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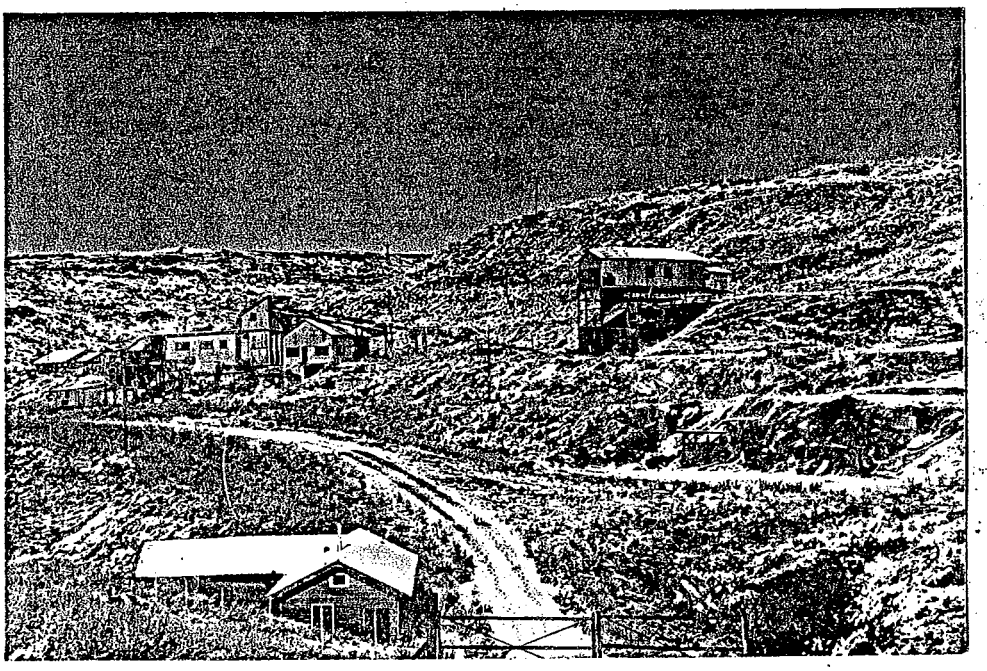
RECLAMATION RECOMMENDATIONS

Red Lodge Coal Field - RED LODGE, MT.

Phase I Report

VOLUME I



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JANUARY, 1983

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Volume 1

Prepared by:

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January 1983

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1.0 Summary

The Red Lodge Coal Field is located in Carbon County, Montana, in and around the Cities of Red Lodge and Bear Creek, Montana. With the exception of the old Brophy Mine now operated by Beartooth Mining Company, mining operations have ceased. Mining was primarily accomplished by underground mining techniques. However, surface mining was attempted in three separate areas near Bear Creek.

At least nine separate coal seams (No. 1, 1½, 2, 3, 4, 4¼, 5, 6 and 7) up to eight feet thick exist within the study area dipping from 20° to 5° to the southwest. The coal is qualitatively described as a good grade of subbituminous coal of the Fort Union Formation. Mining was primarily confined to six coal seams (No. 1, 1½, 2, 3, 4, 5 and 6).

Kiewit Mining & Engineering Co. (KM&E) was contracted by the Montana Department of State Lands (DSL) Abandoned Mine Reclamation Bureau on October 18, 1982, to prepare a comprehensive engineering reclamation plan for the abandoned mines in the Red Lodge Coal Field. The work under this contract was divided into two parts (Phase I and II). Phase I, which this report details, was to carry out general studies of impacts of the Abandoned Mine Land (AML) sites to the surrounding populations and the environment and to develop alternate reclamation plans and recommended reclamation plans. Phase II, which will be completed after review by DSL of Phase I, will develop engineering plans and specifications for reclamation construction.

Included in this report is a study of the abandoned mine lands and reclamation plans. The study of the abandoned mine land includes a literature search, soil and overburden testing, hydrology analysis,

geotechnical studies and AML site inventories. The reclamation plan details reclamation alternatives, costs and recommendations. Also, included in the reclamation plan is an analysis of the sources of pollution, the effects of the pollution and recommended environmental monitoring.

The recommendations contained within this report are based upon KM&E's opinion of the most cost effective solution to mitigating AML related problems of the Red Lodge Area. No warranty is expressed or implied as to the accuracy of those recommendations or the assumptions leading to them.

what's this mean?

The estimated cost to reclaim the area studied using our recommended reclamation plans would be approximately $3,120,000.

2.0 Introduction

In August of 1982, KM&E was contacted by DSL to submit pre-bid information along with six other engineering or environmental firms. KM&E was selected to submit a detailed scope of work and fee schedule. On October 13, 1982, the Montana Department of State Lands (DSL) Bureau of Abandoned Mine Reclamation selected Kiewit Mining & Engineering Co. (KM&E) to provide an engineering reclamation plan for the Red Lodge Coal Field. Kiewit Mining & Engineering Co. started work on the project on October 18, 1982.

This report is a comprehensive documentation of the results of Phase I of the project. The objective of Phase I was to provide general studies of impacts to the surrounding populations and the environment so as to develop a reclamation plan which would eliminate the AML associated hazards.

Keeping in mind the objective of Phase I, the study included a literature search, water quality testing, soil and overburden quality testing, geotechnical testing and site inventories. The literature search was conducted to provide background information on the individual mines within the Red Lodge Coal Field. The literature search uncovered mine maps, mine plans, production figures, past water quality problems, locations of mine openings, and mining practices.

Surface water, groundwater and mine discharge were sampled to determine both quality and quantity. Soil and overburden samples from mine disturbed areas were collected so that representative data for the entire study area could be obtained. The samples were analyzed to determine soil fertility and for presence of toxic material.

Because of relatively inconclusive results of past geotechnical studies conducted with seismic surveys, a seismic survey was not conducted. A drilling program was conducted to substantiate the accuracy of the underground mine plans, determine the characteristics of the roof material, substantiate evidence of underground rooms remaining open and determine the depth of such openings. Also, if caving or subsidence had occurred, the height to which such caving had advanced.

A site-by-site inventory was conducted to determine the size and number of abandoned structures, the location and condition of portals, the estimated volume and location of gob and spoil piles, and the number, location and extent of surface subsidence.

Once the site study was completed, a reclamation plan was developed. The plan integrates the results of the AML study and identifies and locates all hazards to public health and safety and/or the environment and provides options and recommendations for measures to abate these hazards. The reclamation plan includes sources and effects of pollution, reclamation alternatives, recommended reclamation, reclamation costs, and recommended environmental monitoring.

KM&E used personnel from several intercompany departments. With the exception of the literature search, which was conducted by Robert A. Murray of Western Interpretive Service, all of the work was accomplished by KM&E. Personnel from KM&E's Hydrology and Soil Science Departments were responsible for water and soil studies respectively. The drilling for geotechnical studies was accomplished by KM&E's Exploration Department. Water and soil chemical analysis were completed by KM&E's Environmental Lab. Engineers from the Special Projects Department developed the reclamation plan and costs with the coordinated effort of the other departments.

This report contains several sections which detail the work that was performed. These sections are capsulized as follows:

Section 3 - "Abandoned Mine Land Study" contains a discussion of the literature search, hydrology, soil and overburden, geotechnical study and site inventories.

Section 4 - "Reclamation Plan" contains a discussion of sources of pollution, effects of pollution, reclamation plan alternatives, recommended environmental monitoring, recommended reclamation plans and reclamation costs.

Section 5 - "Area-by-Area Reclamation Plan" details the reclamation plan on an area-by-area basis.

Section 6 - "Appendix" contains detailed reports on the Abandoned Mine Land Study including the literature search, the hydrology, the soil and overburden, and the geotechnical studies.

3.0 Abandoned Mine Land Study

3.1 Terms of Reference

The abandoned mine land study was conducted to address five different facets of the abandoned mines in the Red Lodge Coal Field. Included in the abandoned mine land study is a literature search, hydrology study, soil and overburden analysis, geotechnical study and site inventory. A literature search of site specific abandoned mine land records was conducted to determine the location of open shafts, adits and mining practices. Production figures, past water quality problems and the last mine operator were investigated in the literature search.

The hydrology study analyzed water quality to ascertain the degree of surface and groundwater pollution. Abandoned mines in the area discharging mine drainage were identified. Discharge rates and chemical analysis of mine drainage were measured. Local landowners were contacted to determine the location of shallow aquifer wells. Surface water samples were taken at strategic locations to isolate the source and magnitude of the pollution.

Soil and overburden samples were collected adjacent to and over abandoned mine areas to insure that representative data for the entire study area would be obtained. The samples were analyzed to determine soil fertility and/or the presence of toxic material. The analysis of soil and overburden data provided the basis for the development of reclamation techniques for the area.

A geotechnical study was conducted in the form of plug hole drilling to ascertain the present condition of known workings, verify historical mine maps and help confirm the theory for existing surface subsidence.

Drilling was utilized to determine the existence of voids, their depth, whether caving had occurred and the characteristics of the roof material.

Site-by-site inventories were taken to determine the size and location of abandoned structures, the presence of open portals, the extent and location of subsidence and the location and quantity of gob or spoil piles. The size of abandoned structures was determined and the location of the structures was noted on maps. Portals were located and the condition noted. Air at selected open portals was sampled for methane and carbon monoxide. Subsidences were also measured and noted on maps. Gob and spoil piles were measured and the quantity of the material estimated.

In order to facilitate the development of the reclamation plan and the abandoned mine land study, the Red Lodge Coal Field was divided into five topographical areas (see Exhibit No. 2). For convenience the areas were named as follows:

1 Red Lodge Area

2 Scotch Coulee Area

3 Bear Creek Area

4 Foster Gulch Area

5 Virtue Gulch Area.

The "Red Lodge Area" includes the abandoned mines in and around the city of Red Lodge. This area consists of the following sites as described in the Montana Department of State Lands request of proposals of August 23, 1982:

1 Red Lodge Dump

2 Red Lodge Mines and Subsidence

3 Red Lodge Airport Dump (Added at a later date)

The "Scotch Coulee Area" includes the abandoned mines lying immediately to the north of Scotch Coulee and Bear Creek which are north of Montana State Highway No. 308. This area consists of the following sites as described in the DSL request for proposals:

4 Bear Creek Dump

5 Smith Mine

6 Washoe Strip Mine

7 Washoe Dump

8 Coulee Mine

9 The "Bear Creek Area" includes the abandoned mines lying along Bear Creek which are south of Montana State Highway No. 308. This area consists of the following sites:

10 Burns Mine

11 Highway Mine

12 Smith Mine (minor)

13 Bear Creek Strip Mine

14 The Highway Mine was dropped from the study because land owner consent could not be obtained. The Smith Mine (minor) included in the Bear Creek Area was not listed in DSL's request for proposal but was noted by KM&E prior to submitting our proposal. The Smith Mine (minor) Site which is included in the Bear Creek Area consists of portals and structures which historically were a portion of the Smith Mine which lies north of Montana Highway No. 308.

The "Foster Gulch Area" includes the abandoned mines lying along Foster Gulch. Included in this area are the 15 Foster Mine and 16 Foster Gulch Strip Mine as described by the DSL in their request for proposals.

17-18 The "Virtue Gulch Area" includes the abandoned mines lying along Virtue Gulch. Excluded from the Virtue Gulch Area is the old Brophy Mine which is currently operated by Beartooth Coal Company. The abandoned mine sites along Virtue Gulch were not included in DSL request for proposals but were added later.

3.2 Method of Approach

The abandoned mine land study was accomplished by several departments within the KM&E organization. With the exception of the literature search the study was performed by personnel of KM&E. The literature search was conducted by Robert A. Murray of Western Interpretive Services (WIS) of Sheridan, Wyoming.

Water quality sampling and flow measurements were undertaken by the Hydrology Department. Soil and overburden sampling was undertaken by members of the KM&E Environmental staff. KM&E's Environmental Lab was responsible for chemical analysis of the water, soil and overburden samples. The site inventory and plan preparation was undertaken by engineers of the KM&E Special Project Staff. The drilling for the geotechnical study was accomplished by the KM&E Exploration Drilling operation.

In order to insure a continuity of effort and a platform for communication, weekly meetings were held. The meetings were attended by representatives of the various KM&E departments and Mr. Murray of WIS. Mr. Murray kept in constant contact with KM&E in order that technical information could be supplied as quickly as possible to other members of the project team. Mr. Murray searched several archives and libraries including those of the Historical Society of Minnesota, Meridian Minerals

DSL needed to have close contact during phase I

and Land Company and the U. S. Geological Survey. Interviews were also conducted with individuals who are familiar with the mines in the Red Lodge Coal Field.

Qualified hydrologists from the KM&E organization sampled water in the area to determine the potential pollution from the abandoned mine land studies. Twenty surface water samples were taken at strategic locations in the study area on two separate occasions. Eight groundwater samples were taken from either springs or portals discharging water. All samples were taken in order to help isolate the source and magnitude of pollution. The samples were chemically analyzed by the KM&E Environmental Lab in accordance with DSL's 1977 Water Resources Guideline. In addition to determining the quantity of the flow, dissolved oxygen, temperature, specific conductance and pH were also checked in the field. T.S.S.?

Soil and overburden samples were collected by soil scientists of the KM&E Environmental staff and analyzed by the KM&E Environmental Lab. Soils were sampled at 29 different sites selected according to their proximity to abandoned mine land sites. Overburden samples were taken at 31 different sites from gob and spoil piles within the area. Both soil and overburden sample sites were selected so that representative data for the entire study area could be obtained. The samples were analyzed in accordance with the Montana Strip and Underground Mine Reclamation Rules and Regulations and pursuant guidelines.

The geotechnical study was undertaken by KM&E exploration drill crews under the supervision of engineering personnel. Drilling was primarily confined to the visible subsidence just east of the City of Red Lodge as specified in the contract. Drill holes were located to

confirm the underground mine plans and determine the existing condition of the underground workings.

Each of the abandoned mine sites were inventoried by engineers of the KM&E organization. At each site the location and volume of gob or spoil piles were determined. The size and location of abandoned structures were catalogued. Portals were located and the condition of each was noted. Areas of subsidence were also noted. This catalogue of gob or spoil piles, structures, subsidence and portals was developed for use in determining alternate reclamation plans and the cost of reclamation.

3.3 Literature Search

A detailed report on the results of the literature search prepared by WIS is included in Section 6.1. Mr. Murray of WIS did an excellent job of researching the literature. He was able to uncover a wealth of site specific information including mapping of underground mine workings. Historical highlights of his report are summarized below:

Red Lodge Area

Mining started in the Red Lodge Coal Field in 1882 by Rocky Fork Coal Company at Red Lodge.

North West Improvement Company, a subsidiary of the North Pacific Railroad, purchased the Rocky Fork Coal Company in 1903 and increased production.

The Red Lodge mine produced approximately 21 million tons of coal before it ceased operations in 1932.

Scotch Coulee Area

Montana Coal and Iron Company started operating their Smith Mine in 1900 and operated almost continuously from 1907 until 1953.

The Smith Mine was the site of an explosion in 1943 that killed 73 miners.

The Anaconda Copper Company opened the Washoe No. 1 and No. 2 mines in 1906. The Washoe mines were closed in 1938.

Bear Creek Area

This area includes a portion of the Smith Mine operated by Montana Coal and Iron Company.

The Burns Mine was operated by Robert Burns from sometime in the 1920's until 1932.

Other small mines including the Highway Mine and another small mine referred to by the DSL in their request for proposal as the Coulee Mine never had a high level of production.

Foster Gulch Area

The Foster Mine was started by a man named Flaherty, subsequently purchased by Montana Coal and Iron Company, and provided additional accesses to the Smith Mine.

Virture Gulch Area

International Coal Company operated their mine until 1916 or 1917 when a fire destroyed much of their surface workings.

Smokeless and Sootless Coal Co. was the forerunner of the Brophy Coal Company which operated a mine in Virtue Gulch outside the study area.

3.4 Hydrology

A detailed discussion of the hydrology study is contained in Section 6.2. A total of 20 surface water quality samples and eight groundwater quality samples were collected in the Red Lodge Coal Field.

The surface water quality samples were taken at two different times: mid-October and November 1982. Eight surface water quality samples were taken at the same sites in October and November. The remaining surface water quality and groundwater quality samples were taken between November 8 and November 12, 1982.

Preceding the October sampling period was a heavy snowfall, particularly in the vicinity of Red Lodge, Montana. During sample collection, snowmelt was evident. Little or no snowmelt runoff occurred during the November sampling period. All reduced field data is presented in Section 6.2. The analysis of the water samples indicate that although some degradation of the waters in the area is occurring due to AML related disturbance, that degradation does not constitute an enviornmental hazard in our interpretation.

In addition to water quality sampling, Section 6.2 also contains a discussion of water well inventory, sample site descriptions, methodology of sampling and water quality testing results.

3.5 Soil and Overburden

A detailed discussion of the soil and overburden study is contained in Section 6.3. Soils were sampled at 29 sites and overburdens (gob and spoil piles) were sampled at 31 sites. All but two soil samples proved to be chemically suitable for reclamation purposes. However, there is a general lack of sufficient soil quantities for reclamation efforts. — Borrow sites?

Of the 31 overburden samples, 22 samples were taken from gob piles and nine samples were taken in the surface mine spoil piles. The material contained in most of the gob piles is undesirable for use as surface material for reclamation purposes. With the exception of two samples,

gob - no good
spoil - ok

believed to be a localized problem, all of the spoil material outcast from the surface mines appears to be suitable for use as either surface or subsoiling material in reclamation efforts.

3.6 Geotechnical Studies

A detailed discussion of the drilling performed is contained in Section 6.4. A total of 15 holes were drilled in the Red Lodge Coal Field by KM&E to determine the accuracy of the underground mine plans and the characteristics of the mine voids and strata. Eleven holes were drilled on the bluff east of Red Lodge. Holes were also drilled into the Washoe and Smith Mines. The logs of these holes are contained in Section 6.4 and the holes may be located on Exhibits No. 3 and 4.

The information gathered from the drilling indicates that downdip of the obvious subsidence the roof of all but the No. 4 seam has caved to a certain extent. However, this caving has advanced only a maximum of 10 or 15 feet above the original roof. At this point a competent shale or sandstone strata has halted further collapse. The expansion of this roof material as it fell has, in some cases, almost filled the voids and is probably providing some measure of support. The No. 4 seam shows evidence of only minor roof collapse. This is undoubtedly due to a competent sandstone roof lying directly above the seam.

? explain this

3.7 Site Inventory

The objective of the site inventories was to provide a detailed catalogue of the gob and spoil piles, portals, subsidence and structures at each of the abandoned mine sites. The volume of the gob and spoil piles was measured with a tape and abney hand level for piles in excess of 5,000 cubic yards. Piles smaller than 5,000 cubic yards were esti-

mated by visual comparison. The area was scoured for portals and subsidence holes. The condition of the portals was noted and the air was sampled for methane and carbon monoxide at open portals. The size and location of subsidence holes was recorded. The size, location and construction of all abandoned structures was also recorded.

The results of the site inventory were used extensively in preparing the reclamation plans on an area-by-area basis in Section 5. The data sheets for the site inventory are not included in this report. The tables in Section 5 were developed from the site inventory data.

Numerous photographs were taken as a part of this site inventory and a set will be made available to DSL if they desire. — Yes! in final report for would be very useful.

4.0 Reclamation Plan

4.1 Terms of Reference

The objective of the reclamation plan as presented in this Phase I report is to utilize the abandoned mine land study to develop a reclamation plan which would eliminate the abandoned mine land associated hazards to both the surrounding population and the environment. The reclamation plan provides recommendations for measures to abate the identified hazards. The plan includes:

(1) the location of all sources of water and air pollution, subsidence hazards, and hazards to safety caused by open shafts, adits or old structures;

(2) the effects of pollution on the surrounding populations, flora, fauna and hydrologic environment;

(3) the state of the art technology of reclamation techniques and cost estimates for all alternatives;

(4) an analysis of field collected data for use in developing reclamation plans for the Red Lodge Coal Field;

(5) a plan for reclamation of the abandoned mine lands emphasizing cost effective techniques for large scale reclamation of the disturbed areas. The plan is consistent with local land use and open space planning;

(6) recommended projects for reclamation including recommended priorities for all encountered hazards.

4.2 Method of Approach

The reclamation plan for the Red Lodge Coal Field is discussed in a broad sense in this section. Details of the reclamation plan on an

area-by-area basis are discussed in Section 5. This section contains discussion of the following items for all of the abandoned mines in the Red Lodge Coal Field:

(1) Sources of Pollution;

(2) Effects of Pollution;

(3) Reclamation Plan Alternatives;

(4) Recommended Environmental Monitoring;

(5) Recommended Reclamation;

(6) Reclamation Cost.

4.3 Sources of Pollution

No sources of pollution we consider hazardous to the environment were discovered in the study of the Red Lodge Coal Field. However, safety hazards to the surrounding population were in evidence in the field. The safety hazards include subsidence holes, open portals and abandoned structures. The safety hazards pose the greatest threat to the surrounding population of any of the sources of pollution.

Flows from mine portals were located in the Virtue Gulch, Scotch Coulee and Red Lodge Area. Naturally occurring seeps of "Black Water" from coal seams were located in the Bear Creek area. Raw sewage and garbage, indirectly related to mining activities, also provides a source of pollution to the hydrologic system. In addition to these sources, the gob and spoil piles, where natural revegetation has not occurred, somewhat increase the turbidity of the stream during periods of runoff. Most of the gob piles will not support vegetation.

In addition to providing sources for hydrologic pollution, the spoil and gob piles are also a source of occasional air pollution. Although not witnessed in our study of the Red Lodge Coal Field, the gob piles have ignited in the past. Because of the granular size of the material in the piles, or at least at the surface of these piles, the source for dust loading is probably minimal.

4.4 Effects of Pollution

The effects of the sources of pollution from the abandoned mine lands on the flora and fauna are minimal and localized. As stated previously, the only major hazard of the abandoned mine lands in the Red Lodge Coal Field are the associated public safety hazards. These hazards are presented by the existence of subsidence holes, open portals, abandoned structures and occasionally burning gob piles.

The environmental pollution sources affect only a very localized area. For example, the gob piles preclude the growth of vegetation essentially only over their surface area. In fact, the mine drainage from the Red Lodge Mines supports unique vegetation within the area.

One potential threat to the environment, however, is presented by the gob piles and the coal exposed in the surface mines. This threat is fire started by spontaneous combustion of the carbonaceous material. This threat also exists for the public in the area.

One additional effect of the abandoned mine lands in the Red Lodge Coal Field is the damage to the aesthetics of the area. Although the abandoned mine lands represent a part of our history, they also detract from the generally pleasing nature of the area at the foot of the Bear Tooth Range. This may or may not present a problem depending upon the view of the beholder.

4.5 Reclamation Plan Alternatives

A review of the state of the art technology for reclamation methods was undertaken to insure that no viable alternative plan for reclamation was overlooked. For the sake of this discussion and further discussions in the report, the types of disturbance were divided into the five following categories:

(1) Portals to the underground workings;

(2) Subsidence;

(3) Structures and the associated clutter;

(4) Gob Piles;

(5) Surface Mines.

The first alternative that must be considered is to do nothing at all to reclaim the abandoned underground mine lands. However, this approach would leave some threats to the public safety in existence. Therefore, the minimum that was considered was to remove all threats to the public.

For the open portals found in the Red Lodge Coal Field the following methods of reclaiming were considered:

(1) secure the opening with a gate and lock;

(2) doze material over the portal;

(3) blast the roof down and regrade the area;

(4) pump a lean concrete into the portal;

(5) pump material by pnuematic means into the portal.

The portals could be fitted with a steel gate and locked. This would limit access but allow access in the remote possibility of future re-opening.

The open portals could be shut and prepared for revegetation by dozing and caving the mouth of the portal from the sides. The surrounding area could then be smoothed by dozing and bucking up material from below the portal entrance. No dozing would be done from above the portal for safety reasons. The initially collapsed portals could also be prepared for revegetation in this manner.

The open portal could also be collapsed by drilling a tight drill pattern above the opening with an airtrack drill and shooting in the roof with explosives. A dozer could then regrade the area in preparation for revegetation.

Portals with a sizeable entrance and adequate roof support could be sealed by forming a hollow barrier wall and pumping the wall full with concrete or erecting a backing wall and pneumatically stowing gob material from the wall to the portal entrance. Available material could then be dozed against the entrance to prepare for revegetation.

Subsidence exists in the Red Lodge Coal Field. The most extensive subsidence is on the bluff east of the City of Red Lodge. Subsidence has, however, occurred in a much more minor degree in all of the areas in the Red Lodge Coal Field.

For the surface subsidence, the following methods of reclamation were considered:

(1) fill with borrow, topsoil and revegetate;

(2) fill with gob material, topsoil and revegetate.

Whether the subsidences are filled with borrow material from the nearest source or with gob material from the most likely pile, a fleet of highway legal dump trucks could be used to backfill those holes which

are accessible. Those holes inaccessible to dump trucks could be filled by either traming the borrow or gob material with a loader or by dozing material into the hole from the surrounding area. Once filled, the area could be compacted, leveled with blade or dozer, topsoiled with acceptable material and revegetated.

The existing abandoned structures for the most part are in ill repair and pose a threat to the public. However, some abandoned mining structures are in use and should not be destroyed. For the dilapidated structures the following alternative methods of reclamation were considered:

(1) salvage the structures under a contract;

(2) dismantle and bury at site;

(3) dismantle and bury in the surface mines;

(4) dismantle and haul to remote site for burial.

Using a salvage contract, the contractor would be paid to dispose of all structures but would be allowed to salvage anything of value. This would reduce the contract price compared to a contract to dismantle or demolish the structures, excavate a pit on site, bury the trash, cover and reclaim the area. If site burial was not acceptable, the structures would be demolished and hauled and buried in the surface mines but only if the reclamation plan for the surface mine called for backfilling the pits. Another option would be to haul all demolished structures to a remote burial site specifically designated for that purpose.

Salvage without a contract was also considered but was not opted for because the structures have been salvaged to some extent. If this was an economic alternative, the structures would have been salvaged in

the past. The costs associated with demolition of the structures also includes funds for the clean-up of the debris and clutter at each site.

Many gob piles exist in the abandoned mine lands of the Red Lodge Coal Field. For the most part these piles are void of vegetation. The piles are a decrement to the aesthetics of the area and a potential fire hazard, therefore, the option of doing nothing was only considered for piles that are being used for construction material. The alternatives for reclamation are as follows:

(1) do nothing for piles used for construction material sources;

(2) pull the slopes away from the immediate vicinity of drainages;

(3) remove from drainage area and reduce slopes;

(4) transport to a remote site and bury.

How about 3+4?

Two other alternatives were also considered but abandoned. The transport and burial in surface mines was abandoned because the volume of the gob piles could not be held in the surface mines. Also considered was stowing the material in the underground voids. But this concept was abandoned because of the caving which has occurred in the underground voids and the cost associated with handling this amount of material by pneumatic means.

For those gob piles directly adjacent to drainages the slopes would be pulled back by either a scraper or truck/loader fleet. Gob pile slopes would be reduced to 3:1 by dozers and blades. For those piles transported to a remote site (head of hollow fill) either a scraper or truck/loader fleet would be used depending on the circumstances.

Three separate sites in the Red Lodge Coal Field have been surface mined. For the most part natural revegetation has taken place. The following alternative methods of reclamation were considered:

(1) do nothing;

(2) grade areas void of vegetation and vegetate;

(3) reduce the highwall and vegetate;

(4) regrade spoil and revegetate.

Grading with a small dozer and hand seeding would be adequate for small areas of unvegetated spoil. Most work involved in reducing the highwall to 3:1 and regrading the spoil could be accomplished with dozers and blades. Scrapers could move the remaining spoil to balance the cut/fill. Revegetation could be done with standard reclamation equipment except for localized areas of hand seeding.

4.6 Recommended Environmental Monitoring

Since no significant environmental hazards were found during the abandoned mine land study, no major monitoring programs are believed to be required for the area. The following is a list of specific recommendations for a monitoring program:

(1) soils - no further sampling is required;

(2) vegetation - inspect the results of revegetation after two growing seasons;

(3) hydrology - Foster Gulch samples were essentially an indication of groundwater from the Foster Gulch coal spring. It is recommended that two additional surface water samples be taken from Foster Gulch during surface runoff. The sites should be located upstream and downstream, respectively, of mine disturbance and used for baseline establishment.

In those areas where reclamation of gob piles has been completed, surface water quality sampling should be conducted after the land has been revegetated (one or two growing seasons).

Sample locations should remain consistent with those established by KM&E pre-reclamation.

All samples should be collected with standard techniques, field parameters measured, streamflow carefully measured, and analyses to include all parameters specified by the 1977 DSL Water Resources Guideline.

(4) subsidence - monitor the area during the vegetation and hydrology monitoring period.

4.7 Recommended Reclamation Plan

The recommended reclamation plan is detailed on an area-by-area basis in Section 5. During the abandoned mine land study no environmental hazards were identified and only minor or very limited pollution of the environment was found. However, hazards to the public safety were identified in the form of open portals, subsidence holes and abandoned structures. This then forms the overriding consideration in our reclamation recommendations. Based on potential hazard, the priority of reclamation is as follows:

1. Portals
2. Subsidence
3. Structures
4. Gob Piles
5. Surface Mine.

The priority of reclamation by area is essentially based on proximity of the area to population centers and availability of access to an area. Therefore the priority of reclamation ranked by area is as follows:

1. Red Lodge
2. Scotch Coulee

3. Foster Gulch

4. Bear Creek

5. Virtue Gulch.

The recommended reclamation plan for open portals is to blast the roof down and to regrade the area around all portals. Blasting the roof down is recommended because it is more cost effective than stowing shut with gob material. Also, blasting down will minimize the chance of subsidence re-opening the portal which might be the case with dozing, gating or concreting.

The recommended reclamation plan for subsidence holes is to fill with borrow material. This is recommended because it is cost effective and will minimize barren patches which have evolved in previous attempts to use substandard material (evidenced by pan marks on the bluff east of Red Lodge).

The recommended reclamation plan for the structures, with the exception of the Red Lodge Area, is to dismantle, demolish and haul to remote fills. The structures would be disposed of in the same fills as the gob piles. This plan is recommended because it will minimize the amount of disturbance from reclamation compared to individual burial of the structures at each building site. Salvage of the structures is not viable because the structures have very little value and the valuable components have already been salvaged. Burial of the structures in the surface mines is not recommended because only minimal reclamation is actually necessary for the surface mines.

The abandoned structures in the Red Lodge Area could be disposed of in the subsidence holes. This is recommended primarily because of a lack of other nearby suitable places for burial.

potential for erosion?

It is recommended that most of the gob piles be placed in head of hollow type fills. Piles currently being used for construction material should not be moved or buried which would preclude their economical utilization. The North Red Lodge Dump need not be moved because of the volume of material contained within this pile and the lack of a nearby disposal site. The North dump should be pulled back from Rock Creek and the side slopes reduced. Transport of the South Red Lodge dump to a disposal site or an attempt to stow it in the underground workings is felt to be too expensive in light of its minimal environmental impact. We feel pushing it back toward the eastern bluff and blending it into the slope will be the best option. Transport and burial in head of hollow type fills is considered the only permanent solution for the balance of the piles in the Red Lodge Coal Field.

burial in place on small ones?

Only minimal reclamation is recommended for the surface mines which pose very minimal hazards to surrounding populations. The recommended plan for the Foster Gulch Strip Mine, which has the greatest amount of barren area of the three surface mines, considers only highwall reduction. The plan for the remaining two surface mines, (Washoe and Bear Creek) recommends only the areas void of vegetation be graded.

The estimated costs for the recommended reclamation plans are summarized below.

Red Lodge	$1,260,893
Scotch Coulee	1,227,745
Foster Gulch	449,450
Bear Creek	97,705
Virtue Gulch	83,965
Total	$3,119,758

4.8 Reclamation Costs

The reclamation costs were estimated using standard engineering procedures. The equipment operating costs are based on the "Cost Reference Guide for Construction Equipment" (Blue Book) published by the Equipment Guide-book Company. Labor rates were obtained from the 1982-83 agreement of the Associated General Contractors with the International Union of Operating Engineers Local 400.

The ownership costs for equipment were modified to be 42 percent of those outlined in the Reference Guide. The blue book ownership rates are generally considered high. This adjustment was taken to arrive at a more equitable ownership rate. The 42 percent factor is the same factor generally used by state highway departments for cost estimates. The costs for equipment repair parts, fuel, oil and grease, and tires and track were taken directly from the blue book. Maintenance labor rates for the equipment were derived from KM&E experience, using labor rates from the Operating Engineers' agreement.

The total hourly operating costs by equipment type as used to estimate the reclamation costs are summarized below.

Table 4.8.1

Equipment	$/Hour
Pickup 2x4 3/4 ton	8.21
F-700 Mech. Truck	23.00
LT-9000 Water Truck	32.00
20 cy End Dump (highway)	47.24
Cat D-6 with Ripper	47.24
Cat D-8 with Ripper	98.68
Cat D-9 with Ripper	122.37
AC 7040 Farm Tractor	32.42
Cat 14-G Blade with Ripper	67.77
Cat 637D Scraper	155.15
Disc	1.58
Roller Harrow	0.47
Cat 215 Backhoe	53.67
Cat 631 Water Wagon (8000 gal.)	97.47

Air Compressor (1000 CFM)	37.64
5 KW Maxiliter	4.85
Cat 980 F.E.L.	81.12
Cat 992 F.E.L.	177.43
Air Track Drill	52.30
Grain Drill	1.32
Hydroseeder	65.29

Production rates for earth moving equipment were derived from methods outlined in the "Caterpillar Performance Handbook" published by Caterpillar Tractor Co. KM&E's experience supports these rates and compares favorably to production rates estimated in this manner. Production rates for farming, demolition, etc., were estimated using engineering judgment and experience.

Rates for pnuematic stowing of gob piles were derived from consultation with experts within the field along with engineering judgment and experience.

5.0 Site-by-Site Reclamation Plan

5.1 Red Lodge Area

5.1.1 Abandoned Mine Land Study

Those areas of the reclamation plan herein termed the Red Lodge Area include the following sites designated in the RFP: Airport Dumps, North Red Lodge Dump, South Red Lodge Dump and Red Lodge Mine (Exhibit No. 3). Our research has uncovered the fact that all these sites are actually the results of a single major underground mine operation, The Northwest Improvement Company Mine.

The major "Airport Dump" is located on the bluff west of the townsite and very near the local airport, thus the name. The dump at one time must have been somewhat circular at its base and approximately 80 feet in height. About half of the original dump has been removed over the years for various uses such as backfill material and road sanding. A beacon light for the airport is presently located at the top of the dump. The dump is estimated to contain 239,000 cy of material.

A minor dump is located below the bluff east of the Airport Dump. A private auto repair shop has been constructed on it and local dwellings exist along each side. The western end of the dump is steep, unvegetated and eroded. The height of this dump is estimated to be 30 feet and contains perhaps 30,000 cy of carbonaceous waste. We found four obvious subsidence holes along the slope of the bluff. They were all approximately 50 feet in diameter and roughly 10 feet deep.

The "North Red Lodge Dump" is located on the northeastern outskirts of the townsite and abutts Rock Creek along its western bank. It is by far the most extensive dump within the study area with an estimated

volume of 2,445,000 cy. The surface of the dump is rather flat and rises approximately 40 feet above the surrounding terrain. The northern end of the dump is presently being utilized as a waste landfill by the City of Red Lodge. An oval race track has been constructed on the top of the dump.

The "South Red Lodge Dump" is located on the eastern outskirts of the townsite along the eastern bank of Rock Creek. The dump is barren of vegetation and is quite noticeable from within the town itself. It appears as an elongated pyramid in shape, rises to a peak height of 60 feet and contains approximately 113,000 cy of coal fines. No use is being made of the dump at this time.

The "Red Lodge Mine" is associated with disturbances located along the bluff east of the townsite. It consists of abandoned structures along the base and face of the bluff, closed and open portals and mine water discharge at the base of the bluff, and major subsidences above and east of the bluff. The structures are remnants of what was once the coal processing facilities. The mine water discharge issues from three different sources: an open portal, a caved-in portal and the foundation of an old fanhouse.

There are in excess of 50 subsidence pits on the ridge to the east of town and they extend eastwardly up to two miles from the portals. The sizes vary from as small as 5 feet in diameter to as large as about 50 feet. A couple of the pits are open into the underground workings but most of them are 10 to 15 feet deep with a closed bottom. A couple of the pits have been filled with trash and a few more have had large rocks deposited in them. Two portals are also located in this area but

are closed by caving and appear similar to the subsidence pits. An interesting feature exists about one mile east of Rock Creek where the water from a pair of springs flows approximately 1,800 feet to a point where a subsidence pit has intercepted the natural drainage. The water then totally disappears into this pit. The flow was measured at 0.25 cfs at the time of our site visit.

It appears that a series of subsidence holes in this area have been backfilled at some time in the past. The soil used has a high clay content and revegetation of those pits has not been successful. However, in most cases the filled in areas have not subsided further although several do exhibit shallow depressions in their centers (± one foot) that may be the result of material settlement. We have information from one interview that these holes were filled in the 1940's.

The furthest east disturbance noticed consisted of a few small refuse piles totaling less than 100 cy. A few timbers, rails and assorted metal hardware were also discovered here.

The disturbances associated with the Red Lodge Area result from the operation of a single large mine complex, the Northwest Improvement Company Mine (NWI). Up to six separate seams were mined over a large area extending both to the east and west of the City of Red Lodge (see Exhibit No. 1). The seams mined in this area were numbered sequentially from top to bottom as one thru six, with some localized splits numbered as 1½ for example. They were all generally between five to eight feet in thickness. They dip almost due south at between 12 to 18 degrees and subcrop to the north as shown.

Mining commenced here in 1889 and lasted until about 1932 with productions exceeding 1,000,000 tons per year during peak production. The earliest workings extended to the east of town with the haulage way at the water level and rooms worked up dip to as close to the surface as they dared.

It is interesting to note that we discovered a map of the mining in the No. 4 seam dated 1898 that indicated several rooms having "caved to the surface." Those coincide with the extreme eastern existing holes above the No. 4 workings.

Eventually the workings were extended far below the water level and then west beneath the City of Red Lodge. Subsequently, the workings were joined with those of the Sunset Mine which had commenced mining the same seams to the west of Red Lodge. By the end of mining in the area, workings had been extended down dip to over 1,000 feet below the surface and an area of some 3 square miles had been undermined. The uppermost, earliest workings appear to have been exclusively room and pillar operations with little subsequent pillar extraction. However, starting in about 1920, pillars were extracted as a part of normal operations in certain areas and continued until the end of mining.

The workings to the east of town were extended almost to the surface which has resulted in numerous obvious subsidence holes in this area. Superimposing the maps of the underground workings over a topographic map shows close correlation of the rooms and escape shafts to the surface subsidence (Exhibit No. 3). Since this area exhibits by far the bulk of the subsidence in the entire field, most of our exploratory drilling was performed in this area.

A total of 11 holes were drilled in this area (Appendix 6.4 and Exhibit No. 3). The workings of all seams mined in the area (1, 1½, 2, 3, 4 and 6) were penetrated.

Based upon this drilling the following conclusion can be drawn. The roofs of all but the No. 4 seam have caved to a certain extent but the caving has advanced only a maximum of 10 or 15 feet above the original roof. At this point a competent shale or sandstone strata has halted further collapse. Furthermore, the "swelling" of the roof material as it fails has in some cases almost filled the voids. This is undoubtedly providing some measure of support.

The No. 4 seam shows evidence of only minor caving. A competent sandstone roof lies directly above the seam which is reaffirmed by historical reports. This, in fact, may have been a contributing factor to why the No. 4 seam was the first seam mined and was mined to a greater areal extent than any of the others.

The extent of mining beneath the town of Red Lodge itself is, of course, of particular interest. We were able to closely estimate the nearest the workings approached the surface beneath the town due to the very detailed mine maps kept by the NWI Co. It appears that only the No. 1½, 2, 4 and 5 seams were mined beneath the town. The mine operators were evidently concerned with mining beneath the city because they did not advance their workings nearly as close to the surface here as they did to the east of town. The very shallowest of the workings appears to be those of the No. 4 seam mined some time before the turn of the century, which approaches to within about 200 feet of the surface. This area lies about one block either side of Hauser Street and about halfway

between 13th and 14th Streets. The Red Lodge Civic Center is one of the structures lying directly over this area. This building was constructed in the 1940's. Field examination of this structure and the surrounding area shows no evidence of subsidence related damage. The concrete foundation of the structure was intact with only the tension cracks expected of an older structure evident. Concrete sidewalks in this area exhibit no unusual cracking that might be associated with subsidence.

Conversations with Ron Kotar, Mayor of Red Lodge, indicates the city has not experienced any problems such as broken water or sewer lines that might be subsidence related.

Exhibit No. 7 is a cross-section taken down Hauser Street that shows the uppermost extent of the workings beneath the city. These upper workings were primarily rooms and pillars without subsequent pillar extraction. The maps indicate that the uppermost area beneath the city where pillar extraction was done is approximately 360 feet down, located in an area between Broadway and Rock Creek along 15th Street. Again, no surface evidence of subsidence above this area was noticed. There is little doubt that all the workings beneath the city are flooded and probably under substantial hydrostatic pressure.

Mining beneath the bluffs west of town was confined primarily to the No. 1½ and 4 seams. The maps indicate the nearest this mining approached the surface is roughly 100 feet in the case of the No. 1½ seam. This portion was mined in 1909 and lies immediately west of the "Airport Dump" gob pile. There is evidence that some pillars were pulled in this area as close as 150 feet from the surface, however, again no subsidence was evident from field inspections.

The soils sampled in the Red Lodge Area are physically and chemically suitable for use as topsoiling material. Soils on the steep bluffs paralleling Rock Creek are shallow and bedrock outcrops are common (samples 9-TS-1 and 9-TS-2). Topsoil quantities in this area are probably insufficient for reclamation purposes.

Soils occurring on the high benches above the bluffs are underlain by coarse gravels at depths of a few inches on the flat bench crests to over five feet on the gently sloping bench sideslopes. pH readings of these soils range to as low as 5.1 (sample 9-TS-4). However, these strong acid conditions should not preclude the use of these soils as a source of topsoiling material as the area now supports a good vegetative cover. It is estimated that sufficient topsoil quantities exist on these benches to supply most of the reclamation needs of the Red Lodge Area.

The two large gob piles adjacent to Rock Creek have extremely acid conditions in all surface materials sampled. The south gob pile is barren of any vegetation and has a pH 3.7 in the surface 12 inches (sample 9-OB-1). The north gob pile has mostly barren side slopes and some moderate stands of mixed vegetation on its broad, flat top. pH readings range from 3.6 to 5.3 (samples 8-OB-1, 8-OB-2, 8-OB-3 and 8-OB-4), and it appears that salts, boron and some heavy metals become more concentrated with depth (sample 8-OB-4). None of the materials in either the north or south Red Lodge gob piles are recommended for use as either a topsoiling or a subsoiling medium.

Is th.5 runoff into Rock Cr

The surface of the airport gob pile is well vegetated, high in humic-like materials and is medium to strongly acid (pH 5.7 to 5.2;

sample 14-OB-1). However, an eight foot thick composite sample (sample 14-OB-2) taken from the southeast cut face of the pile indicates that salts become highly concentrated with depth (E.C. 10.1; SAR 25.3). Only some surface material from this gob pile may be used as either a top-soiling or a subsoiling medium or selected sites.

Data collected from the Rock Creek sites (1-3) indicate that flow was 26% higher at site number 1 in October than in November and 23% higher at site 3. Streamflow from site 1 downstream to site 3 increased 10-15%. Since seeps from underground mine portals contributed only a total of 0.61 cfs to the flow of Rock Creek, other non-mining related sources of recharge must be present.

The location of the two gob piles on the Rock Creek floodplain and the size of each pile constricts flood flows. This would increase the peak elevation of flood events and coupled with steep side bands along the east edge of the floodplain, could increase flooding potential in Red Lodge. This could result in a hazard to life and property.

The effect of the gob piles and portal discharge on water quality was also evaluated. Specific conductance and total dissolved solid concentrations (TDS) were not appreciably different from sites 1 to 2, indicating no or little impact from the southern gob pile and underground mine portal seeps. However, these parameters increased measurably from sites 2 to 3 indicating an impact on water quality from the northern gob pile. When mass balanced, TDS loading increased about 24% from sites 2 to 3. Other indicator parameters (such as sodium) increased similarly. However, this does not constitute an environmental hazard to humans, stock or wildlife.

The overall quality measured at the Rock Creek sites was very good. Since streamflow during late fall and winter months is very low, observed parametric concentrations are much higher than would be observed during runoff periods. All but a few parameters were acceptable for a public water supply, stock usage and long-term irrigation. The most stringent standards are those developed for public drinking water supplies. Only lead, total iron and total manganese concentrations observed are unacceptable for drinking water supplies. Higher iron and manganese are common in surface water in Montana streams. Since lead was observed upstream of coal mining disturbance, it is hypothesized that the source of lead in the stream is the lead and silver mining district in the Beartooth Mountain range. To verify this hypothesis, a silver analysis was conducted from the Rock Creek sites during the November sampling period. The presence of silver in these samples verified this hypothesis.

The seeps and springs originating from underground mine portals along the east bank of Rock Creek contribute dissolved solids to the stream. Water temperature was elevated when compared to Rock Creek with the converse probably true in the summer. The pH of at least one of the seeps was acidic and iron precipitates were observed at the Farm House portal site.

No appreciable change in water quality was found from sites 1 to 2, however. The dilution effect of Rock Creek (128.19 cfs vs. 0.61 cfs from all seeps measured) tends to mask impacts to the stream quality. Very localized impacts to flora and fauna are probable but no overall environmental hazard is expected to occur.

Recharge to the underground mines is supplemented by the Rock Creek terrace spring in the southeast quarter of Section 26, T 7 S, R 20 E.

Recharge quantity was measured to be 0.25 cfs. When compared to the total measured flow discharging into Rock Creek (0.61 cfs), this spring contributes a high proportion of the total recharge to the underground mines.

5.1.2 Reclamation Plan Alternatives and Costs

KM&E feels the priorities of the Red Lodge Area in terms of hazards to the environment and public are, in order of importance, (1) open portals, (2) surface subsidence, (3) abandoned structures and (4) gob piles. Each will be discussed in terms of remedial alternatives to abate the associated hazards.

There are five known portals in the Red Lodge Area, one of which is open and flows water. Another, although collapsed, flows water through rubble. The remaining three have collapsed and are closed.

Reclamation Plan Alternatives		Cost
Gate and Lock	1 @ $2,750	$2,750
Doze and Regrade	5 @ $1,200	6,000
Blast and Regrade	1 @ $2,000	2,000
Concrete Openings	1 @ $1,650	1,650
Pneumatically Stow Shut	1 @ $2,650	2,650

Surface subsidence has been detected at three separate locations within the Red Lodge Area. Subsidence of a minor nature can be found on the face of the bluffs east and west of Red Lodge but the majority of the significant subsidence occurs beyond the crest of the east bluff. Approximately 82 separate subsidence holes exist which range in diameter from 10-50 feet and in depth from 4-20 feet.

Reclamation Plan Alternatives		Cost
Fill with borrow from nearby sites	82 @ $280	$22,960
Fill with gob material from the South Red Lodge dump	82 @ $480	39,360

The majority of the abandoned structures found in the Red Lodge Area which pose a hazard to the public are found at the base of the eastern bluff of Red Lodge. Most are crumbling concrete structures which are readily accessable to the populus of Red Lodge.

Reclamation Plan Alternatives		Cost
Salvage	120 ft^2 @ 0.734 + 9,535 ft^2 @ 0.898	$ 8,650
Bury at site	120 ft^2 @ 0.918 + 9,535 ft^2 @ 1.122	10,800
Remote burial	120 ft^2 @ 1.284 + 9,535 ft^2 @ 1.561	15,050

There are three major gob piles which exist within the Red Lodge Area designated the North Red Lodge Dump, South Red Lodge Dump and Airport Dump. Although none of these dumps pose an environmental hazard, they are aesthetically unpleasing and have been known to burn. Also, the Airport Dump has been deemed a hazard by the FAA.

Reclamation Plan Alternatives		Cost
Pull slopes and grade	182,800 cy @ $0.44	$ 80,400
Remove from drainage and grade	2,797,500 cy @ $1.085	3,035,300
Transport	2,797,500 cy @ $1.715	4,797,700

5.1.3 Reclamation Plan Recommendations

The following is an outline of the recommended reclamation plan for the Red Lodge Area.

Portals		Cost
Blast shut and regrade	1 @ $2,000	$2,000
Doze and regrade	4 @ $1,200	4,800
Subtotal		$6,800
Contingency		1,360
Move-in		680
Total		$8,840

The one open portal would be shot down and regraded. This would allow the water flowing from the portal to seep through the resulting rubble. The balance of the portals, although already closed, would be regraded.

Subsidence Holes	Cost
Fill with borrow	$22,960
Contingency	4,592
Move-in	2,296
Total	$29,848

The recommended plan for the reclamation of the subsidence holes is to haul the rubble from the structures to these holes and borrow material from areas adjacent to these holes to use as fill. Topsoil would be robbed from the slopes of the bluff. The disturbed areas would then be graded and seeded.

Structures	Cost
Remote burial	$15,050
Contingency	3,010
Move-in	1,505
Total	$19,565

Salvage was not considered a likely solution since the structures are primarily concrete with little or no salvage value. The recommendation is to haul the rubble from the dismantled buildings to the subsidence holes on the bluff east of Red Lodge.

Gob Piles		Cost
Pull slopes and grade	30,000 cy @ $0.44	
	266,700 cy @ $1.085	$ 302,840
Remove from drainage	135,500 cy @ $1.085	147,000
Transport	239,000 cy @ $1.715	409,900
Subtotal		$ 859,740
Contingency		171,950
Move-in		85,975
Total		$1,117,665

The recommended plan consists of hauling the airport dump to mined-out portions of the gravel pit located west of the airport; removing the South Red Lodge Dump from the floodplain and placing it to the east along the bluff; and pulling the North Red Lodge Dump away from Rock Creek and regrading the slopes. It was assumed that the minor dump below the "Airport Dump" would remain as is due to the habitated structure located on it.

Red Lodge Area Summary	Cost
Portals	$ 8,840
Subsidence	29,848
Structures	19,565
Gob Piles	1,117,665
Revegetation 103 Ac. @ 825	84,975
Total	$1,260,893

5.2 Scotch Coulee Area

5.2.1 Abandoned Mine Land Study

Those areas of the reclamation plan herein termed Scotch Coulee include the following sites designated in the RFP: Bear Creek Mine, Coulee Mine, Smith Mine, Washoe Strip and Washoe Dump (Exhibit No. 2). From historical research it has been discovered that the mine area referred to in the RFP as the Bear Creek Mine is in actuality a part of the Washoe Mine complex. The actual Bear Creek Mine is located further down Scotch Coulee to the east.

The "Bear Creek Mine" as located in the RFP is a minor disturbance area located north of Scotch Coulee between the Washoe Dump and the Washoe Strip Mine. It consists of three dumps, some evidence of caved-in portals, a minor subsidence area, a 12 inch vent pipe and one structure. Two of the dumps are of a very minor nature (less than 200 cy) while the

largest is estimated to contain 5,700 cy of barren carbonaceous material. Evidence of three portals exists, but have long since naturally revegetated. There are eight shallow subsidence depressions which have also revegetated. The vent pipe appears to connect to the old workings which have since been flooded as there is water at the bottom of the pipe. The top is screened with heavy grate. The only structure associated with the Bear Creek Mine is an old brick powder magazine.

The "Coulee Mine" is another minor disturbance area located south and adjacent to Highway 308 along an ephemeral draw of Scotch Coulee. It consists of five minor dumps, three dilapidated structures, open and closed portals and minor subsidence. The dumps are carbonaceous with some revegetation on their fringes and are found along the sides of the ephemeral draw. Three of the six portals are open. Two of these are located within view of the highway while the third open portal is located a considerable distance up the draw. Two subsidences exist directly above the portals located near the top of the draw. Both have been used as trash pits in the past.

The "Washoe Strip Mine" is located on the hillside north of Scotch Coulee and between the Bear Creek and Smith Mines. The cut runs for approximately 955 feet in a north/south direction with the spoil casted to the east side. The average depth of the cut to the top of coal is 13 feet. The average width of the floor is 20 feet. The west wall is eroded and steep. The spoil castings on the east side spread beyond the crest of the hill and toe out on a steep sidehill. The spoil has successfully revegetated naturally. The entire strip mine appears to be exploratory in nature as the coal seam has been mined for only the

southern 500 feet of the exposed seam. This may be the #1 seam. Minor mining for personal consumption by local residents still continues.

The "Washoe Dump" area is located north of Scotch Coulee and is the western most disturbance along Scotch Coulee. It consists of one major waste dump, two closed portals, various concrete foundations and structures and one large subsidence. The dump is the predominant feature in the area as it rises 60-80 feet above the immediate surroundings and completely blocks a minor drainage. The dump appears to contain a core of scoria waste which is presently being excavated by the local residents for personal use. This core is overlain by a blanket of coal fines which supports a revegetated surface along the northern face. Excavation is occurring on the southern face. The dump is estimated to contain 181,000cy of material. The caved-in portals are located west of the dump and are of little significance other than the fact that they extend down-dip in a southern direction. Old rails are still visable. The only subsidence is found 200 feet south of these portals in the same direction as they appear to be heading. This would indicate a major collapsed area of the main portal entrances. The subsidence is well revegetated and is presently being used as a trash pit.

The major disturbance site within the Scotch Coulee area is referred to in the RFP as the "Smith Mine" and includes the disturbance of the actual Bear Creek Mine. It consists of a series of dumps along the northern banks of the Scotch Coulee drainage, 34 separate structures of various construction and size, seven portals of which five remain open, and various minor subsidence pits. The four major dumps are estimated to contain a total of 650,000cy of material, most of which appears to be coal reject with some sandstone and shale. The four remaining minor

dumps contain a total of approximately 14,000cy of the same type material. Five of the seven portals are found north of Scotch Coulee at the base of the hillside and the drifts advance to the north. The remaining two portals are located south of Scotch Coulee drainage and the drifts advance south under the highway. Of the four subsidence holes, two are directly related to collapse of old portals and two are possibly vertical shafts long since filled in. The structures are strung along the entire length of the mine and are for the most part in disrepair.

Exhibit No. 4 depicts the location of the various disturbances as well as the soil sampling sites.

The major mines contributing to the disturbance along Scotch Coulee include the Washoe mine, operated by Anaconda Copper, the Smith Mine complex operated by the Montana Coal and Iron Co. (MC&I) and the Bear Creek Mine operated by the Bear Creek Coal Co. Although most of the surface disturbance occurs north of Scotch Coulee, the bulk of the actual underground mining occurs south of Scotch Coulee (Exhibit No. 1). Although it appears the same six seams as mined by the NWI Co. exist in these areas, mining was primarily confined to only seams 2 and 3.

The Washoe Mine operated from about 1906 until 1938 employing primarily conventional room and pillar mining methods. Although research indicates that there was roof caving, no evidence of subsidence was noted above the area mined.

The Smith Mine operated from around 1900 through 1953. Its underground workings rank second only to those of the NWIC operation in areal extent. They also practiced room and pillar mining methods but used wider rooms and thinner pillars which increased the incidence of roof

collapse. Nevertheless, no subsidence was noticed other than that associated with the main haulage routes as they approached the surface.

The actual Bear Creek Mine was located north of Scotch Coulee in the northwest ¼ of Section 6 (Exhibit No. 1). It was operated from about 1905 until the 1920's. The disturbance furthest down Scotch Coulee resulted from their operation.

Some mining was also performed north of Scotch Coulee by Anaconda and MC&I. Although the only subsidence noted was associated with collapse near the portals, maps indicated the workings in this area were some of those nearest the surface. Therefore, we undertook to drill some exploratory holes here to ascertain the condition of the underground workings (Exhibit No. 4). Hole No. 13 intercepted no workings but did penetrate eight feet of coal at 72 feet. We moved south just 40 feet and this time encountered a 1½ foot void followed by 14 feet of loose fill. The bottom of the fill corresponds with the bottom of the seam so one can suppose that the roof has collapsed up to some six feet above the original roof. The collapsed material has swelled to fill most of the void. The present roof is a two foot thick rider seam of coal.

Hole No. 15 was drilled over an area that was indicated to have been mined. We drilled 100 feet without encountering either a significant coal seam or any evidence of subsidence.

The water quality of Scotch Coulee is quite variable and indicates specific conductance is higher downstream of mine disturbance. The Washoe Dump had no effect on dissolved constituents as shown by comparing sites 1A and 2A. However, the Smith Mine dumps along Scotch Coulee had a significant impact. Specific conductance (field) measured

in November increased from 1075 at site 4 to 2300 at site 5A. The primary source of contamination are numerous mine dumps and gob piles in and adjacent to the channel and the Smith Mine portal seep. Even though the quantity of flow of the Smith Mine seep was only 0.006 cfs (increasing Scotch Coulee's flow about 3%), the high specific conductance of seepage water (about 3000umhos/cm) contributes significant additional dissolved solids to the stream. Sodium bicarbonate and sulfate constituted the major ions in the Smith Mine portal seep.

The Washoe Dump spring quality was fair. The spring flows down a drainage until it reaches the Washoe Dump. Since no outlet has been provided, spring water infiltrates into the soil and either recharges groundwater or seeps into Scotch Coulee.

None of the sites sampled constitute an environmental hazard but the Smith Mine portal seep and the various Smith Mine gob piles impact the quality of Scotch Coulee. Smith Mine gob piles also constrict stream flow and flood flow and probably cause accelerated erosion.

All tested soils from the Scotch Coulee area are chemically suitable for reclamation purposes. The soils of this area may be divided into two distinct types: shallow to deep, extremely clayey soils occuring on the western portions of the area (sites 1-TS-1 and 12-TS-1); and, shallow loamy soils occuring on the steep sideslopes of the Coulee (sites 4-TS-1 and 10-TS-1) and the hard sandstone bedrock plain to the north of the drainage (sites 10-TS-2 and 11-TS-1). Because of the steep slopes, clayey textures, shallow soils, and many rock outcroppings that occur throughout the area, the amount of topsoil available for reclamation will be severely limited.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.1.1
Red Lodge Area Portals

No.	Open	Closed	Methane	Co.	Water	Comments
9-P1	-	x	-	-	-	Totally collapsed and overgrown.
9-P2	x	-	none	none	yes	Overlain by massive sandstone, water smells of sulfur.
9-P3	-	x	-	-	yes	Portal is collapsed but substantial flow of water through rubble.
9-P4	-	x	-	-	-	Totally collapsed and overgrown; springs found at slightly lower elevation.
9-P5	-	x	-	-	-	Collapsed and overgrown. Steel rails slightly visable.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.1.2
Red Lodge Area Subsidence

No.	Avg. Dia.-Ft	Avg. Depth-Ft.	Comments
1	8	8	Above portal 9-P4.
2	50	20	Above east bluff. Partially filled with trash; Seam No. 4
3-11	20	10	String of subsidences found in hay meadow; Seam No. 4; some filled with boulders.
12	20	8	Seam No. 6; partially filled with boulders.
13-17	20	8	Seam No. 4; top of hill above bluff.
18-23	20	8	Seam No. 4; in line with 3-11 and 13-17 but due east on top of hill.
24-50	20	10	Seam No. 4; in line with rest of Seam 4 subsidence due east through draw.
51-60	15	8	Seam No. 3; south of subsidence 24-50 in same draw; in line with pan spots.
61-75	15	8	Seam No. 6; north of subsidence 24-50 in same draw.
76-81	20	5	Seam No. 4; near portal 9-P5; 1 mile east of bluff
82	25	10	Seam No. 6; in hay meadow north of subsidence 3-11.
83	15	8	Seam No. 1½; in hay meadow south of subsidence 3-11.
84-88	30	6	On side hill of west bluff below airport. Shallow and overgrown.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.1.3
Red Lodge Area Structures

No.	Construction	Condition	Size Ft.^{2}	Comments
9-S1	concrete	poor	600	Only foundation remains.
9-S2	concrete	poor	-	Minor foundation remains.
9-S3	concrete	poor	1200	Old fanhouse. Major spring issues from foundation.
9-S4	brick	poor	360	Powder magazine.
9-S5	concrete	poor	2000	Fanhouse.
9-S6	concrete	poor	1875	Shop.
9-S7	concrete	poor	extensive	Foundations, floors, and retaining walls remain. 4 levels.
8-S1	wood	poor	120	Shack on concrete pad.
14-S1	concrete	poor	1500	Only foundation remains.
14-S2	concrete	poor	-	Tipple foundation, concrete footings.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.1.4
Red Lodge Area Gob Piles

Location	Est. Vol. $Yd.^3$	Type	Vegetation	Reclamation Suitability
North Red Lodge Dump	2,445,000	coal/waste mix	partial	Unsatisfactory
S. Red Lodge Dump #1	113,000	coal fines	none	Unsatisfactory
S. Red Lodge Dump #2	500	coal fines	none	*Unsatisfactory
S. Red Lodge Dump #3	22,000	waste	90%	Satisfactory
Airport Dump #1	239,000	coal/waste mix	north face	Unsatisfactory
Airport Dump #2	30,000	coal/waste mix	weeds	(1)*Unsatisfactory

* Based on field observation.

(1) Shop constructed on dump.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.2.1
Scotch Coulee Area Portals

No.	Open	Closed	Methane	Co	Water	Comments
1-P1	-	x	-	-	-	Totally collapsed and revegetated.
1-P2	-	x	-	-	-	Totally collapsed and revegetated.
1-P3	-	x	-	-	-	Totally collapsed and revegetated.
4-P1	x	-	no	no	no	Near highway; massive sandstone roof.
4-P2	x	-	no	no	no	Near highway; massive sandstone roof.
4-P3	-	x	-	-	-	Totally collapsed and revegetated.
4-P4	-	x	-	-	-	Totally collapsed and revegetated.
4-P5	-	x	-	-	-	Totally collapsed and revegetated.
4-P6	x	-	no	no	no	Partially collapsed.
10-P1	x	-	no	no	no	Massive sandstone roof.
10-P2	x	-	no	no	no	Massive sandstone roof.
10-P3	x	-	no	no	no	Ten foot vertical shaft to portal entrance.
10-P4	-	x	-	-	-	Entrance structure remains. Portal totally collapsed.
10-P5	x	-	no	no	no	Partially collapsed; small entrance.
10-P6	x	-	no	no	no	Entrance blocked, subsidence exposes tunnel.
10-P7	-	x	-	-	yes	Spring seeping through rubble.
12-P1	-	x	-	-	-	Concrete entrance and rail still exist.
12-P2	-	x	-	-	-	Totally collapsed and revegetated.

RED LODGE COAL FIELD
PHASE I STUDY
Table 5.2.2
Scotch Coulee Area Subsidence

No.	Avg. Dia.-Ft.	Avg. Depth-Ft.	Comments
1-8	10	3	Bear Creek Mine - totally revegetated.
9	12	unknown	Coulee Mine - filled with trash.
10	20	6	Coulee Mine - partially filled with trash.
11	15	10	Smith Mine - above possible portal.
12	10	20	Smith Mine - vertical shaft caved in at bottom.
13	15	20	Smith Mine - vertical shaft plugged with dirt and wood.
14	6	10	Smith Mine - above possible portal.
15	40	6	Washoe Dump - revegetated and used as trash pit.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.2.3
Scotch Coulee Area Structures

No.	Construction	Condition	Size Ft.^{2}	Comments
1-S1	brick	fair	375	Powder magazine.
4-S1	wood	poor	300	Dwelling.
4-S2	wood/metal clad	poor	150	Garage.
4-S3	rock & mortor	poor	-	Hoist foundation.
10-S1	wood	poor	48	Shed.
10-S2	wood	poor	300	Shed.
10-S3	stone/wood roof	poor	400	Shed.
10-S4	wood/metal clad	poor	300	Shed.
10-S5	stone/wood roof	fair	240	Dwelling.
10-S6	wood	poor	1200	Dwelling.
10-S7	wood	poor	450	Garage
10-S8	wood/metal clad	good	150	Shed.
10-S9	stone & mortor	fair	100	Powder magazine.
10-S10	block/wood roof	fair	400	Shop
10-S11	rock	poor	80	Dugout

Table 5.2.3 - Scotch Coulee Area Structures - Page 2

No.	Construction	Condition	Size Ft.^{2}	Comments
10-S12	wood	poor	600	Shed.
10-S13	wood/metal clad	poor	240	Garage.
10-S14	wood/metal clad	fair	1500	Warehouse.
10-S15	wood/metal clad	poor	240	Motor house; concrete floor.
10-S16	concrete/stone	poor	300	Storage room
10-S17	wood	poor	25	Outhouse
10-S18	wood	poor	180	Transformer house
10-S19	wood/metal clad	poor	450	Garage
10-S20	wood/metal clad	fair	4000	Main shop; concrete floor; wire for power.
10-S21	wood/steel/block	poor	4800	3 story coal plant.
10-S22	wood/steel/concrete	poor	2500	3 story primary crusher
10-S23	wood/metal clad	poor	300	Garage
10-S24	wood	poor	25	Outhouse
10-S25	brick/steel	poor	2500	Compressor and boiler building
10-S26	wood/metal	poor	700	2 story warehouse and storage
10-S27	concrete/wood/metal clad	fair	4000	Shop and warehouse

Table 5.2.3 - Scotch Coulee Area Structures - Page 3

No.	Construction	Condition	Size Ft.^{2}	Comments
10-S28	concrete/wood	poor	1200	Office and dwelling.
10-S29	block/wood	poor	175	Water tank foundation.
10-S30	wood	poor	500	Screening tipple
10-S31	wood/metal clad	poor	200	Shed
10-S32	wood	poor	90	Shed.
10-S33	concrete/rock	poor	100	Wall and foundations
10-S34	wood/earth	poor	80	Dugout
12-S1	concrete	poor	1000	Footings and foundations
12-S2	concrete	good	225	Powder magazine
12-S3	concrete	poor	2240	Hoist house foundation

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.2.4
Scotch Coulee Area Gob Piles

Location	Est. Vol. Yd^3	Type	Vegetation	Reclamation Suitability
Bear Creek Dump #1	5,750	Coal/waste	None	Unsatisfactory
Bear Creek Dump #2	100	Coal fines	On fringe	*Unsatisfactory
Bear Creek Dump #3	50	Coal fines	On fringe	*Unsatisfactory
Coulee Mine Dump #1	1,250	Coal/waste	Sparse	Satisfactory
Coulee Mine Dump #2	100	Coal fines	On fringe	*Unsatisfactory
Coulee Mine Dump #3	300	Coal fines	On fringe	*Satisfactory
Coulee Mine Dump #4	200	Waste	Sparse	*Satisfactory
Coulee Mine Dump #5	200	Coal/waste	None	*Satisfactory
Smith Mine Dump #1	310,800	Coal/waste	None	Unsatisfactory
Smith Mine Dump #2	212,200	Coal/waste	None	Unsatisfactory
Smith Mine Dump #3	94,000	Coal/waste	Sparse	Unsatisfactory
Smith Mine Dump #4	6,100	Coal/waste	Sparse	*Unsatisfactory
Smith Mine Dump #5	2,300	Coal fines	Sparse	*Unsatisfactory
Smith Mine Dump #6	500	Coal fines	Sparse	*Unsatisfactory
Smith Mine Dump #7	33,100	Coal/waste	Good	*Satisfactory
Smith Mine Dump #8	5,000	Coal/waste	On flat top	*Unsatisfactory
Washoe Strip Dump #1	600	Scoria/coal	On fringe	*Unsatisfactory
Washoe Dump	181,200	Scoria/coal	On north face	Satisfactory

* Based on field observation

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.2.5
Scotch Coulee Area Strip Mines

Location	Length - Ft.	Spoil Volume Yd^3	Reclamation Suitability
Washoe Strip	955	15,000	Satisfactory

Except for portions of the "Washoe Dump," all gob piles in the Scotch Coulee area are barren of vegetation. Materials in the major gob piles of the "Smith Mine" have a pH as low as 3.2 and boron readings as high as 9.48 ppm. (Sample 10-OB-3), and the "Bear Creek" gob pile has a pH of 3.5 (samples 1-OB-1 and 4-OB-2), the large central gob pile of the "Smith Mine" (sample 10-OB-2), and the "Washoe Dump" gob pile (samples 12-OB-1 and 12-OB-2) fail to show any adverse conditions. Nevertheless, it is recommended that none of these materials should be used as topsoiling material, and should be used as subsoiling material only at a few selected sites.

The outcast spoil material of the "Washoe Strip Mine" site is generally well vegetated. Though some barren spots occur and pH levels range as low as 4.0 (sample 11-OB-2) it is felt that this material is suitable for use as a subsoiling medium. The addition of appropriate soil amendments may make these outcast materials suitable for topsoiling purposes in some instances.

5.2.2 Reclamation Plan Alternatives and Costs

The hazards to the environment and public associated with the abandoned mine lands in the Scotch Coulee Area ranked in order of priority for reclamation are (1) open portals, (2) surface subsidence, (3) abandoned structures, (4) gob piles, and (5) surface mines.

There are eighteen known portals within the abandoned mine land sites of the Scotch Coulee Area. Eight of these are open to varying degrees, ten are closed in various stages of collapse and one of the collapsed portals seeps water into Scotch Coulee.

Reclamation Plan Alternatives		Cost
Gate and lock	8 @ $2,750	$22,000
Doze and regrade	18 @ $1,200	21,600
Blast and regrade	8 @ $2,000	16,000
Concrete openings	8 @ $1,650	13,200
Pneumatically stow shut	8 @ $2,650	21,200

Fifteen separate subsidence holes have been discovered within the Scotch Coulee Area. Eight are minor and naturally revegetated, three are presently used as trash pits and the remaining four pose a serious hazard to the public.

Reclamation Plan Alternatives		Cost
Fill with borrow from nearby sites	15 @ $380	$5,700
Fill with gob material	15 @ $630	9,450

Forty-one abandoned structures have been catalogued in the Scotch Coulee Area. The majority of these are associated with the Smith Mine. Construction material ranges from stone, brick, block and concrete to wood, timber and sheet metal or structural steel. Most of these structures pose a threat to the public safety.

Reclamation Plan Alternatives		Cost
Salvage	90% of site burial	$ 78,165
Bury at site	12,028 ft^2 @ 0.918 + 10,835 ft^2 @ 1.122 + 12,028 @ 5.292	86,850
Bury in surface mine	12,028 ft^2 @ 0.978 + 10,835 ft^2 @ 1.255 + 12,028 ft^2 @ 5.900	96,300
Bury at remote site	12,028 ft^2 @ 1.284 + 10,835 ft^2 @ 1.561 + 12,028 ft^2 @ 6.512	110,700

There are eighteen gob piles of various sizes within the Scotch Coulee Area. Five are of substantial volume, four of lesser volume and the remaining nine are of a minor nature. Although none of these pose

an environmental hazard to the populace, there is a potential safety hazard of fire by spontaneous combustion.

Reclamation Plan Alternatives		Cost
Pull slopes and grade	68,000 @ 0.449	$ 30,500
Remove from drainage and grade	273,000 @ 0.554	151,250
Transport	853,750 cy @ 1.085	926,300

The only strip mine which exists within the Scotch Coulee Area is the Washoe Strip Mine. This surface mine presents neither an environmental nor a safety hazard to the general public. If anything, it may present a displeasing view to the public.

Reclamation Plan Alternatives		Cost
Do nothing		$ 0
Reduce highwall slope	4,000 cy @ 0.247	1,000
Regrade Spoil	15,000 cy @ 0.247	3,700

5.2.3 Reclamation Plan Recommendations

The following is an outline of recommended reclamation for the Scotch Coulee Area.

Portals		Cost
Doze and regrade	10 @ $1,200	$12,000
Blast and regrade	8 @ $2,000	16,000
Subtotal		$28,000
Contingency		5,600
Move-in		2,800
Total		$36,400

Eight portals would be shot down and regraded to insure subsidence would not re-expose the adit in the future. The ten remaining closed portals would be regraded.

Subsidence	Cost
Fill with borrow	$5,700
Contingency	1,140
Move-in	570
Total	$7,410

The subsidence holes would be filled with the closest available material.

Structures	Cost
Bury at remote site	$110,700
Contingency	22,140
Move-in	11,070
Total	$143,910

The structures would be disposed of in the same fills or head of hollow fills as the gob piles. Salvage was not considered viable because it appears that any material or equipment of value has been salvaged.

Gob Piles		Cost
Transport	672,500 cy @ 1.085	$729,650
Transport portion of Washoe Dump	18,100 cy @ 1.085	19,600
Subtotal		$749,250
Contingency		149,850
Move-in		74,925
Total		$974,025

With the exception of the "Washoe Dump" all of the gob piles would be transported to fill areas (head of hollow fill). The cap of coal fines on the Washoe Dump would be placed in a dump area located just to the east and buried. The remaining scoria is a local source for construction material and would remain as is. A diversion for the drainage would be constructed around the remaining pile.

Surface Mines	Cost
Do nothing	0

The "Washoe Surface Mine" provides a habitat for wildlife (deer) in the area and is almost completely revegetated.

Scotch Coulee Area Summary	Cost
Portals	$ 36,400
Subsidence	7,410
Structures	143,910
Gob Piles	974,025
Surface Mine	0
Revegetation - 80 Ac @ 825	66,000
Total	$1,227,745

5.3 Bear Creek Area

5.3.1 Abandoned Mine Land Study

Those areas of the reclamation plan herein termed Bear Creek (Exhibit No. 2) include the following sites designated in the RFP: Bear Creek Strip Mine and the Burns Mine. (Another site not designated in the RFP was located which we refer to as the Smith Mine (minor)).

The "Bear Creek Strip Mine" is located at the point of the ridge which separates the Bear Creek and Scotch Coulee drainages. Access to the mine is from the Bear Creek drainage, which is the reasoning behind inclusion of the Strip Mine in the Bear Creek Area discussion.

The Strip Mine is a single dragline cut in a horseshoe shape which appears to follow the outcrop of the No. 1 coal seam. The total length of the cut is 4500 feet. The spoil has been cast to the outside of the horseshoe and has successfully revegetated for the most part. The inside cut face of the mine is steep and eroded with only minor revegetation. The floor has revegetated except for areas where bedrock is exposed and coal slack remains. Local residents have been mining what coal remains for their personal consumption.

The "Burns Mine" is located in an ephemeral draw draining into Bear Creek from the southwest. The most prominent feature of the mine is the

dump which strings along the northern slope of the draw for approximately 500 feet and toes out directly in the bottom of the draw. This dump contains approximately 12,000 cy of coal fines and sandstone waste and is essentially barren of vegetation. Five dilapidated structures still exist on the property and a good deal of minor junk is strewn around. Three portals exist, two of which are partially collapsed but still open and one which is closed. No subsidence was evident in the area.

A good deal of the disturbance along Bear Creek has been lumped in with the "Smith Mine (minor)" for this report although their relation to the main Smith Mine is unclear. Four portals exist near the major mine area. Two of these portals are open while the other two have collapsed but still remain partially open. Evidence of two collapsed and closed portals exist along the drainage approximately ¼ mile upstream. Four very minor waste piles exist, each in the vicinity of the portal locations. Some subsidence exists directly above the open portals which indicates that the portals may be caved in although the shored up entrances remain open. The primary disturbance associated with this mine area is the abandoned concrete structures and foundations scattered throughout the draw. All are in disrepair and uninhabitable.

Exhibits No. 4 and 6 depict the location of the various disturbances as well as the soil and water sample sites.

The history of the disturbance referred to as the "Smith Mine (minor)" is unclear. No plans or maps were discovered that showed the structures or portals here. Most likely this area was related to the Montana Coal and Iron operation (Smith Mine), since the property bound-

aries seem to indicate such. However, it may have been a semi-independent operation mining coal leased from MC&I.

The "Burns Mine" was a relatively small operation mining coal leased from MC&I and was operated in the 1920's and early 1930's. No record of the method of operation was found but it probably was a typical room and pillar operation mining the No. 2 seam.

No records were found concerning the operator of the surface strip mine. Interviews indicated it was opened in the 1950's or early 1960's.

The water quality of Bear Creek upstream of the Scotch Coulee confluence was very good, with a specific conductance ranging from 234 to 410 umhos/cm at site No. 5. A large spring, presumably from the coal, flows into Bear Creek upstream of the Scotch Coulee confluence. A sample was collected from this spring (site BW) which indicated a specific conductance and total dissolved solids concentration considerably greater than the received stream. However, site 4A downstream of the spring had only a slightly higher specific conductance when compared to the upstream sites (5 and 3A).

Site BW was descriptively termed "black water." Since no detectable oil and grease was found and the concentration of total suspended solids was low, the color must be a result of unknown organic compounds not studied in the laboratory.

The "Bear Creek Strip Mine" was dry when visited. Pyrite associated with the coal seam was exposed to air and water but should have no effect on Scotch Coulee or Bear Creek since runoff is principally contained within the pit.

Total dissolved solids and specific conductance increased significantly downstream of the Scotch Coulee confluence. The TDS of the

downstream site more than doubled (at site 6) and specific conductance at sites 6A and 6 similarly increased. No appreciable change in specific conductance was observed between sites 6A and 6. Dissolved solids and specific conductance increased similarly downstream of the town as shown in the Bear Creek Below Town sample.

Trace metal concentrations of many of the constituents sampled were above detectable limits at all three Bear Creek sites. Of particular interest was detectable mercury and selenium. Concentrations of these parameters hovered around the detection limit, however.

All tested soils of the Bear Creek Area are chemically and physcially suitable for reclamation purposes. The soils are mostly shallow and occur on hard sandstone bedrock plains overlooking the mine sites and on the steep side slopes adjacent to these areas. Bedrock outcrops and broken sandstone fragments occur throughout the area. Additionally, a 12 inch deep sample was taken from the floor of the Bear Creek Strip Mine (sample 2-TS-2). Analysis indicates that this material may be used as topsoiling material.

One barren gob pile occurs in the Bear Creek Area (site 3-OB-1). Chemical analyses indicate the material in this pile is suitable for reclamation purposes, and may be used as subsoiling material where needed.

The spoil outcast pile that parallels the Bear Creek Strip Mine is generally well vegetated. Sample 2-OB-2 was taken from a barren spot on the crest of the outcast pile and has an NO_3 level of 107 ppm. However, it appears that most of the material contained in the outcast pile is suitable as subsoiling material and with the addition of appropriate soil amendments may also be used as topsoil in selected areas.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.3.1
Bear Creek Site Portals

No.	Open	Closed	Methane	Co.	Water	Comments
3-P1	x	-	No	No	No	Partially collapsed; massive sandstone roof.
3-P2	x	-	No	No	No	Small opening in hillside.
3-P3	-	x	-	-	-	Plugged with dirt and shed
13-P1	x	-	No	No	No	Entrance timbered and open.
13-P2	x	-	No	No	No	Entrance timbered and open; 100 ft. above 13-P1.
13-P3	x	-	No	No	No	Partially collapsed but open.
13-P4	x	-	No	No	No	Partially collapsed but open.
13-P5	-	x	-	-	-	Totally collapsed; minor depression remains.
13-P6	-	x	-	-	-	Totally collapsed and revegetated.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.3.2
Bear Creek Site Subsidence

No.	Avg. Dia.-Ft.	Avg. Depth-Ft.	Comments
1	30	15	Large depression above 13-P3 and 13-P4.
2	20	10	On hillside directly above 13-P2.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.3.3
Bear Creek Site Structures

No.	Construction	Condition	Size Ft.^{2}	Comments
3-S1	wood/metal	poor	500	Loadout tipple.
3-S2	wood	poor	400	Shed.
3-S3	wood/metal clad	poor	36	Shed.
3-S4	rock	poor	50	Powder magazine.
3-S5	rock	poor	---	Unknown.
13-S1	timbers	poor	160	Delapidated bridge.
13-S2	concrete	poor	1500	Two story shop; concrete floors with rails.
13-S3	concrete/wood	poor	300	Shop.
13-S4	concrete	poor	700	Compressor house; concrete floor.
13-S5	wood/metal clad	poor	64	Transformer shed.
13-S6	concrete	poor	375	Hoist house.
13-S7	concrete	poor	60	Powder magazine and foundations.
13-S8	stone	poor	600	Building; open cistern in ground.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.3.4
Bear Creek Site Gob Piles

Location	Est. Vol. $Yd.^3$	Type	Vegetation	Reclamation Suitability
Bear Creek Strip	1,000	Coal/waste	Sparse	* Unsatisfactory
Burns Mine	12,000	Coal/waste	None	Unsatisfactory
Smith Dump #1	300	Coal/waste	Sparse	* Unsatisfactory
Smith Dump #2	100	Coal/waste	Sparse	* Unsatisfactory
Smith Dump #3	200	Coal/waste	Sparse	* Unsatisfactory

* Based on field observation.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.3.5
Bear Creek Site Strip Mines

Location	Length - Ft.	Spoil Volume $Yd.^3$	Reclamation Suitability
Bear Creek Strip	4500	200,000	Satisfactory

Although only minor localized subsidence was detected in the Bear Creek Area, we did attempt to drill an exploratory hole in an area above suspected underground workings (see Exhibit No. 4). Unfortunately, the drilling proved futile due to continued collapse of the sedimentary sands near the banks of Bear Creek.

5.3.2 Reclamation Plan Alternatives and Costs

The hazards to the environment and public within the Bear Creek Area ranked in order of priority are (1) open portals, (2) surface subsidence, (3) abandoned structures, (4) gob piles, and (5) surface mines. Each will be discussed in terms of remedial alternatives available.

There are nine known portals within the Bear Creek Area. Six of these are open or partially open and three are closed and in various stages of collapse. No water seeps were found issuing from the portals.

Reclamation Plan Alternatives		Cost
Gate and lock	6 @ $2,750	$16,500
Doze and regrade	9 @ $1,200	9,600
Blast and regrade	6 @ $2,000	12,000
Concrete openings	6 @ $1,650	9,900
Pneumatically stow shut	6 @ $2,650	15,900

Although only two subsidence holes exist within the Bear Creek Area, they are both large, deep holes which pose a safety hazard to the public.

Reclamation Plan Alternatives		Cost
Fill with borrow from nearby sites	2 @ $280	$560
Fill with gob material	2 @ $480	960

Abandoned and dilapidated structures are scattered throughout the Bear Creek Area. The larger buildings associated with mining are con-

structed of concrete, while the lesser ones are constructed of wood and stone. A public safety hazard definitely exists.

Reclamation Plan Alternatives		Cost
Salvage	1,160 ft^2 @ 0.734 + 3,585 ft^2 @ 0.898	$4,050
Bury at site	1,160 ft^2 @ 0.918 + 3,585 ft^2 @ 1.122	5,100
Remote burial	1,160 ft^2 @ 1.284 + 3,585 ft^2 @ 1.561	7,100
Bury at surface mine	1,160 ft^2 @ 0.978 + 3,585 ft^2 @ 1.255	5,600

Five gob piles exist within the Bear Creek Area only one of which is of any magnitude (12,000 cy). None of these gob piles constitute an environmental hazard although the larger pile may have the potential of fire through spontaneous combustion.

Reclamation Plan Alternatives		Cost
Pull slopes and grade	1,000 cy @ 1.085	$ 1,085
Remove from drainage	1,000 cy @ 0.247 + 2,500 cy @ 1.085	2,950
Transport	13,600 cy @ 1.085	14,750

The "Bear Creek Strip Mine" is the only strip mine within the Bear Creek Area. The mine presents neither an environmental nor a safety hazard to the general public. As with all strip mines within the Red Lodge Coal Field, it serves as excellent habitat for wildlife of the area. That area of the strip mine visable to the public is revegetated and blends somewhat with the surroundings.

Reclamation Plan Alternatives		Cost
Grade areas of no growth	10,000 cy @ 0.658	$ 6,700
Reduce highwall	39,500 cy @ 0.247	9,750
Regrade spoil	200,000 cy @ 0.247	49,400

5.3.3 Recommended Reclamation Plan

The following is an outline of recommended reclamation for the abandoned mine land sites in the Bear Creek Area.

Portals		Cost
Blast and regrade	6 @ 2,000	$12,000
Doze and regrade	3 @ 1,200	3,600
Subtotal		$15,600
Contingency		3,120
Move-in		1,560
Total		$20,280

The six open portals would be blasted in and the three closed portals would be regraded.

Subsidence Holes	Cost
Fill with borrow	$560
Contingency	100
Move-in	50
Total	$710

The two subsidence holes in the Bear Creek Area would be filled with available borrow.

Structures	Cost
Remote Burial	$7,100
Contingency	1,420
Move-in	710
Total	$9,230

The structures would be torn down and hauled to fill locations with the gob piles.

Gob Piles	Cost
Transport	$14,750
Contingency	2,950
Move-in	1,475
Total	$19,175

The gob piles would be placed in fills along with the structures.

Surface Mine	Cost
Grade area of no growth	$6,700
Contingency	1,340
Move-in	670
Total	$8,710

The areas where natural revegetation has not occurred would be graded and revegetated.

Bear Creek Area Summary	Cost
Portals	$20,280
Subsidence holes	710
Structures	9,230
Gob piles	19,175
Surface Mine	8,710
Revegetation 48 Ac @ $825	39,600
Total	$97,705

5.4 Foster Gulch Area

5.4.1 Abandoned Mine Land Study

The areas in the RFP termed the Foster Gulch Strip Mine and Foster Mine are the two areas herein referred to as Foster Gulch (Exhibit No. 2). This is the eastern most impacted area of this study and is located in an ephemeral draw draining northeast to Bear Creek at the Bear Creek Townsite.

The "Foster Gulch Strip Mine" is the largest strip mine in the study area with a total length of approximately 9,900 feet. It appears to be a double dragline cut which follows the No. 1 coal seam outcrop from a point on the western slope of Foster Gulch, thru the drainage, up over the eastern ridge and daylites out on the western slope of Snake Draw. The spoil has been cast in the downslope direction leaving a cut with an average depth of 35 feet and an average bottom width of 33 feet. The exposed cut wall is steep, eroded and unvegetated. The spoil ranges

from fully vegetated to sparsely vegetated based more on aspect rather than on soil suitability. The floor is vegetated to some degree except in those areas where coal slack still remains.

The "Foster Mine" consists of portals, subsidence, waste dumps, numerous structures and trash. The majority of activity at this mine site has occurred along the western slope of the draw. Five of the fifteen known portals are found on the eastern slope of the draw. Two of these are open and three have collapsed and are closed. One subsidence hole was found directly above one of these east slope portals but otherwise no subsidence was noted on the east side of the gulch. Some dilapidated structures and trash also exist on the eastern slopes.

Of the ten portals found on the western slope, four are open and six are collapsed. The only signs of subsidence were three holes found in a minor side draw and in close proximity to each other. A large number of structures of various construction materials and in various degrees of disrepair are found along the entire length of the western slope. Trash and scrap metal is also strewn about the entire area.

There are nine separate waste dumps within the Foster Gulch Mine site, three of which are major and six are minor in size. The three largest dumps contain an estimated 148,600 cy of coal fines and waste. The lesser dumps contain an estimated 2,400 cy of coal fines and are scattered throughout the site, some of these directly in the drainage. The major dump is 2,400 feet in length and has been built directly within the Foster Gulch channel. The top is flat and quite barren. The other two major dumps are located at the toe of the western gulch slope and are comprised mostly of coal fines.

There were only four subsidence holes detected in the Foster Gulch area and all were of a very localized nature. The topography of the draw and present knowledge of the mining activities indicates that the workings are deeply covered except near the entrance portals where subsidence now exists.

Exhibits No. 4 and 6 depict the locations of the various disturbances as well as soil and water sample sites.

The major disturbances in Foster Gulch began when the existing small operation there was purchased by MC&I Co. around 1910. Workings were advanced in both the Nos. 2 and 3 seams with the No. 2 seam workings actually joining up with those extended south from Scotch Coulee (See Exhibit No. 1). The No. 3 seam was also worked to the south and west of Foster Gulch over one mile. The entire complex of MC&I was eventually known as the "Smith Mine."

Research indicates they had problems with collapse of their workings due to thin pillars, but no subsidence was noted other than that associated with low cover areas above the main portals in Foster Gulch.

No history of the strip mine was uncovered.

The Foster Gulch spring maintains minimal flow in the channel from its source in coal downstream a couple of hundred feet (Exhibit No. 6). The quality of the natural spring is fair to poor and can only marginally be put to beneficial use.

The water in the channel increases significantly in total dissolved solids concentration; most particularly calcium, magnesium and sulfate. The increase is partially due to gob piles in the channel but also a result of cattle grazing activities. The gob piles also constrict

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.4.1
Foster Gulch Area Portals

No.	Open	Closed	Methane	Co	Water	Comments
6-P1	-	x	-	-	-	East side of draw; bottom of the draw.
6-P2	x	-	No	No	No	West side of draw; very large opening.
6-P3	x	-	No	No	No	West side of draw; partially collapsed.
6-P4	-	x	-	-	-	West side of draw; totally collapsed.
6-P5	-	x	-	-	-	West side of draw; totally collapsed.
6-P6	x	-	No	No	No	West side of draw; shallow opening.
6-P7	x	-	No	No	No	West side of draw; sandstone roof.
6-P8	-	x	-	-	-	West side of draw; totally collapsed.
6-P9	-	x	-	-	-	West side of draw; totally collapsed.
6-P10	x	-	No	No	No	East side of draw; entrance partially collapsed.
6-P11	x	-	No	No	No	East side of draw; sizeable opening.
6-P12	-	x	-	-	-	East side of draw; collapsed.
6-P13	-	x	-	-	-	West side of draw; collapsed with timber remaining.
6-P14	-	x	-	-	-	West side of draw; collapsed with very small hole remaining.
6-P15	-	x	-	-	-	East side of draw; entrance remains, collapsed further on.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.4.2
Foster Gulch Area Subsidence

No.	Avg. Dia.-Ft.	Avg. Depth-Ft.	Comments
1	20	10	Up the drainage west of portal 6-P6.
2	30	15	Up the drainage west of portal 6-P6.
3	25	10	Up the drainage west of portal 6-P6.
4	15	20	Directly above portal 6-P10.
5-6	10	6	Directly above portal 6-P14.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.4.3
Foster Gulch Area Structures

No.	Construction	Condition	Size Ft.^{2}	Comments
5-S1	wood/metal clad	poor	120	Shed.
6-S1	block	fair	375	Motor house; concrete floor.
6-S2	timber	poor	120	Bridge.
6-S3	wood	poor	90	Eating shack.
6-S4	wood/metal clad	poor	64	Shed.
6-S5	timber	poor	100	Minor bridge.
6-S6	wood/metal clad	poor	3000	Change house.
6-S7	wood	poor	300	Shack.
6-S8	stone	poor	600	Engine and electric shop.
6-S9	wood	poor	100	Shack.
6-S10	block	poor	216	Fan house.
6-S11	wood/metal clad	poor	60	Shack.
6-S12	wood/metal clad	poor	64	Transformer shed.
6-S13	block	poor	150	Fan house.
6-S14	wood/metal clad	poor	144	Shed.

Table 5.4.3 - Foster Gulch Area Structures - Page 2

No.	Construction	Condition	Size Ft.^{2}	Comments
6-S15	wood/metal clad	poor	60	Shed.
6-S16	wood/metal clad	poor	720	Shed.
6-S17	wood/metal clad	poor	360	3 Dwellings.
6-S18	wood/metal clad	poor	36	Scale house
6-S19	wood/metal clad	poor	100	Shed.
6-S20	block/metal	poor	4800	Coal plant; major building, extensive trash.
6-S21	concrete/timber/steel	poor	800	Truck dump and hopper.
6-S22	stone	poor	300	Office/
6-S23	wood/metal clad	poor	60	Shed.
6-S24	wood/concrete	poor	3000	Shop.
6-S25	wood/metal clad	poor	450	Shed.
6-S26	stone	poor	144	Powder magazine

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.4.4
Foster Gulch Area Gob Piles

Location	Est. Vol. $Yd.^3$	Type	Vegetation	Reclamation Suitability
F.G. Strip Dump #1	200	Coal fines	None	* Unsatisfactory
F.G. Strip Dump #2	50	Coal fines	None	* Satisfactory
F.G. Mine Dump #1	300	Waste	Sparse	* Unsatisfactory
F.G. Mine Dump #2	200	coal fines/waste	None	* Unsatisfactory
F.G. Mine Dump #3	300	Coal fines/waste	Sparse	* Unsatisfactory
F.G. Mine Dump #4	400	Coal fines/waste	Sparse	* Unsatisfactory
F.G. Mine Dump #5	200	Coal fines	None	* Unsatisfactory
F.G. Mine Dump #6	1,000	Waste	Sparse	* Satisfactory
F.G. Mine Dump #7	39,400	Coal fines/waste	None	Unsatisfactory
F.G. Mine Dump #8	102,400	Coal fines/waste	None	Unsatisfactory
F.G. Mine Dump #9	6,800	Coal fines	None	Unsatisfactory

* Based on field observation.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.4.5
Foster Gulch Area Strip Mines

Location	Length - Ft.	Spoil Volume - $Yd.^3$	Reclamation Suitability
Foster Gulch Strip Mine	9900	400,000	Satisfactory

runoff, particularly flood flow, which could result in accelerated erosion.

Laboratory analyses and field observations indicate that the chemical and physical properties of the soils occuring in the Foster Gulch Area are suitable for reclamation purposes. Where soils are underlain with weathered shale bedrock some clayey textures occur (sites 5-TS-1 and 5-TS-4), but these soils do not appear to be extensive and should not be significant to the overall reclamation of the area. However, the steep slopes, many rock outcroppings, and shallow soils (6 to 12 inches deep) that predominate the area will limit the amount of topsoil available for reclamation.

All gob piles in the Foster Gulch Area are barren of any vegetation, extremely acid (pH 2.9 to 3.8) and unsuitable for any reclamation use. However, the materials in the spoil outcast piles that parallel the strip mined portion of the area appear to be suitable for most reclamation uses. With the exception of sample 5-OB-4 (E.C. 13.0 and 111 ppm Nitrate) all samples taken from the outcast piles have proven to be chemically and physically suitable for use as subsoiling material. The addition of appropriate soil amendments may also permit their use as a topsoiling material in selected areas.

5.4.2 Reclamation Plan Alternatives and Costs

The hazards to the environment and public within the Foster Gulch Area ranked in order of priority are (1) open portals, (2) subsidence, (3) abandoned structures, (4) gob piles, and (5) strip mines. Each will be discussed in terms of remedial alternatives to the associated abandoned mine land studies.

There are fifteen portals associated with the Foster Gulch Area. Six portals in the area are open or partially open. The remaining nine portals are in various stages of collapse. No water seeps were found issuing from the portals.

Reclamation Plan Alternatives		Cost
Gate and lock	6 @ $2,750	$16,500
Doze and regrade	15 @ $1,200	18,000
Blast and regrade	6 @ $2,000	12,000
Concrete Openings	6 @ $1,650	9,900
Pneumatically stow shut	6 @ $2,650	15,900

Six subsidence holes were located above portals in the Foster Gulch Area. Most are deep holes with steep sides which pose a safety hazard to the public.

Reclamation Plan Alternatives		Cost
Fill with borrow	6 @ $280	$1,680
Fill with gob material	6 @ $480	2,880

There are twenty-four separate abandoned structures scattered throughout the Foster Gulch Area. Construction material ranges from stone, concrete, block and steel to wood, timber and sheet metal. The structures are in various stages of disrepair and pose a safety hazard to the public.

Reclamation Plan Alternatives		Cost
Salvage	90% of bury at site	$36,400
Bury at site	5,948 ft^2 @ 0.918 + 4,785 ft^2 @ 1.122 + 5,600 ft^2 @ 5.292	40,500
Remote burial	5,948 ft^2 @ 1.284 + 4,785 ft^2 @ 1.561 + 5,600 ft^2 @ 6.512	51,600
Bury in surface mine	5,948 ft^2 @ 0.978 + 4,785 ft^2 @ 1.255 + 5,600 ft^2 @ 5.900	44,900

There are eleven gob piles within the Foster Gulch Area of which only three have a significant amount of volume. The remainder are small piles scattered along the drainage. Although none of these gob piles presents a real danger to the environment, there is some danger of fire by spontaneous combustion.

Reclamation Plan Alternatives		Cost
Pull slopes and grade	800 cy @ 0.247 + 30,000 cy @ 1.085	$ 32,750
Remove from drainage and grade	26,700 cy @ 0.348 + 30,000 cy @ 1.085	41,850
Transport	161,150 cy @ 1.085	174,850

The "Foster Gulch Strip Mine" is the only strip mine within the Foster Gulch Area and the most extensive surface mine in the Red Lodge Coal Field. As with all other strip mines within the coal field, it presents no major environmental or safety hazard to the general public. The mine does provide wildlife with a diversified habitat. However, the "Foster Gulch Strip Mine" has more of an area void of vegetation than the other two surface mines combined.

Reclamation Plan Alternatives		Cost
Do nothing		$ 0
Grade areas void of vegetation	40,000 cy @ 0.247	9,880
Highwall reduction	39,000 cy @ 0.348	13,570
Spoil regrade	300,000 cy @ 0.247	74,100

5.4.3 Recommended Reclamation Plan

The following is an outline of the recommended reclamation plan for the Foster Gulch Area.

Portals		Cost
Doze and regrade	9 @ $1,200	$10,800
Blast and regrade	6 @ $2,000	12,000
Subtotal		$22,800
Contingency		4,560
Move-in		2,280
Total		$29,640

The six open portals would be blasted down and the area around all portals would be regraded.

Subsidence Holes	Cost
Fill with borrow	$1,680
Contingency	336
Move-in	168
Total	$2,184

The subsidence holes would be filled with the closest available fill and the area regraded.

Structures	Cost
Remote burial	$51,600
Contingency	10,320
Move-in	5,160
Total	$67,080

The structures would be demolished and hauled to "head of hollow" fills along with the gob piles.

Gob Piles	Cost
Transport	$174,850
Contingency	34,970
Move-in	17,485
Total	$227,305

The gob piles would be transported to "head of hollow" type fills.

Strip Mine	Cost
Highwall reduction	$13,570
Contingency	2,714
Move-in	1,357
Total	$17,641

Because the bottom of the Foster Gulch Strip Mine has not revegetated itself, the highwall reduction is recommended.

Foster Gulch Summary	Cost
Portals	$ 29,640
Subsidence Holes	2,184
Structures	67,080
Gob Piles	227,305
Strip Mines	17,641
Revegetation 128 Ac. @ 825	105,600
Total	$449,450

5.5 Virtue Gulch Area

5.5.1 Abandoned Mine Land Study

The disturbances along Virtue Gulch were incorporated into this study following the awarding of the engineering contract. The investigations were limited to those sites east of the present Bear Tooth mine permit boundary. Names have not been assigned to the individual sites along Virtue Gulch. Three separate areas were defined during the site visit and were designated as Site Nos. 15, 16 and 17 (Exhibit No. 2).

"Site No. 15" is a rather small area along Virtue Gulch consisting of one closed portal, four dumps and a dilapidated loadout structure. The major dump contains approximately 14,200 cy of carbonaceous material and is located along the banks of Virtue Gulch. The three minor dumps are estimated to contain 3,600 cy of carbonaceous material and are located along a northern ephemeral draw of Virtue Gulch.

"Site No. 16" is another small area west of Site No. 15 along Virtue Gulch and consists of three portals, two minor dumps and two structures. The portals are located along the northern slopes at approximately the same elevation. One of these portals is open and two are collapsed and overgrown. The two dumps are located below these portals and contain approximately 1,200 cy of waste and coal fines. They are only sparsely vegetated. The structures consist of a shed and mine tipple in poor shape.

"Site No. 17" lies in the hills and ephemeral draws north of Virtue Gulch. It consists of six portals, some subsidence and five small dumps. Only one of the portals remains open while the rest are in various stages of collapse and revegetation. One of the collapsed portals (17-P6) seeps water. Subsidence holes occur on the hillside directly above this same portal. The waste dumps are very minor in nature and are located below the individual portals. Two are revegetated and the remaining three contain approximately 400 cy of carbonaceous material.

Subsidence in the Virtue Gulch area is a localized occurrence above Portal 17-P6 and appears to occur due to the shallow cover above the portal entrance. All other portals appear to be driven immediately into high cover and shown no subsidence.

The two major mining operations in Virtue Gulch were the Brophy Mine and the International Mine (Exhibit No. 1). The Brophy Mine, originally the Smokeless and Sootless Mine, was opened in 1909 and ran continuously until 1932. It was re-opened in 1940 under the name of the Brophy Coal Co. The mine continued in production for several years with

mining done in the No. 1, 2, 3 and 4 seams. In 1978 the property was acquired by the Bear Tooth Coal Company and development work is continuing today. Disturbances from this site were not studied since it is still in operation.

The International Mine was responsible for the bulk of the disturbance studied. This mine opened around the turn of the century and ran only until about 1916 or 1917. Plans found indicate that most of the mining was confined to the No. 3 seam but that openings to the other seams were made for exploratory purposes. This explains the high number of portals for a rather small operation. Mine maps indicate this to have been a conventional room and pillar operation with no evidence of pillar extraction.

The water flow in Virtue Gulch during the study was extremely low (less than 17 gallons per minute) but, considering the slope of the drainage basin and the incised channel, the peak flood flow is high. Gob piles located in the floodplain and channel constrict flood flows probably causing accelerated erosion.

The water quality of Virtue Gulch is fair with its primary use as a water source for stock and wildlife. Water quality rapidly deteriorates from site 9 to site 9A (Exhibit No. 4). Specific conductivity increases by a factor of two. The gob pile and cattle grazing are primarily responsible for the increase in dissolved solids. Evidence of cattle grazing, chunks of weathered coal and slag and evidence of iron staining were observed in the vicinity of site 9A.

The total increase in dissolved solids loading from site 9 to 10 was around 85%. Sodium loading increased similarly from site 9 to 10

(90%, 48%). Several trace metals were analyzed above detectable levels at both sites. In particular, copper, iron, selenium and zinc were often above detectable levels at both sites. Detectable mercury at the downstream site could be a result of mine related disturbance. No specific trend was observed for the remaining trace metals measured above detectable levels.

The observed level of mercury could constitute an environmental hazard since criteria established for stock usage (0.01 mg/l) was exceeded (Zucker, 1972). The observed trace metal concentrations of certain parameters could also have an effect on fresh water aquatic life (Zucker, 1972).

The Virtue Gulch portal seep was indicative of coal water. The seep infiltrates before it reaches Virtue Gulch and has no effect on the quality of the stream. Minimal flow renders the source virtually useless and constitutes no environmental hazard.

Most soils sampled in the Virtue Gulch Area have proven to be chemically and physically suitable for use in reclamation. Sample 15-TS-1 has a rather high boron level (7.44 ppm) in the surface 6 inches. However, this site does maintain a good vegetative cover, and because of some mixing that will occur during salvage operations, it is not believed that the elevated boron levels will present a problem to any reclamation effort. Topsoil quantities in the area are good, but some problems may arise near sample site 16-TS-1 where steep slopes, rock outcrops and scattered rock fragments may limit the availability of suitable topsoiling material.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.5.1
Virtue Gulch Area Portals

No.	Open	Closed	Methane	Co	Water	Comments
15-P1	-	x	-	-	-	Collapsed and revegetated.
16-P1	-	x	-	-	-	Collapsed and revegetated.
16-P2	x	-	No	No	No	Substantial opening.
16-P3	-	x	-	-	-	Collapsed and revegetated.
17-P1	-	x	-	-	-	High in ephemeral draw; collapsed.
17-P2	x	-	No	No	No	Massive sandstone roof; entrance partially collapsed.
17-P3	-	x	-	-	-	Collapsed and revegetated.
17-P4	-	x	-	-	-	Collapsed and revegetated.
17-P5	-	x	-	-	-	Collapsed and revegetated.
17-P6	-	x	-	-	Yes	Collapsed at mouth; water seeping from rubble.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.5.2
Virtue Gulch Area Subsidence

No.	Avg. Dia.-Ft.	Avg. Depth-Ft.	Comments
1-9	10-30	8-12	String of subsidence holes above portal 17-P6

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.5.3
Virtue Gulch Area Structures

No.	Construction	Condition	Size - Ft.^{2}	Comments
15-S1	wood/timber	poor	250	Tipple loadout.
16-S1	wood	poor	100	Shed.
16-S2	wood/timber	poor	250	Tipple loadout.

RED LODGE COAL FIELD
PHASE I REPORT
Table 5.5.4
Virtue Gulch Area Gob Piles

Location	Est. Vol. $Yd.^3$	Type	Vegetation	Reclamation Suitability
Site #15, Dump #1	14,200	Coal fines/waste	None	Unsatisfactory
Site #15, Dump #2	300	Coal fines/waste	None	* Unsatisfactory
Site #15, Dump #3	300	Coal fines/waste	Sparse	* Unsatisfactory
Site #15, Dump #4	3,000	Coal fines	None	* Unsatisfactory
Site #16, Dump #1	1,000	Coal fines	None	Unsatisfactory
Site #16, Dump #2	200	Coal fines	None	Unsatisfactory
Site #17, Dump #1	100	Coal fines/waste	Sparse	* Unsatisfactory
Site #17, Dump #2	100	Coal fines/waste	Sparse	* Unsatisfactory
Site #17, Dump #3	200	Coal fines/waste	None	* Unsatisfactory
Site #17, Dump #4	----	Coal fines/waste	Revegetated	* Satisfactory
Site #17, Dump #5	----	Coal fines/waste	Revegetated	* Satisfactory

* Based on field observation.

Samples were taken from three gob piles in the Virtue Gulch Area. All sites are barren of vegetation and are extremely acid. pH readings range from 1.8 (samples 15-OB-1 and 16-OB-1) to 4.5 (sample 17-OB-1). Materials from these gob piles should not be used as either topsoiling or subsoiling materials.

5.5.2 Reclamation Plan Alternatives and Costs

The hazards to the environment and public within the Virtue Gulch Area ranked in order of priority are (1) open portals, (2) subsidence, (3) gob piles, and (4) abandoned structures. Each will be discussed in terms of remedial alternatives to the abandoned mine land associated hazards.

Ten portals were located in the Virtue Gulch area, two of which are open and eight are closed and collapsed. Water is seeping from the rubble of one of the collapsed portals.

Reclamation Plan Alternatives		Cost
Gate and lock	2 @ $2,750	$ 5,500
Doze and regrade	10 @ $1,200	$12,000
Blast and regrade	2 @ $2,000	4,000
Concrete openings	2 @ $1,650	3,300
Pneumatically stow shut	2 @ $2,650	5,300

One localized area of subsidence activity exists in the Virtue Gulch Area and consists of nine deep holes. These subsidence holes are not easily visable and pose a safety hazard to the public.

Reclamation Plan Alternatives		Cost
Fill with borrow	9 @ $280	$2,520
Fill with gob material	9 @ $480	4,320

There are only three minor structures within the Virtue Gulch Area. All are of timber and wood construction.

Reclamation Plan Alternatives		Cost
Salvage	90% of bury at site	$495
Bury at site	600 ft^2 @ 0.918	550
Remote burial	600 ft^2 @ 1.284	770

Nine gob piles exist within the Virtue Gulch Area of which seven are small in size. The two larger piles lie within the floodplain of Virtue Gulch. Due to the detectable level of mercury below these larger piles, they may be considered a potential environmental hazard.

Reclamation Plan Alternatives		Cost
Pull slopes and grade	4,700 cy @ 0.247 + 3,000 cy @ 1.085	$ 4,415
Remove from drainage and grade	5,800 cy @ 0.247 + 3,000 cy @ 1.085	4,685
Transport	19,400 cy @ 1.085	21,050

5.5.3 Recommended Reclamation

The following is an outline of the recommended reclamation for the Virtue Gulch Area.

Portals		Cost
Doze and regrade	8 @ $1,200	$ 9,600
Blast and regrade	2 @ $2,000	4,000
Subtotal		$13,600
Contingency		2,720
Move-in		1,360
Total		$17,680

The two open portals would be blasted down and the areas regraded. The area around the eight collapsed portals would be regraded.

Subsidence	Cost
Fill with borrow	$2,520
Contingency	500
Move-in	250
Total	$3,270

The subsidence holes would be filled with available borrow and the area regraded.

Structures	Cost
Remote burial	$ 770
Contingency	150
Move-in	80
Total	$1,000

The structures would be demolished and hauled to "head of hollow" fills with the gob piles.

Gob Piles	Cost
Transport	$21,050
Contingency	4,210
Move-in	2,105
Total	$27,365

The gob piles would be removed from the drainages and transported to "head of hollow" fills.

Virtue Gulch Summary

Portals	$17,680
Subsidence	3,270
Structures	1,000
Gob Piles	27,365
Revegetation 42 Ac. @ 825	34,650
Total	$83,965