ENVIRONMENTAL IMPACT OF SURFACE COAL MINING OPERATIONS IN ALBERTA

ENVIRONMENT CONSERVATION AUTHORITY
Edmonton, Alberta

November, 1971

F.F. SLANEY & COMPANY LIMITED
Vancouver, Canada

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PART 1

THE PROJECT

1.1 REQUEST FOR STUDY

This project was carried out in response to a request by the Alberta Environment Conservation Authority for an outline of environmental problems associated with provincial surface coal mining operations, including exploration, extraction, processing and transport.

1.2 PRIMARY OBJECTIVES

The report is primarily intended as a comprehensive basis for discussion at public hearings. Primary objectives of the study were to:

1. Outline and discuss the effects of surface coal mining and their impact upon other natural resources in three regions
2. Describe protective, remedial and restorative measures to cope with those problems
3. Make a broad comparison of the benefits of surface coal mining in Alberta with the projected environmental consequences
4. Suggest a framework for appraising the costs and benefits of individual operations
5. Suggest methods for processing exploration and operating permit applications and for regulating mining operations so as to control their impact upon the environment
6. Determine additional study needs.

1.3 GENERAL APPROACH

The outline and analysis of environmental problems is based on existing knowledge of the type and extent of Alberta's resources, values attached to them, and their rates of utilization. Material was gratefully received from the Conservation Authority, provincial government agencies, and others. Field surveys were under the direction of R. Webb, formerly of the Alberta Department of Lands and Forests.

Special contributions to the project were made by the following:

Ripley, Klohn & Leonoff Alberta Ltd.

Mining and geotechnical aspects in Parts 2 and 3. They have worked with mining companies in Alberta, solving soil and water problems.

Pearse Bowden Economic Consultants Ltd.

Economic considerations in Part 5. They are leading resource economists in Canada.

H. S. Haslam, P.Eng.

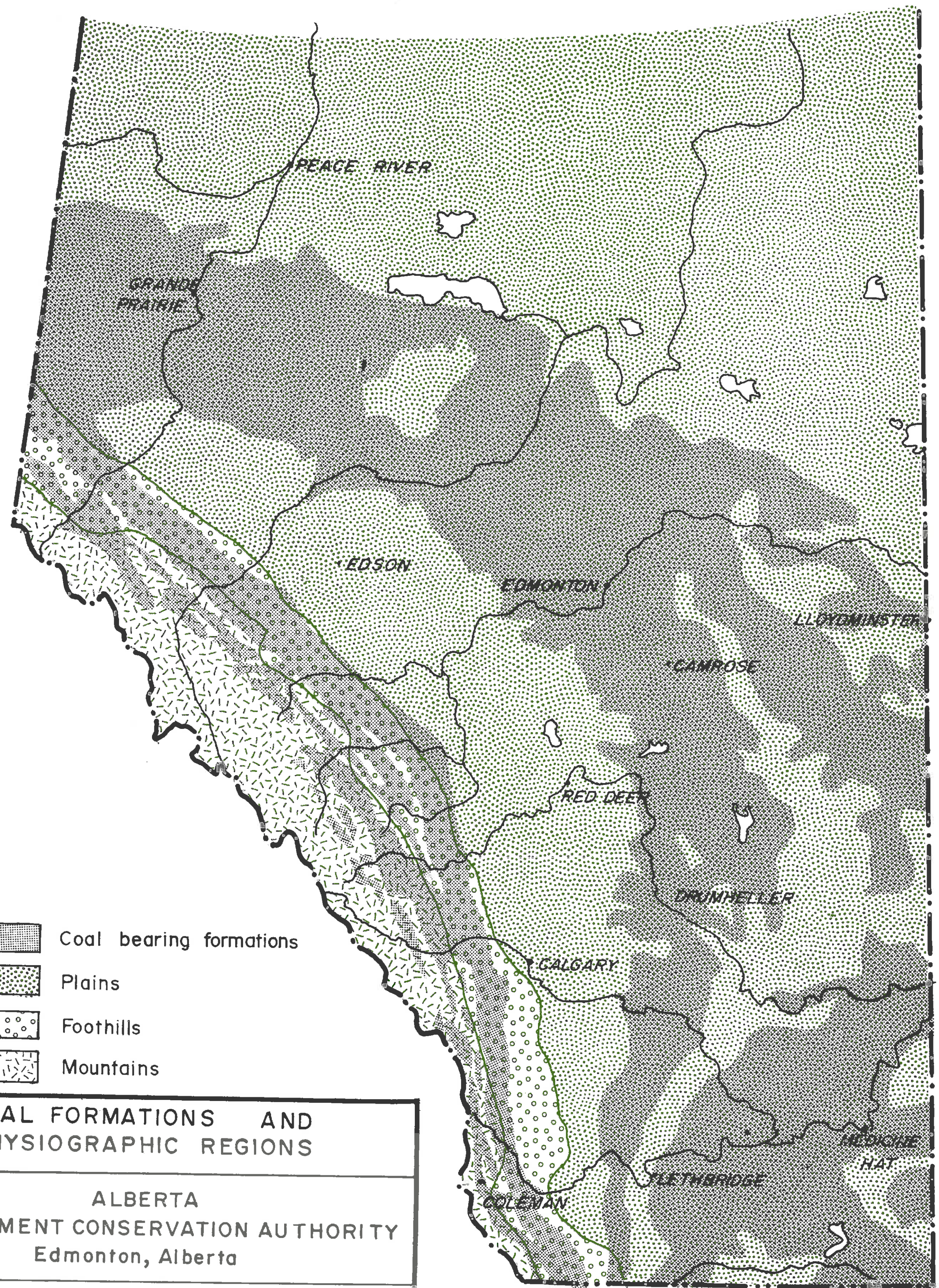
Exploration, mining methods and processing in Part 2. Mr. Haslam has a vast experience in mine management.

1.4 PHYSIOGRAPHIC REGIONS

For the purposes of analysis, the province was divided into three physiographic regions - Mountains, Foothills and Plains (Map 1).

1.4.1 Mountains

Rising to over 12,000 feet above sea level, this region of steep mountains, glaciated valleys and rugged topography supports a sub-alpine forest which gives way to alpine tundra between 7000 and 7500 feet elevation. Short growing seasons, severe climate and thin, easily disturbed soils have created a delicately balanced soil - water - vegetation complex which is susceptible



COAL FORMATIONS AND PHYSIOGRAPHIC REGIONS

ALBERTA
ENVIRONMENT CONSERVATION AUTHORITY
Edmonton, Alberta

PROJECT NO E13.1
DATE December, 1971

SCALE: 1 in =64 miles

F.F. SLANEY & COMPANY LIMITED
Resource Development & Environmental Management

to disturbance and slow to heal. Watershed, aesthetic and recreational values are particularly high. Some small areas support restricted wildlife and fisheries resources.

1.4.2 Foothills

This region of forest and grassland is adjacent to the Mountains and features rolling hills that rise gradually from the level and gently undulating topography of the Plains. It is traversed by numerous watercourses including several major rivers. Watershed, fisheries, wildlife, forestry, range, and recreational values predominate.

1.4.3 Plains

The topography ranges from flat in the east to gently undulating near the Foothills and is marked by river valleys, moraines and sand hills. The region supports a number of ecological types varying from prairie and aspen parkland through the aspen-spruce ecotone to mixed coniferous forest. Ranching, farming, forestry, and wildlife resource values are most significant.

PART 2

SURFACE MINING IN ALBERTA

2.1 THE COAL SCENE

In 1969, coal production, in short tons, was as follows, with the number of producing mines in brackets;

	Surface	Underground	Totals
Mountains	287,851 (2)	879,372 (2)	1,167,223
Foothills	500 (1)	192,372 (1)	192,872
Plains	3,034,154 (16)	121,381 (3)	3,155,535
	3,322,505	1,193,125	4,515,630

In 1970, the last year for which figures are available, total production had risen from 4,515,630 tons to 6,675,687 tons.

Most of the coal reserves are of bituminous and sub-bituminous rank. The bituminous coal occurs in the Mountain and Foothill regions, and the sub-bituminous in the Plains.

Much of the coal in the Mountains and Foothills is of suitable quality for coking coal. During the past few years, the demands of the Japanese steel industry have caused an unprecedented interest in exploration work within these regions. Their desire to secure long-term contracts led to extensive exploration and to large operations, both underground and on the surface. Since 1969, several new, large surface mines have come into production and coal production has increased.

Although the potential of the Japanese market has ebbed somewhat, many of the larger oil and gas companies are looking towards coal as a means of diversifying their interests and it would appear that the current level of interest in coal exploration may be maintained.

At present, the main use of the sub-bituminous coal of the Plains is for power generation. There has also been considerable activity in evaluating possible sites for large surface mines in the Plains region to be accompanied by thermal electric power stations. However, development will depend upon the availability of cooling water.

There are approximately 2.2 billion short tons of measured coal resources in Alberta. Map 1 shows the location of coal bearing formations in Alberta. "Measured" resources occur throughout. They are computed from actual observations and measurements which are so closely spaced and from which the thickness and extent of the coal are so well defined that the computed tonnage is judged to be accurate within 20 percent of the true tonnage. The minimum seam thickness considered is five feet. Not all of the available coal in the province has been measured to date. An estimated 45 billion additional tons is indicated or inferred from geological data and exploration.

It is estimated that about seven percent of the measured coal resources in the Mountains and Foothills (982,100,000 short tons) can be mined by surface methods, whereas all the measured coal resources of the Plains - (1,221,800,000 short tons) are potentially mineable by surface methods under present economic and technological conditions.

In the Mountains and Foothills, the very difficult mining conditions resulting from severe folding and faulting of coal seams, and the requirements for large deposits of high quality coal and financially acceptable coal: overburden ratios would appear to make it unlikely that many more surface mines will be developed in the future. In the Plains all measured deposits lie within 150 feet of the surface and may be mined by surface methods.

When compared to the total land area of Alberta, the amount of land actually disturbed by surface mining has been very small. The amount disturbed to date in all regions is less than 10,000 acres, a small fraction of one percent of the province's total land area. However, the geographically concentrated nature of surface mining can result in intense changes in the environment, and these in turn can affect areas much larger than that of the mine itself.

The area disturbed by exploration will be much greater than that disturbed by surface mining operations. Not all exploration is successful in terms of finding coal that can be mined economically by either surface or underground methods.

2.2 EXPLORATION

The effects of exploration are most severe in the Mountains and Foothills. The general exposure of the coal seams, resulting from severe folding and faulting, and the effects of natural erosion determine the exploratory approach. Surface trenching is carried out to expose the seams and learn more about the nature of the deposit before proceeding with the more expensive drilling operations. To determine the quality of the coal for various markets, it is usually necessary to excavate a test-pit or trench to obtain large samples from beyond the weathered or oxidized zone. This operation often leaves a substantial cut-and-fill excavation on the hillside. On steep hillsides, some excavation may also be necessary to provide level sites for drilling equipment. Roads are built on a short term basis to provide the cheapest access for exploration equipment. The road is made by running a bulldozer through the vegetation, and the surface is usually the coarse fraction of surface soils. Roadside ditches are seldom dug, and crossings over minor streams are usually fords or crude log culverts.

After exploration work has been completed, there remains a network of roads, trenches and drillsites extending for many miles, often over very steep slopes. The disturbance of surface soils and vegetation is often severe and long-lasting. The effects are compounded by the steep gradients over many of these roads.

In the Plains, the horizontal coal seams are generally covered with a mantle of glacial drift and are exposed only where major streams have cut deep channels. Thus, exploration is mainly restricted to drilling operations, although test-pits must be excavated to obtain bulk samples. In forest areas these activities will also necessitate the cutting of exploration access trails.

2.3 MINING METHODS

The method of mining depends upon the configuration of the seam in relation to the surface topography.

The coal deposits of the Plains are generally found in horizontal seams lying at relatively shallow depths below flat to gently rolling terrain. A trench is cut through the overburden to expose the coal seam, and the overburden is placed to one side. After the coal has been extracted, an adjacent, parallel cut is made, and the overburden is placed in the previously excavated cut. This process of area stripping is continued until the economic limits of the coal deposit have been reached. After mining, the land surface consists of a series of parallel spoil ridges and an open trench in the last cut.

The coal seams in the Foothills and Mountains have been subject to severe folding and faulting and are usually steeply inclined. The variable pitch and topography do not lend themselves to contour stripping as practised in the Appalachian coal fields, and the method employed in Alberta is normally some form of open-pit mining.

Once the coal seams have been located and a mining plan prepared, the overburden is removed and dumped outside the planned mine areas. Unlike area strip-mining, the amount of land disturbed is significantly greater than the area of the pit itself. There is no mined-out trench for disposal of overburden, and so it must be dumped onto the side of the hill. Open-pit mining occurs in a wide range of geological and topographic conditions, and so the final profile may vary from a series of benches and high walls to an actual pit.

2.4 TRANSPORT AND PROCESSING OF COAL

Before coking coal can be marketed, certain quality criteria must be met in order to satisfy contract specifications. This involves a series of processing facilities at the mine site. When the coal is extracted from the pit it is broken down to a maximum diameter of four inches and washed to remove the dirt and dross. After being dried, the coal is sorted to satisfy the size requirements of the contract. None of the mines producing coking coal have coking facilities. All coal is marketed as raw coal.

A washing process may extract from 25 - 35 percent waste material. Some of this material is combustible and can be used to supply the thermal plants which provide the heat for the drying process.

As production increases, these residues may be used to generate electric power on a commercial scale. A power station being built at the site of McIntyre Coal Mines in the Smoky River area is scheduled for operation by mid 1972.

In the Plains, thermal electric power stations are associated with the larger mines. Before being used, the moisture content of the coal is reduced by thermal driers. The coal must also be broken down to a suitable size.

In addition to the sites required for the construction of these facilities, areas must be found for the disposal of washery wastes and fly ash sedimentation ponds and waste piles.

Haul roads are necessary for transporting the coal from the mine to the processing plants, and roads or railways are required for transporting the processed coal to market.

PART 3

GEOTECHNICAL ASPECTS OF THE SURFACE MINING OPERATION

3.1 IMPACT ON THE PHYSICAL ENVIRONMENT

3.1.1 Erosion

The extensive slopes of waste and rock usually associated with surface mining are generally bare of any vegetation and are exposed to the full action of wind and rain. These erosive forces will cause a significant increase in the sediment loads of local stream systems. The U.S. Geological Survey have calculated that the sediment yield from strip-mined portions of a watershed can be measured at 10 to 1500 times the sedimentation yield from undisturbed land.

Erosion of slopes takes place in two ways, as sheet erosion and as gullying. Sheet erosion occurs with every rainfall, as individual raindrops displace particles of soil and free surface water carries the particles downward. Gullying develops in depressions on a slope, or wherever surface flows are permitted to concentrate in small streams. Some measure of gullying usually occurs on long slopes.

The construction of roads for exploration and for hauling coal within a mined area creates severe problems in erosion and in destruction of drainage patterns. Many roads are built on sidehill slopes, leading to a great deal of surface disturbance and resulting erosion. Such roads also concentrate surface drainage at low points or at culverts. Such roads are commonly built on gradients so steep that roadside streams scour the ditches and carry a heavy load of sediment.

On the Alberta Plains, erosion connected with surface mining is not likely to be a serious problem because of the topography.

3.1.2 Slope Instability

It is inevitable that mining in mountainous areas leads to sidehill construction of roads, waste piles, storage piles and similar structures. Very often built in dry weather, such structures tend to slide when saturated. The consequences of slides of waste piles may be serious in terms of public safety, and deserve detailed study. The consequences of slides from cut-and-fill road construction may be progressive deterioration of the slopes downhill, a condition that can be corrected with difficulty, if at all.

The interception of groundwater may contribute to slides adjacent to sidehill excavation, especially as a flow of water from a rock face or bank tends to freeze in the winter.

A common companion to coal is shale, a laminated rock derived from the metamorphosis of silts and clays. Some shales are unstable in air, especially when unconfined and exposed to water, and quickly revert to the parent materials. Waste piles and sidehill structures of these shales may appear to be stable when first constructed but become most unstable after a period of weeks or months.

In addition to their effect on surface cover, unstable slopes and slides may encroach on a mountain stream and set up a condition of instability that persists for many years.

3.1.3 Chemical Activity

When freshly broken rock or soil are exposed to air and moisture together, chemical reactions proceed very rapidly, releasing the normal products of geological aging and weathering at a greatly accelerated rate. Such rapid chemical action requires, however, that all three conditions be met -- fresh material, air supply and water. If water is sufficiently plentiful to carry the salts away, the effect on water quality can be severe and immediate.

The coal measures of Alberta in general do not promote acid drainage. At the same time, the natural alkalinity of some foothills streams has been increased by one documented example of mining development, and further increase can be expected as development progresses. Considering that some natural stream flows now require treatment to reduce total hardness for domestic use, the effect of widespread mining may be to increase the load on certain treatment facilities.

Precipitation of iron compound occurs in several streams flowing from abandoned underground mines in the Crowsnest Pass area and so chemical pollution should always be considered as a possibility.

3.2 PROCESSING ACTIVITIES

3.2.1 Coal Treatment Plants

Coal treatment plants will undoubtedly be features of the major coal mines developed in Foothills and Mountains. These plants are conventional industrial installations and occupy relatively small areas of level ground, but three auxiliary surface facilities commonly associated with such plants deserve comment.

3.2.2 Waste Piles

Coal waste piles present a particular problem in some areas because they tend to ignite spontaneously. Fortunately in Alberta the coal appears to be deficient in the minerals that trigger this type of combustion so the problem should not be serious.

3.2.3 Sedimentation Ponds

Sedimentation ponds are used to dispose of the fine waste removed from coal and to permit re-circulation of the water in the plant. The waste is pumped as a slurry to the pond where the solids settle out. In time the pond may be dewatered and dredged for re-use, but the fines must then be stored in the vicinity in permanent storage behind substantial embankments. Because they are fine enough to be carried readily in streams the fines should be isolated from flowing water.

3.2.4 Thermal Plants

Large thermal plants are usually incorporated in coal treatment plants because the fuel is readily available in waste coal and because a large volume of heat is required to dry the product. The thermal plants create some air pollution, but the flue gases from Alberta coal contain little sulphur dioxide and noxious fumes. Ash from the thermal plant would probably be piped to disposal with the fines from the treatment plant. Cooling water circulated through the thermal plant would raise the temperature of receiving water in lakes and streams.

3.3 PROTECTIVE, REMEDIAL AND RESTORATIVE MEASURES

3.3.1 Pre-Planning

The key to success in all control measures is pre-planning. With proper planning, many deleterious effects can be prevented, and others remedied with much less expenditure of time, effort and capital. Remedial and reclamation projects are not always economic propositions to the company but, given that these measures are required by government, there are methods and approaches that are more economic than others. For example, pre-planning will reduce the amount of overburden that has to be re-handled to achieve a topography suitable for post-mining use and will allow more efficient allocation of machine time.

Planning is required in work affecting drainage and road construction.

3.3.2 Drainage

Before a company begins work in an area it should construct catchment ponds in the small streams downhill from the work, in anticipation of sediment entering these streams with the first rainfall. The catchment ponds should then be inspected at regular intervals to ensure that they are effective in preventing the downstream migration of sediments. As the ponds fill they must be excavated or enlarged.

In connection with developing a coal property in mountainous areas it may be necessary to divert a natural water course. Such a diversion must be described in detail in the operating plan and must be constructed, if approved, with consideration for criteria of length, gradient, stream section, and bed material.

3.3.3 Roads

Roads must be planned and constructed with the following objectives:

1. To minimize the effect of road construction on stream systems, following high ground between watersheds where possible
2. Avoid sidehill construction on steep slopes where possible
3. Construct a road to a minimum width compatible with use, using turnouts where needed
4. Build stream crossings to minimize effect on stream gradient and cross section
5. Use of mechanical and biological methods of bank and ditch erosion control.

During the exploration phase, the road system should be located first on aerial photographs, following principles and standards established by the province. The plan may be modified as exploration proceeds but only after approval. The principles of location and construction must be observed throughout. If the exploration team decides that development cannot proceed in any area, the roads that are not required for further use should be "bedded down" in accordance with standards set by the province. Some points to be observed are:

1. Minimize effect of narrow sidehill roads on surface drainage by regrading them away from the hill
2. Constructed water bars across the road on gradients steeper than approximately five percent
3. Rip the surface of all consolidated road beds to permit early revegetation
4. Excavate and remove all culverts and stream crossings to minimize further sedimentation.

The location and construction of haulage roads can be planned to minimize the impact of the roads on area drainage and topography, also to provide roads that perform better during winter break-up, are easier to maintain, and permit rapid haulage. When rendered obsolete by progressive development of the mine, roads should be "bedded down" according to plan, following standards set by the province.

When reclaiming exploration roads, test-pits and trenches should also be graded wherever possible unless the mining operation is expected to overrun them in a short time.

3.3.4 Overburden and Wastes

The intrinsic value of topsoil should be generally recognized and accepted. Generally the surface soil should be stripped, stored and replaced in final grading. If necessary, and where possible, the surface soil should be mixed with a coarse gravel or rocky soil to inhibit erosion by water and wind, and to prevent compaction. The stripping, re-handling and final disposition of the surface soils should be planned in all significant detail, and approved by the licensing authority.

During the removal of overburden an operator may encounter soils or rock that would be undesirable if exposed to air and water, and the operator must identify these materials and plan his earth-moving procedures so that they are safely buried. Examples of these materials are:

1. Chemically reactive soils or rocks
2. Unstable clay shales or mudstone.

The stability of waste embankments is given treatment in a pending publication of the federal Department of Energy, Mines and Resources, "Tentative Design Guide for Mine Waste Embankments in Canada". Its recommendations should be followed wherever spoil banks, waste embankments, sedimentation ponds or similar structures are built.

To ensure that waste slopes can be revegetated calls for surficial treatment of a certain type. In general, that additional work is:

1. Grade the top and terraces of a waste pile inward, to discourage surface flows down a slope
2. Establish terraces on level grades at vertical intervals of no more than 50 feet
3. Grade the slope to a maximum of one on two, or 27° from the horizontal
4. Incorporate some topsoil in finish grading if possible.

3.3.5 Removal of Facilities

When a coal mine has been exhausted, coal treatment plants, thermal power stations and all similar installations should be dismantled and removed, and the site prepared for revegetation.

3.4 REGIONAL ASPECTS OF GEOTECHNICAL PROBLEMS

3.4.1 Mountains and Foothills

The problems encountered in the Mountains and Foothills are similar. Although both regions have exceedingly steep slopes, not all of the land surface is steep. In fact, surface mines occur on relatively gently sloping sites, even in Mountain regions.

Bare slopes result from the construction of roads, spoil heaps and waste piles. The cut-and-fill method of road construction which is necessary on steep slopes denudes areas much greater than that of the road itself. The exposure of these bare slopes to the elements leads to soil particles being washed downhill and increased stream sediment loads.

The hillside construction of roads, spoil heaps and waste piles, which is usually necessary in the Mountains and Foothills, may lead to landslides unless the provisions described in sections 3.3.3 and 3.3.4 are implemented to ensure slope stability. If construction proceeds without due care, progressive destruction of downhill slopes may occur and stream channels may be disrupted.

Because of the open-pit method of mining employed in the Mountains and Foothills, all of the excavated overburden must be stored outside of the pit area until the mining operation has been completed. This may require substantial additional area of disturbance. The handling of overburden will require much supervision to ensure that the minimum amount of re-handling is necessary.

If the overburden is to be backfilled into the pit, substantial amounts of topsoil will have to be stored throughout the life of the mine to enable subsequent revegetation.

3.4.2 Plains

Most of the geotechnical problems associated with the Mountains and Foothills do not occur in the Plains because of the lack of relief and the area-strip method of mining.

Although bare slopes are subject to erosion, there is little problem with increased sedimentation as drainage is usually internal to the mine site. Only the overburden from the first cut lies outside the pit area, and sediment from that source is insignificant.

The area denuded outside of the pit area is much smaller than in the Mountains and Foothills. Most of the overburden is dumped within the pit area and cut-and-fill methods are not usually necessary in road construction in the Plains. Topsoil need not be stored for long periods because reclamation can be continuous. Fresh topsoil can be placed immediately on top of existing overburden heaps.

PART 4

EFFECTS ON OTHER NATURAL RESOURCES AND THEIR MANAGEMENT

4.1 GENERAL REVIEW OF IMPACT AREAS

Although these effects are discussed separately, much of the impact is due to the complex interrelationships occurring between them.

4.1.1 Watersheds

Water resources are of vital importance both provincially and nationally. The Saskatchewan River system supplies water to 85 percent of the population in Alberta and 42 percent in Saskatchewan. The Peace and Athabasca Rivers contribute significantly to northern ecosystems. Any modification of river characteristics may have long-lasting effects on the ecology and economy of areas far beyond the borders of Alberta, or, indeed, Canada. The Milk River, which flows eastward through northern U.S.A., also rises in Alberta.

The alteration of normal surface and sub-surface drainage patterns may have serious consequences. Damage to stream banks, blockage of stream channels and sedimentation cause changes in stream profiles, reduce the storm-carrying capacity of watercourses and increase the danger from flash floods. Sedimentation will also cause the premature silting of reservoirs, with resultant effects on hydro power generation and water supply for domestic, industrial and agricultural use.

Removal of vegetation and the greater capacity for water retention by spoil banks affect the properties of watersheds. Reports of some established coal-fields in the U.S.A. indicate that the increased water storage capacity of a high density of spoil heaps can have a beneficial effect on stream flows. In Alberta, these effects are not expected to be significant.

As well as its effects on ecological, recreational and aesthetic values, any deterioration in water quality has important consequences for domestic and industrial consumers downstream and may necessitate the provision of costly treatments.

Headwaters of the Saskatchewan River within Mountains and Foothills regions supply about 87 percent of the system's total annual flow and are protected by the National Parks and the Eastern Rockies Forest Conservation Area.

While water is the most important product of the Conservation Area, watershed protection and improvement may be attained along with the utilization of other resources. However, as watershed management becomes intensified, greater emphasis will be placed on water quality, and so the effects of surface mining must be controlled.

4.1.2 Ecosystems

Ecosystems are the result of interactions between topographic and climatic factors as well as plants and animals. Changes in any of these factors may have repercussions not only where the stimulus occurred but also in related ecosystems.

During land clearing, attention must be paid to slash disposal. Any outbreak of fire, insects or disease would have a significant impact upon vegetation.

4.1.2.1 Wildlife

Wildlife requires vegetation for food, shelter and escape cover. Each species has become adapted to a certain vegetation pattern, and any change in that pattern could cause changes in wildlife populations.

On areas physically disturbed by mining operations, wildlife habitat is usually destroyed. The impact of such disturbance depends upon the importance of that site to any wildlife species. Where a species is common and there is no shortage of suitable habitat, the impact is small, but where a species has only a limited distribution, any disturbance may have a significant impact upon its survival in that region. The limited winter range of bighorn sheep and goats in the Mountains is an example of the latter case. There is a whole range of intermediate situations, and the impact must be predetermined for each mining operation.

Mining operations may also disrupt seasonal migration patterns. This can be especially important for mule deer, elk, moose, and bighorns in the Mountains and Foothills.

The very presence of human activity is sufficient to discourage certain species such as grizzly bears from using suitable portions of their mountain range.

With proper planning, reclamation can provide a valuable diversification of habitat suitable to certain species. Indeed, wildlife habitat can sometimes be produced elsewhere to compensate for loss or provide some where none previously existed. However, mirror-like duplication is not technologically possible and some changes in the type and extent of wildlife usage are therefore inevitable.

4.1.2.2 Fish

Fish populations are very susceptible to the effects of mining. Any major change in environmental conditions will either effect a change in species composition or eliminate fish from the stream altogether. More valuable species such as cutthroat trout in the Mountains and Foothills often suffer while less valuable species thrive.

Although adult fish can tolerate relatively high sediment loads, deposition of silt and precipitation of iron compounds on stream bottoms will increase mortality of eggs and juveniles by reducing the supply of oxygen. Many of the sediment problems reported in the literature are the result of large-scale discharges, but gradual deposition is sometimes as important. Arctic grayling of the Athabaska and Peace drainages are susceptible to these effects.

The routing and treatment of exploratory and haul roads is as important as the extraction process.

Together with sedimentation, disruption of natural drainage patterns and blockage of stream channels will alter stream profiles and the amount and timing of water flow. Fish species are limited in the water velocities they can negotiate, and changes in stream flow may effect changes by eliminating a species from certain parts of the stream or by preventing its movement.

Chemical pollution from mining operations is of limited importance in Alberta if one considers that the iron "problem" is physical, not chemical.

The only known chemical effect of any magnitude is an increase in calcium carbonate and consequent increases in pH, but this has apparently little effect on fish.

The removal of streambank vegetation affects fish both directly and indirectly. Direct effects are increased water temperatures, which also occur with the addition of warm water from thermal power stations, and the loss of cover, which has important consequences for fishes with regard to the carrying capacity of streams.

Indirect effects include changes in invertebrate fauna, a major food source for fishes. As well as supporting terrestial insects, streambank vegetation provides most of the energy input into stream ecosystems, and the loss of this energy source will bring considerable changes in the composition of bottom fauna. Aquatic invertebrates are also affected by changes in stream flow and by physical and chemical pollution.

In lakes, turbidity caused by colloidal matter may reduce productivity and alter thermal patterns by restricting sunlight penetration. The significance of these effects is extremely variable, depending upon relative volumes and temperatures, circulation, oxygen concentrations, etc., and each lake should be investigated individually.

4.1.3 Recreation

Hunting and fishing are part of the Alberta heritage and play a major role in the recreational activities of its population. Thus, anything that materially affects fish and wildlife could have a significant impact upon available recreational opportunities.

Mining operations may affect the amenity of existing recreational facilities such as parks, campsites and picnic sites. Noise is an important factor, especially for those wishing to escape the industrial noise of urban areas.

Air pollution in the form of dust and smoke is a nuisance factor. Noxious fumes are unlikely to be a problem because of the low sulphur content of the coal.

Lakes and streams are valuable for a number of water-based activities, and any deterioration in water quality may seriously affect their recreational potential. Obstructions and alteration of stream profiles will also affect the value of streams for canoeing or general enjoyment.

One of the possible benefits of mining is that it can provide access and increase the area available for intensive recreation. With proper planning, reclamation may provide recreational facilities such as small lakes, campsites and sites for cottages and commercial recreation ventures. Thus, in areas where such recreational facilities are lacking and budgetary considerations prevent their provision by government agencies, the mining industry can make a significant contribution. Public access to fragile areas with wilderness value, however, would destroy rather than enhance recreational attributes.

4.1.4 Aesthetic, Scientific and Educational Values

Aesthetic values relate to beauty in nature. The visual impact of mining operations depends upon the degree of contrast between the mine and its surroundings and the effectiveness of screening. However, aesthetics relate not only to visual beauty, but also to the concept of nature itself - an unharnessed system of entities, forces and events. Thus, to many people, any industrial activity in wildlands represents a loss in aesthetic values, and no amount of screening or reclamation can prevent that loss. Scientific and educational values associated with unaltered ecosystems are also fragile and irreparable if destroyed. The scarring of high mountain slopes and valleys of the Rockies by coal exploration as well as extraction processes represents a threat to the area where such values are high.

4.1.5 Resource Management

Surface mining operations result in a temporary loss of the productive capacity of the land. They can also interfere with or augment the existing resource management practices in the area.

4.1.5.1 Forestry

Most valuable commercial forest stands are found in the Foothills region. If the area cleared carries mature forest, there is no loss in timber values because the felled timber may be sold or used in the mining operation.

If the area carries timber of unmerchantable size, the growth of previous seasons has been lost. This is especially important if either the Forest Service or a forest company have an investment in forest establishment.

If a mining operation falls within a sustained yield forest management unit, the cutting of both mature and immature stands could have a detrimental impact on the forest management plan and cutting schedules.

One of the advantages of mining industry development, especially in the Foothills, is the provision of access, which may allow the commercial management of previously inaccessible forest areas.

4.1.5.2 Fish and Wildlife Management

In Mountain and to a lesser extent Foothills regions, improved access can result in greatly increased pressure on fish and wildlife resources. Managing agencies as a result must increase both effort and expenditures in order to maintain acceptable levels of administration. Traditional ways of hunting, trapping and fishing are disrupted, to be replaced by different methods often practiced by different people.

Governments often are not able to quickly adjust their programs, approaches and budgets and a management lag develops. This lag, plus the dislocation of established resource use patterns, are seldom met with immediate approval by public organizations representing the users of the resources.

4.1.5.3 Grazing

Cattle ranching is important in the Foothills and the Plains. The proximity of mining operations disturbs cattle, and so the area removed from grazing is slightly greater than that actually destroyed. However, the area actually disturbed by surface coal mining is small when compared with the total area of rangelands.

4.1.5.4 Cereal Production

The Plains region contains some of the finest dry land cultivation areas in Canada. Continued cereal production is limited as much by economic and social conditions and world markets and distribution systems as by biological or physical factors. Although individual farmers may lose productive land, they are presumably compensated by the mining company. The loss of a relatively small area of cropland is not important to Alberta as a whole providing it is only temporary and that reclamation and restoration of productivity follow within a reasonable time.

The effects of surface mining may extend beyond the actual mining area. A dry, and at times windy climate combined with friable soils already creates problems with dust storms. Dust blowing from areas disturbed by surface mining will add to this problem. Dust is not only an inconvenience in urban and rural communities, but may also cause damage to crops by abrasion.

One advantage of land disturbance is that it breaks up the hard pan in solonetzic soils and, with reclamation, may lead to more productive soils.

4.2 WAYS OF PREVENTING AND MINIMIZING IMPACT

4.2.1 Multiple Resource Planning

When planning post-mining use, not only the physical and biological limitations of the site must be considered, but also the current and projected land-uses of the surrounding area. The reclaimed land should complement large scale land use patterns. Disturbed land in the Foothills region should not be reclaimed for cereal production if in some remote forest area. Such land would be better restored to forest or reseeded to raise its wildlife capability.

Planning will identify objectives, rationalize procedures and lead to realization of the same or a better type of land use on disturbed areas.

4.2.2 Management Plan

Following the experience of countries where reclamation has been an accepted principle for many years, a management plan should be drawn up before any disturbance takes place. The plan should outline the projected land-use and the means of achieving it and describe the actions to be taken to reduce or eliminate the undesirable effects of surface mining before, during and after the operation. Initial seeding and planting to achieve a green cover may be only the first step in a program of soil conservation and land-use development. Although further grading should not be necessary, subsequent manipulation of the plant cover may be required to produce food and cover and thus achieve maximum wildlife benefits, for example.

4.2.3 Impact Studies

Impact studies should be locally carried out to form the basis for the management plan. Only when the problems have been identified can steps be taken to reduce or eliminate the undesirable effects of surface mining.

The following factors should be considered: climate, topography, drainage, soils, vegetation, wildlife, aquatic fauna, resource use patterns (current and projected), access, settlements and human interest areas.

4.2.4 Job Supervision

Well considered and practical management plans will be of limited use if they are not properly implemented. The best means of ensuring adequate implementation is to make one agent responsible for extracting the coal and another responsible for all other phases of the plan - erosion control, land clearing, road building, spoil placement, regrading, backfilling and revegetation. He will also be responsible for monitoring all environmental effects so that the plan can be modified to accommodate unforeseen circumstances. In this way the provisions of the management plan will not be jeopardized by concern for efficient extraction.

4.2.5 Remedies

The control measures described in Section 3.3 will reduce or eliminate much of the damage to watersheds in Mountains and Foothills, a prime consideration in Alberta. The importance of installing erosion control facilities before the operation begins cannot be overstressed.

These measures will reduce but not eliminate detrimental effects on water-based recreation and on aquatic fauna. If mining necessitates disturbing streamside zones, the stream should be temporarily diverted to avoid continuous siltation. This act will not be without some impact on downstream aquatic systems, however, and should be undertaken only with full understanding of effects. If possible, care should be taken to protect the original stream course and adjacent vegetation so that the stream may be later restored.

It is possible to mitigate against loss of wildlife habitat by providing alternative habitat. For example, as demonstrated by the provincial Fish and Wildlife Division, clearings may be cut in the forests of the Foothills and Mountain regions and planted to provide compensatory forage for elk and sheep. Ponds can be created to compensate for those drained during the mining operation.

Most cattle ranges are managed quite extensively, and grazing losses in many cases can be mitigated by intensifying management on remaining areas. Improvement in animal husbandry and the use of vegetation management practices can compensate for temporary acreage losses.

At certain sound frequencies, noise levels may be reduced by leaving strips of trees between mining operations and recreational facilities, the width of the strips depending upon the desired amount of sound attenuation.

The leaving of tree strips is also a means of preventing the loss of scenic values and should be common practice in all forested areas. Tree cutting and the displacement of overburden should be planned so that the mine is continuously screened from view. Even in treeless areas, the effect of spoil piles on the landscape may be reduced by proper planning. However, it will be impossible to screen all operations.

4.2.6 Reclamation

4.2.6.1 Site Preparation

To obtain a site compatible with any projected land use, grading, back-filling and the setting of drainage patterns will be required. The management plan will have ensured that, throughout the operation, spoil placement has been carried out in a manner that will minimize the amount of final contouring that is necessary. During final grading and replacing of soil material, care should be taken to avoid compaction. Mixing the soil with coarser material will help, but compacted surfaces may have to be loosened before revegetation can be successful.

4.2.6.2 Revegetation

The most effective method of achieving surface stabilization, reducing wind erosion, and promoting soil conservation is to establish a network of plant roots. Under optimal climatic and soil conditions, natural revegetation may be possible within a short period of time, but these conditions are rare in Alberta. As there appear to be no serious problems with toxicity in the province, revegetation through artificial means should be undertaken as soon as the site has been prepared and the topsoil replaced. Any delay will result in the fine soil particles being eroded downhill, into the soil profile, or wind blown.

The type and method of revegetation depends upon conditions at each stie and upon the projected land use. Because of lack of information about the range of conditions which may be experienced at each site, research and organizational plant trials are advisable soon after mining operations commence. Good early results in mountain areas of Alberta have been achieved by using a mix of the following grasses: creeping red fescue, crested wheatgrass, timothy, brome and Kentucky blue grass. The species used should be suitable for achieving the projected land-use and should have as many of the following characteristics as possible:

a) native or naturalized species;
b) ability to regenerate naturally on industrially disturbed land or in severe natural habitats;
c) proven effective in reclamation work elsewhere;
d) readily reproducible in large quantities by natural or artificial means;
e) low water and nutrient requirements;
f) high rate of root dry matter production; and
g) nitrogen-fixing ability.

Trials should yield information on species performance, possible species combinations and the best timing and density of seeding and planting. Mulches may be applied to increase the water-holding capacity of the surface and improve its chemical properties, such as pH and nutrient status, to reduce wind and water erosion and to moderate soil temperature extremes. Irrigation may be feasible at some sites in the Plains, especially where the land is to be reclaimed for arable production. Fertilizers will, in many cases, aid in the rapid development of a plant cover.

The method of revegetation - hand planting, hand seeding, agricultural seeding, hydro-seeding, aerial seeding, etc. can be varied to suit the circumstances.

4.3 REGIONAL ASPECTS OF RESOURCE CONFLICTS

4.3.1 Mountains

The Rocky Mountains are part of the Canadian heritage, and any industrial development will meet with considerable opposition despite the fact that large areas are protected within Banff, Jasper and Waterton Lakes National Parks. Special considerations are advisable in sensitive areas with demonstrably high resource values. Inviolate buffer zones adjacent to parks, particularly in heavy use transportation corridors, would reduce conflicts. In the alpine tundra, short growing seasons, severe climatic and edaphic conditions and rugged topography have created extremely delicate ecosystems which are difficult or impossible to restore. Even if the area actually disturbed is quite small, the effect may be significant in the Mountains. For example, the continued existence of bighorn sheep and mountain goats depends upon the protection of key winter ranges.

Together with the Foothills region, the Mountains provide about 87 percent of the annual flow through the Saskatchewan River system and make significant contributions to the Arctic rivers. The four surface mines currently operating in Mountain watersheds do not have a significant effect on water quality, although local streams may suffer some damage. However, extensive exploration activity and future mine developments must be carefully regarded.

4.3.2 Foothills

The Forestry Trunk Road and numerous access roads, including those of the mining industry, have made this region extremely valuable for recreation. Opportunities for hunting and fishing are excellent. Each year, many thousands of Albertans enjoy camping, hiking and driving through the Forest Reserve. As recreational use increases, the impact of any mining operations will become more significant. At present, there are only two surface coal mines operating in the Foothills, and so the impact upon recreation over the region as a whole is very small.

Although wildlife is abundant throughout the Foothills, attempts should be made to provide alternative habitat whenever surface mining operations threaten ungulate winter range.

4.3.3 Plains

Land clearing, drainage of sloughs and potholes and overgrazing have severely depleted wildlife habitats which once supported large populations of ungulates and game birds. Wildlife habitats are now concentrated in river-break zones and in pockets of land unsuited to agriculture. Thus, any impact of mining on these areas will be exaggerated.

If properly reclaimed, lands disturbed by mining in the Plains region can be as productive as before or put to an even higher use.

PART 5

IMPACT APPRAISAL

5.1 A NEED FOR APPRAISAL

A problem with surface mining is that the costs it imposes on others do not appear in the internal accounts of the mining company. Thus, a rational decision about the profitability of mining a particular deposit may lead to a socially undesirable result and a net loss to Alberta.

Protection of public welfare may require intervention in the market process to ensure that external costs are considered. The goal of such intervention should be the maximization of net social benefits.

5.2 BROAD COMPARISON OF BENEFITS AND COSTS

It is useful to make a distinction between values which normally occur within an accounting framework, direct benefits and costs, and those which do not, indirect benefits and costs.

5.2.1 Direct Benefits and Costs

Direct benefits to Alberta are payments to the factors of production - land, labour and capital. Royalties are paid to landowners, including the Crown, wages to labour and profits to capital. Taxes are included in the gross returns to labour and capital and cannot be considered as additional benefits.

These payments must be made to Alberta's factors of production to be counted as benefits. If out-of-province labour is employed and sends money out of Alberta, then payments to that labour do not benefit Alberta. To the extent that profits are sent out of Alberta, payments to non-resident capital do not constitute benefits to Alberta. However, any taxes collected before these monies leave the province can be considered as benefits.

Land labour and capital are scarce resources and thus their use in any given activity forecloses their use in any other activity. When these resources are being put to their highest use in the economy, they are earning their highest possible returns or incomes. The second highest or next-best earnings for resources are known as their "opportunity-costs". Thus the direct costs of using land, labour and capital for coal mining are the opportunity costs, or earnings they could command in an alternative use.

The direct cost of using land for the removal of coal is its opportunity cost, namely the amount that would be returned to it if it were used for grazing, cereal production, forestry, etc. Another direct cost is the depreciation in land value during and subsequent to the mining operation.

In a healthy or normally productive economy, wages paid to labour and profits earned by capital will generally be equal to their opportunity costs: that is, these resources will earn little more from their use in surface coal mining than they would in any other business activity in Alberta. In general, unless the mining company proposes to use workers who would otherwise be unemployed, direct costs of labour and capital will be equal to the payments made to them. The fact that there is a certain level of unemployment at any given time does not mean that the creation of new jobs in surface coal mining is a direct benefit. We must be sure that the surface mine employs people from Alberta who actually would otherwise be unemployed and does not simply attract workers from other areas.

The creation of jobs in surface coal mining may be considered a direct benefit to Alberta under certain circumstances. This would be the case if:

a) The government endorses and pursues a policy of economic growth and wishes to increase the population and labour force in Alberta,

b) The government wishes to encourage and promote economic growth in certain regions of the province and this can be done through surface coal mining development,

c) The government wishes to broaden and diversify the economic base of the province so that the economy is less sensitive to changes in any one section. However, coal mining already exists as an underground operation.

We cannot judge in advance the extent to which the government of Alberta may be committed to such goals. To the extent that they are, however, they should still be satisfied that using resources of labour and capital in coal mining will meet these goals more adequately than using the same resources for any other activity.

Similarly, the basic surface mining activity may stimulate spending in other sectors of the Alberta economy, in a "multiplier" or secondary effect. This activity should not be counted as a direct benefit per se, however, for if the resources used in surface coal mining had been used in other productive activity in Alberta, secondary activity would probably be just as great. Thus, the creation of secondary economic activity should not be measured as a benefit that would only come from coal surface mining -- such activity would probably follow from the use of labour and capital if alternative uses exist in Alberta.

If wages paid to labour and the profits earned by capital in surface coal mining are higher than could be earned in any other form of activity, the factors are said to earn economic rent, the difference between the actual return to the factor and its opportunity cost. Generally, the only factor to earn economic rent will be land. Rent accruing to landowners, including the Crown, can be calculated by subtracting the opportunity cost of the land and depreciation in land value from royalties received from surface mining operations.

5.2.2 Indirect Benefits and Costs

The only indirect benefit of importance is the provision of access to areas which were previously inaccessible. If a mine operates in an area already serviced with roads, or if mine roads do not make a significant contribution to access, then the indirect benefits do not occur. Improved access, moreover, does not always constitute a benefit.

Indirect costs result from all the side effects of surface mining operations described in Part 4.

5.3 APPRAISAL MECHANISMS

Although we can make broad comparisons between the benefits of surface coal mining in Alberta and the projected environmental consequences, we need a mechanism to judge the social desirability of any particular surface mine and to indicate the extent to which side effects should be mitigated.

5.3.1 Benefit-Cost Analysis

Benefit-cost analysis was developed, initially in river basin analysis, to appraise the efficiency of public investment projects. Given specific objectives -- i.e. flood protection and power production -- benefit-cost analysis was useful in providing choices as to the most efficient means of meeting these objectives, choosing the optimal size for given projects and in ensuring the optimal allocation of scarce financial resources among competing choices.

The analysis is really very simple. It simply provides for the logical ordering of all benefits and costs to determine "total" project feasibility. Early analyses tended to overlook ecological, recreational and aesthetic values, but these are now being taken into account.

5.3.2 Assessment of Values

In order to apply the benefit-cost analysis in an objective manner, one must be able to assess all benefits and costs in quantitative terms.

Royalties, wages and profits are relatively simple values to measure. The value of any improvement in access to commercial development may be assessed, but to assess its value for recreational pursuits is difficult. The benefits of government policies, such as regional growth and provision of employment are likewise difficult to assess.

The opportunity costs of land, labour and capital can be assessed, as can depreciation in private land values. Depreciation in Crown land values is much more difficult to calculate because there is not, typically, an open market for Crown land. This should not be allowed to distort the decision-making framework, however, because much of the value of Crown land finds its expression in the value residents place on it for recreation.

Some of the costs resulting from such side effects of surface mining can be calculated by looking at market prices of related commodities. Others can be calculated by using indirect techniques which simulate market prices, but there remain some costs which cannot be calculated at all.

Reduced water quality may force downstream users to install costly water treatment facilities. The premature silting-up of dams can also be assessed quantitatively. Sedimentation impairs the storm-carrying capacity of streams.

The costs of increased flood damage -- destruction of crops, livestock and infrastructure and resulting reduction in land values -- should be charged to the surface mining operation. However, flood damage, landslides and damage to property caused by wind-borne dust are costs which are directly measurable only after the fact. This should not prevent their inclusion in the analysis: the potential for damage should be considered as a cost.

Other costs do not find expression in market values, but values can be calculated using indirect techniques. Recreation opportunities lost or impaired fall into this category. These costs can be calculated by recently developed economic techniques which place a monetary value on unpriced recreation. Certain ecological losses may find expression in a reduction in fees collected for hunting and fishing.

The depreciation in scenic values occasioned by a surface coal mining operation is not amendable to calculation either through substitute market values or indirect methods of evaluation. Inherent in any reclamation standards, however, is an implicit assessment of the minimum value of, among other things, scenery. Requiring a mining firm to conform to certain regulations on grading and revegetation of a mine area upon cessation of mining activities implies that the restoration of the area to some aesthetic level is worth at least the price of the restoration work. Thus, to set a minimum dollar value on scenery it is necessary only that some ameliorative standards be imposed. This does not, however, apply during the life of the operation unless screening is effective.

There are further costs which do not lend themselves to any sort of evaluation. The loss in aesthetic values from surface mining in unspoiled natural environments or in the Rocky Mountains cannot be given any realistic value.

5.3.3 Decision Making

In considering individual surface mining operations, all benefits and costs attributable thereto must be weighed to determine the desirability of proceeding with the development. Benefits must exceed costs or the factors of production are poorly allocated. If benefits are just equal to costs, the factors of production are only earning what they could earn in alternative investments.

Because of the impossibility of quantifying certain important effects and the lack of precision in assessing other values, there is no clear-cut, mathematically objective method of comparing benefits and costs. What must be done is to make a subjective decision as to whether or not the social costs and risks are offset by the benefits. Benefit-cost analysis does not make this decision: it only provides some guidance and orders things logically. Once all of the measurable effects have been taken into account, the onus is still with the public administrator to judge whether or not the benefits also justify the immeasurable costs.

When weighing benefits and costs, he must also consider the possibility of remedial and restorative procedures and their effect on the balance. Many costs can be reduced or eliminated by applying techniques which cost less than the benefits achieved.

If there is no method of preventing undesirable social costs and these costs cannot be tolerated -- for example, extensive damage to the headwaters of the Saskatchewan River system -- then there is no alternative but to prohibit that particular operation.

5.4 RESPONSIBILITY FOR REMEDIAL MEASURES

Whenever benefits exceed costs, those who gain from the surface mining operation can afford to compensate those who lose from it. The mining company can afford to pay for remedial measures up until that point where profits are reduced to less than could be achieved in alternative investments. It should be remembered, however, that any money spent on remedial measures cannot be spent on hospitals, schools, etc.

Beyond this point of profitability, the company has three courses of action, viz. -- to increase the efficiency of its operations, to close down or to seek a reduction in royalty payments or environmental standards. The last alternative is unacceptable unless the social benefits of the operation exceed social costs, such as might occur when subsidizing an operation to maintain employment in a rural community. If the mining company cannot operate in a situation where reclamation is necessary to balance benefits and costs, it must increase the effeciency of its operations or not operate at all.

PART 6

THE ACCEPTABILITY OF SURFACE MINING AND ASSOCIATED ACTIVITIES

6.1 BASIS FOR GUIDELINES

On a province-wide basis the area covered by operating surface coal mines is relatively insignificant. There are four surface mines in the Mountains, two in the Foothills and eighteen in the Plains. They cover estimated areas of 2, 3, and 4 square miles respectively out of a total of 248,800 for the province.

The justification for government guidance or control then lies less within total acreages than the potential significance of impact. Even a small area of disturbance will be of vital importance if bighorn sheep or Rocky Mountain goat herds are destroyed. The future intensification of watershed management in the Mountains and Foothills of Alberta will alone demand that no industrial operation be allowed to jeopardize the water resource.

The geographical extent of exploration activity is much greater than the area of actual mine disturbance. Cumulative effects will be far-reaching and of greater consequence if current exploration levels and methods are maintained or increased.

Control of surface coal mining, exploration, road building and the construction and operation of coal treatment plants and thermal electric power stations is required to ensure against irretrievable loss of vital environmental and resource values. Objectives should be the assessment of resource values that could be impaired or enhanced, the minimizing of resource use conflicts and the maximizing of benefits.

The following sections outline an optimal approach. Some of the provisions suggested are already being implemented by government agencies, but they are mentioned here in order to give an overall picture of how the impact of surface coal mining and its associated activities may be controlled and minimized.

6.2 LAND USE DETERMINATION

Solutions to resource conflicts posed by surface mining must be based upon sound land use policies and a clearly defined system of land management zones. These zones should be delineated by considering physiographic and ecological boundaries and the needs of people.

Since coal bearing sections of the Plains Region are populated, regional planning bodies will be involved. Foothills and Mountain Regions are mostly Crown lands and subject to provincial and federal control.

Certain "best use" designations have already been made in all three Regions, some of which render areas "out of bounds" to coal mining exploitation. Parks and Wilderness Areas are examples of the latter category.

"Inviolate" areas should be listed in guidelines to industry, and projected land uses for other areas made known where specific allocations have been taken and/or the parameters of policies determined.

6.3 REGULATIONS AND GUIDELINES

All industrial activity should be authorized by land use permit. This applies equally to Crown and private land. Operations on private land can affect other property owners and the general public.

Applications for land use permits will be considered by a reviewing body which should operate in a flexible manner under broad powers accorded by law. Flexibility is essential when dealing with such a wide range of conditions and needs as are found throughout Alberta.

Dialogue should be instigated whenever a mining company expresses interest in an area. The company should be able to readily find out what regulations are applicable to that area. The government should have guidelines available on request to indicate to industry the rules for permit applications, indicate what effects must be prevented and suggest general approaches to prevention.

Conditions of operation should be generally outlined on the permit with other specific considerations added by existing statutes, to which reference should be made on the permit.

Alberta must develop statutes and regulations taking note of what has happened both in the U.S.A., Canada and elsewhere throughout the world but must avoid indiscriminate use of other laws.

It has been common practice to point to the very detailed statutes and regulations which have been developed over a period of many years in parts of the U.S.A. It is fallacious to say that, because these provisions have been adjusted several times over a period of years, they are the best per se. In fact, their evolution indicates that they have become adapted very specifically to local conditions, and those conditions are very different from those found in Alberta.

Certain federal statutes must be borne in mind.

1. Canada Water Act - this deals with inter-jurisdictional waters with respect to the quantity and quality of water flowing from Alberta to the north, to Saskatchewan and to the U.S.A. Reference is made to water quality standards, the quantity and type of water that may be discharged and the treatments required.

2. Clean Air Act - this deals with federal-provincial co-operation in formulating air quality objectives and standards.

3. Fisheries Act - Section 33(2) deals with knowingly permitting the passage of any deleterious substance (any substance which would degrade, alter or form part of a process of degradation, heat being included), into any water frequented by fish.

Some provincial statutes that may apply in specific instances are:

The Forest Reserves Act
The Coal Mines Regulation Act
The Fish and Wildlife Act
The Forest and Prairie Protection Act
The Forests Act
The Provincial Parks Act
The Public Health Act
The Public Lands Act

6.4 PERMIT APPLICATIONS

Permit applications should be accompanied by a management plan. This plan will describe:

a) the nature and extent of the industrial activity;

b) the environmental impact of that activity;

c) the measures to be taken to reduce that impact;

d) the projected land use after mining; and

e) the measures to be taken to acheive that land use.

The applicant should employ qualified personnel to prepare the plan and it should be based on adequate study.

When the permit application is received, the reviewing body should assess its feasibility and authenticity. The reviewing body should approve the application within a reasonable time, or notify the applicant in writing that it wishes to carry out or have carried out, a more detailed investigation, which may take up to six months.

Notice of intention to apply for a permit should be given in the Alberta Gazette and placed in a suitable newspaper at least two weeks before the application is submitted. This will allow members of the public and federal, provincial and municipal government agencies to make initial representations to the reviewing body.

If sufficient interest is generated by an application or resource conflicts appear highly significant, the reviewing body may instigate public hearings. Public hearings need not be held for every permit application.

Once industry, the public and other government agencies have made inputs, the reviewing body should render its decision. Terms and conditions would be attached to approved permits and the company and government formally agree to abide by them. The management plan should form part of the covenant.

It is important that dialogue be maintained at all stages of the permit application review. If certain portions of the management plan are unclear or unacceptable, government and industry should attempt to resolve the conflict without rejecting the permit application out of hand.

6.5 INSPECTION AND MONITORING

Regular and frequent inspections should be made to ensure that all operations are according to the management plan and the permit.

Certain monitoring programs should be in the covenant as company responsibility. Examples are:

a) a program of stream monitoring should begin before any operations are started and should be carried on throughout the life of the mine;
b) trials should be carried out as soon as possible after operations have begun to ensure that revegetation proposals are satisfactory.

Inspectors should take note of the progress and results of those trials, the data from stream monitoring, and any unforeseen problems. If unforeseen circumstances necessitate any deviation from the management plan, the changes must be approved by the reviewing body under the same conditions for considering initial permit applications.

Performance bonds may be considered in order to ensure that the provisions of the management plan and covenant are implemented. These bonds should be subject to the following considerations:

a) the total acreage to be disturbed;

b) annual re-assessment considering the acreage of new disturbance and and acreage satisfactorily reclaimed;

c) the value or amount should be greater than the estimated cost of reclamation and should take into account the general inflation in the economy.

The permit would be subject to suspension and/or cancellation if conditions were not satisfied. Security of tenure should be ensured, but the right to operate made dependent upon implementing the management plan.

PART 7

RECOMMENDATIONS FOR FURTHER STUDY

7.1 SUBJECT AREAS

The following subject areas are recommended for further study:

1. Primary Statistics - A program of regular accumulation of statistics that describe the number, extent, and impact of operating mines and associated activities is required. Exploration should be monitored in the same way, and the information made public.

2. Reclamation - Although the individual mining companies will be required to carry out research and organizational trials, it will be necessary to co-ordinate reclamation research to avoid wasteful duplication of effort and to develop a fund of reclamation knowledge for Alberta. Attention should be given to obtaining reasonable estimates for reclamation costs.

   All of this information should be made available in the form of a reclamation handbook.

3. Water Quality - The physical and chemical parameters of natural streams should be monitored over time to obtain quantitative estimates of the effects of surface mining and to set water quality standards.

   The ecological effects of cooling water and eutrophication resulting from large fertilizer applications during reclamation should be studied to determine their application under the Alberta conditions.

4. Watersheds - Studies of surficial geology and topography should be undertaken to delimit these watersheds which are extremely susceptible to damage by any industrial activity.

   At the same time, research should be carried out to develop remedial and restorative measures and methods of mining which would allow these susceptible areas to be mined without danger.

   Standards should be set for the construction of exploration and haul roads.

5. Wildlife - Key winter ranges, migration routes and stop-over points should be delineated.

   Research is necessary to develop methods of providing alternative facilities when such habitat is endangered by a surface mining operation.

6. Screening - Methods of screening mining operations should be investigated in order to maintain or improve scenic values and reduce noise levels.

7. Economic Studies - Information on the assessment of side effects should be gathered on a continuing basis. This would include a file on case studies, especially those pertaining to Alberta. This file would then provide up-to-date information which should be considered whenever decisions on surface mining are being made.

   More basic information is required in order to determine the benefits of surface mining to the people of Alberta.