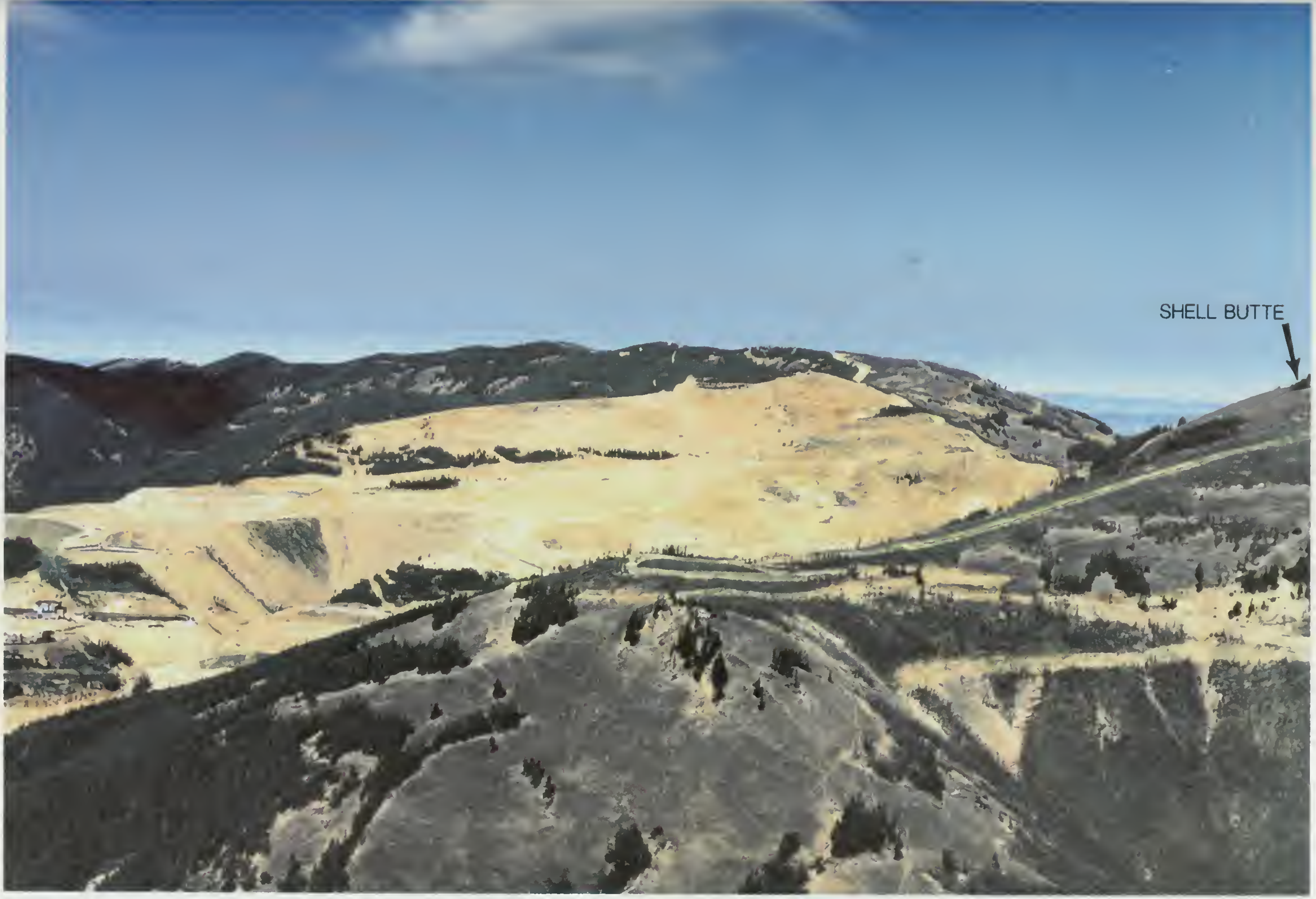


FIGURE D-15 VIEWPOINT: OLD SCRAGGY PEAK VIEW: EXISTING CONDITION

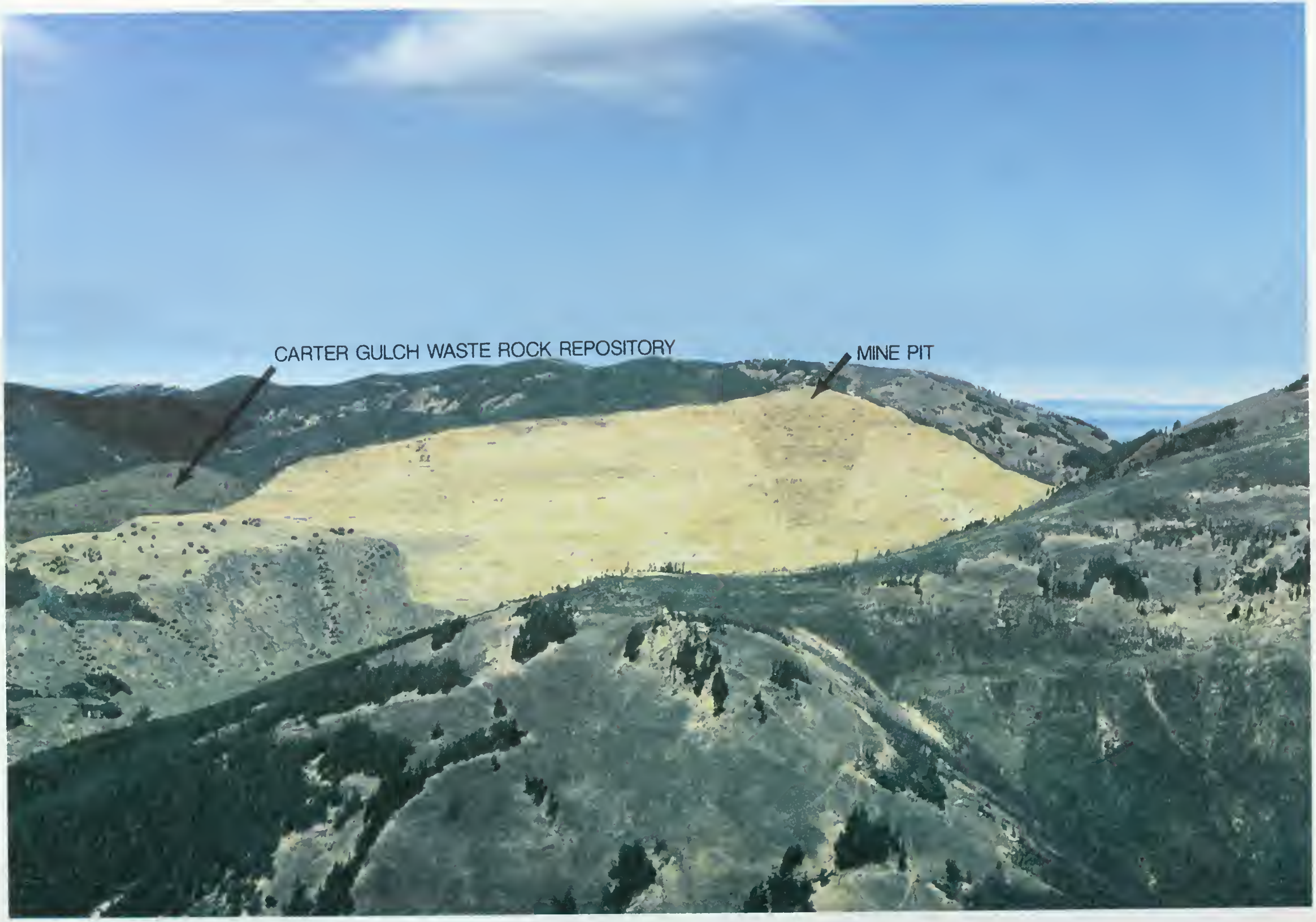


FIGURE D-16 VIEWPOINT: OLD SCRAGGY PEAK VIEW: ZORTMAN/ALT. 4

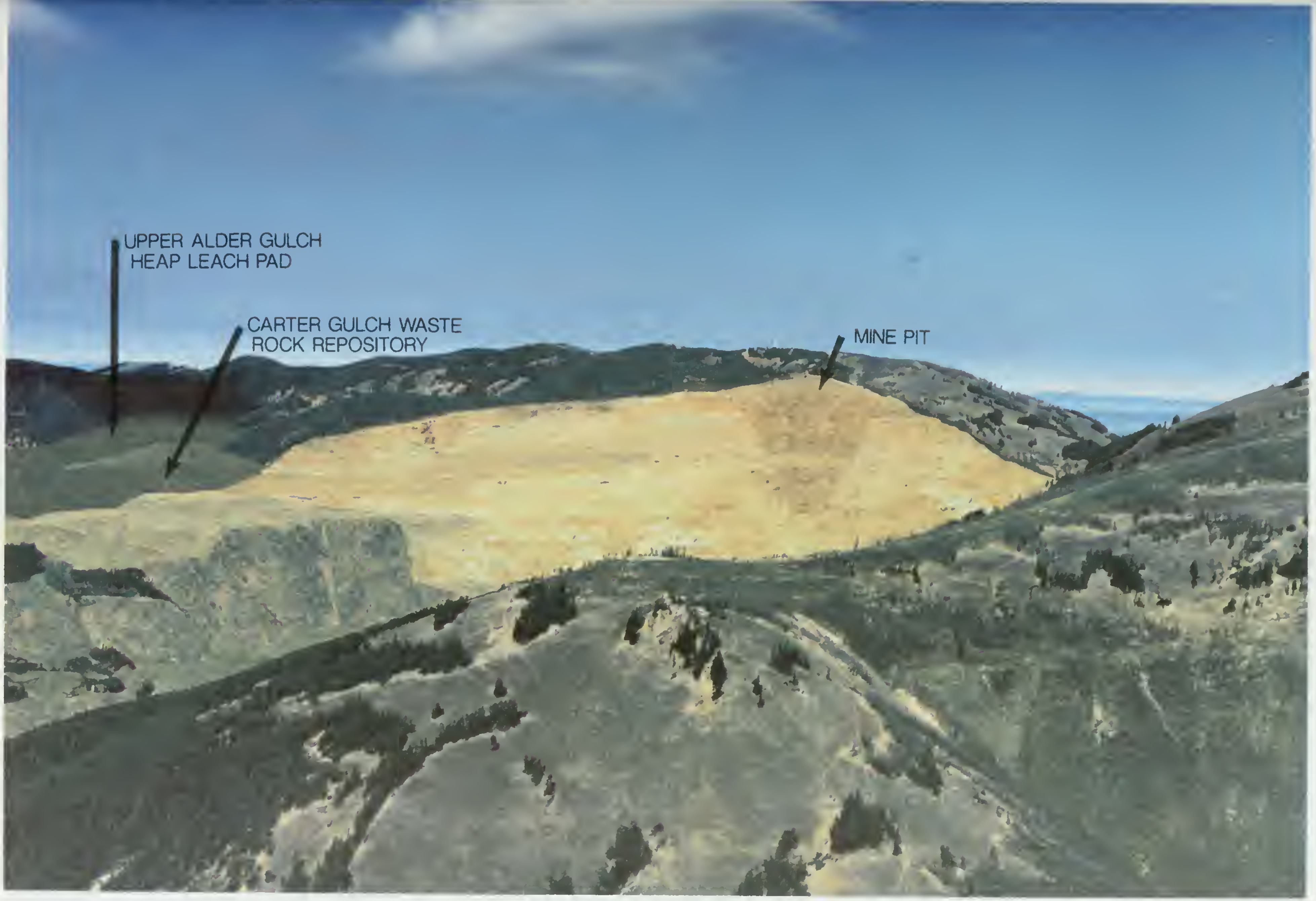


FIGURE D-17 VIEWPOINT: OLD SCRAGGY PEAK VIEW: ZORTMAN/ALT. 5

FIGURE D-18 VIEWPOINT: OLD SCRAGGY PEAK VIEW: ZORTMAN/ALT. 7 (BUILDOUT)

FIGURE D-19 VIEWPOINT: OLD SCRAGGY PEAK VIEW: ZORTMAN/ALT. 7

FIGURE D-20 VIEWPOINT: SADDLE BUTTE VIEW: EXISTING CONDITION

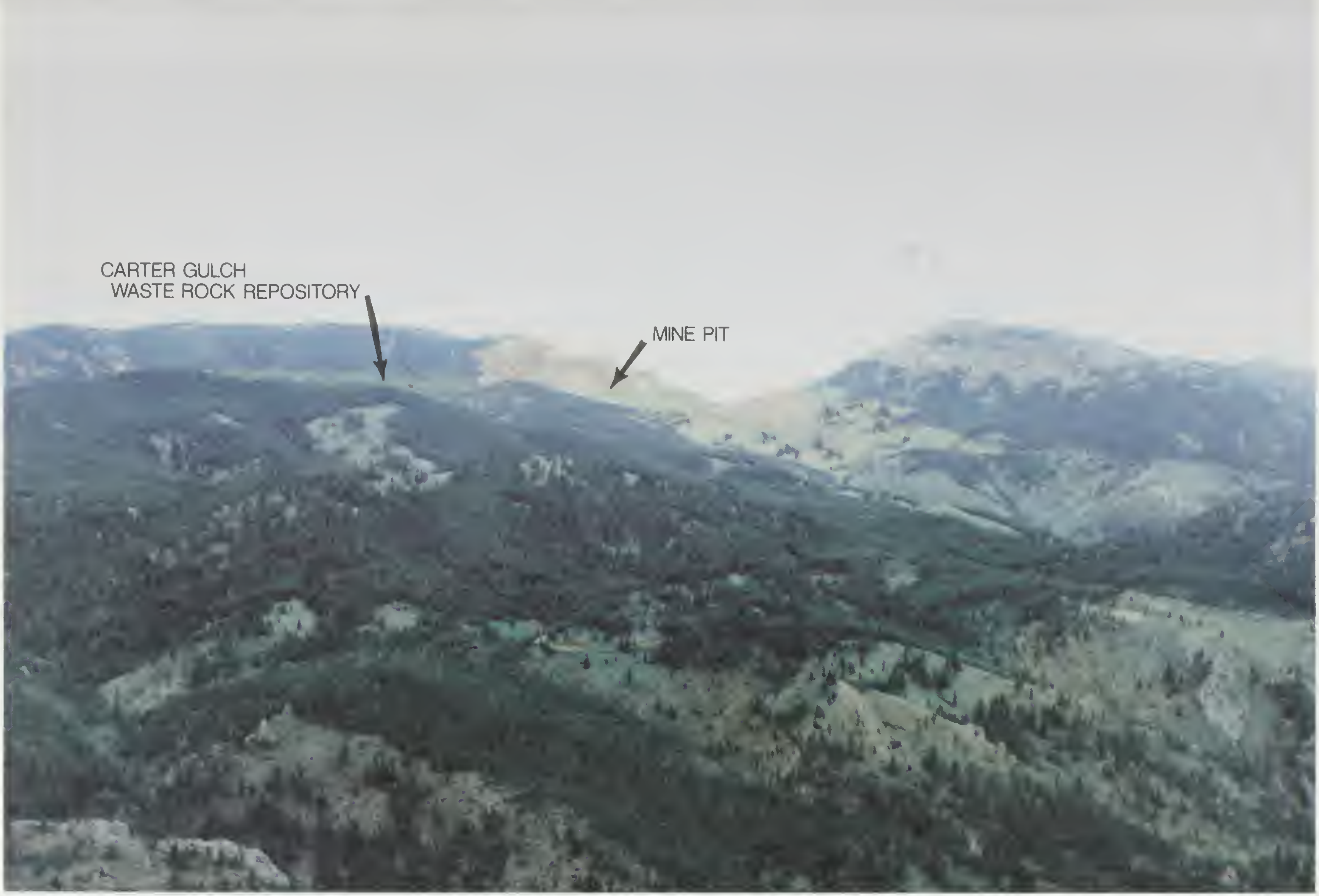


FIGURE D-21 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 4

FIGURE D-22 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 5

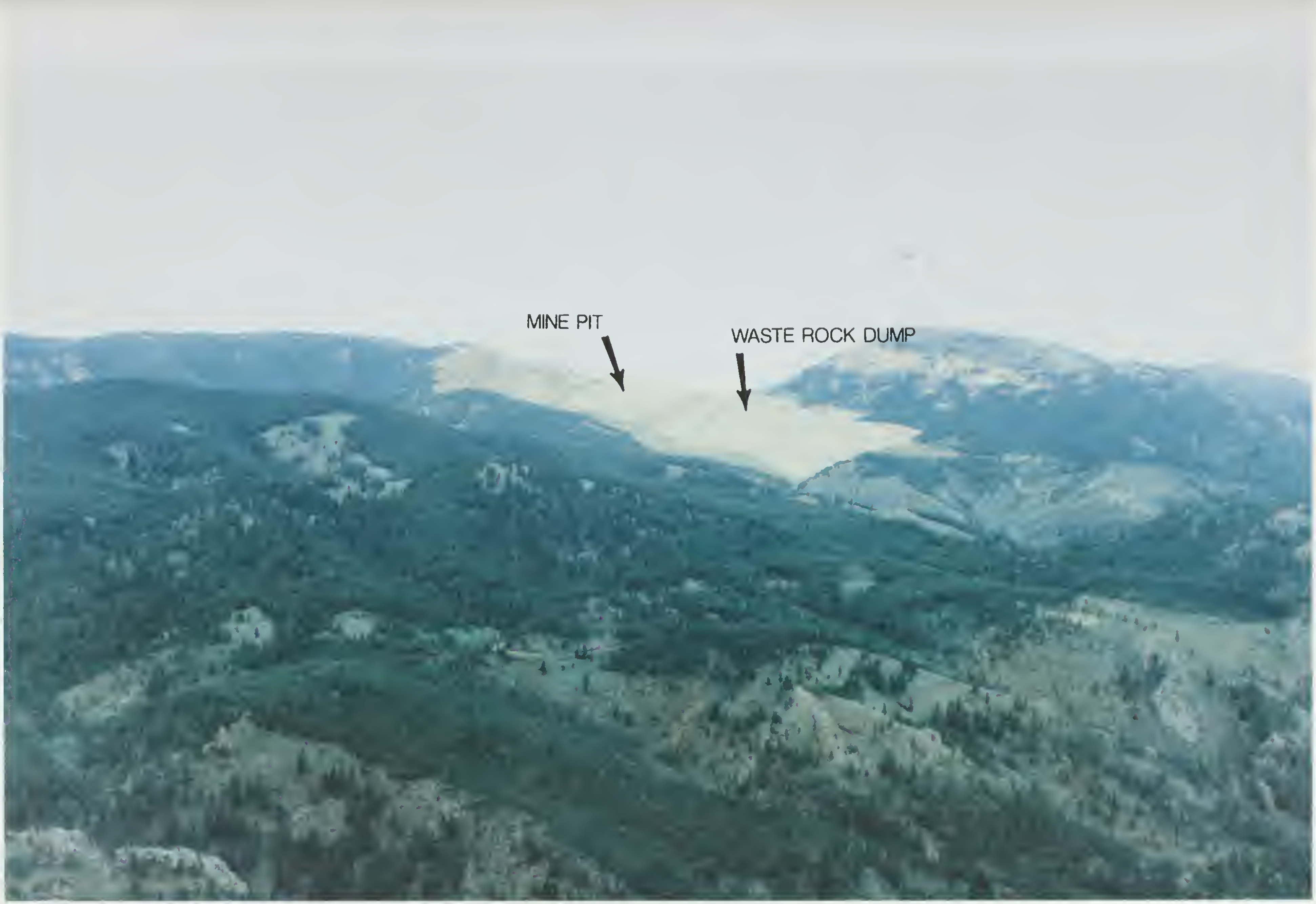


FIGURE D-23 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 7 (BUILDOUT)

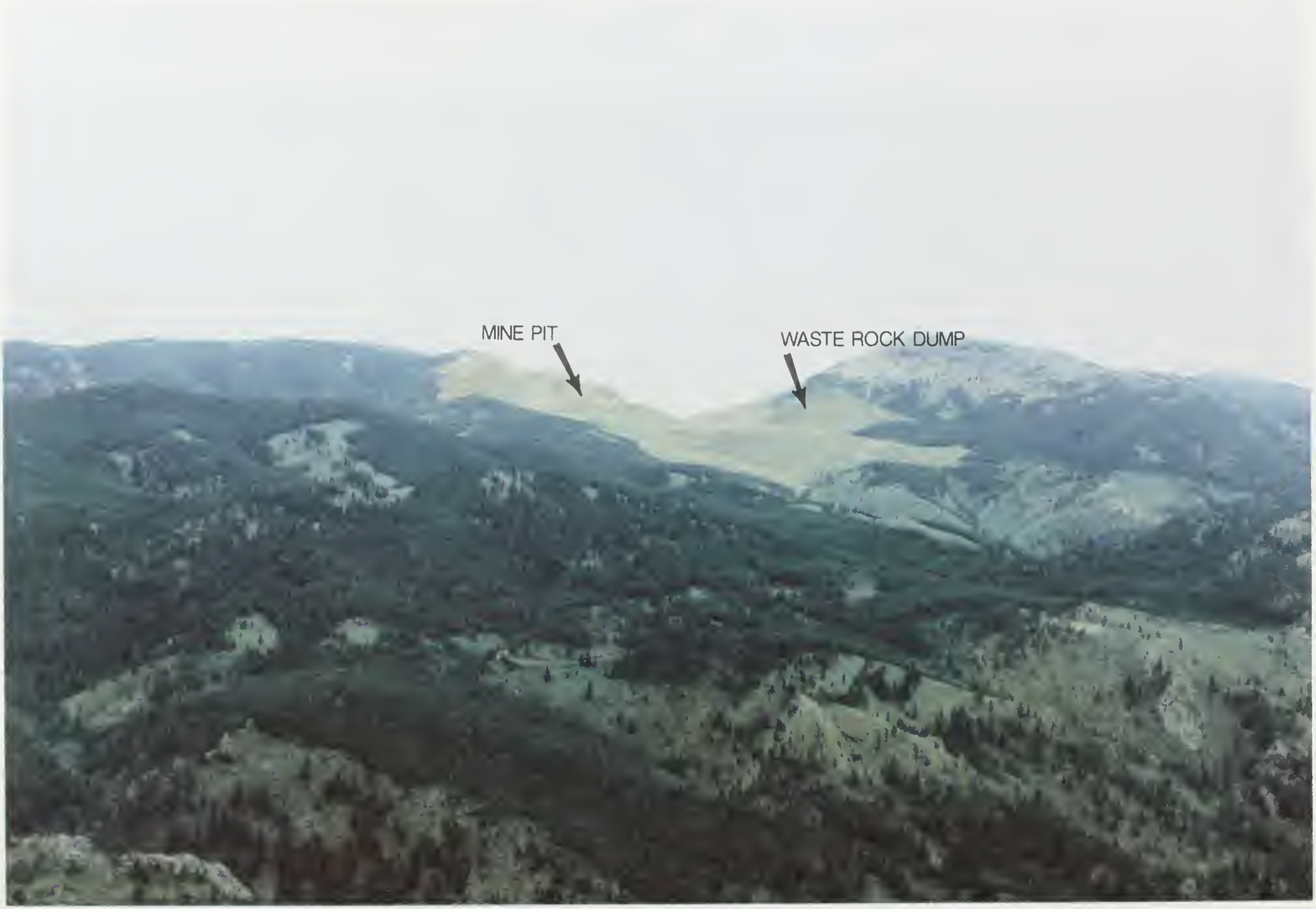


FIGURE D-24 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 7

FIGURE D-25 VIEWPOINT: SADDLE BUTTE VIEW: EXISTING CONDITION

FIGURE D-26 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 4 (BUILDOUT)

FIGURE D-27 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 4

FIGURE D-28 VIEWPOINT: SADDLE BUTTE VIEW: ZORTMAN/ALT. 6

FIGURE D-29 VIEWPOINT: BEAR GULCH RD. VIEW: EXISTING CONDITION

FIGURE D-30 VIEWPOINT: BEAR GULCH RD. VIEW: ZORTMAN/ALT. 5

FIGURE D-31 VIEWPOINT: BEAR GULCH RD. VIEW: ZORTMAN/ALT. 6

FIGURE D-32 VIEWPOINT: BEAR GULCH RD. VIEW: EXISTING CONDITION

FIGURE D-33 VIEWPOINT: BEAR GULCH RD. VIEW: ZORTMAN/ALT. 4

RUBY FLATS WASTE ROCK REPOSITORY

FIGURE D-34 VIEWPOINT: BEAR GULCH RD. VIEW: ZORTMAN/ALT. 6

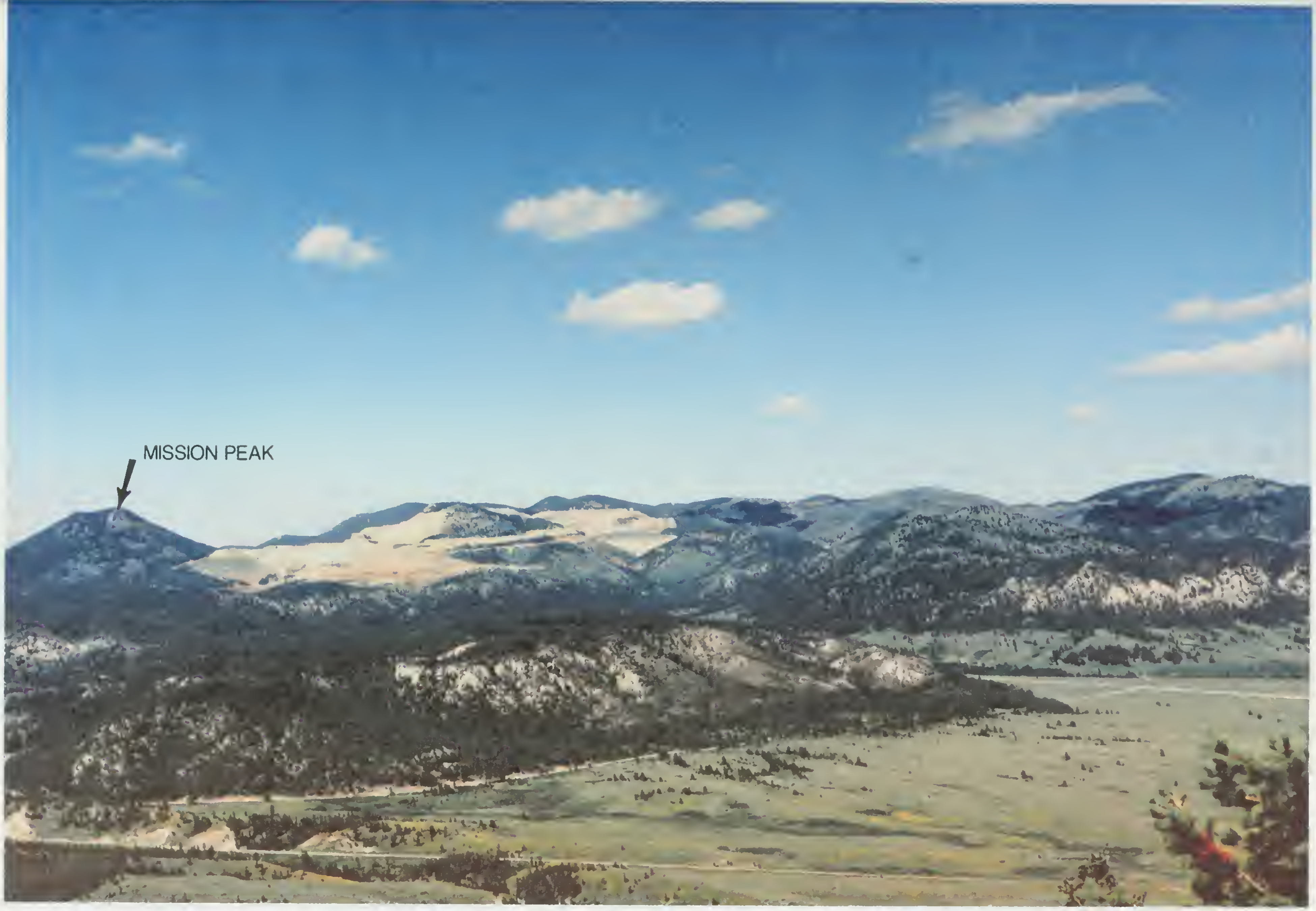


FIGURE D- 35 VIEWPOINT: THORNHILL BUTTE VIEW: EXISTING CONDITION

FIGURE D-36 VIEWPOINT: THORNHILL BUTTE VIEW: LANDUSKY/ALT. 4

FIGURE D-37 VIEWPOINT: POW WOW GROUNDS VIEW: EXISTING CONDITION

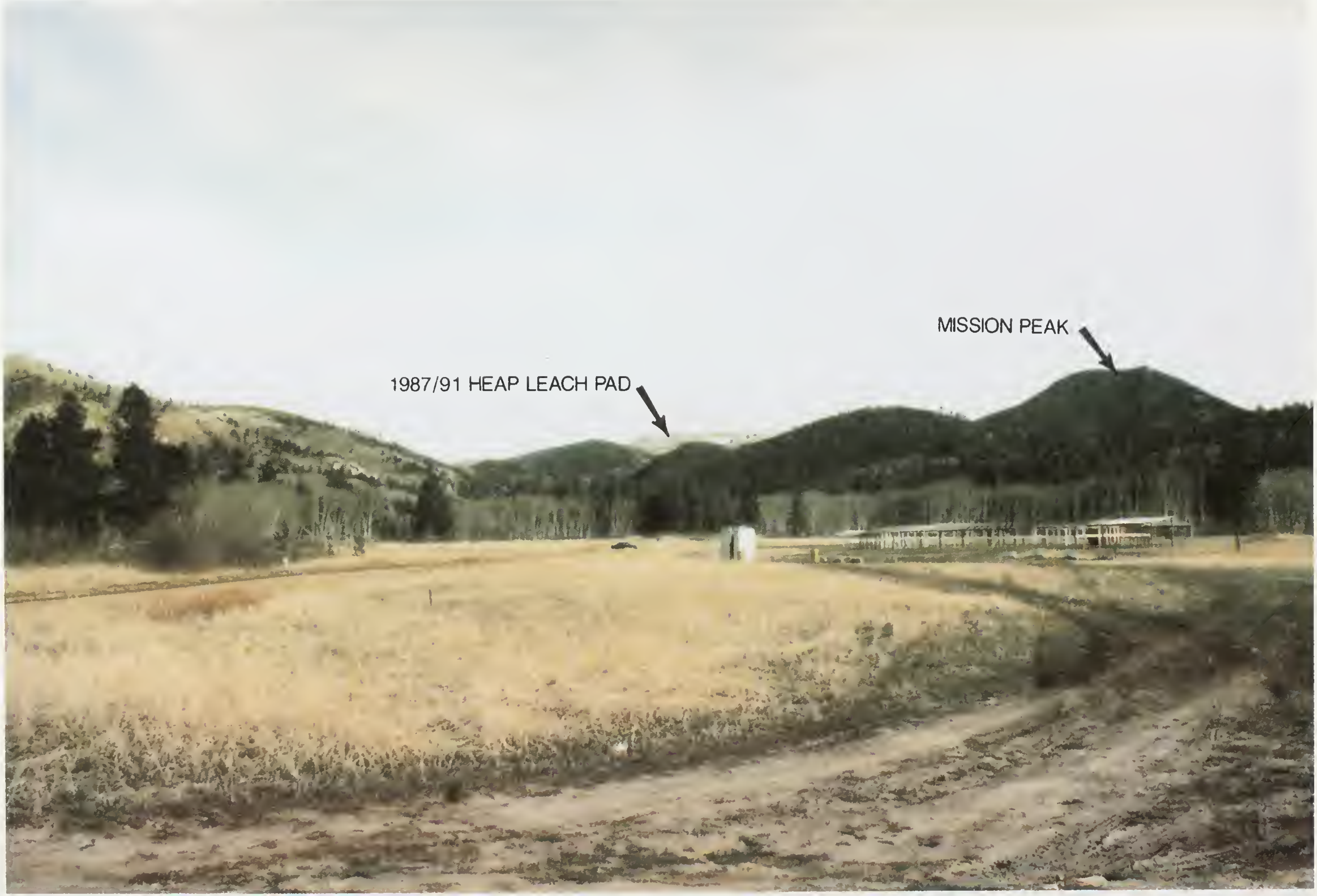


FIGURE D-38 VIEWPOINT: POW WOW GROUNDS VIEW: LANDUSKY/ALT. 4

FIGURE D-39 VIEWPOINT: HWY 66/LANDUSKY TURNOFF VIEW: EXISTING CONDITION

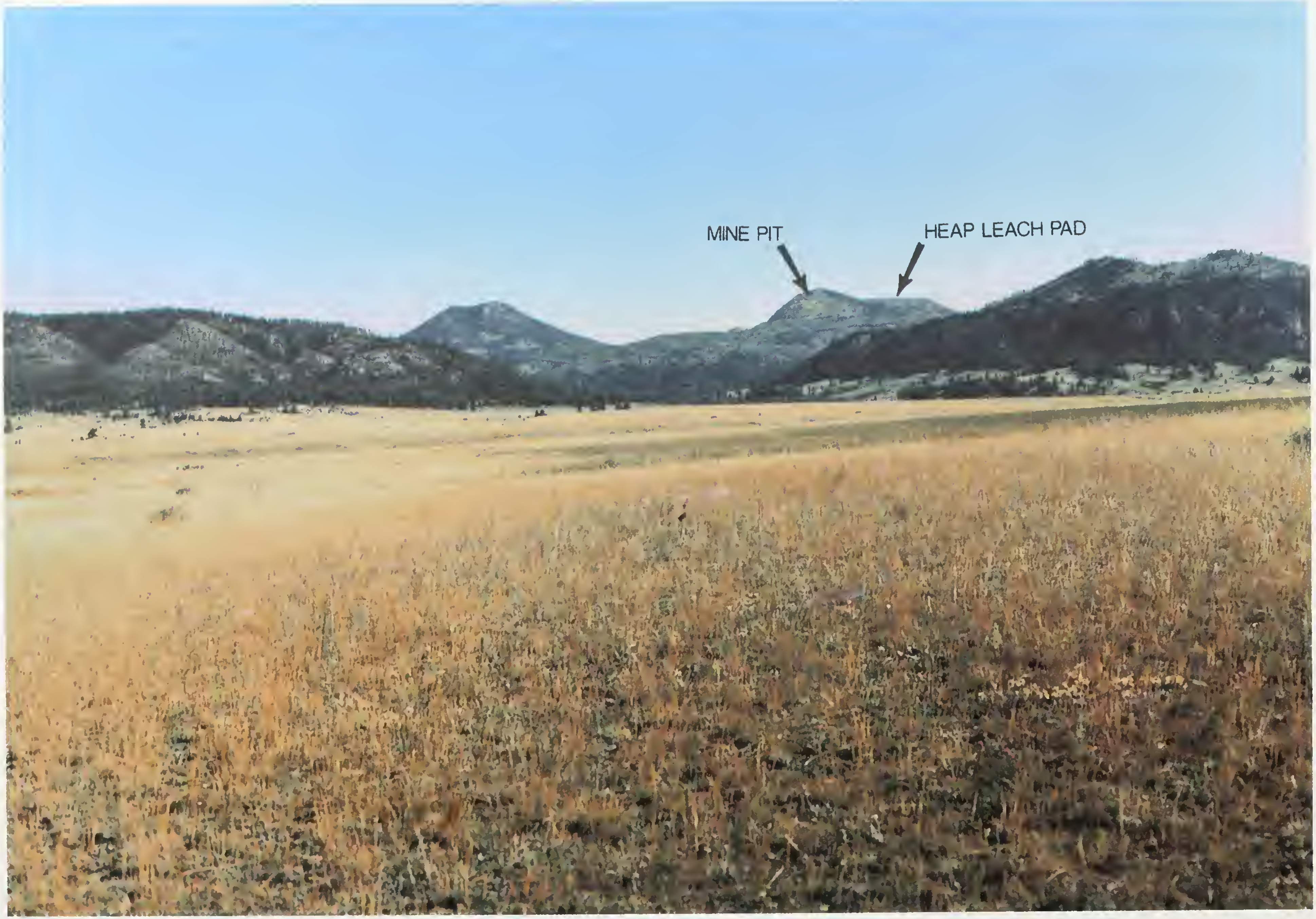
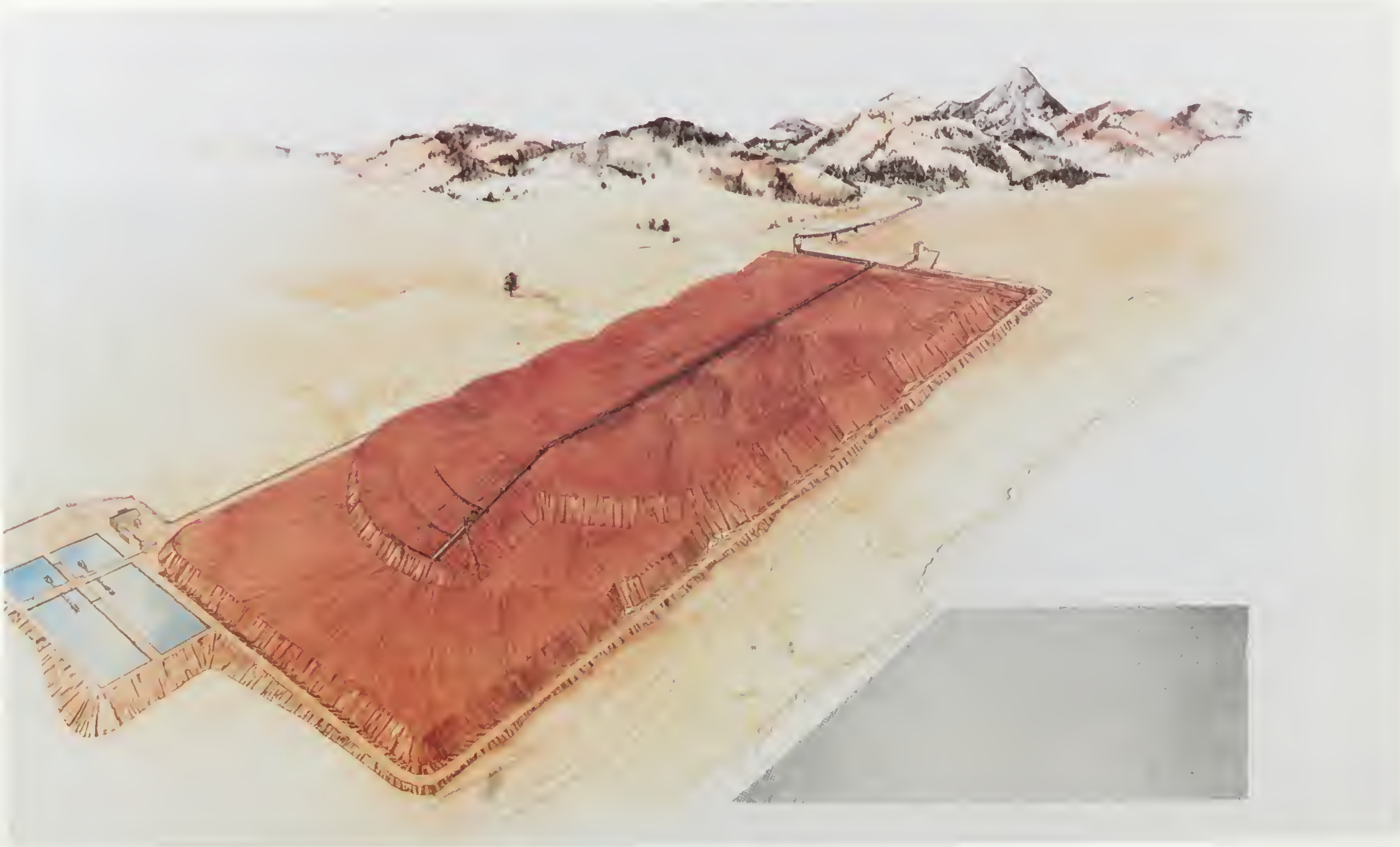


FIGURE D-40 VIEWPOINT: HWY 66/LANDUSKY TURNOFF VIEW: LANDUSKY/ALT. 4

FIGURE D-41 VIEWPOINT: MISSION PEAK VIEW: EXISTING CONDITION (JUNE 1994)

FIGURE D-42 VIEWPOINT: MISSION PEAK VIEW: LANDUSKY/ALT. 4 (BUILDOUT)

FIGURE D-43 VIEWPOINT: MISSION PEAK VIEW: LANDUSKY/ALT. 4



GOSLIN FLATS HEAP LEACH PAD AND CONVEYOR SYSTEM

SOURCE: ZMI 1995

APPENDIX E

DRAFT 6/3/95

MEMORANDUM OF AGREEMENT AMONG THE BUREAU OF LAND MANAGEMENT THE ADVISORY COUNCIL ON HISTORIC PRESERVATION AND THE MONTANA STATE HISTORIC PRESERVATION OFFICER REGARDING ZORTMAN AND LANDUSKY MINES PROPOSED RECLAMATION PLAN MODIFICATIONS AND MINE-LIFE EXTENSIONS

WHEREAS, the Lewistown District Office of the Bureau of Land Management (BLM) has determined that the Zortman and Landusky Mines proposed reclamation plan modifications and Mine-Life Extensions will have an effect on historic properties eligible for inclusion in the National Register of Historic Places, and has consulted with the Montana State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation (Council) pursuant to 36 CFR 800, regulations implementing Section 106 of the National Historic Preservation Act (16 U.S.C. 470f); and

WHEREAS, the historic properties that may be affected by the proposed undertaking include a traditional cultural properties (TCP) district, and historic and prehistoric sites located in the Little Rocky Mountains (LRM); and

WHEREAS, there has been mining in the LRM since the 19th century, and large scale surface mining activities since 1979 have resulted in existing physical, visual, and aural impacts; and

WHEREAS, the Fort Belknap Community Council (FBCC) and Zortman Mining Incorporated (ZMI) have been consulted and invited to concur in this Memorandum of Agreement (MOA); and

WHEREAS, site descriptions are presented in Appendix A and the definitions given in Appendix B are applicable throughout this MOA; and

WHEREAS, The BLM and the Montana Department of State Lands (DSL) are currently preparing an Environmental Impact Statement (EIS) examining potential impacts that would result from seven possible alternatives; and

WHEREAS, Appendix C is a summary of the Purpose and Need of the project and a brief description of the seven alternatives; and

WHEREAS, one of these seven alternatives will be selected as the Preferred Alternative and impacts to historic properties will vary according to the alternative selected; and

WHEREAS, Alternatives 1, 2, and 3 are reclamation alternatives, do not include additional mining beyond that already permitted, and would not result in additional impacts to historic properties;

WHEREAS, the BLM, the Montana SHPO, and the Council recognize that potential impacts to the Little Rockies Traditional Cultural Property District resulting from alternatives 4,5,6 and 7 cannot be fully mitigated in the view of Assiniboine and Gros Ventre Traditionalists of Fort Belknap;

NOW, THEREFORE, the BLM, the Montana SHPO, and the Council agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effect of the undertaking on historic properties.

STIPULATIONS

BLM shall ensure that the following stipulations are carried out.

I. Treatment Plans

A. Treatment Plans will be prepared and implemented according to the Alternative selected in the Record of Decision (ROD) that will be issued by the BLM according to the requirements of the National Environmental Policy Act (NEPA). Treatment Plans will be required if Alternative 4, 5, 6, or 7 is selected. Required Plans for each alternative are described in Stipulation III.

B. Treatment Plans shall be consistent with the Secretary of the Interior's Standards and Guidelines (48 FR 44716-44742), the Council's handbook Treatment of Archaeological Properties: A Handbook, guidelines included in National Register Bulletin 38, and any applicable regulations and guidance of the BLM and the BIA.

C. Where data recovery is determined by the BLM to be the most prudent and feasible treatment option, the research design proposed in the Treatment Plan shall specify, at a minimum:

1. the historic properties to be affected and the nature of those effects;

2. the research questions to be addressed through data recovery, with an explanation of their relevance and importance;

3. the fieldwork and analytical strategies to be employed, with an explanation of their relevance to the research questions;

4. proposed methods of addressing individual discovery situations;

5. methods to be used in data management and dissemination of data, including a schedule;

6. a proposed disposition of recovered materials, human remains, and records; and

7. a proposed schedule for the submission of progress reports to the BLM and the SHPO.

D. The National Park Service office of Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) shall be consulted to determine the appropriate level of documentation for historic structures and mining remains. The BLM shall ensure that all documentation is completed and accepted by HABS/HAER (National Park Service), and that copies of this documentation are made available to the SHPO.

E. The Treatment Plans for historical and archaeological sites shall be submitted by the BLM to the SHPO for review. Unless the SHPO objects within 30 calendar days after receipt of the Plan, the BLM shall ensure that it is implemented.

G. ZMI will be responsible for all costs associated with development and implementation of the Treatment Plans. Once the costs of the post-field work have been determined, ZMI shall post a surety bond to cover these costs. The bond shall be held until all reporting and other mitigative work has been completed according to Stipulations IV. D, E, and F.

II. Professional Qualifications

A. The BLM shall ensure that all historic research carried out pursuant to this MOA is carried out by or under the direct supervision of a person or persons meeting at a minimum the Secretary of the Interior's Professional Qualifications Standards (48 FR 44738-9) for Historians; that all studies in architectural history are carried out by or under the direct supervision of a person or persons meeting at a minimum the same Standards for Architectural Historians; and that all archaeological studies are carried out by or under the direct supervision of a person or persons meeting at a minimum the same Standards for Archaeologists.

III. Alternative Treatment Plans

A. Alternative 4

1. BLM shall ensure that adverse effects to the Little Rockies TCP District are minimized to the extent practicable. This will be done in two primary ways: 1) visual and aural effects will be reduced to the extent practical within the constraints of the operating plan and, 2) BLM will serve as an intermediary between the Ft Belknap

Traditionalists and ZMI to facilitate ongoing discussions to reduce the effects of the expansion for the duration of the proposed expansion project.

2. The BLM shall ensure that ZMI develops and implements a Treatment Plan documenting the character of the Ruby Mill (24PH255). This Plan shall include HABS/HAER documentation of the site, prepared according to Stipulation I.D.

3. The BLM shall ensure that ZMI prepares and implements a Treatment Plan for the Alder Gulch Historic District. One site within the District (24PH2863, a lime kiln) would be directly impacted by construction of the conveyor system. The Plan, including data recovery and photographic documentation of the existing conditions in the District (including HABS/HAER recording), will be prepared according to the requirements of Stipulation I. Extensive data recovery in the form of archaeological excavations is not required. Excavation may be proposed as part of a plan to substantiate historical research, test hypotheses, or to mitigate direct physical impacts to 24PH2863. A certain amount of excavations in workers housing or in trash dumps may be appropriate, depending on the research design contained in the Treatment Plan. It should be noted that sites that comprise the District are not all from the same time period. Additionally, the original purpose of some of the features is not known. The Plan should take this information into account.

   a. The Treatment Plan will include preparation of interpretive signs for the Alder Gulch District. A minimum of three signs will constructed, incorporating results on the research done for the District. The signs will be no less than 2 square feet in size and of appropriate construction for outdoor durability.

   b. The BLM shall ensure that reclamation measures include removal of the conveyor system upon mine closing.

4. The BLM shall ensure that ZMI prepares and implements a Treatment Plan addressing impacts to archaeological site 24PH2905, located in the land application area. The Plan shall be prepared in accordance with Stipulation I.

B. Alternative 5

1. Mitigation for the TCP District according to Stipulation III.A.1.

2. A Treatment Plan shall be prepared and implemented for the Ruby Mill according to Stipulation III.A.2.

C. Alternative 6

1. The BLM shall ensure that ZMI prepares and implements a Treatment Plan addressing impacts to archaeological sites 24PH2905 and 24PH3203. The Plan shall be prepared in accordance with Stipulation I.

2. A Treatment Plan shall be prepared and implemented for the Alder Gulch Historic District according to Stipulation III.A.3.

3. Mitigation for the TCP District according to Stipulation III.A.1.

4. A Treatment Plan shall be prepared and implemented for the Ruby Mill according to Stipulation III.A.2.

D. Alternative 7

1. A Treatment Plan shall be prepared for the Alder Gulch Historic District according to Stipulation III.A.2.

2. Mitigation for the TCP District according to Stipulation III.A.1.

3. A Treatment Plan shall be prepared for the Ruby Mill according to Stipulation III.A.2.

4. A Treatment Plan shall be prepared for site 24PH2905 according to Stipulation III.A.4.

IV. Schedule

A. If Alternative 1, 2, or 3 are selected in the ROD, no Treatment Plans will be required.

B. If Alternative 4, 5, 6, or 7 is selected in the ROD, the BLM shall ensure that the appropriate Treatment Plans, according to Stipulation III.B, C, or D, are submitted to BLM within 90 days of signing of the ROD.

C. Mitigation for the TCP District will be ongoing for the duration of the extension project.

D. Fieldwork for the Treatment Plan for the Alder Gulch Historic District shall be completed prior to construction of the conveyor system. A final report and the proposed wording and sign configurations shall be submitted within one year of completion of the fieldwork.

E. Fieldwork for the Treatment Plan for site 24PH2905 shall be completed prior to use of the land application area. The final report shall be submitted within one year of completion of the fieldwork.

F. Fieldwork for the Treatment Plan for site 24PH3203 shall be completed prior to construction of the waste rock repository. The final reports shall be submitted within one year of completion of the fieldwork.

G. The Treatment Plan for the Ruby Mill shall be developed and implemented within one year of signing of the ROD.

V. Progress Reports

The BLM shall ensure that ZMI prepares annual progress reports detailing the status of Treatment Plans development and implementation. The reports will be submitted to the BLM, SHPO and FBCC. The BLM shall submit a yearly report to the Council addressing work completed, work in progress, and a schedule of events for the upcoming year by April 1st of each year until all treatments are complete.

VI. Dispute Resolutions

Should the SHPO or ZMI object within 30 days to any Treatment Plans pursuant to this MOA, the BLM shall consult with the objecting party to resolve the objection. If the BLM determines that the objection cannot be resolved, the BLM shall request the further comments of the Council. The Council will provide comments to the BLM in response to such a request within 30 days. The BLM will take the Council's comments into consideration when deciding on the resolution of the dispute. The BLM's responsibility to carry out all actions under this MOA that are not the subject of the dispute will remain unchanged.

VII. Amendments

The BLM, SHPO or Council may request that this MOA be amended, whereupon the parties will consult in the same manner as this MOA was negotiated to consider such amendment.

VIII. Termination

Either the BLM or the Council may terminate this MOA for cause by providing 30 calendar days notice, in writing, to the other parties, provided that the parties will consult during the period prior to the termination to seek agreement or amendments or other actions that would avoid termination. In the event of a termination, the BLM will comply with 36 CFR 800.6(b) and 36 CFR 800.8(d) with regard to this undertaking.

IX. Failure to Carry Out Terms

Failure on the part of the BLM to carry out the terms of this MOA requires that the BLM again request the Council's comments. If the BLM cannot carry out the terms of this MOA, it shall not sanction any action, or make any irreversible commitment, that would foreclose the Council's consideration of alternatives to avoid or mitigate adverse effects, until such time as the commenting process has been completed.

X. Execution

Execution of this Memorandum of Agreement and implementation of its terms evidence that the BLM has afforded the Council an opportunity to comment on the Zortman and Landusky Mines Proposed Reclamation Plan Modifications and Mine-Life Extensions and its effects on historic properties, and that the BLM has taken into account the effects of the undertaking on historic properties.

ADVISORY COUNCIL ON HISTORIC PRESERVATION

By:______________________________ Date:__________
Executive Director

BUREAU OF LAND MANAGEMENT

By:______________________________ Date:__________
Lewistown District Manager

MONTANA STATE HISTORIC PRESERVATION OFFICER

By:______________________________ Date:__________

Concur:

ZORTMAN MINING INCORPORATED

By:______________________________ Date:__________

APPENDIX A - SITE DESCRIPTIONS

Alder Gulch Historic District

Twelve sites comprise the historic district and are listed below. A map delineating the District boundary is attached.

24PH2821	Adits	24PH2860	Mining Camp
24PH2822	Mining Camp	24PH2862	Alder Gulch Mill and Camp
24PH2823	Mining Camp	24PH2863	Alder Gulch Lime Kiln
24PH2824	Alder Gulch Dam	24PH2864	Pony Gulch Adit
24PH2825	Miner's Shack	24PH2865	Pole Gulch Mine
24PH2826	Adit	24PH2867	Adit

24PH255

This is the Ruby Gulch Mill. Site 24PH255 was originally recorded in 1978 by Hogan and Fredlund (Cultural Resources Inventory: Zortman and Landusky Mining Tracts) as the Ruby Gulch Mine and Townsite. The mill was not included as it was outside the survey area. The townsite and mine have been destroyed by mining activities. The extant mill is the third one constructed for the Ruby mine; it was built in 1936.

24PH2905

This site was recorded by Rossillon in 1991 and described in Cultural Resource Inventory in the Little Rocky Mountains in and Adjacent to Pegasus Gold Corporation's Proposed Zortman Mine Expansion Project. The site consists of eleven rock rings on the east terrace of Ruby Creek. Lithic artifacts found in subsurface tests included tools, cores, debitage, and a projectile point fragment. A few small, unidentified bone fragments were also recorded.

24PH3203

This site was recorded by Munson in 1994 and described in Class III Cultural Resource Inventory of the Proposed Goslin Flat Waste Rock Repository. It is described as an oval-shaped cluster of heavily sodded-in cobbles. Tests revealed a layer of charcoal stained soil containing fragments of charcoal and calcined bone. The only artifact recovered from the tests was a possible pestle. The site may be the remains of a large hearth-type feature or a dwelling structure.

APPENDIX B - DEFINITIONS

Data Recovery - The procedures that collect information to address research questions outlined in the Treatment Plan. These procedures usually include archaeological excavation, collection of artifacts and other samples (e.g., soil, pollen, charcoal, macrobotanical), and site mapping. Data recovery is followed by data analysis in the laboratory of the collected samples and a report detailing the investigations.

Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) - An office of the National Park Service that maintains records of buildings, structures, and engineering sites. The office also maintains standards for recording those site types; these procedures may include measured architectural drawings and scaled, large-format photography.

Historic Properties - "Any prehistoric or historic district, site, building structure, or object included in, or eligible for inclusion in the National Register. . . . The term 'eligible for inclusion in the National Register' includes both properties formally determined as such by the Secretary of the Interior and all other properties that meet National Register listing criteria." 36 CFR 800.2(e)

Land Application Area - Disposal method to neutralize effluents consisting of low levels of cyanide and metals. The method involves application by spraying of effluent onto a designated land application area for removal of metals through soil adsorption and soil microbe destruction of cyanide. The effluent is distributed by means of a sprinkler system laid on the ground surface.

Record of Decision (ROD) - The decision document prepared by the Federal agency detailing their decision concerning which of the alternatives examined in the Environmental Impact Statement was selected for implementation.

Research Design - The part of a Treatment Plan that outlines questions about a historic property or district that can be addressed data recovery, historic research, and/or ethnographic inquiry.

Traditional Cultural Property - "A traditional cultural property, then, can be defined generally as one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community." National Register Bulletin 38, p. 1.

Treatment Plan - The plan that addresses how impacts to a (or several) historic property will be mitigated. Depending on the type of property and level of impact, a treatment plan may include archaeological excavations, historic or ethnographic research, HABS/HAER recording, or other forms of research or recording.

Undertaking - "A project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency including . . .those requiring a Federal permit, license, or approval. . ." National Historic Preservation Act, Section 301(7)(C).