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VOLUME I

HOSMER-WHEELER COAL PROJECT

STAGE II ENVIRONMENTAL ASSESSMENT

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ASSESSMENT REP

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HOSMER-WHEELER COAL PROJECT

STAGE II ENVIRONMENTAL ASSESSMENT

October 1976

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GEOLOGICAL BRANCH
ASSESSMENT REPORT

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SUMMARY

DEVELOPMENT

This report contains a detailed environmental assessment of the proposed Hosmer-Wheeler development program, fulfilling Stage II criteria outlined in the "Guidelines for Coal Development" of the Environmental and Land Use Committee (1976).

Kaiser Coal of Canada Ltd. proposes to develop an underground hydraulic coal mine and surface processing plant in south-eastern British Columbia. The mine will be located on the Hosmer-Wheeler coal property in the Elk River valley just north of the community of Hosmer between the village of Sparwood and the town of Fernie.

The mining plan involves the extraction of 60 million tons of raw coal over a 20 year period to yield an estimated 2.2 million tons of clean coal per year which will be shipped by rail to Roberts Bank for export.

The mine will consist of the following surface facilities: portals, ventilation shafts and fan sites, water head tank and pumping station, processing plant, tailings dam and pond, railway loop, water intake and road system to service the facilities.

Access to the coal will be by twin 10,000 ft long rock tunnels from the valley bottom at 3350 ft elevation up to the coal seams at about 4460 ft elevation.

Coal will be mined hydraulicly using high pressure water and the resulting slurry will be flumed to the processing plant.

In the processing plant the coal will be separated from water and waste materials by a series of cyclones, centrifuges and filters; waste materials will be disposed of in the tailings pond.

The processing system will utilize a closed water system; process water will be clarified and re-used. A water intake on the Elk River will provide start-up and make-up water. Domestic sewage will be treated before discharging to the tailings pond.

Kaiser Resources are committed to rehabilitation of their disturbed lands. They have six years experience and have developed extensive reclamation expertise.

Exploration areas on the Hosmer-Wheeler site have been reclaimed as part of an ongoing program.

Final reclamation of the mine and plant areas will be carried out at project completion. Short term revegetation and reclamation programs will be instituted as required during mine construction and operation.

ENVIRONMENTAL DATA

The Cretaceous Blairmore Geologic Formation caps Hosmer-Wheeler Ridge and is underlain by the coal bearing Cretaceous Kootenay Formation. The underlying Jurossic Fernie Formation does not outcrop in the mine area.

The Elk River Valley has been glaciated. River cut fluvial terraces characterize the valley bottom. The valley sides are bedrock controlled consisting of rolling to moderately steep till covered lower slopes and steep to very steep upper slopes of veneer colluvium.

The climate of the Elk River Valley is characterized by hot summers with sporadic rain shower activity and mild to severe winters with heavy snowfall at higher elevations.

The air quality at the proposed mine site is good averaging 27 $\mu g/m^3$ suspended particulate and 9.2 tons/mile^2/month dustfall. Air quality was poorer along Highway 3 and in the community of Hosmer.

The development area is drained into the Elk River by a small stream known locally as No-name Creek. This creek and its tributaries are characterized by steep gradients on the slopes of Hosmer-Wheeler Ridge and low gradients in the valley bottom.

The physical characteristics are described for seven reaches of No-name Creek, tributaries K2 and K4 and the beaver pond areas below Highway 3. Stream substrait varies from gravel and rocks in the uplands to silt and gravel in the lowlands.

Extremes of flow were recorded for No-name Creek near the development site of over 30 cfs (May) and 3 cfs (September); actual peak flow may be 1-2 times the recorded peak.

Subsurface flow was found to contribute extensively to the combined discharge of No-name Creek and other discharges to the Elk River.

Surface waters were sampled at 19 sites. Seasonal variations in the surface water quality characteristics of Transmission Line Creek, No-name Creek, K2 and K4 Creeks and the Elk River showed normal patterns.

Groundwaters were sampled from four drilled wells on the development area and five nearby domestic wells. Dissolved minerals were higher than in surface waters.

Dissolved metal concentrations in leachate from adit coal samples were all lower than PCB Level A objectives for mine discharges.

Five species of fish were observed in No-name Creek: cutthroat trout, Dolly Varden char, eastern brook trout, longnose dace and longnose suckers.

No-name Creek has excellent spawning and rearing habitats for eastern brook trout and cutthroat trout. Eastern brook trout are most numerous and appear to utilize all lower reaches of No-name Creek. Cutthroat trout appear to be limited to the upper reaches of No-name Creek.

Land forms and surficial materials were mapped for the general area; soils were mapped for the development and immediately adjacent areas.

Six soil mapping units are described for the lowland areas. Orthic Regosols, Orthic Eutric and Degraded Eutric Brunisols were found developed on a fluvial sand and silt capping over very coarse stony gravels. Rego Gleysols were found in wetter areas.

Ten soil mapping units were described for the upland areas. Orthic, Degraded and Lithic Eutric Brunisols have developed on till materials. Soils on shallow colluvium included Degraded and Lithic Dystric Brunisols while Orthic Humo-Ferric Podzols have developed on deep colluvium.

The lowland areas fall within the Douglas fir biogeoclimatic zone; areas above 4500 ft (1372 m) fall in the Engelmann spruce-subalpine fir biogeoclimatic zone.

In the lowland areas twelve vegetation types are described for six vegetation map units. Vegetation ranges from meadow through deciduous mixed and coniferous forests.

In the upland areas eight vegetation map units are described ranging from hillside meadow through young low elevation forests and mid- and high elevation forests.

No rare or endangered vegetation communities or plant species were identified on the study area.

Elk are the most important wildlife species in the area. Other ungulate species present include white-tailed deer, mule deer and moose.

The study area provides summer ungulate range. Lowland areas are particularly important as elk winter range.

Furbearers observed in the area include black bear, coyote, beaver and muskrat. Felids and mustelids were not observed although they are likely to occur.

Columbian ground squirrels were the most evident small mammal on the study area.

Ruffed grouse were the most common upland game bird on the study area; spruce grouse and blue grouse were also present but in lower numbers.

An active osprey nest is present along the Elk River just north of the community of Hosmer. No substantial habitat exists for waterfowl. Good populations of songbirds were found in the lowland areas.

No rare or endangered wildlife species are likely to be present on the development area.

Most of the development area is owned by Crows Nest Industries (CNI). Upland mine facilities will be located on Parcel 69 held by the Province.

Present land use in the lowland include Highway 3, a B.C. Hydro Power line, the Canadian Pacific Railway and immature productive woodlands, open grasslands, open wetlands and cropland-pasture complexes as mapped by Canada Land Inventory (CLI).

Lower slopes are mostly immature productive woodland and non-productive woodland on productive sites. Mid-slope areas are mapped as mature productive woodland while the upper slopes are mature productive woodland and non-productive woodland on non-productive sites (CLI).

The development area lowland lies within the Agricultural Land Reserve. The development area is grazed as part of a CNI grazing lease. Soils are mapped by CLI as a complex of Class 4 and 5 soils. No agricultural use is made of the upland areas.

Most of the lowland areas have been mapped by CLI as Class 3 and 4 for forestry. The lowland areas were logged at the turn of the century and are now mainly in young forest; some of the better stands have been recently logged by CNI.

Low and mid-elevation upland areas have been mapped by CLI as Class 2 to 5 forest capability. Much of the low elevation forest has been logged or burned; logging by CNI has recently commenced in mid-elevation older forests. High elevation forest capability is generally low.

The study area lowland is rated by CLI as Class 4 land capability for outdoor recreation. The study area provides good opportunities for hunting, angling, camping, canoeing and nature study.

The Elk Valley Provincial Park with a small rest stop is located in a beautiful setting directly across the highway from the development area.

The study area lies within Management Unit 4-23 of the Kootenay Region. Use of the study area by hunters has not been documented.

The Elk River, No-name Creek and the beaver ponds are fished; fighing use has not been documented.

The development area is trapped by permit from CNI.

Two historic sites were identified; Site DjPrH1, a three building logging camp complex of high archaeological value and Site DjPrH2, a log loading ramp of medium archaeological value.

IMPACTS AND MITIGATIONS

An environmental impact matrix was prepared as a checklist for environmental impacts.

The present Elk Valley Site was chosen as superior to the alternative Michel Creek Site.

At the Elk Valley Site, there are no alternative locations for the mine, plant site or railway loop. Two alternatives to the present tailings pond were rejected as they would have had serious impacts on No-name Creek.

Air emission sources include: the drier scrubber exhaust, the drier feed conveyor dust collection equipment exhaust, the load-out and silo transfer conveyor dust collection system exhaust and the dust vacuum system on the roof of the silo. Emission from these sources have been designed to meet B.C. Level A objectives.

Suspended particulate levels and dustfall levels at the plant site will probably not exceed federal objectives. Further wind data will permit more accurate predictions.

Exploration activities thus far appear to have had little effect on surface water quality. Present logging activities appear to be contributing much greater quantities of sediment to surface waters than coal exploration.

Relatively little contamination of surface water will occur during construction and operation of the mine. Sedimentation of No-name Creek could interfere with fish spawning and invertebrate productivity.

Unnecessary road building and heavy equipment use, particularly in fine soils, should be minimized; erodable surfaces should be stabilized and revegetated.

Water used in mining will be recirculated through the system; losses will be minimal but will include seepage and evaporation from the tailings pond.

Run-off from the plant site will be diverted via a surface retention pond to the tailings pond.

Few chemical surface water contaminants will be present during construction and operation. Supplies of absorbent materials should be maintained for cleanup of minor fuel spills.

Flotation agents and flocculents used in coal processing will remain with the clean coal or be discharged to the tailings pond.

Sewage discharge to the tailings pond will need existing government standards for sewage disposal to tailings ponds.

Seepage loss from the tailings pond is not expected to cause deterioration of groundwater quality.

Regular monitoring of wells downslope from the tailings pond is recommended to ensure groundwater remains potable.

Increased groundwater discharge to the beaver ponds and No-name Creek if it occurs will merely increase surface water flow in these areas.

The tailings pond and rail loop which lie near No-name Creek are not expected to affect trout spawning in these areas. Stream crossings should be minimized; No-name Creek should not be confined.

The water intake system will have minimum impact on Elk River fish habitat.

The major soil impact will be caused by the tailings dam and pond (121.4 ha).

It is not recommended that topsoil from the tailings dam and pond be conserved expressly for reclamation of the tailings dam and pond.

The railway loop (76.9 ha) impact on soils will be considerably lower as only soils on the right of way will be disturbed. Topsoil should be stripped and used to reclaim the ditches and embankment slopes.

No serious soil impacts are anticipated for the plant site (46.5 ha). Topsoil should be stripped and used to landscape the plant site area.

No serious soil impacts will occur for the lowland road network. Topsoil should be stripped and used to reclaim the ditches and borrow areas.

Minimal soil impact will occur due to water pipeline construction. Topsoil over the ditch should be stripped and replaced.

Portal 52, fan sites and the water head tank and pumping station will occur in shallow colluvium. Serious soil impacts are possible; mitigation procedures are suggested.

Portal 202 will occur in deeper colluvium. Serious soil instability and impacts are possible; additional on site engineering studies are recommended for this area.

Impact of upland road network construction will be low; existing exploration will be upgraded.

209 ha of lowland vegetation and 9 ha of upland vegetation will be directly affected by the development.

No vegetation map unit was found to be so valuable or ecologically sensitive as to warrant avoidance or special treatment.

Vegetation will be cleared to make way for the upland facilities, plant site, tailings dam and pond, rail loop, pipeline and road network. Additional clearing may be required for access, visibility and fire suppression.

Upland exploration roads have been built to minimize vegetation impacts; all merchantable timber has been salvaged.

Disturbance to vegetation should be minimized where possible. Vegetation screens should be left to conceal plant facilities from highway travellers.

Clearing for the tailings pond should be progressive and only as necessitated by dam expansion. Retention of the screening vegetation between the railroad and the highway is extremely important.

Mine development will affect wildlife in two ways: habitat will be removed through clearing, and the physical presence of the mine will alienate additional habitat thus reducing the wildlife carrying capacity of the area.

Mine impact on ungulate summer range will be low. In severe winters, loss of elk winter range could reduce winter elk survival and the general carrying capacity of the area for elk.

The carrying capacity of the area will be reduced for black bear and perhaps cause reduction in black bear populations.

The effect of the development on felids, canids and mustelids is not known. Little effect is expected on aquatic rodents.

Mine development will cause loss of habitat and reduce populations of small mammals in the mine area.

Ruffed grouse habitat will be reduced; little impact will occur in spruce grouse or blue grouse habitat.

The effect of the development on raptors is expected to be low; the osprey nest along the Elk River should not be affected.

The importance of impact on small birds will be low. The effect on waterfowl will be minimal.

Impact of the development on present land use will be low; some lands now under forest production and grazing will be alienated.

The plant site, tailings pond, rail loop and buffer zone will occupy Class 2, 4 and 5 agricultural lands (CLI). Development areas within the Agricultural Land Reserve will require exemption from the Reserve.

Forest cover will be removed on much of the development area to make way for the facilities. Class 1 to 4 lands for forestry (CLI) will be affected in the lowlands while Class 2 to 5 lands for forestry will be affected by the upland developments.

The major impact of the development on recreation will be the aesthetic detraction of the planned facilities. The tailings dam, loading silos and main portals will be visible to Highway 3 travellers. Immediate planting of vegetation screens to hide facilities is recommended.

Noise and dust impacts of mine development and operation are not expected to be high.

The impact of the development on the Elk Valley Provincial Park can be reduced by immediate screen plantings to hide the proposed tailings dam and railway loop from the picnic rest stop. No changes in park use patterns are anticipated due to the development.

A no-shooting zone should be established around the development site. It was not possible to estimate the number of hunting days, kill or hunting revenue which will be lost due to the development.

Impacts of the development on angling will be minor.

It was recommended by the Archaeological Sites Advisory Board that the two archaeological sites near the development area not be destroyed and that their construction be documented. It is suggested that Kaiser follow the first recommendation.

Deep lowland soils have a high reclamation potential and are most suitable for stockpiling; shallower soils have lower potential.

Upland soils are often difficult to save due to adverse topography but have moderate to high reclamation potential.

On site decisions during soil removal will be required to determine if topsoil depth and quality are sufficient for stripping and salvage.

Reclamation of the development will take place after project completion. After reclamation, land capabilities of the tailings dam will be greatly reduced while tailings pond land capabilities are expected to generally improve. Plant site and railway loop land capabilities may be reduced slightly after reclamation.

Reclamation of sites similar to upland areas of this project has already been accomplished by Kaiser. Fresh slopes should be reclaimed immediately and topsoils salvaged if possible.

RECOMMENDATIONS

Further studies are not recommended for hydrology, fisheries, soils, vegetation, wildlife or human use. However, it is recommended that monitoring studies continue on air and water quality.

INTRODUCTION

OBJECTIVES

The objectives of the Stage 2 Environmental Assessment for the proposed Hosmer-Wheeler Development Program are:

- to describe the proposed development program.
- to describe the biophysical resource base within the area that may be affected by the proposed development.
- to make a site specific analysis of impacts on the natural environment.
- to recommend procedures to avoid impacts.
- to recommend measures for mitigation of unavoidable impacts.

BACKGROUND

In June, 1974 an agreement was entered into between Kaiser Resources Limited, Mitsui Mining Company and Mitsubishi Corporation whereby the participants would jointly conduct a coal exploration and mine feasibility study program on the Hosmer-Wheeler coal property in south east British Columbia. The property is located in the Elk River valley about nine miles south of the village of Sparwood and about 10 miles north of the town of Fernie (Figure 1). The small community of Hosmer is located about two miles south of the proposed development (Figure 2). The area is directly adjacent to Highway Number 3 and the Canadian Pacific Railway mainline.

The study area considered in this study includes the development area and extends west to the Elk River south to the town of Hosmer and north to Olson Crossing (Figure 2). It includes the water sheds of the three small streams on the west side of Hosmer Ridge which drain the development area.

The coal reserves lie above 5000 ft on Hosmer Ridge. Geological mining reserves are estimated at 49,035,000 tons of which 38,904,000 will be recoverable. Access to the coal seams will be through two long tunnels beginning at the 3500 ft level. Coal extraction will be hydraulic and similar to that used in the Balmar South

Hydraulic Mine at Sparwood. A surface preparation plant will process the coal. Processed coal will be shipped to the coast by rail. Production is estimated at 2,200,000 tons of clean coal per year.

Land disturbance will be primarily associated with the coal processing and transportation facilities since all mining will be underground. The major land area affected will be in the valley bottom and will include the tailings dam and pond (300 acres), plant site (115 acres) and the railway loop (190 acres). Additional surface disturbances associated with the mine will be caused by the construction and operation of the portals, ventilation shafts, fan sites, the water head tank and pumping station, and a road system to service these facilities.

Construction is scheduled to begin immediately upon project approval and production will commence approximately 36 months later. The expected life of the mine is 20 to 25 years.

This report is a detailed environmental assessment of the Hosmer-Wheeler development program, fulfilling the Stage 2 criteria outlined in the Guidelines for Coal Development (Environment and Land Use Committee [ELUC], 1976).

PERSONNEL

This study was undertaken in the Division of Applied Biology, by the Terrestrial Ecology Group headed by Mr. I.V.F. Allen. Mr. A. Bruynesteyn was project manager. The environmental data components were assembled, analyzed and reported by Ms. C. Jones (Human Use), Mr. R.A. McLachlin (Vegetation), Mr. C. Schmidt (Wildlife), Mr. H. Slavinsky (Soils) and Mr. M. Zallen (Aquatic). Technical assistance was provided by Mr. M. Blazecka, Mr. K. Chatel, Mr. G. Longworth, Mr. S. Parmar, Mr. B. Pridmore and Mr. D. Watt. Dr. J.C. Errington reviewed the section on reclamation.

Water quality assessment was undertaken by the Water Quality Group headed by Dr. J.M. Leach.

Analyses were done by Mr. L.T.K. Chung, Mr. H. Hori, Ms. H.E.T. Kurtz, Ms. M. Lewis, Ms. J.D. Mackey, Mr. E.T. Marsh, Mr. H.P. Meier and Mr. H. Stutz under the supervision of Mr. H. Lanz.

The air quality assessment was by Mr. R. Serenius of the Division of Applied Chemistry.

Technical editing was done by Mr. B.J. Clarke. Mr. F. Phillips and Mr. R. Allen provided drafting services and Ms. C. Prang and Ms. C. McKinnon typed the manuscript.

ACKNOWLEDGEMENTS

B.C. Research wishes to extend their thanks to the following contributers to this report:

1. Mr. A. Milligan of Kaiser Resources, Environmental Services, Sparwood, B.C. for the section on reclamation.
2. Crows Nest Industries Ltd., Fernie, B.C. for their kind permission to use their Forestry Inventory Map of the Hosmer-Wheeler area (Figure 70).
3. Western Botanical Services Ltd., Vancouver for identification of some sedges, bryophytes and lichens.
4. R.M. Hardy and Associates Ltd., Calgary, Alberta for their report Hydrogeological Investigations; Hosmer-Wheeler Project, British Columbia (Appendix A).
5. Archaeological Sites Advisory Board for their report Heritage Resource Assessment of the Proposed Hosmer-Wheeler Coal Development (Appendix B).
6. L.W. Pommen, Water Resources Service for water quality results from Elk River sites.

METHODS

ATMOSPHERIC STUDIES

CLIMATE

Data on the climate for the Hosmer-Wheeler area were obtained from four sources:

(1) Atlas of Canada (1957). Department of Mines and Technical Surveys, Geographical Branch.

(2) Climate of British Columbia (Annual reports 1965-1974). British Columbia Department of Agriculture.

(3) Weather station installed at Hosmer in April, 1976.

(4) Weather station in Sparwood, 1971-1974.

The types of data available from the four sources are tabulated below:

Type of Data Provided	Source			
	1	2	3	4
Wind direction	x		x	
Wind speed			x	
Solar radiation	x			
Temperature*	x	x	x	x
Precipitation	x	x		x
Relative humidity	x		x	

*With the exception of atmospheric temperature gradient data

AIR QUALITY

Evaluation of air quality is based on data which has been collected at four monitoring stations (Figure 3) since the spring of 1976. The types of data collected and the methods of collection were as follows.

Dustfall. Monthly averages obtained with conventional type dustfall jars.

Suspended particulate. About ten days of sampling in spring, summer, fall and winter for a total of about 40 sampling days per year. Standard type high volume air samplers were used.

Sulphation. Monthly averages were obtained by sulphation plates.

The placement of the air quality monitoring equipment is detailed in the table below.

Site Number	Location (See Figure 3)	Type of Equipment		
		Dustfall Jars	High Volume Samplers	Sulphation Plates
1	Hosmer	x	x	x
2	Proposed plant site	x	x	x
3	Approximately 3 miles NE of plant site (at bend in highway)	x	x	x
4	Approximately 1 mile NE of plant site	x		x

HYDROLOGY

Surface Water

Measurements of streamflow were obtained from Kaiser Resources Environmental Services Dept. In addition, B.C. Research took September streamflow measurements (Figure 4) using a Marsh-McBurney model 201 electronic current meter.

Groundwater

A hydrogeologic study of the groundwater conditions of the strata at depth in the development area was conducted by R.M. Hardy and Associates Ltd. Their report entitled "Hydrogeological Investigations: Hosmer-Wheeler Project, British Columbia" is Appendix A.

WATER QUALITY

Site Selection and Analytical Variables

Surface water sampling locations were situated to obtain baseline information on water quality upstream and downstream of the planned mining operations (Figure 3). The contributions of K2, K4 and K7 Creeks to No-name Creek were monitored by means of sampling sites upstream and downstream of the confluence points. Site KG, above Hosmer, was measured to register the full effect of potential mine drainage from K2, K4 and upper No-name Creek. The contribution of No-name Creek to Elk River water quality was assessed by the monitoring stations HW13 at the mouth of No-name Creek and HW14 and HW11 in the Elk River above and below the confluence with No-name Creek. Care was taken to insure that complete mixing of waters had occurred at site HW11. An upstream reference site, HW15 in the Elk River, was added in May, since the original reference site HW10 might be affected by seepage from the proposed tailings pond and coarse refuse pile.

Analyses for the standard variables, temperature, dissolved oxygen, solids, turbidity, alkalinity, hardness and conductance were done to characterize normal seasonal variations in water quality. Sulphate, TOC, dissolved heavy metals, phenols, ammonia and nitrate were measured to obtain baseline levels of constituents that might be leached into surface or groundwaters during mine development.

Volatile suspended solids analyses were initiated in June, 1976 as a means of indicating the presence of carbonaceous suspended material. Complete analyses of these variables were carried out on samples from key locations of the proposed operation.

Sample Collection

Surface water samples were collected in pre-rinsed plastic bottles from K2, K4, K7, No-name and Transmission Line Creeks and from the Elk River at sites shown in Figure 3. The creeks were sampled at mid-stream and Elk River samples were taken 20 ft from the east bank. Groundwater from drill holes G1-G4 (Figure 3) was obtained using a well sampler designed by B.C. Research to cause minimal disturbance of the subsurface water during sampling. Drinking water from groundwater sources was sampled from a standpipe in the campground in the Elk Valley Provincial Park and from four domestic supplies in Hosmer (HGW1-HGW4).

Samples were preserved in the field as follows: Phenolics; in 1-litre glass bottles containing 10 ml 10% copper sulphate solution and 2 ml 1:9 phosphoric acid. Metals: samples were filtered in the field through acid-washed 0.45 Millipore paper directly into two nitric acid-soaked 1-litre plastic bottles. In the first bottle the dissolved metals in the filtrate were preserved by addition of 1 ml concentrated AR hydrochloric acid. The second 1-litre samples was preserved for mercury analysis by the addition of concentrated sulphuric acid. Other constituents: 1-litre pre-rinsed plastic bottles with no preservatives added.

Water temperature and dissolved oxygen levels in the July survey were measured using a YSI Model 54 polarographic oxygen analyser. Field Winkler titrations were used for dissolved oxygen determinations in August. On-site pH measurements were made using IL Model 175 or Metrohm E488 portable pH meters.

Analysis

Samples were returned to the laboratory within 3 days of collection and were stored at 2°C until analyses were completed. Analytical procedures were based on methods outlined by the American Public Health Association (1975) and B.C. Water Resources (1973, 1976).

Total organic carbon (TOC) was measured using a Beckman Model 915A TOC analyser; pH was measured with a Radiometer Model 26 pH meter; turbidity was measured using a Hach 2100A turbidimeter.

Zinc, copper, lead and iron were determined after chelating with ammonium pyrhollidine dithiocarbamate, extracting the chelate into chloroform, evaporation of the solvent and digestion of the residue in concentrated nitric acid. The aqueous solution obtained on diluting the digest with de-ionized water was analysed by atomic absorption spectrophotometry (AAS) using a Perkin-Elmer Model 306 instrument equipped with deuterium background correction. Manganese and on occasions other heavy metals were analysed directly by flameless AAS using an HGA-70 or HGA-2100 graphite furnace. Mercury was determined by the cold vapour technique using a Pharmacia UV monitor. Arsenic was analysed by the Gutzeit method after pre-concentration onto ferric hydroxide floc, according to the procedures described by Thiel and Carpentier (1970). Sulphate was analysed turbidimetrically.

Reference water samples from the US Environmental Protection Agency and "round-robin" interlaboratory comparison samples from the Canada Centre for Inland Waters were analysed satisfactorily as a check on procedures.

Coal Leachate Analysis

Two pound coal samples from various coal seams were obtained from exploration adits on the Hosmer-Wheeler property. 100 g from each sample was weighed into acid-washed 1-litre plastic bottles. The samples were leached with 250 ml de-ionized water adjusted to pH 4 with nitric acid in a Gyratory shaker at $100^{o}F$ ($38^{o}C$) for 24 h and 48 h. The samples were then decanted, filtered and the pH adjusted to pH 2 with nitric acid. Dissolved metal concentrations in the filtrates were then determined by flameless AAS using a Perkin-Elmer Model 306 spectrophotometer equipped with a heated graphite atomizer HGA-2100.

FISHERIES

In addition to the preliminary survey of the area in October, 1975, a Fisheries assessment of No-name Creek was made in September, 1976. Physical habitat characteristics of No-name Creek and other drainages (Figure 5) in the area were assessed and stream reaches (homogeneous sections of watercourses) were mapped using stream survey forms (Appendix C).

Direct sampling for fish was carried out using live trapping, electroshocking, and limited gillnetting. Fish captured were identified and released following measurement of fork length and weight. Some specimens were autopsied to determine sexual maturity and stomach contents.

TERRESTRIAL STUDIES

SOILS

Soil and terrain mapping was carried out to determine the extent and distribution of the surficial materials and associated soils in the project area. Aerial photographs at a scale approximately 2 inches to the mile were used to delineate the boundaries of the terrain units. Approximately 75 soil sites were examined (Figure 6). The recent exploration activity and road construction in the study area provided good access and exposed numerous soil profiles which allowed for the accurate determination of the extent and variability of the mapping units; where exposures were not available, soil pits were dug by hand. Soil profiles were described and classified in accordance with "The System of Soil Classification for Canada" (CSSC, 1974). Terrain units were mapped using the "Terrain Classification System" (Environmental Land Use Committee [ELUC] May, 1976).

Soils were sampled on a horizon basis and retained for laboratory analysis. Selected chemical and physical analysis were conducted employing standard methods as outlined by Black (1965) and the US Department of Agriculture (1954). Chemical elements were determined using AAS.

VEGETATION

Vegetation studies were carried out from May 27 to June 1, July 5 to July 14 and August 31 to September 5, 1976. The vegetation of the study area (Figure 2) was mapped and described.

The study area was divided into two major vegetation categories: the lowland areas of the valley bottom along the Elk River and the upland areas of Hosmer Ridge. As the major surface development will occur in the lowland areas and since these areas have the greatest present human use and use capability, the lowland areas were mapped in greater detail than the upland areas.

Preliminary vegetation map units were determined during the May-June field trip. Map units were selected on the basis of air photo mapability, physiognomy, vegetation structure and species composition. Preliminary mapping was done on 1 inch to 20 chains (1:15840) black and white air photos; map units and maps were adjusted and modified during later field work when the vegetation analysis plots were completed. A total of 18 map units were distinguished for the study area.

Lowland map units were further subdivided where necessary into vegetation types. Vegetation types could not be distinguished easily on air photos but were distinguishable on the ground on the basis of physiognomy, vegetation structure and species composition.

A modified ELUC "plotless" sampling technique was used to describe the vegetation of the map units and the vegetation types. Boundaryless plots were analyzed using forms similar to Appendix D.

On each plot, elevation, slope, aspect, moisture regime, slope position and surface slope were recorded. Vegetation was described in terms of cover (Daubenmire, 1959) for each species and as a total for each of the five vegetation layers: trees, shrubs, forbs, grasses and sedges and rushes, and bryophytes and lichens. As well, on each plot tree height, diameter at breast height (dbh) and a core for age determination were taken from a representative tree of each tree species present. In addition, a prism measurement of tree basal area was taken on or near each forested plot; only trees of 5.2 inches (13 cm) dbh or greater were recorded.

Three representative plots were chosen in each map unit or vegetation type. A total of 60 plots (Figure 7) were described.

Representative plant specimens were collected and taken to B.C. Research for identification. Bryophytes, lichens, sedges and rushes collected on lowland plots were identified by Western Botanical Services.

WILDLIFE

The wildlife field program was carried out from May 27 to June 4 and from July 1 to July 8, 1976. Wildlife observations, tracks, droppings, evidence of browsing and other sign were recorded, both during wildlife surveys and during subsequent trips to the area by other B.C. Research field crews. Wildlife observations were referred to landmarks, transect lines, mammal traplines, water sample sites or mileages along the access road.

The main emphasis of the wildlife program was a series of permanent pellet plot transects (Figure 8) in selected habitats in the valley bottom both on and near the planned development to determine the distribution of ungulates and the relative use of the different vegetation types. Sixteen 250 m pellet plot transects were done in various vegetation map units and vegetation types. Each transect consisted of five sets of five 1/500 ha (20 m^2) circular plots; plot sets were spaced 50 m apart along the transect. Each plot set consisted of a central plot and four surrounding plots of 5.04 m diameter at 10 m distance at 90^{o} intervals from the central plot. The beginning of each transect is permanently marked with an aluminum tree tag bearing the date, distance and orientation to the first plot set (usually 50 m). The central plot of each plot set was marked with a labelled orange wooden survey stake; the surrounding four plots were marked with flagged aluminum pins.

Plots were searched for pellet groups (a group consists of a minimum of 10 pellets). Pellet groups were identified by species (deer, moose, elk or cattle), age (whether more or less than 1 year old) and type of dropping (winter or summer). After analysis, plots were cleared of pellets.

A browse survey was conducted in conjunction with the pellet survey. Browse utilization was estimated (nil, light, moderate or heavy) for the central plot of each plot set.

Four small mammal traplines were operated in selected habitat types (Figure 8). Each trapline consisted of 10 Sherman small mammal line traps (8x9x23 cm) spaced at about 10 m intervals. Each line was operated for four nights (40 trapnights per trapline).

HUMAN USE

Present Resource Use

Information on present resource use was obtained from the Canada Land Inventory (CLI) Present Land Use maps and from our knowledge of the area.

Land Use Capability

Land capability information was obtained from the Canada Land Inventory maps of the area.

Historic and Archaeological Sites

Studies on historic and archaeological sites were carried out by Mr. Wayne T. Choquette of the Archaeological and Historical Site Board of the Provincial Museum, Victoria, B.C. (Appendix B).

DEVELOPMENT PROGRAM

DEVELOPMENT PROGRAM

INTRODUCTION

The Hosmer-Wheeler development will consist of an underground hydraulic mine, processing plant, tailings pond, railway loop and associated surface facilities such as roads, entrance portals, ventilation shafts, fan sites and water head tank and pumping station (Figure 9). Details of the plant area are shown in Figure 10.

EXPLORATION

EXPLORATION REVIEW

Limited reconnaissance and geological mapping of Hosmer and Wheeler Ridges had been conducted before 1960 by the Geological Survey of Canada, British Columbia Department of Mines and Crows Nest Pass Coal Company. In 1968, Kaiser Resources completed an access road south of Sparwood to Wheeler Ridge. The 1970 surface exploration program included: tracing two and one-half miles of coal outcrop primarily along seam 3, driving eight prospect adits, completing preliminary geological mapping of trenches and surface exposures along the seam outcrop traces, and obtaining bulk samples for washability tests from the seams exposed on Wheeler Ridge.

During 1974 and 1975 an intensive exploration program was conducted in the Joint Venture Hosmer-Wheeler Area of Investigation to assess the reserve potential required to support a new mine complex capable of producing 1.5 to 2.0 million tons of clean coal per year for a period of 20 to 25 years.

The main purpose of the 1974 Program was to assess 98.1 million tons of in-place reserves of seam 3 projected prior to exploration. On the basis of a 20 year mine life, the required mineable clean coal reserves of seam 3 range from 30 to 40 million tons. Mineable clean coal reserves of seam 3 found within the original mine area amounted to 20.7 million tons and were insufficient to support the above mentioned rate of production and operating period. In the same area, the overlaying seams 1 and 2 are considered unmineable and contain no reserve potential. During the investigation, data were obtained on seam 4 from the bore holes deepened beyond seam 3. An additional mineable clean coal reserve of 4.8 million tons of seam 4 was confirmed from bore hole data. At the Technical Committee Meeting held November 27, 1974 to review the geological findings, it was mutually agreed by the participants to include seam 4 in the Project Reserve Area. It was further agreed that the combined total of 25.5 million tons for seams 3 and 4 were still insufficient to support a production rate of 1.5 to 2.0 million tons per year (30 to 40 million tons over a 20 year period). To satisfy the requirement for a 20 year operation an additional 4.5 to 14.5 million tons of mineable clean coal would be required. For a 25 year operation, an additional 12.0 to 24.5 million tons would be required.

The principal purpose of the 1975 Program was to assess in particular the reserve potential of the lower seams adjacent to the proposed rock tunnel at the north end of Parcel 69 (Figure 2) with a view to providing the 4.5 to 14.5 million clean tons for the 20 year period. Additional reserves found in the lower seams 8, 9, 10 and 11 amounted to 15.4 million tons. Total hydraulically mineable clean coal reserves of seams 3, 4, 8, 9, 10 and 11 found within the project reserve area amounted to 44 million tons and appear sufficient to support the above-mentioned rate of production required for a mine complex over a 20 year period.

In addition, supplemental reserves of 3.1 million tons clean coal from seam 2 (subject to confirmation by additional exploration) and 2.8 million tons clean coal from seam 4 by methods other than hydraulic, are tentatively available as well. Summarized, the reserves are as follows.

Hydraulically Mineable

Seam	Reserves (000's tons mineable clean coal)	
3	20,762	
4	7,889	
Subtotal		28,651
8	7,839	
9	3,005	
10	2,872	
11	1,668	
Subtotal		15,384
Total		44,035

Supplementary Additional Reserves

Seam	Reserves (000's tons mineable clean coal)	
4	2,867	
2	3,105	
Subtotal		5,972
Grand Total		50,007

1975 field studies commenced in August and were completed in November and included geological mapping, drilling and road building. Adit work required for bulk sampling purposes began in late August and was completed in early March of 1976. During this seven month period, two core drills were utilized to complete five bore holes with a combined length of 7846 ft. Three adit crews were employed to drive eight new adits. Two of the adits were abandoned because of an excessive inflow of water. Metallurgical samples of coking coal were obtained from five of the eight adits. 15.3 miles of access roads were built for drilling and geological purposes. The cumulative field work for the 1974 and 1975 programs included:

	1974	1975	Cumulative Total
Adits	1	8	9
Length (ft)	160	1,587	1,747
Bore Holes	17	5	22
Length (ft)	19,228	7,846	27,074
Access Road (miles)	5.5	15.3	20.8

Within the entire area investigated, the principal reserve is contained in seam 3. The thickness of the various coal seams (excluding partings) is as follows:

Seam	Thickness Range (ft)	Remarks
2	12 - 15	Mineable reserve confined to Hosmer Ridge area
3	12 - 65	
4	12 - 26	Reserve area designated for hydraulic mining
4	8 - 10	Reserve area designated for other methods
8	26 - 33	
9	14 - 26	
10	12 - 16	
11	14 - 15	

COAL QUALITY

According to the American Society for Testing Material standards (ASTM), coal seams 2 and 3 are high volatile bituminous in rank. Seam 4 is borderline between high and medium volatile bituminous in rank, while the lower seams 8, 9, 10 and 11 are medium bituminous volatile in rank. Seams 2, 3 and 4 will provide a low ash metallurgical coal with good fluidity by blending while seams 4, 8, 9, 10 and 11 will provide a medium volatile coking coal.

The Proximate Analysis (dry basis) of the raw adit samples and a seam 3 composite is as follows:

Seam	Composite	Raw Adit Samples				
	3	4	8	9	10	11
Ash %	7.9	9.8	9.9	9.1	8.4	9.9
Volatile Matter %	30.3	28.2	23.1	20.9	21.6	21.2
Fixed Carbon %	61.8	62.0	67.0	70.0	70.0	68.9
Btu/lb	14,094	13,630	14,061	13,965	14,436	14,100

COAL RESERVES

The following guidelines were used in calculating the coal reserves:

- exclude seams less than 10 ft in coal thickness (unless potentially mineable by other than hydraulic methods).
- exclude rock partings greater than 3 ft thick.
- exclude outcrop pillar, approximately 200 ft in width.
- include area defined by maximum 1500 ft cover line.
- seams of more than 5 ft thickness may be mined conventionally.

The mining plan involves the extraction of 60,704,000 tons of raw coal from seams 2, 3, 4, 8, 9, 10 and 11, yielding a total of 38,904,000 tons of clean coal. All reserves are considered mineable utilizing hydraulic techniques with the exception of 2,867,000 tons of seams 2 and 4 which would be mined by conventional methods. The reserve calculations have been based on the following considerations:

- seams 2, 3, 4, 8, 9, 10 and 11 to be mined.
- maximum cover, as far as practicable, 1500 ft above seam to be mined.
- individual panels not to exceed 1.5 years of life.
- pillar dimensions related to seam thickness and depth.
- a geological factor of 60-86% was applied.
- a recovery factor of 62% was used to obtain the raw coal production.
- plant yield factors; Upper Seams 65%
  Lower Seams 59.5%

Additional coal reserves between the 1500 and 2000 ft cover lines were also estimated but are not included as part of the reserves.

FAULTS

The exploration study has revealed several faults which generally strike north. The study interpreted positions and magnitudes of the faults largely from bore hole data, strata mapped on the surface, projections of surface dips and seam thicknesses and elevations obtained from the bore holes. The interpretation of the faults is of considerable significance in the computation of the coal reserves and in providing basic data necessary for the commencement of mine feasibility studies.

MINE DEVELOPMENT

Kaiser Coal Canada Ltd. submitted to B.C. Research its Mine Planning Study, Phase II - Joint Venture Hosmer-Wheeler Project, dated June 15, 1976 to assist in the preparation of the environmental impact statement. The Mine Planning Study which is part of the overall program to determine the feasibility of mining the coal deposits in the Hosmer-Wheeler area is presented below in summarized form.

MINING PLANS AND MINE LAYOUT

General Layout

The hydraulic mining plan layout consists of:

- twin rock tunnels, each 10,400 ft long, driven at a positive gradient of five degrees, commencing at an elevation of 3,350 ft (Portals 1 and 2) and terminating at 4,460 ft where they intercept seam 4 (Figure 9).
- five air-intake roadways (fan sites) driven in seam 4 commencing at an elevation of 5,200 ft (outcrop of seam 4) and connecting, via seam 4 coal roadways, with the rock tunnels.
- two air-intake roadways driven from the outcrop of seam 2 (Portal No. 52) and a 1,500 ft rock cross-measure drift driven from the termination of seam 4 intake slopes (Portal No. 202) will provide access to seam 2.
- access to seams 8, 9 and 10 will be provided via air-intake slopes driven in the seams from the outcrop and via the main rock tunnels.
- access to seam 11 will be via the main rock tunnels only.
- each seam will be divided into panels.
- ventilation roadways will be to the outcrop.

The twin rock tunnels will be 16 ft wide and 10 ft high and will be driven on 150 ft centres. Main support will be provided by rockbolts and shotcrete supplemented with arches in coal seams, poor ground conditions and faults. The rock tunnels will be driven utilizing conventional equipment.

The rock tunnels will provide the following services:

<u>Rock Tunnel 1</u>

- one 24-inch plastic lined flume line.
- two 16-inch diameter water lift pipelines.

Rock Tunnel 2
- twin monorail system for transportation of men, materials and supplies.

Intake Slopes and Main Entries

Intake slopes and main entries will be 18 ft wide and 10 ft high or 16 ft wide and 10 ft high dependent upon location and ventilation requirements. Grade will vary from a minimum of five degrees to a maximum of fourteen degrees.

Continuous miners will be used to develop slopes and main entries. Smaller coal development machines referred to as cross-cut machines will be used to develop the cross-cuts.

Main roadways, sub-levels and sub-rises will be supported with steel arched supports and fully lagged. Cross-cut roadways will be supported with square sets and fully lagged.

The air intake slopes and main entries will include the following services:

- two 16-inch water lift pipelines.
- one 10-inch and three 8-inch diameter high pressure pipelines.
- three 12-inch low pressure pipelines.
- 24-inch or 20-inch flume lines.
- monorail system.
- electrical distribution and communication cables.

Cross-Measure Drifts

Approximately 24,000 ft of rock work will be required to provide access from one seam to another and to negotiate faults. This development will be completed utilizing conventional drill and blast techniques.

Rock cross-measures drifts will be 16 ft wide and 10 ft high supported with rockbolts and wire mesh in good ground conditions and arches completely lagged in faulted or poor ground conditions.

Panel Development

Two parallel headings will be driven to develop individual panels. Development procedures will be identical to those used for the main entries.

Sub-levels and Sub-rises

Sub-levels and sub-rises will be developed in the same manner as the main entries.

Cross-cuts in the Coal

Cross-cuts will be required between coal entries to complete ventilation circuits and to provide a second means of egress.

Cross-cuts will be developed with the cross-cut miner, at 800 ft intervals, on a square-set profile supported with steel sets at five ft centres and completely lagged.

MONITOR OPERATIONS

Monitor units similar to those being used at the Balmer South Hydraulic Mine will be used to cut the coal.

It is proposed to bore the tunnel on a contract basis at about 1,000 ft per month using a full-face boring machine. The entire tunnel will be completed in about 12 months and produce about 180,000 tons of rock to be used as fill around the portal site.

Continuous miners will be used to develop main entries from the outcrop at 5,250 ft to the adit at gradients of five to fourteen degrees. The main entries (fan sites) which will provide access for pipelines, flumes, men and materials as well as providing ventilation airways, will continue from the adit to the working areas. They will be supported by three-piece "TH" yieldable steel arches at 5 ft centres and will be completely lagged.

Double rock cross-measure drifts will be provided at three locations for access to seam 3 from seam 4. Conventional drill and blast techniques will be used.

DEVELOPMENT AND PRODUCTION SCHEDULE

Twelve months has been allowed from the date of approval of the project to acquire suitable equipment to drive the coal entries. It has been assured that suitable equipment can be obtained in the twelve month period and that these machines, if not available directly from the manufacturer, can be leased from other sources.

Seam 2 will commence production 36 months after approval of the project with seam 3 production commencing after 48 months from approval of the project.

The initial three months of the schedule covers detailed engineering, awarding of contracts and ordering of equipment. This is followed by site work at both 3,500 ft elevation and 5,200 ft elevation. Upon completion of the site work at 3,500 ft, the rock tunnels 1 and 2 will commence and continue for 20 months. Upon completion of the site work at 5,200 ft, development will commence in seam 4 and continue until a connection is made with the rock tunnels. A changeover period of three months duration will occur during which time the conveyors will be removed and the water coal transportation system installed. Development will then continue, with seam 2 commencing production 36 months after approval of the project.

At development peak, the schedule demands a maximum of six continuous miners, three cross-cut machines and four monitor units operating at any given time.

Water Requirements

Water requirements will depend on the hardness of the coal to be cut and the coal:water ratio required for hydraulic transportation in flumes. Low pressure make-up water will be provided as required. The water will be recirculated through a closed system with small volumes of make-up water being provided from the Elk River.

Coal-water mixtures will be transported from the mine to the surface in special, plastic-lined, steel flumes. The size of the flume and thickness of the plastic liner will vary depending on the nature and quantity of material to be transported in each situation. In full production, an average of 20,000 gal/min of coal-water mixture will flow out of the mine. At maximum production, there will be 300,000 gallons of mixture containing 900 tons of coal in the flume line.

Ventilation

Ventilation quantities are predicated on the requirements for the machines in the operating areas. Borehole information and experience in the nearby mines indicate that methane levels will not exceed normal rates of emission. Main fans for each seam will be located at main entries at outcrop. Ventilation will be achieved by a forced air system with outlets to surface via outcrop breakthroughs. Air velocity will not exceed 1,200 ft/min. In winter months, mine air will be heated.

Subsidence

The Study made no reference to subsidence although discussions with company personnel indicate that subsidence, especially near outcrops, will occur. Serious alterations of the topography are not expected.

PROCESS DESCRIPTION

RAW COAL HANDLING

Mined coal, which has passed through a monitor feeder breaker to crush it to -4 inches, is flumed at a normal rate of 560 tons/h to a 1½ inch grizzly screen (Figure 11). For equipment sizing, periodic surges of up to 1400 tons/h and 20,000 gal/min are anticipated in the design.

The +1½ inch fraction from the screens passes to the woodpicking circuit where tramp metal and wood is removed and the coal crushed to -1½ inch and transported to the raw coal storage.

Wood will be disposed of by mobile equipment. The -1½ inch material from the screens will be dewatered on a 0.5 mm screen. The +0.5 mm fraction will go directly to the raw coal storage area while the -0.5 mm fraction will be directed to two 220 ft diameter clarifiers. The overflow from the clarifiers containing approximately 100 mg/l of solids will be directed to the clear water storage pond. The clarifier underflows will be treated by a series of disc vacuum filters. The filter cake will be sent to the raw coal storage while the filtrate will be returned to the clarifiers where it will be treated with a flocculant to remove fine particles.

The raw coal stockpile will be sized to handle one day's production or 14,000 tons. In emergency cases, the size of the stockpile can be increased or decreased by the use of mobile equipment. A two compartment emergency dump pond of approximately one million gallons total capacity will be provided close to the portal of the Rock Tunnel to handle the 300,000 gallons of water and coal in the mine flume under emergency conditions. Facilities will be provided to feed the contents of these ponds back to the normal flume system.

PREPARATION PLANT

Structure

A structural steel building, enclosed by insulated siding and roofing on built-up metal decking, will house the preparation plant equipment. Chain-operated monorail hoists and jib cranes throughout will facilitate maintenance of the equipment. The central control room, motor control room, laboratory, toilet and lunchrooms will be of concrete block design and provided with heat.

A 10-ton monorail will service the central machinery well and laydown areas next to the well will be provided to each main floor. A rollup door on the side of the building will provide ground-floor access to the well for trucks. A freight elevator and man-lift will also be provided.

Heavy-medium Cyclone Cleaning

Raw coal from the preparation plant feed conveyor belt will pass over a tramp iron magnet and through a single roll breaker where any plus 1½ inch coal, ice blocks, or other oversized material, which might have been introduced into the feed during the stockpiling operation, will be reduced to a 1½ inch maximum size (Figure 12). The product will drop into a two-way distributor in the preparation building which will direct the feed to the two circuits.

Each circuit will separate the plus 28 mesh fraction of the feed by desliming sieve bends and screens. The oversize fraction will be gravity fed to the heavy-medium cyclones where, depending upon the specific gravity of medium employed, separation of clean coal and refuse products will take place. The major quantity of medium used in the process will be drained by sieve bends and screens for both clean coal and refuse and will return directly to the heavy-medium sump. The remaining medium adhering to the coal and refuse products will be rinsed on the rinse section of the screens and will separate as refuse dilute medium and clean coal dilute medium. The product from the clean coal drain and rinse screens will be dewatered in mechanical centrifuges so that it can be handled at about 7% surface moisture. The refuse product from the refuse drain and rinse screens will normally be crushed and added to the refuse sump.

Medium Recovery System

The dilute medium in this plant will be handled separately as clean coal dilute medium and refuse dilute medium. The softness of the coal and the physical forces inside the cyclones are expected to cause degradation in both the clean coal and refuse product of the heavy-medium cyclone. The recovery circuit will remain the magnetite rinsed from the clean coal and the refuse products of the heavy-medium cyclones. Separating the dilute medium from the clean coal and refuse sections will separate the degradation products into clean coal and refuse product. This separation of the products will help to control the product metallurgy in the plant.

The dilute medium from the clean and refuse sections of both circuits will be handled separately in standard 30-inch diameter double-drum magnetic separators. The magnetite concentrate from the separators will report to the respective heavy-medium circuits through control circuits. The tailings of the refuse magnetic separators will report directly to the refuse thickener. The tailings of the clean coal magnetic separators will report to the secondary water-only cyclone circuit and the dewatered product will report to the Derrick screens.

The make-up medium circuit will start at the railroad car unloading station from where the media will be pumped to sieve bends. The underflow of the sieve bends will report to a 40 ft diameter magnetite thickener. The underflow of the magnetite thickener will be recirculated and an automatic specific gravity indicator, installed on the plant control panel, will remote-monitor the respective circuit.

Water-only Cyclone Cleaning

The desliming sieve bend and screen underproduct in each circuit, consisting of -28 mesh material, will be pumped to the primary water-only cyclones. The water-only cyclone circuit in the plant will consist of a "recycled circuit" to provide a more efficient specific gravity separation of the 28 mesh x 60 mesh size fractions than possible in a one-stage separation. The overflow of the primary water-only cyclones will be fed to the Derrick screens which will deslime the clean coal product. The plus 60 mesh coal product will be fed to the vacuum disc filters. The effluent of the Derrick screens, which will consist of the -60 mesh fraction of the coal, will be fed to the froth flotation circuit.

Primary water-only cyclone underflow will be sumped and pumped through the secondary water-only cyclones for recleaning. The overflow will return to the primary water-only cyclone circuit where any misplaced coal will be removed with the clean coal stream. The underflow will be sent to the refuse sump, where it will be combined with other refuse fines and pumped to the tailings pond.

Flotation Cells and Filter Circuits

The flotation circuit in this plant will process the undersize of the Derrick screens, which consists of the -60 mesh size fraction.

The float product, together with the dewatered 28 mesh x 60 mesh water-only cyclone product from the Derrick screen, will be fed to the vacuum disc filters. Variations in the quantity and quality of both the 28 mesh x 60 mesh and the 60 mesh x 0 washing have been anticipated in the sizing of the filters. There will be three 12.5 ft diameter x 12 disc vacuum filters provided.

In order to avoid disruption of the plant production during any emergency breakdown in the filter systems, a filter feed thickener has been provided. This 130 ft diameter concrete thickener will be fed filter overflow from the operating filters. This overflow from each filter will enable the filters to operate at proper levels at all times and will remove the heavy froth layer that generally accumulates in the filter. In addition, filter drainage from each filter (when they are shut down) and thermal dryer scrubber effluent will be fed to this thickener.

The underflow of the filter feed thickener will be recycled back to the filter feed distributor and then to the filters. A density measuring device will be used to control the addition of this stream to the filter.

Refuse Thickener

A 200 ft diameter concrete refuse static thickener will be provided in an area next to the preparation plant to remove most of the fine solid content in the process water. Sources of water to the refuse thickener are: make-up water from the clarifier overflow tank via the dewatering facility head tank, tailings from the refuse magnetic separators, flotation cell tailings, decanted water from the tailings pond and overflow water from the filter feed thickener.

The underflow from the thickener will be pumped to the tailings pond through a refuse sump (where the underflow of the secondary water-only cyclone will be added) by the fine refuse pumps. The thickener overflow will supply water to the preparation plant head tank and dryer scrubber; any excess overflow will flow by gravity to the clarifier.

This thickener will have a heating system to prevent freezing during the winter period.

Dryer

A 36-inch dryer feed belt conveyor, enclosed in a 10 ft diameter steel tube, weather insulated and heated, will carry the clean coal from the preparation plant to the dryer building. Normally, all the coal will be directed to the

250 ton capacity dryer feed bin, but provision will be incorporated to allow bypass of a portion or all of the clean coal to the storage and loadout system. Coal will be fed to the fluid bed type dryer from this bin by means of screw feeders.

The dryer will have a maximum moisture evaporation rate of about 60 tons/h. The dryer feed rate is 460 tons/h. On the basis that the coal feed contains approximately 14.8% surface moisture, the dryer will be capable of producing a product up to a maximum of 6.5% surface moisture.

The combustion equipment for the furnace will be fired either by natural gas or by coal, depending on the decision of the British Columbia Energy Board to grant permission for natural gas firing. We are advised that on projects where alternate fuels are available, the Energy Board may decide not to grant permission for natural gas firing of dryers. This study has been prepared on the basis of stoker coal firing. An ash handling system including discharge bin, fly ash conveyor and ash bin at truck hopper will be provided.

A 5,000 hp exhaust fan positioned between cyclones and scrubber will pull the heated air through the construction deck and, in doing so, will fluidize the coal. While drying, the coal will pass across the deck in this fluidized form and eventually discharge from the dryer to the 36-inch clean coal loadout belt conveyor. An automatic two-stage sampler will be provided.

The moisture and fine particles of coal contained in the exhaust gas will pass through large-diameter cyclones, where the majority of the coal will settle out from the air stream. The coal particles collected by the cyclones will join the dried coal through rotary valves and screw conveyors and will be conveyed to the clean coal silos. The gas and extreme fines will pass through the exhaust fan and on through a high-energy venturi gas scrubber to remove the remaining superfine solids from the gas stream, which is then passed through a mist eliminator before being exhausted to the atmosphere via a stack. Exhaust gases will meet Level A standards of the Pollution Control Board (PCB) of 0.05 grains of particulate per cubic foot (gr/ft^3). Scrubber effluent will be pumped back to the filter feed thickener.

STORAGE AND LOADOUT

Clean metallurgical coal will be conveyed from the thermal dryer to the clean coal silos by a 36-inch loadout conveyor which will be enclosed in a 10-ft diameter steel tube, weather insulated and heated. This conveyor will discharge directly into silo 1 or be directed by flop gate and chute to the bypass conveyor for discharge into silo 2. A belt scale will be provided.

The 36 inch bypass belt conveyor on top of the silo in an enclosed and heated housing will be approximately 70 ft in length and will have dust collecting equipment and wet scrubbers at the transfer points. A vacuum cleanup system will be provided at the top of the silos and, the fire protection will consist of dry sprinklers in the silo house and in all conveyor galleries.

Each clean coal silo will have a capacity of about 13,500 tons and will be approximately 70 ft in diameter and approximately 250 ft high. They will be of slip-formed reinforced concrete construction. Each silo will have two discharge hoppers and gates, with each gate provided with flood loading facilities. All clean coal will be loaded into gondola cars of the Canadian Pacific Railroad unit trains. A spray system will be furnished at the silos for spraying a chemical coating on top of the coal load to prevent dusting while the car is en route.

A covered and enclosed axle weighing scale of 100 ton per axle capacity will be provided north of the silos to allow weighing and recording of loaded moving railroad cars prior to leaving the plant site. The scale pit will contain a sump and pump. A small scale house will house the necessary gages, computers and recording instruments with space for an operator.

To allow for continual preparation plant operations even when the silos are full, a concrete floor in the area around the tracks under the silos will be provided to allow for unloading the silos into trucks. These trucks will dump the clean coal in an adjacent emergency clean coal storage area. Reclaim from this storage pile will be by front-end loader into a reclaim hopper, where a 60-inch emergency reclaim belt conveyor approximately 200 ft long and with a discharge flop gate will discharge into the unit train cars.

REFUSE DISPOSAL

All refuse will be disposed of in the tailings pond which will be located at the north of the plant site about 6,000 ft from the preparation plant (Figure 9). Over the expected 20 year life of the project, a total of 41,140,000 tons of clean coal will be produced and 23,023,000 tons of refuse. 5,987,300 tons of refuse will be used in the construction of the dam which will leave 17,536,200 tons to be impounded. The impounded refuse will settle at 80-85% solids and have a density of 87 lb/ft^3. Thus, the impoundment volume required will be:

$$\frac{17{,}536{,}200 \text{ tons} \times 2{,}240 \text{ lb/ton}}{87 \text{ lb/ft}^3} = 451{,}507{,}000 \text{ ft}^3$$

As shown in Figure 13, this will bring the level of the refuse in the tailings pond to the 3,513 ft elevation. The tailings dam will be constructed to 3,523 ft elevation to provide a 5 ft freeboard and allow for a 5 ft water layer on the tailings.

Coarse refuse separated in the heavy-medium cyclone circuit will be transported by a reversible 36-inch belt conveyor either to the refuse sump or to the coarse refuse bin. Under normal operations, the coarse refuse will be crushed to minus 1/8 inch and fed into the fine refuse sump, where it will be slurried together with the minus 28 mesh already reporting to this sump.

Staged pumps will draw the refuse and water slurry from the sump and pump it to the tailings pond via a 10-inch diameter steel pipe. Normally, the slurry will be predominantly minus 28 mesh at 35% concentration by weight.

Under emergency conditions, or when it is required to have coarse refuse of 1½ inch x 28 mesh for waste or dam construction, the coarse refuse can bypass the crusher and be fed to the 200 ton refuse bin. Removal will be into trucks for haulage to the dam site or to other disposal areas as required.

The tailings pond starter dam, approximately 30 ft maximum height, will be built from material excavated from within the pond area. During plant operations, the remainder of the dam will be built, if possible, during the summer months from dry refuse material. During winter, the dam will rise only when there is no snow on the ground.

The tailings pond will ultimately have an effective maximum height of approximately 83 ft and will have a storage capacity of approximately 451,000,000 ft^3. This will handle the refuse plus the slurry water, non-intercepted rainfall runoff, and plant area runoff, which will be pumped to the pond.

Since the fill for the anticipated full-height dam requires only 4,140,000 yd^3 of dry material, plus the 450,000 yd^3 of in-pond excavation, the remainder of coarse dry refuse will be disposed of in the coarse coal crushing and pumping described above.

The dam will be raised by the downstream method. The starter dam will become the lower upstream face of the fill. Additional coarse refuse material will be placed on the downstream face of the starter dam as a first priority after plant production starts. The crest height will be gradually increased as required up to the maximum dam height of elevation, 3,523 ft. An underdrain system and a seepage collection pump system will be installed at the downstream toe. Unlined ditches will be built immediately uphill of the pond to intercept surface runoff and convey it to existing drainage channels. These interception ditches will reduce the required runoff storage capacity of the pond.

Seepage at the pond will be collected in a sump and pumped back into the tailings pond. A decant and pumping system will return water in the pond back to the refuse thickener.

Extensive borings, sampling and testing work will be required at the dam site to insure its stability.

MINE REQUIREMENTS

The mine planning group has provided certain design criteria concerning the estimated raw coal production and estimated water consumption of the mine. These are as follows:

- the coal-to-water ratio will be 1:3.
- flat-bottomed type plastic-lined flumes will be at five-degree slope.
- the mine raw coal output was established at:

Normal	560 tons/h
Design	900 tons/h
Surge	1,350 to 1,400 tons/h

- the estimated maximum water consumption in U.S. gallons per minute will be:

Monitor extraction	5,188
Development mining	6,118
Dilution	4,542
Total	15,848 gal/min

- the net mine water usage from the head tank over a 6 hour shift will be 778,400 gallons.

FRESH WATER INTAKE

The fresh water intake pumphouse will be located at the Elk River (Figure 9) about 1 mile west of the plant. The pumphouse will include: water intake structure; screen structure provided with log stop gates, trash racks, coarse screens and fine screens; pumphouse structure made of pre-engineered steel, concrete slab, and insulated roof on steel supports; two pumps (one operating and one standby) each with a capacity of 5,000 gal/min and 2 ton monorail hoist.

All make-up water for the plant will be supplied by this pumphouse, which is connected to the clear water storage pond by a 16 inch diameter buried pipe.

CLEAR WATER STORAGE POND

The clear water storage pond will have a capacity of 10,000,000 U.S. gallons to supply make-up water for the preparation plant, make-up water for the mine monitor and development water systems, fire protection water and domestic water uses.

The storage pond will be built from material excavated from within the pond area and lined with a soil-cement lining. The expected water level is at approximately 3,438 ft elevation and water depth is 18 ft.

The pumphouse will be a heated structural steel building enclosed by insulated siding and roofing on built-up metal decking. A 7.5 ton overhead crane will be provided to service the pumps. The central control room and motor control center will be of concrete block design. A floor sump will be provided. The fire protection will be wet-type sprinkler system.

In addition to the fresh water make-up, the other source of water for the clear water pond will be the recycled water from the mine as the overflow from the clarifers, estimated at 19,175 gal/min.

HEAD TANK

A head tank of 1,250,000 gallon capacity will be provided near the air-way slopes portal area at 5,300 ft elevation. The top portion of this tank will be used to supply the 1,200,000 gallons required for operation of the monitor feed pumps and the flume pumps. The balance of the tank will be reserved strictly for fire protection purposes at the portal areas. Heating will be provided to prevent freezing during the winter period.

Water supply for this head tank will be from the water lift booster pumps at the clear water storage pond.

MONITOR AND FLUME PUMPHOUSE

A pumping station, located at 5,180 ft elevation near the portal, will be provided to house the monitor feed pumps and flume water pumps. This building will be a structural steel frame enclosed by insulated siding and roofing on built-up metal decking. A 10-ton overhead crane will be provided to service the pumps. The control room and motor control room will be of concrete block design. An air compressor and a floor sump pump will be provided. The fire protection will be wet-type sprinklers.

WATER BALANCE

The water balance for the proposed development (Figure 14) shows that the water circuit is designed as a closed system with process water being reclaimed from the tailings pond. A make-up system capable of handling 5000 gal/min is included to facilitate plant start-ups and to take care of the unavoidable seepage losses from the tailings pond which are expected to be significant during the initial stages of the project. It is expected that the quality of the natural mine water is such that any excess that may have to be removed from the process can be discharged into the Elk River after passing through the clarifier and clear water storage pond. If no excess minewater is encountered, the only water losses will occur as seepage from the tailings pond, as bound water in the clean coal product, as vapour in the discharge from the dryer and as retained water with the solids in the tailings pond.

Water clarification will be accomplished in two 220 ft diameter concrete clarifiers. The overflow from the refuse thickener and the water from the dewatering screen pans will be treated with chemicals in the clarifiers to flocculate and remove the remaining solids. The clarified water is anticipated to contain approximately 100 mg/l solids. The underflow from the clarifiers will be pumped back to the filters. The overflow will be directed to the dewatering head tank and the clear water pond. Heating will be provided to prevent freezing during the winter.

STORM DRAINAGE

The storm drainage system will collect surface runoff from the undeveloped and developed areas within the plant. All runoff from the process plant, portal and storage areas will be collected and directed in open ditches leading to the surface water retention ponds for pumping to the tailings pond. No significant plant area storm runoff water will be discharged to a natural watercourse. Facilities will be provided to prevent runoff from surrounding areas from entering the plant area.

Surface runoff from the plant will be collected in the main surface water retention pond. This pond has been sized to have a storage capacity of 87,000 ft^3 or 2.0 acre ft. For design criteria purposes, a rainfall intensity - duration curve was developed for the general plant site area using the available data for Fernie, B.C. for the years 1941 to 1970. With this curve, the rainfall rate was estimated to be 0.99 inches per hour for a storm duration of one hour and a return period of 25 years. Runoff for design purposes was defined as 50% of the total rainfall. The contributing area of the plant was 19.3 acres. The pond was then designed to store the total runoff from the contributing area of the plant site for two continuous hours of rainfall at the 0.99 inches per hour rate. Based on this criteria, the total volume required for the collection and short term storage of the storm water runoff was established at 2.0 acre ft.

The main surface water retention pond will be lined with an impervious material that is chemically compatible with the effluent characteristics resulting from spillage in any of the plant areas drained. A pumping station will be provided to reclaim the surface drainage water by pumping it to the tailings pond.

SANITARY SEWAGE SYSTEM

Sanitary wastes will be discharged from the office-maintenance complex and the coal preparation building. Sewage will be carried by buried pipe to a package sewage treatment plant and pumping plant. The underground piping will be 8-inch and 6-inch vitrified clay pipe with factory-molded compression joints. The minimum depth of cover will be provided at all breaks in grade or changes in direction.

The package treatment plant will be an extended aeration plant of 28,000 gal/day capacity. The plant will be provided with a chlorination unit. Discharge from the treatment plant will be pumped by a 4-inch cast-iron force main to the tailings pond for disposal. Sewage plant effluent will be diluted more than 100 times by the 3.6 million gallons of tailings water flowing into the pond daily.

Since the laboratory will perform ash analyses only, no chemicals will be discharged into the sewage treatment plant to interfere with its operation.

RECLAMATION

Kaiser Resources Ltd. have all the facilities and expertise required to conduct reclamation programs for all aspects of the Hosmer project. Their reclamation personnel have prepared the following summary of their philosophy, experience, facilities and reclamation plans for the Hosmer project.

DESCRIPTION AND GENERAL APPROACH OF THE RECLAMATION PROGRAM

Kaiser Resources stated policy has been the rehabilitation of all industrially disturbed lands under company control, which have been affected by past and present industrial activity. To implement this policy the reclamation program has two basic aims:

- to re-establish watershed values on disturbed lands as soon as possible after the cessation of industrial activity.
- to accomplish this watershed restoration in a way that is compatible with the potential prime surface use of the land.

In the developing phase of the reclamation program the land use objectives were based largely on the information designated in the Canada Land Inventory Capability Analysis. As most of the areas which had been disturbed by mining were valuable wildlife habitat it was felt that the vegetative cover on reclaimed areas should provide alternate feeding areas for those animals alienated by the ongoing mining program. Agronomic grasses have been used to provide high quality forage for wildlife and are compatible with the philosophy of establishing a primary level of succession and allow the natural succession to develop from this point.

On Kaiser Resources Ltd. property, surveys conducted by the B.C. Fish and Wildlife during the summers of 1974, 1975 and 1976 have shown that ungulates are in fact using the reclaimed sites more heavily than the surrounding areas.

KAISER RESOURCES LTD.'S RECLAMATION PROGRAM

Kaiser Resources Ltd.'s reclamation program became fully operational in the spring of 1970 at which time work began on the several dormant mine sites acquired with the property. Because of the urgency of the program and the limited information available, it was decided to use these sites for full scale field trials rather than continuing the research on small test plots. This decision has proved very successful and these larger areas have provided information on all aspects of revegetation. Many of the problems associated with a variation in slopes, aspect and diverse spoil material were present on each site and an annual vegetation assessment provides data on these factors for a more comprehensive analysis.

Grasses and legumes used in the program are all agronomic species because of the difficulty in obtaining sufficient quantities of native seed required for a large scale project. The species used have been selected over the years, based on the annual vegetation assessment of survival and production of reclaimed sites.

Tree and shrub species have mainly been those indigenous to this area. The introduction of exotic species is approached with caution because (a) they may become noxious weeds, (b) they may appear successful initially but lack the genetic resistance and adaptability to survive in local conditions.

Native species used are developed from seeds or cuttings and certain basic criteria are used to determine the priority for the species collected. These are valuable for forage, soil improvement abilities and tolerance to slope, aspect and elevation requirements. Whenever possible, many different preferred species are collected each year and stored for future use. In good seed years, as many as twenty to thirty different species of tree, shrub and forb seed have been collected.

The nursery and greenhouse have supplied all the planting stock used in the program since 1972 and the expansion of the planting program and the obvious need for trees for the future have made it essential that a larger nursery area be developed. This will enable planting stock to be grown to a size more suitable for field planting.

The greenhouse itself now has the capability of producing three crops annually with the total environmental control system now installed.

Site preparation is regarded as the most significant operation in the reclamation program. Once stability and control of surface runoff have been achieved then the subsequent operations of seeding and planting show more successful results.

Seeding is done with the hydroseeder or cyclone hand seeders and where the latter are used, conventional agriculture harrows pulled over the ground cover the seed.

On Kaiser Resources Ltd.'s property over 1,000 acres of industrially disturbed land have been reclaimed. This includes eight dormant mine sites and several waste dumps which were inherited with the property.

RECLAMATION PROGRAM FOR THE HOSMER-WHEELER PROJECT

Reclamation of Exploration Areas

The reclamation of the exploration areas have been an ongoing program since the inception of this project. This program started with the pre-planning of the proposed road locations using environmental sensitivity maps as initial guidelines. The roads were then flagged in the field and an on-site inspection was made prior to construction to ensure that no problems were overlooked. When heavy timber was encountered then pre-logging of the right-of-way was undertaken.

Monitoring of progress has continued throughout the construction stage to ensure that the slash abatement was being properly performed and that culverts, ditches and waterbars were correctly located and functioning effectively.

Drillsites, adits and dormant roads were stabilized to ensure control, then seeded and fertilized. Dormant roads were ripped and seeded.

Reclamation of Mine and Plant Areas

Final reclamation of the mine and plant areas will be carried out at project completion in about 20 or 25 years. Short term revegetation and reclamation programs will be instituted as required during mine operation. The Environmental Services Division of Kaiser Resources has sufficient expertise at present to ensure good reclamation of such an area; their expertise can only increase in the future. B.C. Research and Kaiser Resources Environmental Division have collaborated on the reclamation planning for the mine and plant area: Reclamation planning is dealt with in the Impacts and Mitigation section of this report.

FUTURE CONSIDERATIONS

The facilities outlined herein describe a flexible preparation plant designed for processing Hosmer-Wheeler coals. The coals mined from the upper seams 2, 3 and 4, will be processed for the first 13 years of the project. Beginning the 14th year, however, the coal production from the upper seams will start to decrease and production from the lower seams 8, 9, 10 and 11, will begin, consequently changing the quality of plant feed. When compared to the upper seams, these lower seams have a poorer washability, which will increase the amount of expected ash content. In addition, the lower coal seams are generally not as thick as the upper seams and thus the percentage of dilution in the seams is expected to be higher.

To adjust for this change and produce the 2,200,000 tons/year of clean coal at 8% total moisture, it is expected that the target percentage of ash in the clean coal will be increased from 8.0% to 9.5%. The average clean coal yield will decrease from 65% to 59.5%.

Prior to the commencement of production from the lower seams and after more information is available on screen analysis, washability data and projected dilution, it is recommended that the preparation plant process flow be reviewed in light of the latest data. Changes can be initiated where required and in a sequence compatible with coal production requirements.

In general, it is expected that additional magnetic separators may be required, resulting from the necessary increase in specific gravity of separation in the heavy-medium cyclones. The probable changes in size distribution may also require the addition of more fine screening devices and water-only cyclones.

The refuse pond total capacity has been sized to handle the refuse from the plant for 20 years and takes into account the lower average yield and consequent increase in refuse production from seams 8, 9, 10 and 11. No change in the tailings pond will be required.

The quantity of water used in the mining operation may change when the lower seams are mined. The effects of underground pumping of seam 3, more lower-seam production, etc., are not known at this time and should be evaluated prior to the later production.

ENVIRONMENTAL
DATA

ENVIRONMENTAL DATA

PHYSICAL OVERVIEW

PHYSIOGRAPHY

Hosmer-Wheeler Ridge lies along the northwest limb of the Fernie Coal Basin, adjacent to the community of Hosmer (Figure 1). At Hosmer (elevation 3360 ft) the Elk River valley is approximately 1 mile wide and runs southwestward. Throughout the study area the meander river channel runs close to the west side of the valley (Figure 2). The Elk River valley has been glaciated. River cut fluvial terraces subdivide the valley bottom, above which several fluvial fans have formed along the toe of the mountain slopes. The upland areas consist of rolling to moderately steep lower slopes and steep to very steep upper slopes rising to an elvation of 7000 feet. No-name Creek emerges from the upland area to cross the lowland and join Hosmer Creek and finally the Elk River at the town of Hosmer. The bottom lands have been logged in the past and have naturally revegetated to meadow and coniferous, deciduous and mixed forest cover. Some areas have been used as pasture lands and for forage crops production. The upland slopes are mantled with trees except in small areas which have been logged or are natural meadow.

GEOLOGY

The stratigraphic units mapped in the development area include the Jurassic Fernie and Cretaceous Blairmore and Kootenay Formations (Geological Survey of Canada, 1970). The Kootenay Formation comprises grey and black, carbonaceous sandstones, siltstones, mudstones, and shales with interveds of coal and minor conglomeratic sandstone and conglomerate. It occupies the stratigraphic internal between the soft shales and sandstone of the Fernie Formation and the non-carbonaceous quartzitic pebble - conglomerate and sandstone of the Blairmore Formation. The Blairmore Formation caps the Hosmer-Wheeler Ridge while the Fernie Formation does not outcrop in the development area.

About ten coal seams of mineable thickness occur within the Hosmer-Wheeler Ridge area. Only seams 2, 3, 4, 8, 9, 10 and 11 are considered suitable for hydraulic mining and are located within the coal-bearing member of the Kootenay Formation. These coal measures dip moderately south and have been displaced up to 200 ft by several normal north striking faults.

SURFICIAL GEOLOGY

The formation of the study area has been controlled by the last glaciation period. The majority of the surficial materials have originated through the interaction between the glacial ice and the pre-existing bedrock, from the Jurassic Fernie marine shales and sandstones and the continental coal-bearing Kootenay Formation. During deglaciation gravelly fluvial materials were deposited in the valley bottom. Numerous terraces have since been cut by the meandering of the Elk River. These terraces have been capped by sand and silt fluvial deposits varying in depth from a few centimeters to a meter or more. Above the valley bottom partially eroded and slumped glacial fluvial terraces have been cut by upland drainage channels forming several gravelly fluvial fans.

In the upland area bedrock controls the topography. The lower slopes are covered by till of varying thickness, with a veneer and blanket of colluvium on the steeper slopes and gully areas respectively. The very steep upper slopes are covered by a veneer of colluvium over bedrock. Bedrock outcrops are a common occurrence. Deep colluvium deposits are found in old avalanche and slide tracks.

ATMOSPHERIC RESOURCES

CLIMATE

Present climate data is insufficient to give a complete description of climate for the area. Nevertheless it is possible to generalize climate of the area based on such information as is available.

The main factors determining the climate of the general area are its distance from the coast, the intervening major topographical features, and locally, the high mountains surrounding the Elk River basin. The prevailing large scale air flow is from the west, but the more detailed patterns of wind, temperature and precipitation are determined by the orientation of the local mountains.

Wind

Adequate wind data are not yet available, but data for April through July 1976 indicated that the dominant wind directions during these months were southwest, south and north. Northeast winds were also prominant in April while northwest winds tended to become more prominant as summer progressed. There is practically no wind from the east and little from the southeast and west. The wind speeds during April-July were moderate, averaging below 8 mph for the period, with the highest observed daily 1 h maximum at 20 mph. Available data for Hosmer are summarized below:

Month (1976)	% of Time with Wind Blowing from Stated Direction								Wind Speed, mph	
	N	NE	E	SE	S	SW	W	NW	Daily Average	Highest 1 h Daily Maximum
April	30	16	1	1	16	25	7	6	8	20
May	18	5	2	4	23	30	8	10	8	15
June	22	6	1	4	18	29	7	14	7	13
July	20	4	1	1	16	31	8	19	7	14

Temperature

The generalizations in this paragraph on temperature are based on data collected at Fernie, B.C. (Tables 1, 2 and 3) for the 10 year period 1965 to 1974. The annual mean temperature ranges from 4°C (39°F) to 6°C (43°F). January is the coldest month with a mean temperature of -8°C (18°F) and July-August the warmest with a mean of 16°C (61°F). The average monthly maximum temperatures range from 6°C (43°F) for December to 33°C (91°F) for August. The average monthly minimum temperatures range from -29°C (-21°F) for January to 2°C (36°F) for July. The highest and lowest temperature readings on record are 36°C (97°F) and -42°C (-43°F) respectively.

Data obtained by interpolation between curves presented in the Atlas of Canada are compared, below, with four-year averages from the weather station at Sparwood, B.C.:

	Atlas of Canada	Weather Station at Sparwood
Mean date of first frost -0°C (32°F)	Aug. 15	Aug. 26
Mean date of last frost -0°C (32°F)	June 15	June 18
Mean annual frost-free period	60 days	71 days
Length of growing season	180 days	
Number of degree days over 42°F	2750	
Annual mean maximum temperature	33°C (91°F)	33°C (91°F)
Annual mean minimum temperature	-32°C (-25°F)	-33°C (-28°F)

Precipitation

The total precipitation averages 1189 mm (46.8 in) per year and the annual snowfall averages 4310 mm (169.7 in). The monthly average precipitation decreases rather steadily from a high in January to a low in August and then again increases. Detailed data are shown in Table 4.

Relative Humidity

Data on the relative humidity are only available for the period of April 8, 1976 to June 12, 1976. A summary of the data is given in the table below:

Month (1976)	Monthly Average of Daily 1-h Extremes		Daily Average
	Maximum	Minimum	
April	80	41	61
May	86	42	65
June	91	53	74

Solar Radiation

Special local data are not available, but interpolation between curves, which cover the south-eastern portion of B.C. in broad outline, indicates that the annual mean hours of bright sunshine is in the order of 1900.

AIR QUALITY

Air quality data for the vicinity of the proposed Hosmer-Wheeler development are only available for the period of March 31, 1976 to August 3, 1976; data collection is continuing. However, based on this limited data (table below) it can be tentatively concluded that the air at the proposed plant site and north of the plant site is very much cleaner than at the centre of the town of Hosmer.

PRESENT CONDITIONS

Location	Suspended Particulate; μg/m³ (Geometric means)		Dustfall; tons/mile²/month (Arithmetic means)	
	Highest 24-h sample	Four month average*	Highest 24-h sample	Four month average*
Hosmer	428†	91 (16)	45.6	31.7
Proposed plant site	67	27 (8)	14.3	9.2
~3 miles NE of plant site	113	55 (9)	27.4	18.2
~1 mile NE of plant site	NA	NA	14.5	11.3

* Number of samples in brackets
† Six samples >120 μg/m³
NA Not Available

A comparison with existing Federal and British Columbia provincial standards is of interest. These standards are tabulated below:

SUSPENDED PARTICULATE MATTER: μg/m³

A. Federal Objectives

Desirable, annual geometric mean	0– 60
Acceptable, annual geometric mean	< 70
24-h average	0–120
Tolerable 24-h average	< 400

B. British Columbia Limits

Residential	50% of results	< 45
	84% " "	< 70
Commercial	50% " "	< 65
	84% " "	<100
Heavy industrial	50% " "	< 80
	84% " "	<120

DUSTFALL; tons/miles^2/month

British Columbia Limits

Residential and commercial	15
Industrial	30

The suspended particulate at Hosmer fails to meet the federal objectives and the B.C. limits. No explanation for this surprising result is available at present although road dust is logically suspect. The figures for Hosmer are regarded as questionable and a check for possible bias in the sampling station placement will be made. At the plant site the suspended particulate level meets the "desirable" federal objective. Three miles northeast of the plant site the suspended particulate level is higher, apparently because of the proximity to the highway, but still meets the "desirable" objective. The plant site levels meet the B.C. residential limits while the B.C. commercial limits are met at the highway three miles northeast of the plant site.

The dustfall at Hosmer fails to meet the B.C. industrial limits as well. At the plant site and one mile northeast thereof the B.C. residential and commercial dustfall limits are met. By the highway, three miles northeast of the plant site the B.C. industrial limits are met.

AQUATIC RESOURCES

IDENTIFICATION AND DESCRIPTION OF DRAINAGES

In the area of the proposed development, surface drainage on the west slope of Hosmer Ridge collects into one creek referred to locally as No-name Creek (Figure 4). The creek is approximately 7.5 mi (12 km) long receiving water from Creeks K2, K4 and Hosmer Creek before entering the Elk River as Hosmer Creek at the town of Hosmer. The total drainage area is 3568 ac (1445 ha). No-name Creek is characterized by steep gradients on the slopes of Hosmer Ridge but changes to a low gradient stream in the valley bottom near the proposed tailings pond. (Apply overlay to Figure 4).

Other drainages in the area are the beaver ponds below the highway and south of the Provincial Park. All of the drainages listed above are discussed in detail below with respect to physical characteristics for the purpose of subsequently assessing fish habitat.

No-name Creek

No-name Creek was surveyed on foot from above Creek K5 to its confluence with the Elk River. On the basis of this survey, the creek was divided into seven reaches (Figures 5 and 15) which are described below and summarized in Table 5.

Reach NA. This reach represents a portion of the steep gradient section of No-name Creek. The creek flows over rocks in a stepped sequence of riffles and pools. The surrounding terrain creates a deep entrenchment and the surrounding coniferous vegetation provides thick cover (Figure 16).

The streambed consists mainly of gravel and rock, but some deposits of sand and coal fines are evident. Portions of the surrounding bank contain fine textured materials and coal particles. The channel is narrow and confined throughout the reach.

At present, Crows Nest Industries (CNI) is logging hillsides adjacent to this reach of No-name Creek and as a result sediment is evident downstream (Figure 17).

Reach NB. This reach begins just upstream of the CNI logging bridge and extends through the region near the proposed tailings pond. The reach has an lower gradient than Reach NA, averaging 11%. Vegetation surrounding the creek opens up to typically mixed forest and meadow vegetation. The channel widens but remains single. Entrenchment is medium in this reach. Vegetative cover is still abundant (Figure 18).

Reach NC. This reach begins when No-name Creek reaches the valley bottom and is characterized by a low gradient, lack of cover and abundant side channels (Figure 19). The creek is slow moving and pools are created where bottom gravel has been scoured. The bottom material is predominantly gravel and sand. The surrounding vegetation is mainly meadow with few shrubs and trees. Entrenchment in this reach is low because of the low gradient and the soft bank materials. As a result, the channel configuration appears somewhat unstable; during peak flows water may occupy several small channels. During periods of low flow this reach can dry and flow subsurface.

Reach ND. The reach flows through the valley bottom vegetation which ranges from closed deciduous forest to meadow. The bank and bottom material is fine textured and silty. The creek is slow moving and debris and organic matter litter the bottom. Deep pools (approximately 1.5 m) are formed where debris builds up or bottom material has been scoured away. This reach is similar to Reach NC in experiencing intermittent flow and shifting channel configuration. A large beaver pond exists at the lower boundary of this reach just upstream of the main highway (Figure 20). Numerous surrounding areas adjacent to this reach are marshy and appear to be collecting seepage from the upland slopes.

Reach NE. This reach is not part of the main channel of No-name Creek, but is a drainage which collects seepage from the valley into a channel alongside the highway (Figure 21) parallel to No-name Creek.

It is a straight channel confined to a trench beside the highway and flows into No-name Creek at the highway crossing. Some sections are covered by thick overhanging shrub, but the remainder is exposed. Bottom material is gravelly. The flow is swifter than in Reach ND because of the confined channel.

Reach NF. This is the longest reach of the creek and extends from the highway crossing to the community of Hosmer. Old beaver dams are common throughout the reach and the channel exhibits alternate stretches of ponding behind dams and reaches of flowing water over a gravelly substrate (Figure 22). Table 5 summarizes the characteristics of the flowing portions of this reach. Beaver ponds behind dams are mapped in Figure 5 and are characterized by silty bottoms with large amounts of accumulated organic debris. In some ponds dense growths of algae or sedges occur in the shallow areas (Figure 23). No active beaver dams were observed and none of the existing old dams appeared to cause a blockage for fish. The bank material is silty gravel. The creek flows through some cultivated land. Some tree and shrub cover occurs throughout most of the reach. The channel widens considerably in this reach as the creek approaches the Elk River.

Reach NG. This is a short reach just below the town of Hosmer where the creek cuts through gravel and enters the Elk River. It flows as a shallow riffle. Streambank vegetation is largely deciduous and mixed forest.

Creek K2

Creek K2 is a small drainage which exits from a draw in Hosmer Ridge above the proposed plant site and drains approximately 616 ac (249 ha). During the summer of 1976, Creek K2 disappeared below ground in the valley bottom. Flow was estimated at less than 0.5 cfs. The upper flowing portion cascades over rocks.

Creek K4

This creek is larger than Creek K2 (823 ac, 333 ha) and maintained surface flow through the summer of 1976. Discharge values for this creek at the highway crossing were in the order of 0.5 cfs during July, 1976 (Table 6), but later in the summer, flow was well below this level.

Beaver Ponds

Below the main highway, water is collected into No-name Creek and a series of large ponds which extend from the Provincial Park to the Elk River (Figure 5 and 24). These ponds were formed by beaver activity and although most are now deserted, the old dams still retain water. The uppermost dam near the Provincial Park is isolated from those downstream and appears to prevent fish movement. The ponds range in depth from about 0.5 m to 2 m. Dense aquatic vegetation dominates the shallow areas, while deposits of fines and organic matter litter the bottom. A smell of hydrogen sulfide emanates from disturbed bottom sediments in these ponds. Eventually, flow from these ponds reaches the Elk River via two small drainages (Figure 5). The downstream portion of these ponds connects with No-name Creek. The ponds generally lie in open meadows, tree-shrub or mixed forest vegetation map units. Some flow occurs in channels between ponds and the bottom material in these channels is often gravelly. However, most of the bottom material in this area is silt.

HYDROLOGY

Results of flow measurements taken in No-name Creek above the valley bottom discontinuously from late May, 1976 are shown in Figure 25 and Table 6. The peak flow measured at the logging bridge above the proposed tailings pond was over 30 cfs in May. Low flow measured was approximately 3 cfs in September. During the observed peak flow the creek level was approaching the existing bank suggesting that actual peak flow level is 1-2 times the observed peak.

Rainfall and temperature data are available only for Fernie (Figure 25) and not locally for the Hosmer-Wheeler area.

The Fernie data show that rainfall was low on June 10, 1976 yet No-name Creek showed an increase in flow of 10.8 cfs. Increased flow may have been the result of increased snow melt, since temperatures increased between June 9 and 10. Between August 10 and 20 flow in the creek steadily decreased while the rainfall in Fernie increased substantially. Since summer rainshowers in this area are very local, rainfall fluctuations in Fernie may not be a useful indicator of flow fluctuations in No-name Creek.

Flow measurements were taken on only two other drainages into No-name Creek (Creeks K2 and K4). Creek K4 was measured in July and had flows of about 10% that of No-name Creek. In September, flow in Creek K4 had virtually ceased at the highway crossing. No measurement was made of Creek K2 at the highway because it is much smaller than Creek K4 and appears to flow at the highway only during runoff and storms. It therefore appears that Creek K2 and K4 combined contribute to less than 20% of the flow of No-name Creek as measured above the proposed tailings pond.

The discharge of the Elk River near Natal is shown in Figure 26. The combined discharge of No-name Creek and its tributary creeks appears to be less than 1% of this flow.

The valley bottom in the region of the proposed development is flat and composed of alluvial gravels. When creeks from Hosmer Ridge reach this area they lose a portion of their flow to subsurface seepage. Creek K2 disappears completely below ground in the region of the plant site. During a survey of the area in October, 1975 a portion of No-name Creek in the valley bottom was dry. A detailed discussion of subsurface flow is contained in a report by R.M. Hardy and Associates (Appendix A). Their report states that subsurface flows from Hosmer Ridge flow through porous gravel material in the valley bottom area of the proposed tailings pond. Pockets of clay exist approximately 20 feet below the surface gravels in the region of the southern area of the proposed tailings pond. Thus, most of the groundwater from the slopes flows through the upper levels of gravel while some is channeled below the clay layer until it eventually recharges the Elk River downslope (south-west) of the proposed tailings pond. On the basis of the groundwater report, it seems likely that the extensive ponds in the Elk Valley below the highway are the result of the high water table in this region and the surfacing of some subsurface flows from the upper valley slopes.

The approximate subsurface flow reaching the valley bottom below the highway was determined by simultaneous surface flow measurements in the upper valley above the highway and in the lower valley (Figure 27). Measurements were takn throughout the drainage area of No-name Creek upstream of the confluence with Creek K4 at sites shown in Figure 4. Flows were measured in No-name Creek above the valley bottom (site A), in the highway drainage (site B), below the road crossing (site C) and downstream of the area where Creek K2 disappears (site F). Other measurements were made of drainage from No-name Creek into the Elk River and from the seepage and beaver ponds near the provincial park (sites D and E). The total flow in No-name Creek above the highway (sites A and B) was 4.8 cfs compared to a flow of 3.7 cfs below the highway (site C), indicating that most of the flow of No-name Creek does collect at one point above the highway before crossing it. The discrepancy in flow between upstream and downstream of 1 cfs was probably a result of measuring error, since flow measurements at site C was impeded by dense aquatic vegetation.

The combined discharges of No-name Creek further downstream (site F) and the other discharges into the Elk River (sites D and E) was 10.9 cfs while the only measureable surface flows above these sites was from sites A and B, totalling 4.8 cfs. Thus, subsurface flow in the valley bottom appeared to be approximately 6 cfs. This flow may represent the water from Creek K2, Transmission Line Creek and the subsurface flow from the development area including that of the proposed tailings pond. The surplus of water in the valley below the highway may therefore represent the reappearance of some seepage water from the Hosmer Ridge slopes.

WATER QUALITY

Water quality analysis results obtained by B.C. Research between October 1975 and August 1976 are shown in Appendix E. Results from analyses performed by Kaiser Resources Environmental Laboratory are contained in Appendix F, and Water Resources Service data for Elk River sites supplied by L.W. Pommen, are reproduced in Appendix G. Summaries of B.C. Research and Water Resources data are given in Tables 7 and 8. Comments in this report will relate principally to the results obtained by B.C. Research.

Surface Water Quality

Seasonal variations in the water quality characteristics of Transmission Line Creek, No-name Creek, K2, K4 Creeks and the Elk River showed normal patterns, with the highest levels of dissolved constituents occurring in fall and winter and decreased levels occurring during the high-flow periods of late spring and early summer (Figures 28-32). Dissolved minerals in the Elk River were below the 11 year summer average (Appendix G) due probably to the higher than normal summer rainfall and river discharge levels.

Therefore dissolved minerals were probably also lower than normal in No-name Creek and its tributaries. Sulphate concentrations in the Elk River were appreciably higher than in No-name Creek.

Dissolved oxygen concentrations were more than 70% of the air-saturation value at all sites. Winter measurements through the ice were not made. Field and laboratory pH reading frequently differed by 0.1-0.3 units. The discrepancy may be due to problems of standardizing the pH meter in the field, or to changes in samples during shipment. Total organic carbon, ammonia and heavy metal concentrations were low, except for iron and on occasion, manganese. Phenol concentrations were two to three times those levels recommended for drinking water. Increased iron levels were associated with high run-off conditions caused by snow-melt or rainfall. Concentrations of iron at sites KB and KD reached 0.2-0.5 mg/litre.

Changes in the levels of dissolved minerals along No-name Creek under fall, winter, spring and summer conditions are illustrated by Figures 33-36. Water in the upper region of No-name Creek is moderately hard on the scale used by Durfor and Becker (1964). The dissolved mineral content increases downstream with contributions of higher hardness water from K5 and K7 Creeks. There was negligible increase in dissolved constituents in No-name Creek between KC and KB, but considerable accumulation of dissolved minerals occurred along the lowlands between KB and KG. Appreciable additions to flow from subsurface seepage is indicated in this area (see Hydrology). At the mouth of Hosmer Creek at the junction with the Elk River, levels of dissolved constituents were lower than at site KG, presumably due to contributions from Hosmer Creek.

Suspended solids concentrations in the various streams are shown in Figure 37. Approximate suspended solids loadings based on flows measured at site KB on No-name Creek are given in Table 9. The high loading on August 9, 1976 followed heavy rains. Suspended solids levels and the turbidity of No-name Creek increased at successive downstream sites (Figures 38-41). The limited data available indicate that some solids settled out between KD and KG and the water transparency improved.

Corresponding data for the Elk River are given in Figure 42 for two occasions during the spring and summer of 1976. Minimal changes in water quality were detected through the section of the Elk studied. Influx of No-name Creek water appeared to have no consequential effect on the chamical characteristics of the Elk River, except for small increases in manganese and ammonia concentrations.

Groundwater Quality

A limited number of samples from wells in the area has been obtained to date. As would be expected, dissolved minerals in all groundwater samples were higher than in surface water samples, although sulphate concentrations were lower than those present in the Elk River. The pH of groundwater samples was also generally lower than of those collected from creeks and the Elk River. Dissolved heavy metal concentrations in certain samples are noteworthy. For instance, samples obtained on July 11, 1976 from drill-holes G1 and G2 contained 0.84 and 0.16 µg/l mercury (Appendix E - 24 and 25); a zinc concentration at 0.17 mg/l was found in the sample from the campsite well at Elk Valley Provincial Park (Appendix E - 27); iron levels in household water supplies HTW1 and HTW2 exceeded the Provincial drinking water standard of 0.3 mg/l (Appendix E-27); and manganese levels were high in the sample from well G4 (Appendix E - 26). The contributions from well casings and domestic plumbing to dissolved metal levels in these instances are not known but are logically suspect. Ammonia levels were moderately high in HTW1, HTW2 and G1 (August 20, 1976) samples, and the nitrate concentration in well G2 on July 6, 1976 was considerably above that in the other subsurface samples.

Mineral contents of water obtained from wells G1 and G2 were similar, with the exception of iron and nitrate levels, which were appreciably higher in well G2 than in G1 on July 7, 1976; and ammonia which was much higher in well G1 on August 20, 1976. However concentrations of dissolved inorganic constituents were appreciably less in well G4, upslope of the proposed tailings pond location, than in the downslope wells G1 and G2.

Concentrations of dissolved constituents in the effluent and thickener overflow at Kaiser's Sparwood plant are shown in Table 10 and are generally lower than levels of dissolved inorganic materials in the groundwater at the Hosmer-Wheeler development site (Appendices E - 24 to E - 27).

Coal Leachate Analysis

Results of the coal leachate analysis performed on adit coal samples are shown in Table 11.

From experience it is known that the coal in the tailings will be alkaline. To create the most unfavourable leaching conditions conceivable, the leaching test was initiated in acid solution (pH 4) and conducted at 100^{o}F.

Metal concentrations in the leachage were all lower than the PCB Level A objective for effluent discharges for mining, mine-milling, smelting and associated industries. Even if the tests had been performed with a pulp density of 200 g/250 ml, none of the metal values would have exceeded level A objectives. It is extremely unlikely that higher metal levels could be obtained under neutral or basic conditions. Thus, it is reasonable to conclude that the seepage from the future tailings pond will meet PCB Level A objectives.

FISH SPECIES PRESENT

Fish sampling stations in September in the Hosmer area are shown in Figure 5 along with a summary of fish captured at each site. Fishing effort at each site is described in Table 12. The species captured were cutthroat trout, Dolly Varden char, eastern brook trout, longnose dace and longnose suckers. Specimens are listed in Appendix H.

Yellowstone Cutthroat Trout

Yellowstone cutthroat trout (Salmo Clarki) are common to most watercourses in the East Kootenays and exist in small mountain drainages at over 8,000 ft elevations (Scott and Crossman, 1973). In the Hosmer area cutthroat were only found in upper reaches of No-name Creek (reaches NA, NB, NC, ND), and were the only species inhabiting the upper reach NA (Figure 5). Trout were abundant in these reaches and were captured by shocking at a rate of 0.60 to 2.16 fish per minute (Table 13).

Fish captured ranged in size from 7.9 cm to 21 cm (Figure 43). Although ages were not determined for these fish, they appeared to be predominantly young fish below the normal size (approximately 30 cm) for adult non-coastal cutthroats (Scott & Crossman, 1973).

In keeping with the preference of trout for gravelly streams they were captured in reaches of No-name Creek characterized by steep gradients and gravel and rock bottoms. These reaches also contain areas of spawning gravel.

Cutthroat trout are spring spawners and the presence of trout in the upper reaches of No-name Creek in September suggests that they may overwinter there in deep pools. Young trout are known to spend their early life in small gravelly spawning streams, such as the upper portion of No-name Creek (Scott & Crossman, 1973).

Trout observed in No-name Creek may later migrate downstream to the Elk River. Blockages caused by beaver dams and debris may hinder upstream spawning migrations, but would probably not intefere with the downstream movement of young fish. The absence of cutthroat trout from the lower reaches of No-name Creek suggest that no fish were moving downstream at the time of sampling.

Eastern Brook Trout

Eastern brook trout (Salvelinus fontinalis) were the most abundant fish captured in No-name Creek and were found in all reaches of the creek (except reach NA) and in the beaver ponds near the Provincial Park. This species was most abundant in Reaches NB and NE of No-name Creek.

Brook trout are fall spawners and usually migrate upstream to reach spawning grounds. Spawning areas are usually clear, gravelly headwaters of streams. Eggs once deposited in the gravel depend on a good supply of oxygen to develop (Scott & Crossman, 1973). Sexual maturity of brook trout captured in September in No-name Creek indicated that the species was approaching spawning condition. Several males already had flowing milt (Appendix H).

The size range of fish captured was 5 to 26 cm (Figure 44). A large number of small, young fish were captured in reaches NC and NE where the habitat appears most suited to spawning and rearing. These drainages contained clear water flowing over a smooth gravel substrate. Adult fish were scattered and appeared to be present in the deeper sections of the creek and in beaver ponds and pools.

Although, this species probably migrates seasonally, the pools and beaver ponds in reaches ND and NF of No-name Creek appear to offer suitable over-wintering habitat even during severe winters.

Dolly Varden Char

Only one specimen of Dolly Varden (Salvelinus malma) was captured in the area in September (Appendix H). This was in reach NA of No-name Creek. The extremely low incidence of this species suggests that they are not normally present, since other individuals, especially young, would normally occur if the creek was used regularly for feeding or spawning. It is possible, however, that Dolly Varden may migrate upstream in late fall to spawn and return to the Elk River. It is also possible, but unlikely, that young fish may return downstream the following summer.

Longnose Dace

Longnose dace (Rhinichthys cataractae) were found in a clear flowing side channel (reach NF) of No-name Creek where the bottom was clean gravel (Appendix H). This species, a common minnow, is widely distributed in Canada and is important as a forage species. The species is reported to be resident in clean, gravelly regions of watercourses (Scott & Crossman, 1973).

Longnose Sucker

Longnose suckers (Catostomus catostomus) were found in the lower reaches of No-name Creek and the beaver ponds near the Provincial Park (Appendix H). The species is widespread in Canada and their presence is not unexpected in No-name Creek and associated watercourses. They are spring spawners and migrate upstream to spawn, preferring gravelly spawning areas (Scott & Crossman, 1973). They are common to water bodies with silty bottoms; the silty reaches of No-name Creek and the beaver ponds near the Park appear to be suitable habitat for longnose suckers. A resident population of suckers appears to exist in the beaver pond nearest the Park where 52 individuals were captured in a trap in two days. No other fish species were captured in this isolated pond.

FISHERIES EVALUATION

On the basis of stream habitat considerations and fish sampling, No-name Creek appears to offer excellent habitats for eastern brook trout and cutthroat trout. Eastern brook trout are more numerous and more widely distributed than cutthroat trout in No-name Creek. Longnose dace and longnose suckers are not important as game fish.

Cutthroat trout are limited to reaches NA, NB and NC where habitat for spawning, rearing and overwintering occur. Size ranges of fish captured suggested that these areas are used by young fish. Older fish probably migrate downstream.

Eastern brook trout appear to utilize all sections of No-Name Creek except the steeper Reach NA. Within the development area, reaches NC and NE are important for spawning and rearing of this species. Other reaches provide predominantly feeding and overwintering areas with limited spawning potential. Adult fish were common in deep beaver ponds and slow moving sections of No-name Creek, while young fish frequented the clean faster moving reaches. In general, both cutthroat and brook trout require creek segments similar to reaches NA, NB, NC and NE which are generally clear and provide clean spawning gravel.

Beaver ponds which occur near the Provincial Park and south to the Elk River provide habitat for brook trout and longnose suckers. Fish movements appear to be possible between most of the ponds, No-name Creek and the Elk River. The outlet of the pond nearest the Provincial Park (fish sample site FS-2) [Figure 5]) was blocked by a beaver dam during the September field trip.

TERRESTRIAL RESOURCES

SOILS

Land forms and surficial materials were mapped for the study area (Figure 6). Soils were mapped for the development area and immediately adjacent areas only. Each soil mapping unit represents a subdivision of surficial materials and also an individual soil subgroup or an association of two or more soil subgroups based on individual soil or soil association properties.

Lowland Areas

The lowland areas are characterized by a number of river cut terraces having a fluvial sand and silt capping of varying thickness overlaying very coarse stony gravels. Soil development is dependent on the age and the amount of disturbance of each terrace. The major soil orders mapped in these areas were Regosols and Brunisols. A total of six soil mapping units were delineated in the lowland area.

Soil mapping unit 1a

This unit occurs along the bank of the Elk River and extends up to three meters above the average river level. The topography is undulating as a result of meander scars left from previous river channels. The parent material consists of a capping of fine textured fluvial sand and silt overlaying coarse stony gravels of unknown depth. The surface fluvial capping varies in depth from a few centimeters up to two meters. The dominant soil subgroup is an Orthic Regosol (Appendix I-1) covering approximately 85% of the unit. These soils have sandy loam to loamy sand surface horizons overlaying coarse stony gravels. The soils are well to rapidly drained but are subjected to exceptionally high water table levels during freshet conditions. Carbonates are commonly detected in the surface horizon and are generally encountered within 50 cm of the surface. The subsurface stony gravels are extremely calcareous.

Soil mapping unit 1b

This unit is very similar to unit 1a but is differentiated on the basis of a greater number of depressed areas and numerous drainage channels. The topography is gently undulating and depressional. Orthic Regosols cover approximately 60% of the unit while a Rego Gleysol subgroup covers about 40% (Appendix I-2). During most of the year and especially during freshet conditions the water table is at or near the surface. Carbonates are present in the stony gravels and occasionally in the lower portion of the C horizon.

Soil inclusions in soil mapping unit 1 comprise less than 10% of the unit and include a Rego Gleysol in soil mapping unit 1a and Rego Humic Gleysol, including a peaty phase in soil mapping unit 1b.

Soil mapping unit 2a

This unit occurs on the lower terraces of the Elk River. Surface expression is similar to unit 1a. The parent material consists of a capping of fluvial silt and sand (10 to 100 cm) overlying stony gravels. The terraces are older and consequently greater soil development has occurred. Two soils are dominant in the unit. In areas where minor disturbances have occurred during past logging, Degraded Eutric Brunisols have developed (Appendix I-3, Figure 45 and Appendix I-4, Figure 46). The soils represent 50% of the unit. An Orthic Eutric Brunisol has developed in areas under deciduous and mixed forest sites (Appendix I-5) and in old river channels (Appendix I-6). The soils are well drained, carbonates are usually encountered within 15 cm of the surface. The stony gravels are highly calcareous.

Soil mapping unit 3a

This unit is similar to unit 2, occurring on higher and older terraces. It is differentiated on the basis of having greater area of Degraded Eutric Brunisols (Appendix I-3, Figure 45; Appendix I-4; Figure 46 and Appendix I-7) and a greater percentage of sand in the fluvial capping. Degraded Eutric Brunisols comprise 85% of the unit. The parent material consists of a capping (10-100 cm) of sandy loam to loamy sand and sandy fluvial material overlaying coarse stony gravels. Soils are well to rapidly drained. Depth to carbonates in the fine fluvial capping varies from 15 to 100 cm. The coarse stony gravels are extremely calcareous.

Soil mapping unit 4a

This unit consists of fluvial fans resulting from side streams entering the bottom lands. The fans radiate from the stream mouths and have been reshaped by the Elk River. For this reason the lower extension of the fans grade into the terraces and have been included within soil mapping unit 3. The topography is gently sloping with a maximum slope of 5^{o} near the apex of the fan. The parent material consists of a capping of up to 20 cm of fluvial sand and silt overlying coarse stony gravels with excessively stony inclusions. The dominant soil, an Orthic Eutric Brunisol (Appendix I-8, Figure 47) comprises over 85% of the unit. The soil is rapidly drained. The fluvial capping is free of carbonates, while the stony gravels are strongly calcareous.

Soil mapping unit 4b

This unit is similar to unit 4a and has been differentiated on the basis of a greater cover of Degraded Eutric Brunisol soils and the presence of a clay loam matrix in the surface portion of the stony gravel layer (Figure 48). The dominant soil is an Orthic Eutric Brunisol (Appendix I-8) which covers 60% of the unit. Degraded Eutric Brunisols (Appendix I-4) have developed under closed coniferous forest stands growing on a fluvial capping of up to 100 cm.

Soil mapping unit 5a

This unit occurs on the upper partially degraded terraces adjacent to the upland area. These are the oldest terraces in the Elk Valley and rise approximately 10 meters or more above unit 3. The parent material consists of stony gravelly sand deposits derived from highly calcareous till. The dominant soil, comprising over 80% of the unit is an Orthic Eutric Brunisol (Appendix I-9, Figure 49). Soil inclusions comprise less than 10% of the unit and include a Degraded Eutric Brunisol. The soil is rapidly drained. Carbonates are present within 15 cm of the surface.

Soil characteristics

The lowland soils are characterized by a fine fluvial capping overlying coarse gravelly fluvial material. Textures vary from sandy loam to silty clay loam in the fluvial capping, to very gravelly loam to sandy loam in the underlying fluvial layer (Table 14). Surface textures become coarser closer toward the Elk River as sand content increases.

The pH (Table 15) of the fluvial materials is strongly acid to neutral (3.8 to 6.6) depending on the presence of calcium carbonate. Exchange capacity ranges from approximately 10 to 60 me/100 grams and can be considered to be low to moderate. Exchangeable cations follow a Ca>Mg>K>Na relationship. Base saturation ranges from low to high (9.4% to 100%) but is generally greater than 50%. Electrical conductivity values are low (less than 0.5 mmhos/cm).

The nutrient status for the lowland soils is moderate to high. The distribution of available cations in lowland soils is variable; available Ca, Mg and K range from 68 to 25,200 ppm, 25 to 870 ppm and 30.5 to 435.0 ppm, respectively (Table 16). Potassium is more abundant in the surface horizon and decreases with depth while both Ca and Mg show considerable variation with depth. Nitrogen is highest in surface horizons and ranges from 0.031% to 0.3%. Organic matter ranges from a high of 23.23% in the surface horizons to 1.41% at depth. Available P ranges from 2.2 to 83.6 ppm showing a decreasing trend with depth. Boron values are low ranging a high of 0.23 ppm to a low of 0.07 ppm. Heavy metals values are low.

Upland Areas

The upland areas are characterized by moderate to very steep slopes. The area is bedrock controlled with bedrock being encountered within 1.5 meters of the surface except in depressional or gully areas where surficial materials may be up to 6 meters in depth. The lower undulating and hummocky topography is covered mainly by colluvium or till parent materials. In the gullies and depressional areas, water worked colluvium or till or a combination of the two and colluvium over till may exist.

On the upper slopes, bedrock is usually encountered within a meter of the surface. Colluvium is the dominant parent material although occasionally it is mixed with till especially in the gullies and depressional areas. The till is noncalcareous and ranges from a gravelly sandy loam to gravelly loamy sand texture. Soils developed on this material are Eutric Brunisols belonging to the Orthic, Degraded and Lithic subgroups. Textures of the colluvium vary with bedrock type ranging from conglomerate to claystone. Soils developed on shallow colluvium include Degraded or Lithic Dystric Brunisols while on deep colluvium in seepage areas Orthic Humo-Ferric Podzols have developed. A total of 10 soil mapping units were delineated for the upland area.

Soil mapping unit 6a

This unit consists of a rolling undulating and slightly hummocky topography. The parent material consists of both till and colluvium, usually less than a meter in thickness. The prominent soil is a Degraded Eutric Brunisol developed on till and comprises 70% of the unit (Appendix I-10, Figure 50); on colluvium a Degraded Dystric Brunisol (Appendix I-11) has developed. The soil is well to rapidly drained and noncalcareous although carbonates are occasionally detected below 2 meters in deeper till.

Soil mapping unit 6b

This unit is similar to unit 6a but was differentiated on the basis of steeper slopes and the greater area of colluvium parent material. The dominant soil subgroup is a Degraded Dystric Brunisol developed on till material (Appendix I-12) which covers approximately 70% of the unit. The soils are rapidly drained and noncalcareous. Depth to bedrock averages approximately 75 cm.

Inclusions, comprising less than 10% of the unit, include a Lithic Dystric Brunisol (Appendix I-13) and occasional bedrock outcrops.

Soil mapping unit 7a

This unit occupies the lower portions of No-name Creek and its main tributary, Creek K6. The parent material consists of till, colluvium and colluvium till of extremely variable texture. Soil depth varies ranging from approximately one meter to 6 meters. The soils are rapidly to moderately well drained depending on texture and compaction. Where colluvium/till occurs the colluvium is generally a mixture of till and colluvium that has been partially sorted by water and is usually less than a meter in thickness.

Occasionally buried horizons occur in this deposit indicating past slide activity. Soil texture ranges from gravelly sandy loam to gravelly clay loam and often contains excessively stony inclusions, especially near the drainage channels. The dominant soil is a Degraded Dystric Brunisol (Appendix I-14, I-15 and I-16) which covers approximately 85% of the unit. These soils are usually noncalcareous although in the deeper deposits, carbonates can occasionally occur at depth.

Soil mapping unit 8a

This unit occurs in the gully and depressional areas on the upper slopes. The parent material is colluvium ranging in depth from less than a meter on side slopes up to 6 meters in the gully bottoms (Figure 51). These gullies are remnant slide tracts which have been stabilized by vegetation. Some creep and slumping has occurred on disturbed sites. Drainage is influenced by seepage during most of the year, especially during the spring melt since snow pack is substantial in this unit. Texture is variable and ranges from gravelly loamy sand to gravelly clay loam and gravels where water worked colluvium has been deposited. Excessively stony inclusions occur throughout this unit.

Soil development is variable within the unit and depends primarily on the amount of seepage activity. A Brunisolic Gray Luvisol (Appendix I-17) covers approximately 50% of the unit while Orthic Dystric Brunisol (Appendix I-18) covers about 30% of the unit. Soils are well to imperfectly drained and are noncalcareous. Weakly calcareous sandstone fragments occurred in pockets.

Soil mapping unit 9a

This unit consists of steeply to very steeply sloping, bedrock controlled high relief ridges which are largely colluvium covered; exposed bedrock is present on the steepest slopes and rock benches. The parent material is less than a meter in thickness except in depressions and high elevation gullies where it can reach a depth of 2 meters or more. The soils are rapidly to imperfectly drained depending on their position in the landscape. Soil texture varies from gravelly sandy loam to silt and clay loam depending on the present bedrock type from which the colluvium was derived. The dominant soils include a Degraded Dystric Brunisol (Appendix I-19 and I-20) which covers 60% of the unit and an Orthic Dystric Brunisol (Appendix I-21 and I-22; Figure 52) which covers approximately 30% of the unit.

The major soil inclusions representing less than 10% of the unit are: an Orthic Eutric Brunisol (Appendix I-23) on extremely dry south facing slopes and an Orthic Humo-Ferric Podzol in seepage areas (Appendix I-17). Lithic phases of all soils occur throughout the map unit.

Soil mapping unit 9b and 9c

These units are similar to unit 9a but have been differentiated on the basis of the following:

- unit 9b is gullied and has a greater area of deep colluvium and a greater occurrence of lithic soil subgroups mentioned above.

- unit 9c contains Brunisolic Gray Luvisols (Appendix I-17, Figure 53) and a greater area of colluvium of over one meter in depth.

Soil mapping unit 10a

This unit occurs on moderate to steep slopes below high elevation gullies. Parent material is variable and includes till, colluvium and colluvium/till of varying depths. Inclusions of water-worked colluvium derived fluvial gravels may also be present. The soils are well to imperfectly drained depending on the amount of seepage received. The dominant soil, a Degraded Dystric Brunisol (Appendix I-24, Figure 54) covers approximately 60% of the unit while 30% of the unit is covered by an Podzolic Gray Luvisol (Appendix I-25). These soils are non-calcareous. Soil depth ranges from approximately 75 cm to more than 6 meters.

Mapping unit 10b

This unit is similar to unit 10a but is differentiated on the basis of greater area of colluvium/till and water-worked colluvium. The dominant soil is a Degraded Dystric Brunisol (Appendix I-24) covering 50% of the unit while an Orthic Dystric Brunisol (Appendix I-18 and I-21) covers approximately 40% of the unit. Major soil inclusions, covering less than 10% of the unit, are a Brunisolic Gray Luvisol in seepage areas (Appendix I-17), a Degraded Dystric Brunisol on fluvial gravels (Appendix I-26) and a Lithic Dystric Brunisol on ridges (Appendix I-13).

Soil characteristics

The upland areas are characterized by colluvium and till parent materials. Soil texture varies considerably ranging from a very gravelly to gravelly sandy loam to clay loam in both parent materials (Table 14).

The soils developed on the colluvium and till materials show similar ranges in soil chemical properties and nutrient status levels (Tables 15 and 16). Soil pH ranges from 3.8 to 5.8 (extremely to slightly acid). Exchange capacity is low to moderate, varying from 10.22 to 59.83 me/100 gm; values are generally slightly lower for the till materials. Exchangeable cations follow a Ca>Mg>K>Na relationship. Base saturation ranges from <10% to 86.4%. Electrical conductivity is low (>0.5 mmhos/cm).

Nutrient status for both the colluvium and till materials is moderate to high. Available Ca, Mg and K ranges from 20.0 to 4540.0 ppm, 7.5 to 615.0 ppm and 25.0 to 490.0 ppm, respectively. Magnesium and K values are highest in the surface horizons and decrease with depth while Ca distribution is variable. Nitrogen ranges from 0.016 to 0.713%; values decrease with depth. Organic matter ranges from a high of 22.80% in the surface horizon to 0.69% at depth. Higher values (up to 68%) were found where coal layers or coal fragments occurred. Available P ranges from a high of 320 ppm to a low of 5.4 ppm. Available boron is low, ranging from 0.03 to 0.15 ppm. Heavy metal levels are typical for these soils.

VEGETATION

The Hosmer-Wheeler study area (Figure 2) falls within two biogeoclimatic zones, the interior Douglas fir zone and the Engelmann spruce-subalpine fir zone (Krajina, 1969). In the study area the interior Douglas fir zone (IDF) occurs on the Elk River valley bottom and extends up the hillside to a maximum elevation of about 4,500 ft (1,372 m). The Engelmann spruce-subalpine fir zone (ESSF) occurs from a minimum elevation of 4,100 ft (1,250 m) and extends to the top of Hosmer-Wheeler Ridge at an elevation of just over 7,100 ft (2,165 m). Very little of the projected surface development lies within this latter biogeoclimatic zone. An area of transitional vegetation which has characteristics of both zones occurs between the two biogeoclimatic zones and may extend over several thousand feet of elevation. The level and extent of the area of transition varies, depending upon aspect, topography, soil, drainage and past history.

A wide diversity of plant communities reflecting the previous variables are found on the study area. Human activities in particular have been extremely important in modifying the vegetation of the valley floor and the lower slopes of Hosmer Ridge. On the valley floor, the original merchantable timber has long since been removed; wildfire, clearing and grazing have also contributed to the lowland vegetation patterns. The accessible lower slopes of Hosmer Ridge have also been logged and extensive areas have been burned; these areas are now largely vegetated with immature forest.

The study area was divided into two major categories: the lowland area which includes the floodplain and river terraces of the Elk River, and the upland area consisting of the slopes of Hosmer Ridge. Based on air photo interpretation and field work the lowland area was mapped into ten vegetation map units while the upland area was mapped into eight vegetation map units (Figure 7). As map units were selected on the basis of air photo interpretation, physiognomy, structure and species composition, the map unit classification does not completely conform to the biogeoclimatic zone divisions. The relationship between major categories, map units and biogeoclimatic zones is shown in Table 17. The data for the map units is shown in Appendix J.

A total of 279 species of vascular plants, bryophytes and lichens were identified on the study area (Appendix K).

Lowland Vegetation Map Units

The lowland areas consist of the floodplain and alluvial terraces of the Elk River. The map units of the lowland areas have relatively level to slightly rolling topography and as the valley runs nearly north and south, have a generally western exposure.

As most of the surface development is to occur on the lowland areas, the vegetation was described in considerably more detail than that of the upland areas: twelve vegetation types were described in the six major map units.

Meadow map unit

The meadow map units consists of open meadow with few trees. These meadows are a result of logging, agricultural clearing, fire and grazing; along No-name Creek many of the meadow areas are a result of beaver activity. As many of the meadow-forming disturbances have now been halted, forest is now generally encroaching on the meadow areas.

The meadows are grazed as a part of CNI's grazing lease operation and as a fire prevention practice. The meadow areas are particularly important as part of ungulate winter range complex of the valley bottom. Generally, the meadow areas show evidence of poor range management. In 1976, however, a combination of reduced grazing pressure and good rainfall resulted in an improvement of the meadows in the study area.

Four meadow vegetation types were distinguished in the meadow map unit, largely on the basis of moisture regime: the dry meadow type, the grass meadow type; the shrub meadow type and the wet meadow type. No trees were found on the meadow plots.

Dry meadow vegetation type. This meadow type (Appendix J-2) is characteristic of the excessively drained gravelly alluvial river terraces to the east of the highway.

Shrub cover was generally low although buck brush (Symphoricarpos occidentalis), creeping mahonia (Berberis repens) and Saskatoon-berry (Amelanchier alnifolia) occurred on two of the three plots. On the driest sites pussytoes (Antennaria spp.) were the dominant forbs while under slightly moister conditions ox-eye daisy (Chrysanthemum leucanthemum) was most important. Other common species included common yarrow (Achillea millefolium), wild strawberry (Fragaria virginiana), yellow clover (Trifolium agrarium) and common dandelion (Taraxacum officinale). The dominant grasses were Kentucky bluegrass (Poa pratensis), Canada bluegrass (Poa compressa) and timothy (Phleum pratense). Lichens and mosses were most important on the drier sites and included Cladonia squomosa, Peltigera canina and Polytrichum piliferum.

Grass meadow vegetation type. Of all the meadow types, grass meadows (Appendix J-3; Figure 55) offer the best grazing. They are on the deeper silty soils which lie as a cap over the coarser alluvial materials. Where meadows have been overgrazed such as near salt block locations, thistle (Cirsium spp.) and other weeds were present at the expense of the grass species; in relatively ungrazed locations good forage species such as wild vetch (Vicia americana) and clover (Trifolium spp.) were found.

The most important shrub was buck brush, while Canadian buffalo-berry (Shepherdia canadensis) and willow (Salix sp.) were found on two of the three plots; several other species were found as well. The most important forb was wild strawberry while common yarrow, cut-leaved anemone (Anemone multifida), Canada thistle (Cirsium arvense), tall buttercup (Rannunculus acris) and ragwort (Senecio integerrimus) were important as well. The grasses were the dominant vegetation layer: Kentucky bluegrass was the most important grass on the plots followed by timothy. The moss, Brachythecium plumosum was extremely important on one plot.

Shrub meadow vegetation type. In this meadow type (Appendix J-4) the shrub layer by definition is extremely important. In some of these meadows the presence of numerous small trees in the shrub layer indicates a fairly rapid transition to forest. Buck brush was found on all three plots while common wild rose (Rosa woodsii) was found on two of the three plots. Many other shrub species were found as well.

The forb layer of this meadow type was quite well developed; wild strawberry was most common followed by Canada thistle while many other forbs were present as well. The most important grasses were Kentucky bluegrass and Timothy. No bryophytes and lichens were found on the plots.

Wet meadow vegetation type. Wet meadows are found mainly to the west of the highway and are characteristic of poorly drained areas including wet areas caused by beaver activity.(Appendix J-5).

Important shrubs include green alder (Alnus crispa) and willow. Large shrubs were common. Forbs were not well represented although water hemlock (Cicuta douglasii), common horsetail (Equisetum arvense) and wild mint (Mentha arvensis) were characteristic of the wet meadow type. The most important sedges were beaked sedge (Carex rostrata) and sawbeak sedge (Carex stipata), although many other sedges, rushes and grasses were found. Bryophytes were relatively unimportant although Brachythecium plumosum was found on all three plots.

Tree meadow map unit

The tree meadow map unit consists of two vegetation types: the coniferous tree-meadow type, and the deciduous and mixed tree-meadow type. These vegetation types show characteristics of both meadow and forest. The trees are widely spaced or grouped in small clumps while the meadow occurs either among the trees or in larger openings between the clumps of trees. These vegetation types have fair to good capacity for domestic grazing and are important as wildlife habitat, particularly ungulate winter range.

Much of the map unit is reverting to closed canopy forest cover although reversion rates appear variable.

Coniferous tree-meadow vegetation type. This vegetation type (Appendix J-6; Figure 56) is usually characterized by the presence of lodgepole pine (Pinus contorta) although some white spruce (Picea glauca) and Douglas fir (Pseudotsuga menziesii) occur (Douglas fir was not found on any of the plots). The lodgepole pine on all the plots of this vegetation type appeared to be similar in age to the low elevation young forest of the upland areas (50-65 years). The shrub cover was quite extensive; white meadow sweet (Spiraea lucida), buck brush and common wild rose were most important although many other species of shrubs were found as well. The most common forb was wild strawberry followed by nuttall's pussy-toes (Antennaria parviflora). Common yarrow, pussy-toes (Antennaria neglecta), ox-eye daisy, northern bedstraw (Galium boreale) and wild vetch were found on two of the three plots.

The grasses were reasonably well represented; pine grass (Calamagrostis rubescens), Kentucky bluegrass and timothy were the characteristic species. Bryophytes and lichens were quite important and included Cladonia squamosa, Peltigera canina, Pleurozium schreiberi and Polytrichum juniperinum.

Deciduous and mixed tree-meadow vegetation type. This vegetation type (Appendix J-7) is similar in vegetative structure to the previous type; deciduous and/or deciduous-coniferous tree mixtures are interspersed with meadow. This vegetation type usually offers better domestic grazing capacity and wildlife habitat than the previous vegetation type.

The tree layer includes most species present in the lowland areas. The shrub layer was extremely variable; buck brush and Canada buffalo-berry appear to be the most important shrubs. The forb layer was more diverse than that of the coniferous tree meadow type and included wild strawberry, northern golden rod (Solidago multiradiata), star-flowered Solomon's-seal (Smilacina stellata); many other species were present as well. The grass component of the vegetation was also variable and included brome grass

(Brome pumpellianus), timothy and Kentucky bluegrass. The moss Brachythecium plumosum was found on all three plots.

Tree-shrub map unit

Only one vegetation type was described for this map unit, the deciduous and mixed tree-shrub type.

Deciduous and mixed tree-shrub vegetation type. This vegetation type (Appendix J-8) is characterized by a thick shrub layer and relatively low tree cover. It usually occurs on moist sites such as the seepage receiving areas at the foot of Hosmer Ridge or around the beaver ponds. The vegetation type is important as moose habitat; many of the shrubs showed signs of moderate browsing.

The most important trees were balsam poplar (Populus balsamifera) and aspen (Populus tremuloides) although birch (Betula papyrifera) and several coniferous species also occurred at lower cover values on the plots. The shrub layer was extensive, in some cases so thick as to be almost impenetrable. Green alder, saskatoon-berry, white birch and Bebb willow (Salix bebbiana) and mountain maple (Acer glabrum) were present in the upper shrub layer. The lower shrub layer was composed of red-osier dogwood (Cornus stolonifera), wild gooseberry (Ribes oxycanthoides), rose, Bebb willow, and buck brush with other species occurring as well. The forb layer was varied and included common horsetail, sweet-scented bedstraw, nettle, star-flowered Solomon's-seal and western meadow rue (Thalictrum occidentale) among other species.

A variety of grasses and sedges were found but with low individual cover values. Brachythecium plumosum was found on three plots while Plagiomnium ellipticum was extremely important on one plot.

Coniferous forest map unit

The coniferous forest map unit was divided into two vegetation types: the lodgepole pine type and the coniferous tree mixed type. These second growth lowland forests are important for present and future timber production. In addition, they provide wildlife habitat. These vegetation types are generally unsuitable for domestic grazing.

Lodgepole pine vegetation type. This forest type (Appendix J-9; Figure 57) is the result of a forest fire and is composed almost entirely of even-aged lodgepole pine (in the study area about 75 years of age). Most stands are over-stocked and have stagnated. Even if treated (cutting and thinning) the stands would probably never be suitable for dimension lumber but could now be harvested as posts and rails. The shrub layer is fairly well-developed; important species include white meadow sweet, red twin-berry (Lonicera involucrata), Canadian buffalo berry and thimble berry (Rubus parviflorus). The forb layer is variable and includes bunchberry (Cornus canadensis), heart-shaped arnica (Arnica cordifolia) and pea vine, as well as many other species. Pine grass is the dominant grass species. The bryophyte layer is quite diverse although most species occur at low cover values.

Coniferous tree mix vegetation type. Many of the trees of this vegetation type (Appendix J-10) are of merchantable size. Last winter (1975-76) some of the better stands in the study area lowlands were logged (Figure 7). The stands appear to be about the same age as the lodgepole pine vegetation type. The greatest basal area found on the plots was 45.8 m^2/ha.

The tree cover of the plots consist mainly of western larch (Larix occidentalis), Douglas fir and lodgepole pine in about equal proportions. The low shrub layer was very well developed and consisted mainly of white meadow sweet, Canada buffalo-berry, saskatoon-berry and thimble berry. The forb layer consists of twin flower (Linnaea borealis), bunchberry, evergreen violet (Viola orbiculata) and pea vine with several other species occurring at lower frequencies and cover values. The grass layer is sparse, consisting mostly of pine grass. Bryophytes and lichens are well represented but with low individual cover values.

Deciduous forest map unit

Only one vegetation type was described for this map unit, the closed poplar type.

Closed poplar vegetation type. This vegetation type (Appendix J-11; Figure 58) is utilized as shelter and browse by big game, particularly moose. Many of the palatable shrubs showed moderate browsing.

The forest consists of stands of balsam poplar with aspen and Douglas fir. Some of the balsam poplar were extremely large; the largest tree found on a plot was 35 metres in height with a dbh (diameter breast height) of 59 cm. An upper shrub layer of green alder and Bebb willow was found on the plots. Dogwood and red twin-berry were typical of the lower shrub layer. The forb layer was quite variable and included common horsetail, sweet-scented bedstraw (Galium triflorum) and star-flowered Solomon's-seal. In wetter areas, nettle (Urtica lyallii) occurred with relatively high cover values. Fringed brome grass (Bromus ciliatus) was found on all three plots. Moss cover was typically very low.

Mixed forest map unit

The mixed forest map unit on the study area has some merchantable timber although volumes per acre are low and do not warrant harvesting at the present. The mixed forest map unit was divided into two vegetation types: open mixed forest type and closed mixed forest type. The open mixed forest type with less complete canopy and greater shrub and understory layers has a better capacity for browsing and grazing than the closed mixed forest vegetation type.

Open mixed forest vegetation type. This vegetation type has by definition relatively low tree cover values (Appendix J-12; Figure 59). The composition of the tree layer was extremely variable, composed of a wide mix of coniferous and deciduous species. The highest basal area found on the plots was 13.8 m^2/ha. The shrub layer is extremely rich with many species occurring on each plot. The most important species were: saskatoon-berry, Canada buffalo-berry, buckbrush and mountain maple. The forb layer was also quite rich showing considerable variation and diversity on the plots. Only wild strawberry and showy aster (Aster conspicuus) were found on all three plots. The grasses showed a species diversity as well; bearded wheat grass (Agropyron subsecundum), pine grass and timothy were found common to all three plots. Bryophytes and lichens did not have high cover values although Brachythecium plumosum was found common to all the plots.

Closed mixed forest vegetation type. This forest type (Appendix J-13) has by definition a greater canopy coverage than the previous forest type. Basal area is also greater; two plots had basal areas of 36.8 m^2/ha. On some of the better sites timber has nearly reached merchantable size and will probably be harvested in the near future. Due to the relatively closed canopy this vegetation type has a low browsing and grazing potential. The tree layer is similar in species composition to the previous vegetation type. The shrub layer is extremely rich but because of the closed canopy has lower cover values than the previous forest type.

Important shrub species included Canada buffalo-berry, common wild rose, dogwood, saskatoon-berry and white meadow sweet with many other species occurring as well. The forb layer also shows considerable species diversity and includes wild strawberry, wild sarsaparilla (Aralia nudicaulis), heart-shaped arnica, bunchberry and evergreen violet. Grasses were present in low cover values; the most important species was pine grass. The dominant moss is Brachythecium plumosum.

Disturbed lands map unit

These areas include borrow pits, gravel pits and disturbed yard areas associated with the railroad right-of-way. Vegetation was not described for this map unit or the three following map units.

Agricultural lands map unit

Several cultivated fields are located on either side of the highway just north of the town of Hosmer. In the summer of 1976 the land was mostly in forage crops (Brome-clover forage mixtures) although one field was in cereal grain. Several fields are apparently being allowed to return to natural vegetation.

Developed lands map unit

These areas include the picnic site at the Elk Valley Provincial Park, the yards around farm buildings and the residential areas of the town of Hosmer.

River bars map unit

These areas include the relatively unvegetated sand and gravel bars along the Elk River. These areas are unstable and subject to change with changes in the river's course.

Upland Vegetation Map Units

Upland vegetation units occur on the slopes of Hosmer Ridge above the valley floor. Exposure is generally western although in some of the small drainage valleys, north and northeast slopes occur. Slopes are generally more pronounced at higher elevations.

As little development is scheduled to occur in the upland areas, vegetation was not described or mapped as intensively as the lowland areas; vegetation types were not described within map units. A total of eight upland vegetation map units were delineated.

Hillside meadow map unit

This map unit (Appendix J-14; Figure 60) is characteristic of many of the steeper west facing slopes on Hosmer Ridge. Sun, wind and excessive dryness generally prevent the establishment of trees, although some of the meadows which are the result of logging or recent fires are being re-invaded by forest. As hillside meadows are windswept in winter, they are extremely valuable as winter range for big game. In early spring due to the warming effect of the early sun, they provide the first new grazing. As this map unit includes meadows from all elevations on Hosmer Ridge there is considerable variation in the species composition.

Trees were not found on the plots although individual trees and clumps of trees are found in this map unit. The shrub layer is often quite extensive and includes a small tree component consisting of lodgepole pine, balsam poplar, mountain maple and Douglas fir. Other shrubs include saskatoon-berry, common wild rose, Canadian buffalo-berry, buck brush and ground juniper (*Juniperus communis*). Forbs are extremely variable depending upon elevation: typical meadow forbs consist of common yarrow, nodding onion (*Allium cernuum*), wild strawberry, alum-root (*Heuchera cylindrica*) and goat's-beard (*Tragopogon dubius*). Grasses also vary with elevation: timothy and Kentucky bluegrass were shared by mid-elevation plots while other species occurred only on one plot. Mosses and lichens were most important on the mid-elevation plot.

Upland tree-shrub map unit

The vegetation of this map unit (Appendix J-15) in the study area is a result of relatively recent logging and burning. For the most part this unit is rapidly returning to forest. The vegetation consists mainly of small trees and shrubs, many of which serve as browse for deer and moose.

Tree cover is low, if present at all. Western larch occurred on one plot; tree data were taken from nearby lodgepole pine and Douglas fir. Trees were very small, rarely exceeding 10 m.

The shrub layer is by definition extensive; a large porportion of the shrubs were shrub-sized tree species such as western larch, lodgepole pine, Douglas fir and western red cedar (*Thuja plicata*), of which many were in the upper shrub layer. Other important shrub species included mountain maple, saskatoon-berry, Canadian buffalo-berry, buck brush and green alder. The forb layer was not well developed although wild strawberry, twin-flower, pea vine and yellow clover appeared important on the plots.

Pine grass was the dominant grass species while the most important mosses included *Brachythecium velutinum*, *Pohlia nutans* and *Polytrichum juniperinum*.

Upland mixed forest map unit

In the study area this hillside map unit (Appendix J-16) is found only on the lower elevation slopes around Transmission Line Creek where it often forms a complex with the hillside meadow map unit. It is likely that much of this vegetation map unit is a result of forest regrowth in meadow vegetation. Although very little of this vegetation type is present on the study area it is common locally. Vegetation of this map unit is important as big game range; the shrubs provide winter browse and the west facing meadow areas are important as winter and early spring range. The overstory is relatively open; low tree cover values were recorded for lodgepole pine and aspen on the plots although tree data were taken from nearby Douglas fir as well. The upper shrub layer consisted of mountain maple, trembling aspen and Bebb willow, while the lower shrub layer included Canadian buffalo-berry, common wild rose, white meadowsweet and buckbrush. The forb layer is less well developed; commonly recurring species on the plots included pussytoes, showy aster, few-flowered aster, pea vine and clovers.

Pinegrass was the most important grass on the plots while Brachythecium velutinum appeared to be the most important moss.

Slide vegetation map unit

Slide vegetation (Appendix J-17; Figure 61) is found at mid and upper elevations in steeply sloping creek tracks where snowslides have prevented the establishment of forest. The areas are usually well-watered, due at least partly to late melting snow and characteristically vegetation becomes very dense by mid-summer.

The dominant shrub is usually green alder, often twisted and mis-shapen by the action of creeping snow. Other shrubs include small alpine fir (Abies lasiocarpa), devil's-club (Oplopanax horridum), bristly black current (Ribes lacustre) and thimbleberry. The forb layer includes the large moisture-loving forbs such as cow parsnip (Heracleum lanatum), twisted-stalk (Streptopus amplexifolius), western meadow rue, nettle and false hellebore (Veratrum eschscholtzii). Other forbs include red and white baneberry (Actacea rubra), few-flowered aster (Aster modestus), arrowleaf groundsel (Senecio triangularis) and foamflower (Tiarella trifoliata). Grasses were poorly represented although drooping woodreed (Cinna latifolia) was found on two of the three plots. The most important mosses were Brachythecium spp.

Low elevation young forest map unit

The forests of this map unit (Appendix J-18; Figure 62) appear to have a maximum age of about 70 or 75 years and are apparently the result of a fire or series of fires which burned the lower slopes of Hosmer Ridge. Some of the young forest near the community of Hosmer may be the result of logging as well as fire. The forests of this map unit have little value as big game range.

Tree cover was dominantly lodgepole pine although young forests of mixed conifer species occurred toward the south end of the study area. Many stands are overstocked and have stagnated. The shrub layer generally consisted of Canadian buffalo-berry, thimbleberry, white meadowsweet and mountain maple although in the mixed conifer species forests the shrub layer often had a small tree component of Douglas fir and western red cedar. The forb layer was sparse and few grasses were present. In the young lodgepole pine forest the important mosses were Brachythecium frigidum and Brachythecium velutinum.

Low elevation older forest map unit

Very little of this forest map unit remains on the study area as much of the original forest has been burned or logged (Appendix J-19); low elevation older forest remains only in less accessible areas. The old logging camp, logging roads and skidways are still in evidence along No-name Creek and its tributary K7 Creek. Much of this forest type is merchantable timber; basal areas from 35 to 91 m^2/ha were recorded.

The tree layer consists of a coniferous tree mix dominated by western larch, lodgepole pine and Douglas fir with a minor western red cedar component. In some stands, large older relict western larch are present above the main forest canopy. The lower shrub layer species on the plots included thimble-berry, red twin-berry and white meadow-sweet, while the upper shrub layer consisted of mountain maple, douglas fir and western red cedar. The forb layer is reduced; typical species included mountain arnica, rattlesnake plaintain (Goodyera repens), one-sided wintergreen (Pyrola secunda), foam flower and evergreen violet. Pinegrass was found on only one plot. The lichen and bryophyte layer on the plots showed species diversity and included Brachythecium frigidum, Mnium spinulosum, Cladonia sp. and Peltigera canina although individual cover values were low.

Mid-elevation older forest map unit

Many stands of older mid-elevation forest on the study area contain good merchantable timber (Appendix J-20; Figure 63). These forests appear to be well in excess of 100 years of age; cores at breast height showed unadjusted ages to 114 years. Basal areas of 50 to 60 m^2/ha were recorded on the plots. Thus far, the forests of this map unit have remained largely untouched due to lack of access. However, with the increased interest in the area and the opening of coal exploration roads, Crows Nest Industries began logging operations in the summer of 1976 in this map unit (Figure 64). These forests have low wildlife habitat values although they may be used as shelter by big game.

The forests are composed of Douglas fir, Engelmann spruce (Picea engelmannii), western larch and alpine fir in varying porportions. The shrub layer is variable and was generally greater in moister sites. Important species include thimbleberry, devil's-club, mountain maple and red-twinberry. The forb layer was generally not well developed and consisted of mountain arnica, rattlesnake plaintain, false Solomon's-seal among other species. Grasses were poorly represented. The bryophyte and lichen layer was quite diverse although individual species had generally low cover values.

High elevation older forest map unit

These forests are found on the high slopes of Hosmer Ridge and are best characterized by the presence of white-bark pine (Pinus albicaulis) and grouseberry (Vaccinium scoparium) (Appendix J-21). On less favourable exposures (north, northeast) the influence of this forest extends quite far down the mountainside. Due to the high elevation these forests have low productivity and are generally unsuitable for timber production. They are also unsuitable as winter wildlife habitat, although they may provide some summer big game range. However, they are important for water production and for the protection of the unstable upper slopes of Hosmer Ridge.

The trees are generally well spaced with relatively low total tree cover values. White-bark pine is common at higher elevations; alpine fir and lodgepole pine are usually present as well. Unadjusted tree core ages at breast height of 118 years were recorded. Shrubs included grouseberry, white-flowered rhododendron (Rhododendron albiflorum) and tall billberry (Vaccinium membranceum). The forb layer is variable depending largely on the richness of the site and included mountain arnica and hawkweed (Hieracium spp.) among other species. Grasses and sedges were generally poorly represented. Lophozia lycopodioides and Pohlia nutans were important mosses on one of the plots.

MAMMALS

The ranges of 53 species of mammals coincide with the general area (Appendix L): the occurrence of many of these species in the study area has not yet been documented. Ungulates and furbearing mammals have economic importance for hunting and trapping. Ungulate ranges and numbers are fairly well known for the general Fernie-Sparwood area; much less is known about furbearers and small mammals.

Ungulates

Four ungulates species are known present for the study area: mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), moose (Alces alces) and elk (Cervus elaphus). Mountain goats (Oreamnos americanus) and Rocky Mountain bighorn sheep (Ovis canadensis) occur in the mountains in the general Hosmer area but due to lack of habitat are not expected to occur in the study area.

Mule deer and white-tailed deer

Deer are primarily browsing animals, although they are known to graze in spring and early summer. They do best in habitats composed of a mixture of young plant communities. Much of the lowland and lower upland vegetation of the study area is suitable deer habitat.

The study area alone is rated by CLI (Canada Land Inventory) as deer summer range (Figure 65) with slight limitations for deer production (Class 3) while upland regions are rated as having slight or moderate limitations for deer production (complex of Class 3 and 4). No specific deer winter range has been identified in the study area by CLI although the lower slopes of the upland areas have been described as "fire formed elk and mule deer winter range" (Demarchi, 1967).

The pellet transect survey produced little winter evidence of deer on the study area (Table 18); field reconnaissance also indicated few winter deer pellets throughout the area. It is therefore probable that the study area is not heavily utilized in winter by deer.

The pellet transect surveys are not an adequate base to discuss deer distribution within the vegetation map units and vegetation types. However, on the basis of availability of cover and browse, suitable summer deer habitat in the lowland areas includes the mixed forest, deciduous forest, tree-shrub and tree-meadow vegetation map units and the edges of coniferous forests. In upland areas, summer deer habitat includes the hillside meadow, upland tree-shrub, slide vegatation and upland mixed forest vegetation map units. Important browse species found in these vegetation units include: willow, aspen, red-osier dogwood and saskatoon-berry (Table 19).

In mild winters with low snow accumulation it is probable that the valley bottom and lower slopes of the upland areas provide suitable deer winter range. In lowland areas this would include the mixed forest, deciduous forest and tree-shrub vegetation map units while the upland winter deer range would include hillside meadow, tree-shrub and upland mixed forest vegetation map units.

Both mule and white-tailed deer were observed in mixed forest, and at the edge of a coniferous forest and meadow vegetation map unit and in the upland tree-shrub vegetation map unit above No-name Creek (Appendix M). The relatively low number of sightings and relative scarcity of tracks and droppings suggest that deer population of the study area is not high.

Moose

Moose are primarily browsers preferring young growth of willows, aspen, poplar and in particular red-osier dogwood, although in summer they may also take a variety of forbs, grasses and aquatic plants. The upland region of the study area has been rated by CLI as moderate moose summer range (complex of Class 3 and 4) having slight or moderate limitations for moose production (Figure 65). No moose winter range has been identified in the area by CLI.

The pellet transect survey indicated very low use of the study area by moose. Generally, summer moose pellets were found in pellet plots in grass meadow, hillside meadow, and upland mixed forest vegetation map units while winter pellets were found mainly in mixed forest (Table 18). During general field work, pellets were also noted in the tree-shrub and wet shrubby areas of the closed poplar vegetation type. In both these areas willow and red-osier dogwood were heavily browsed indicating winter use by moose. The only moose observed during the study were a cow and a very young calf sighted along No-name Creek on July 4, although several sets of moose tracks were found in the study area as well (Appendix M).

Generally, the tree-shrub and deciduous and mixed forest vegetation map units have a moderate capability as moose range, providing carrying capacity for moose both in summer and winter, particularly in wetter areas. The upland areas are summer moose range, mostly of low capability.

American elk

Elk are primarily grazers but will also take browse, particularly in winter. In summer they range widely utilizing both upland and lowland habitats. In winter however, they are generally restricted to valley bottoms and open windblown hillsides. The study area provides both summer and winter elk range.

All the study area and land surrounding it have been rated by CLI as elk summer range with slight or moderate limitations (Class 3) and a complex of Class 3 and 4 (Figure 65). Elk winter range (Class 3W) is shown by CLI on the lower slopes of Hosmer Ridge. These areas correspond to the upland vegetation map units: hillside meadow, upland tree-shrub, upland mixed forest and low elevation young forest. This winter range corresponds to the "fire formed" elk and deer winter range identified by Demarchi (1967). Pellet plot evidence suggests that elk are the most numerous ungulate species in the study area. The vegetation types receiving highest general use by elk (Table 18) were the grass meadow vegetation types (0.64 to 1.4 mean pellet groups per plot) and hillside meadow map unit (0.76 to 3.6 mean pellet groups per plot) although the results may be biased due to relatively slower deterioration of pellets on drier sites.

Winter use (1975-76) of the grass meadow and hillside vegetation types was relatively high, ranging from 0.32 to 1.0 and from 0.16 to 0.60 mean pellet groups per plot, respectively. The dry meadow vegetation type showed moderate use in total with light use over the winter. The tree-meadow map unit received moderate general use by elk with moderate use over the past winter. Several coniferous forest and mixed forest vegetation types also showed moderate use by elk. The deciduous forest map unit showed a relatively low use by elk although this result is probably biased as pellets probably deteriorate very rapidly in this vegetation type.

Elk were observed throughout the summer in the study area; observations were most frequent on meadow edges. Well used elk trails were found throughout the upland region and tracks were fairly common on old logging roads and mine development raods. A well used salt lick was found near the log loading ramps referred to in the Archaeological Sites Advisory Board Report (Appendix B).

Elk appear to utilize the study area year round. In summer and fall, use of the area is extensive and include the high elevation areas; winter use appears confined to lower slopes and valley bottom areas. As elk winter range in the area is in relatively short supply, animals which summer elsewhere may winter in the study area.

Browse survey

Red-osier dogwood and willow appear to be the most utilized and important browse species (Table 19: Appendix N); red-osier dogwood was browsed in

80% of the plots in which it was present and showed a mean degree of browsing of 1.86 while willow was browsed in 59% of the plots where it was present and showed a mean degree of browsing of 1.32. Saskatoon-berry and mountain maple was moderately important browse species with mean degrees of browsing of 0.70 and 0.33, respectively. Willow and saskatoonberry were the most common and widespread of the preferred browse species. Several other species including buffalo-berry, common rose and red twinberry, although reasonably common on the plots, were scarcely utilized as browse.

Preferred browse species in the study area were, in decreasing order of preference: red-osier dogwood, willow, aspen, western red cedar, saskatoonberry and mountain maple (Table 19). The distribution of preferred browse species on the transects in the various vegetation types is shown below:

Hillside meadow map unit - Transect 10 30%; transect 11, 26%.
Closed poplar vegetation type - Transect 8, 23%.
Open mixed forest vegetation type - Transect 16, 21%.
Coniferous tree mix vegetation type - Transect 14, 20%.
Coniferous tree-meadow vegetation type - Transect 6, 18%.
Closed mixed forest vegetation type - Transect 7, 15%; transect 15, 5%.

Stanlake and Stanlake (1975) found that in natural communities around the reclaimed McGilvary pit the preferred browse species were willow, mountain maple, cottonwood, saskatoonberry and aspen. Around the reclaimed Erickson pit browse species include willow, aspen, chokecherry, saskatoonberry and cottonwood.

None of the map units or vegetation types of the study area appear to be generally overbrowsed although willow and red-osier dogwood were heavily utilized in some locations; severe browse damage was noticed on some willows.

Furbearing Mammals

Few observations of furbearing mammals were made ; consideration of most species was based on knowledge of habitat. As furbearer species are taken by hunters as big game and by trappers for fur, furbearers as a group have considerable economic importance.

Bears

Black bears (Ursus americanus) were observed several times in the study area (Appendix M). Droppings and tracks were found throughout the study area. All the lowland map units represent good spring and summer habitat for black bears; the coniferous forest, mixed forest and tree-meadow units are probably preferred habitats. Several lodgepole pines in the lowland tree-meadow and mixed forest map units had bark stripped and portions of the cambian layer removed (Figure 66). Jonkel and Cowan (1971) have reported similar findings; this behavior may be the result of a nutritional requirement by bears.

Good black bear habitat occurs in the upland areas of the study area. Jonkel and Cowan (1971) cite "spruce-fir forests" as preferred black bear habitat where there is a well developed understory; older coniferous forests with poor understory are less favourable. Meadows and slide areas are used in May and June. Younger forests including the upland tree-shrub and low elevation young forest vegetation map units of the study area are also good black bear habitat. The higher elevation forests of the study area are less suitable.

Old coking ovens located behind the trailer park in the town of Hosmer are well known locally as black bear denning sites. Several black bears have been reported moving in and out of the coke oven area in the winter of 1975-76.

Grizzly bears (Ursus arctos) or grizzly bear sign was not observed in the study area. The high level of human activity and the ease of access to the study area and immediately surrounding areas has probably eliminated the grizzly bear from the general area, although wandering individuals may occasionally occur in the study area.

Canids

Although only one coyote (Canis latrans) was observed in the study area, evidence of coyote presence in the study area was provided by frequent observations of tracks and scat. Lowland areas are the most favourable coyote habitat including nearly all the lowland vegetation map units; upland older forest vegetation map units are less suitable.

Wolves (Canis lupus) or wolf sign was not observed during the study. All lowland map vegetation map units and lower upland vegetation units have good capability as wolf habitat although human activities have probably eliminated wolves from the study area and surrounding areas.

The status of the red fox (Vulpes vulpes) on the study area is not known. Mr. Jack Williams (Personal communication) a local conservation officer reports that this species has not been recorded in the area in recent years.

Felids

The ranges of three cats coincide with the study area (Cowan and Guiget, 1973): mountain lion (Felis concolor), bobcat (Lynx rufus) and lynx (Lynx lynx). No sightings of cats or sign of cats was recorded during the field work and their status in the area is not known; if cats are present in the study area, their numbers are expected to be low. Much of the study area has good habitat capability for all three species.

Mustelids

Members of the weasel family were not observed during the study and the status of these animals in the study area is unknown. Marten (Martes americana) are expected to occur in the coniferous and mixed forest vegetation map units of the lowland and upland areas. Ermine (Mustela erminea) and long-tailed weasel (Mustela frenata) are expected to occur in the more open habitats at lower elevations. Mink (Mustela vison) are expected to be present on the lowland areas, particularly along streams and in the wet flatlands along the Elk River. Wolverine (Gulo gulo) may be present in very low numbers in the study area and surrounding areas. River otters (Lutra canadensis) if present, will be limited to the Elk River, the lowest portion of No-name Creek and the wetlands along the Elk River.

Rodents

Beaver (Castor canadensis) are largely responsible for the formation of the wetlands of the study area along the Elk River. Beaver were observed in ponds of the Elk Valley Provincial Park and fresh cuttings were evident elsewhere. Many dams were untended and ponds unmuddied and probably empty of beaver; low beaver populations can probably be attributed to overharvest.

Muskrats (Ondatra zibethica) were observed in the study area in the slow moving streams channels of No-name Creek. Muskrat populations did not appear to be high.

Small mammals

A large number of small mammal species are possible for the Hosmer area (Appendix L). Small mammals are an important part of the biologic food chain and serve as food for carnivorous mammals and predatory birds.

The most evident small mammal on the study area is the burrow dwelling Columbian ground squirrel (Spermophilus columbianus). Colonies of ground squirrels occur throughout the meadow and the tree-meadow vegetation types. Populations are greatest in the lowland areas but animals were also observed in the hillside meadows and high elevation talus slopes. Yellow pine chipmunks (Eutamias amoenus) and American red squirrels (Tamiasciurus hudsonicus) were frequently observed in coniferous and mixed forests. The showshoe hare (Lepus americanus) is expected to occur throughout the forested map units up to high elevations. At high elevation, American pika (Ochotona princeps) were observed on talus slopes. Subalpine meadows and talus areas may also support hoary marmots (Marmota caligata) and least chipmunks (Eutamias minimus. Porcupines (Erethizon dorsatum) were observed by geologists working along Sparwood Ridge this summer; porcupine damage to high elevation coniferous trees was observed in the study area.

Three species of small mammals were taken in the small mammal trapline (Figure 8; Table 20); yellow pine chipmunk, deer mouse (Peromyscus maniculatus) and Gapper's red-backed vole (Clethrionomys gapperi). Trapping success was highest in open mixed forest (trapline 1) and lodgepole pine (trapline 4) vegetation types, lower in the closed mixed forest (trapline 2) vegetation type and lowest in the deciduous and mixed tree-meadow vegetation types (trapline 3). Deer mouse were captured with a success ratio of 8.75/100 trapnights. This compares favourably with capture rates reported by Soper (1973) in nearby Waterton Lakes National Park (0.7-24.5 - average 6.20 - captures per hundred trapnights). Gapper's red-backed vole was taken in the traplines with a capture success ratio of 0.62/100 trapnights which is comparable to 0.34/100 trapnights reported by Soper. With the exception of the Idaho jumping mouse (Zapus princeps) populations of other small mammals in the study area are expected to be quite low.

BIRDS

The birds whose breeding ranges (Godfrey, 1966) coincide with the study area are shown in Appendix O; many of these species may not be present in the study area due to lack of suitable habitat. Bird species observed in the study area are shown in Appendices P and Q. Due to the relatively short time spent in the study area these lists are far from complete.

Waterfowl

The study area is classified by CLI as Class 7 land for waterfowl production (lands with such severe limitations that almost no waterfowl are produced); limitations are adverse topography and severe climatic conditions. However, some limited waterfowl habitat is available in the beaver pond areas and the lower portion of No-name Creek. Although several broods of mallards (Anas platyrhnchos) were observed, even in these apparently favourable habitats, waterfowl production is generally low. Common mergansers (Mergus merganser) were observed along the Elk River and in the beaver pond area; a common merganser brood was observed on the Elk River. Several Canada geese (Branta canadensis) were heard calling along the Elk River in early spring.

Raptors

Red-tailed hawks (Buteo jamaicensis) were observed soaring over the study area (Appendix P). Goshawks (Accipiter gentilis) were seen in both upland and lowland forests. An immature bald eagle (Haliaeetus leucocephalus) was observed over the study area ridgetop. American Kestrels (Falco sparverius) were frequently observed on the telephone lines along the highway; one female was observed along the powerline in the study area. Other hawk species may be present in the study area and surrounding areas but were not recorded. An active Osprey nest (Pandion haliaetus) is present in the forest along the Elk River just north of the community of Hosmer Ospreys were frequently sighted along the Elk River.

A Barred owl (Strix varia) was observed in early September in the mid-elevation older forest vegetation type of the study area (Appendix P). Other owl species may be present as well.

The status of eagles, hawks and owls in the study area is not well understood.

Upland game birds

Three upland game birds were observed in the study area (Appendix P); ruffed grouse (Bonasa umbellus), blue grouse (Dendrogapus obscurus) and spruce grouse (Canachites canadensis). Although the study area is within the breeding range of sharp-tailed grouse (Pedioecetes phasianellus) and white-tailed ptarmigan (Lagopus lecurus), due to lack of suitable habitat the presence of these species in the study area is questionable. Ruffed grouse appeared to be the most common upland game bird in the study area. Ruffed grouse drumming was heard frequently in the spring. A female and brood were observed just west of the Elk Valley Provincial Park. The ruffed grouse habitat on the study area consists of the tree-shrub deciduous and mixed forest vegetation map units of the lowlands and the mixed forest and tree-shrub vegetation map units of the uplands.

One blue grouse was observed in hillside meadow near the ridgetop of the study area. Blue grouse numbers and distribution in the study area are not known.

Song Birds

The varied nature of the vegetation cover of the study area provides a variety of song bird habitat; a total of 45 species of song birds were identified in the study area (Appendix Q). The lowland areas of the study area are generally the most highly productive song bird habitat (Appendix Q); highest song bird densities occur in the wetter lowland areas west of the highway around the beaver pond complex.

Other Birds

Common snipe (Capella gallinago) were observed in wet meadows of the study area, spoted sandpipers (Acitis macularia) were found along Hosmer Creek and on the bars of the Elk River. Killdeer (Charadrius vociferus) were particularly common in the disturbed areas which had exposed gravel and standing water. Several nighthawks (Chordeiles minor) were seen over the study area in late summer. A rufous hummingbird (Selasphorus rufus) and several Calliope hummingbirds (Stellula calliope) were observed; several of the Calliope males were observed in territorial display. Belted kingfishers (Megaceryle alcyon) were common along the Elk River, No-name Creek and the beaver ponds.

Several woodpecker species were recorded including: Common flicker (Colaptes auratus), hairy woodpecker (Dendrocopos villosus), pileated woodpecker (Dryocopus pileatus) and Lewis's woodpeckers (Asyndesmus lewis).

RARE AND ENDANGERED SPECIES

The ranges of five endangered wildlife species (Canadian Wildlife Federation, 1970) coincide with the study area: Rocky mountain bighorn sheep, bald eagle, osprey, prairie falcon (Falco mexicanus) and peregrin falcon (Falco peregrinus). These are of little concern for this project. Rocky mountain bighorn sheep range is not present on the study area. Bald eagle and ospreys cannot really be considered endangered species in British Columbia. Neither peregrin falcons or prairie falcons are likely to be present in the study area or surrounding areas.

HUMAN USE

LAND TENURE

Most of the development area and much of the study area is held as deeded land by Crows Nest Industries (CNI). (Figure 2) Other land holdings on the study are as follows:

- Parcel 73 (Dominion Government Block) is located in the northeast corner of the study area (Figure 2) and includes the headwaters of Transmission Line Creek and the upper reaches of K6 and K7 Creeks. B.C. Forest Service has the power of attorney to dispose of timber in this parcel.

- Parcel 69 (known as the Canadian Pacific Railway Block) is located in the southeast of the study area. Ownership of the block has reverted to the province. Most of the upland mine facilities are located in this block as well as the headwaters of No-name, K2, K4 and Hosmer Creeks.

- Parcel 70 located above the community of Hosmer (Figure 2) is private land held by Messrs. Ernest I. Stephenson and Eugne I. Stephenson of Fernie.

- Elk Valley Provincial Park held by the province, is located between Highway 3 and the Elk River directly opposite the development area.

- Various land holdings by private individuals and the Crown in the community of Hosmer.

Agricultural leases are held from CNI in the study area lowlands by Messrs. G. Hutchinson and T. Katura of Fernie and Mr. J. Dominick of Hosmer. North of Olson Crossing, just northeast of the study area on the Elk River, McGauley Ready Mix Concrete Co. Ltd. operates a plant on lands leased from CNI.

Most of the forested land in the study area is part of CNI's Voluntary Tree Farm Lease No. 27. The timber, although on private land, is included by the Provincial Government in calculations of allowable cut.

PRESENT AND POTENTIAL RESOURCE USE

Present Land Use

Present land use mapping by CLI (Figure 68) shows the lowland areas of the study area as immature productive woodland, open grasslands, open wetlands, cropland-pasture complexes, outdoor recreation areas (Elk Valley Provincial Park) and small areas of non-productive woodlands.

The community of Hosmer is located on the south edge of the study area. Highway 3, the Canadian Pacific Roadway and a B.C. Hydro powerline cross the area. A yard is located between the railway and the highway at Olsen. Several abandoned farmsteads are located along the highway just north of Hosmer although the lands are still cropped. North of these cultivated areas the study area lowland is grazed between the highway and the river as far north as the provincial park; east of the highway grazing extends north to Transmission Line Creek.

Lower slopes in the upland areas of the study area are mapped by CLI (Figure 69) as mostly immature productive woodland and non-productive woodland on productive sites. Mid-slope areas are mapped as mature productive woodland while the higher slopes are mapped as mature productive woodland and non-productive woodland on non-productive sites.

Some lower slopes have been logged and logging is just beginning in the mid-slope forests. In addition to forest production, the upland areas are important for water and wildlife production.

Agriculture

With the exception of the community of Hosmer the entire study area lowland lies within the Agricultural Land Reserve (Figure 67). The cultivated lands are used mostly for forage production although some cereals are grown; much of the uncultivated land is grazed.

The lowland areas of the study area have a complex of Class 4 and Class 5 soil capability for agriculture (Figure 67). Class 4 soils have severe limitations restricting the range of crops while Class 5 soils have severe limitations that restrict production to perennial forage crops; low soil moisture holding capacity and stoniness are the major limitations to crop growth. The capability of some of the lowland areas could be increased to Class 3 through irrigation. A small area of Class 6 soil occurs in the beaver pond area; limitations there are excess water, inundation and stoniness. Class 6 soils are capable only of perennial forage production; improvement practices are not feasible.

The study area agricultural land reserve soils are typical for the area; relatively small pockets of arable soils are scattered in soils suitable only for grazing. Livestock operations are best suited for this land; arable soils can be used to produce feed while poorer soils are used as pasture. The agricultural capability of the study area Agricultural Land Reserve is not fully developed.

The upland areas have soil capabilities for agriculture of Class 6 (capable only of producing perennial forage crops) and Class 7 (no capability for arable culture or permanent pasture) rating. Limiting factors are adverse topography, shallowness to solid bedrock and adverse climate. No agriculture use is made of the upland areas.

Forestry

Most of the study area lowland (Figure 69) has been rated by CLI as having Class 3 and Class 4 land capability for forestry (moderate and moderately severe limitations respectively to the growth of commercial forests). The indicator species is lodgepole pine and the limiting factor is soil moisture deficiency.

Small areas of Class 2 forest land occur (slight limitations to the growth of commercial forests) occur in the lowland areas; Engelmann spruce is the indicator species and the limiting factors are soil moisture deficiency and excessive levels of calcium. The lowland areas were logged early this century. At the present time most lowland forested areas are noncommercial, although the lowland coniferous and mixed forest vegetation map units contain some merchantable timber. Some of the better stands were logged by CNI (Figure 7) over this last winter (1975-76).

In the upland area, to 5,000 ft elevation, 70% of the slopes are designated Class 2 capability for Engelmann spruce; cumulative affects of minor adverse soil characteristics are the main limitations. The remaining 30% of these slopes are Class 3 (moderate limitations to the growth of commercial forests) due to soil moisture deficiency and Class 5 (severe limitations to the growth of commercial forests) limited by the depth of rooting zone. Lodgepole pine is the indicator species for the Class 3 and Class 5 forest lands. Much of the low elevation merchantable forest (low elevation older forest vegetation map unit) of Hosmer Ridge has been logged in the past. Low elevation slopes are being logged at present in Parcel 70 along K4 Creek. Regeneration in some low elevation logged sites is good while others are not satisfactorily restocked.

CNI has begun logging operations (summer 1976) along No-name Creek in the previously untouched mid-elevation forests (mid-elevation older forest vegetation map unit (Figures 7 and 64). Mature mid-elevation forests are composed of mixed stands of Douglas fir, larch, Engelmann spruce and sub-alpine fir containing 20-30 cunits/acre (Figure 70). Similar stands also occur at mid-elevations along Transmission Line Creek.

Forest land capability above 5,000 ft on the study area is reduced and includes lands with Class 5, 6 and 7 forest capability. Limitations are: adverse climatic conditions, short growing season, restricted rooting depth and soil moisture deficiency. No logging has been done in these high elevation forests.

Recreation

Crows Nest Industries Ltd. has an open access policy allowing recreational users access to the study area. Vehicle access to the lowland area is by Highway 3 and by the old highway which leaves Highway 3 approximately 2.5 km north of Hosmer and rejoins it again just north of Olson Crossing (Figure 2).

Access to the upland areas includes, the B.C. Forest Service access road to the Fire Lookout (Figure 2), CNI logging roads and Kaiser mine exploration roads.

The Elk Valley Provincial Park is located between Highway 6 and the river (Figure 2). An old road now overgrown and impassable to vehicles leads from the park picnic area to the Elk River.

The study area lowland has been rated by CLI (Figure 74) as having moderate (Class 4) land capability for outdoor recreation: features are described for upland viewing, angling and viewing of wildlife. The upland areas of the study area was rated as having low capabilities for outdoor recreation (Class 6): features are described for topographic patterns, significant vegetation and viewing of wildlife. Hosmer ridgetop, directly above the community of Hosmer has been given a moderately low capability for outdoor recreation (Class 5): features are described for significant vegetation, upland viewing and viewing of wildlife.

The varied terrain and vegetation of the study area provides potential for hunting, angling, camping, hiking, canoeing and nature study. Hunting and angling are discussed in later sections. The study area provides good opportunities for hiking and camping; access road development has increased these opportunities. Lowland areas, particularly in the beaver pond area have good potential for wildlife viewing and nature study. Canoeing on the Elk River is becoming increasingly popular. At present, only low to moderately low recreational use appears to be made of the study area.

Elk Valley Provincial park

A 199 acre Class A Provincial Park (Figure 2) is located between the highway and the Elk River west of the development area. Development within the park is limited to a picnic and rest stop beside the highway. Facilities include parking for 15-20 cars, 5 picnic tables, a well and toilet facilities; camping facilities are not provided. The park receives considerable use during the tourist season as a picnic site.

The park is in a beautiful setting; panoramic views to the east and west of the picnic site entrance at Highway 3 are shown in Figure 71. Some of the best habitat and wildlife viewing areas of the study area are located in the beaver pond areas of the park (Figure 24).

The regional district of the East Kootenay has proposed that the park should come under its control as a regional park. The site has good potential for the location and development of a campground area.

Hunting

The study area lies within Management Unit 4-23 of the Kootenay Region. During the 1976/77 hunting season there were open seasons on the following game animals which are known to occur or are likely to occur in the study area: mule deer, white-tailed deer, moose (bulls only), elk (bulls only), black bear, cougar, coyote, blue grouse, spruce grouse and ruffed grouse (B.C. Fish and Wildlife Branch, 1976). There was also an open season on waterfowl in the area.

The study area offers good opportunities for the hunting of elk, deer, bear and upland game birds. Crows Nest Industries Ltd., have an open access policy enabling hunters to have free access to the area. In upland areas the logging and mine exploration roads provide good access by motor vehicle, trail bike or foot. The actual use of the study area by hunters has not been documented.

Angling

The Elk River is famous for its sport fishery: sport fish species include Dolly Varden char, cutthroat trout and Rocky Mountain whitefish. Of the small streams in the study area only No-name Creek has angling potential. The lower reaches of the stream extending just upstream and downstream from the highway contain eastern brook trout and are fished. The beaver pond areas are fished as well. The use of the study area by fishermen has not been documented.

Guiding

Guiding does not occur in the study area as the area has not been assigned to a licence guide by the Fish and Wildlife Branch.

Trapping

The study area has not been assigned as part of a registered trapline by the B.C. Fish and Wildlife Branch. CNI allows trapping in the study area by permit. As individuals with permits to trap on private lands are not obliged to file fur returns, data on trapping in the study area is not available.

HISTORIC AND ARCHAEOLOGICAL SITES

Mr. W.T. Choquette of the Archaeological Sites Advisory Board in his report "Heritage Resources of the Proposed Hosmer-Wheeler Coal Development" (Appendix B) notes the presence of two sites on the study area uplands:

- site DjPrH1 a three building logging camp complex of high archaeological value.

- site DjPrH2 a log loading ramp of medium archaeological value.

He dates the buildings and presumably the log loading ramp to part of the 1914-16 Higgins Logging Company operations which logged the lowlands of the study area.

However, Mr. Roger Burdesco of Kaiser Resources Environmental Services (pers. comm.) advises us that the buildings and loading ramp were part of more recent logging operation started in the fall of 1938 by Oscar Higgins.

IMPACTS

IMPACTS AND MITIGATIONS

An environmental impact matrix has been prepared (Appendix R) as a guide and check list to the impacts of the proposed Hosmer-Wheeler project. The intensity and importance of these various impacts are discussed in the text under the separate disciplines; environmental planning and mitigations are discussed with the impacts.

ALTERNATIVES

In late 1974, a site reconnaissance was made of the two areas being considered as potential plant sites, the Elk River Valley Site where the plant is presently planned and the Michel Creek Site on the opposite side of the Hosmer-Wheeler Ridge. The Elk River Site was chosen over the Michel Creek Site as the former was both operationally and economically superior.

At the present Elk River Valley Site there are no alternatives for the mine location, plant site or railway loop. However, three alternative tailings ponds were considered (Figure 73).

It should be noted that each pond has a different final dam storage capacity since each pond was considered at a different point in design development. The reasons, however, for eliminating alternatives "A" and "B" are equally appropriate when these locations are considered for the required 20 year tailing production storage.

> Alternative "A" could be designed to contain the total 20 year refuse with the lowest maximum dam height, but it would require the longest dam. More importantly, it would encroach upon No-name Creek and would require diversion of the Creek. These two factors removed it from further consideration.
>
> Alternative "B" would not provide sufficient storage without an extremely high dam and, as above, the diversion of No-name Creek would still be required. It was therefore rejected.

The proposed tailings pond and dam will contain the entire plant refuse for the 20 year life, and will require only a dam of moderate height. No diversion of the creek will be required and the storm water/snow melt runoff can be diverted away from the pond to natural drainage courses with relative ease.

After consideration of those sites studied, there appears to be no suitable alternative to the present proposed tailings pond.

AIR QUALITY

PRESENT RESOURCE USE

At present the Hosmer-Wheeler plant site is still undeveloped; the only air quality resource uses in the vicinity are the traffic on the nearby Highway 3 and the residential activities in the nearby community of Hosmer.

If it is considered that the sampling results (see Air Quality - ENVIRONMENTAL DATA) at the proposed plant site (27 $\mu g/m^3$ average suspended particulate and 9.2 tons/mile^2/month average dustfall) then the present impacts on air quality resources by the community of Hosmer and the highway may be calculated:

present impact of the community of Hosmer = recorded values (community of Hosmer and highway) - background value (plant site)

The results of these calculations are shown in the following table:

IMPACT OF PRESENT AIR QUALITY RESOURCE USE

Source of Impact	Present Impact expressed as values in excess of background values at the proposed plant site (Four-Month Means)	
	Susp. Particulate ($\mu g/m^3$) Geometric mean	Dustfall, (tons/mile^2/month Arithmetic mean
Highway Traffic	28 $\mu g/m^3$	9.0 tons/mile^2/month
Community of Hosmer	64 $\mu g/m^3$	22.5 tons/mile^2/month

While the figures for Hosmer are high, it must be emphasized that the available data only cover a four month period. Any conclusions based on the available data must therefore be regarded as tentative.

PROPOSED DEVELOPMENT IMPACTS

The air emission sources at the planned Hosmer-Wheeler facility will be:

- the dryer scrubber exhaust
- the dryer feed conveyor dust collection equipment exhaust
- the load-out and silo transfer conveyor dust collection system exhaust
- the dust vacuum system on the roof of the silos.

All of the above emission sources have been designed to meet the B.C. Level A objective of 0.1 gr/scf (229,000 μg/m^3). Based on the design figure of 0.03 gr/scf (69,000 μg/m^3) and the total design volume of 302,300 cfm, which is emitted from the main stack, the total daily particulate emission is 1866 lb.

The maximum ambient concentration of suspended particulate will occur at the point where the stack plume impinges on the ground. If it is assumed that the dilution ratio at this point is 1000 (a common rule of thumb) the ambient concentration of stack-derived particulate would be 0.001 x 69,000 = 69 μg/m^3. This level is just below the "acceptable" federal objective of 70 μg/m^3. Another approach would be to assume that all of the emitted 1866 lbs would remain as suspended particulate and to calculate the volume into which this amount would have to be distributed evenly to give an average concentration of 70 μg/m^3. The unit is a cubic air space with about a 1.43 mile side. Since the available time for this dispersion is 24 hours it is easily appreciated that conditions of essentially no wind (i.e <1 mph) would be required to confine the spread to the volume cited above. During the four month period over which wind data have been collected, the lowest observed daily average wind speed was 5.9 miles per hour. Based on this reasoning it would therefore be concluded that the impact of the stack emissions from the proposed Hosmer-Wheeler plant would not cause the "acceptable" federal objective for particulate matter to be exceeded. However, since the available wind data only cover a period of four months the tentative conclusion of acceptable impact needs to be confirmed when data for a full year have accumulated. When data for a full year are available it will be possible to apply a computer program to predict particulate isopleths - a more informative approach than the simplistic reasoning applied to the sparse data now available.

In this context a comparison with the existing hydraulic mining operation near Natal is pertinent in that it lends support to the tentative prediction of an acceptable suspended particulate level. Routine sampling by Kaiser Resources near this operation gave the following results:

Period	Average Suspended Particulate µg/m^3
January - April 1976	58.4
May 15 - July 15, 1976*	30.0

* Shut-down due to strike

Background suspended particulate levels at Natal were recorded from May 15 - July 15 when plant operations were suspended due to a strike; plant operating levels were recorded from June to April. The table shows that the contribution from the operation over and above the background amounted to 28.4 µg/m^3 (58.4-30). If this is considered typical, the resulting level of suspended particulate matter at the Hosmer-Wheeler plant site which has a background level of 27 µg/m^3 of suspended solids would be (27 + 28.4) = 55.4 µg/m^3, and which would meet the "acceptable" federal objectives.

If it is assumed that all of the emitted 1866 lbs appear as dustfall in an area of 1 mile radius around the plant, the corresponding dustfall load would be 8.9 tons/mile^2/month. Since the background dustfall is 9.2 tons/mile^2/month the total dustfall would amount to 18.1 tons/mile^2/month, i.e. well within the British Columbia limit for industrial locations. However, the assumption that the entire emission would appear either as dustfall or as suspended particulate is unrealistic. The realistic assumption is that part of the emitted matter would appear as dustfall and part as suspended particulate. This will, of course, lower the estimates made above for either of the two modes of appearance.

The elemental composition of the Hosmer-Wheeler coal ash is given below. The figures are expressed as percentages of the total (unburned) coal.

Al	2	Fe	0.3
Ba	0.005-0.2	Mg	0.1
B	0.003-0.005	P	0.1-0.2
Ca	0.5	Si	Matrix
Cr	0.001	Sr	0.01-0.03
Cu	0.001-0.003	Ti	0.5
Au	Trace	V	0.01

The sulfur content of the coal is less than 1%

The American Conference of Governmental Industrial Hygienists lists threshold suspended particulate limit values for compounds of four of the ash elements tabulated above as follows:

Soluble Ba compounds	500 $\mu g/m^3$
B_2O_3	10,000 $\mu g/m^3$
Chromate Salts	100 $\mu g/m^3$
V_2O_5 dust	500 $\mu g/m^3$
V_2O_5	100 $\mu g/m^3$

The threshold limit values represent conditions to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect, that is, these values pertain to working atmosphere and not to ambient air. However, since a comparison of these values with predicted ambient concentrations may be of interest, the suspended particulate concentrations for Ba, B, Cr and V compounds in ambient air have been calculated for the project as:

$BaCO_3$	0.2 $\mu g/m^3$
B_2O_3	0.001 $\mu g/m^3$
Na_2CrO_4	0.001 $\mu g/m^3$
V_2O_5	0.001 $\mu g/m^3$

Dust will be emitted during rail car loading; no quantitative data on this source of dusting is currently available. As in other Kaiser operations coal in open rail cars will be protected from dusting in transit by a polymer spray which is applied to the load surface immediately after loading.

Limited quantities of dust will be generated in earth moving operations during construction. Water sprays and $CaCl_2$ should be applied to dust producing areas as necessary; open earth surfaces (fines) should be revegetated.

Existing suspended particulate background levels are major factors in determining the capacity of the atmosphere to accept further pollutants without exceeding current limits or objectives. With high background levels, the atmosphere can accept little further pollution, and is highly sensitive to quality-deteriorating influences. At the proposed Hosmer-Wheeler plant site, the background suspended particulate is low (27 $\mu g/m^3$) and the assimilative capacity of the atmosphere correspondingly high. However, near the highway 3 miles northeast of the proposed plant site, the assimilative capacity is low while at the community of Hosmer it is non-existant. Since the evaluation of the assimilative capacity is based on only four months of data and since there is reason to suspect that the sampler at Hosmer may require relocation to give unbiased data, it is not at present possible to predict the exact input assumptions regarding dispersion of suspended particulates. The basis for these assumptions will be wind data, as yet available only for a four month period. When more wind data are available it may be helpful to apply a computer program to correlate the effects of background levels and dispersion on the sensitivity of the atmosphere.

AQUATIC FACTORS

SURFACE WATER QUALITY

Exploration activities concentrated at high elevations near the headwaters of No-name and K2 Creeks with some exploration activity on Transmission Line and K4 Creeks thus far appear to have had little effect on overall water quality. The greatest impacts on water quality of the Hosmer-Wheeler development will occur as a result of mine construction and operation; the overall effect of these activities on surface water quality is also expected to be low.

Coal fines evident in reach NA of No-name Creek were not necessarily deposited as a result of exploration activities as some natural cut banks containing coal fines were observed along this reach of the creek. At present, logging activities (Figure 64) by Crows Nest Industries appear to be contributing much greater quantities of sediment into the creek than the coal exploration activities in the upland areas. Side slopes near the creek are being clearcut and extensive road building and log hauling is in progress near reaches NA, NB and NC of the creek. Turbidity in the creek as a result of these activities was evident in No-name Creek at least as far as the road crossing (Figure 17). Effects of present and future logging must be assessed separately in estimating the effects of mine construction and operation.

During the construction phase of the mine, some contamination of surface waters will occur. Sedimentation in No-name Creek will occur primarily as as a result of road building and heavy equipment use, since soils in the area contain significant quantities of fine textured material. These materials could cause siltation of No-name Creek to a point where fish spawning and invertebrate productivity would be adversely affected. These impacts would be minimized by avoiding unnecessary roads and stabilizing and revegetating erodable surfaces.

Construction of portals, fan sites and water facilities in the upland areas will affect tributaries K2 and K3 of No-name Creek. As areas to be disturbed are relatively small, impacts on water quality will be minimal.

During mine operation potential sources of increased sediments in surface water from the mine area will include: excess mine water, the transportation system for hydraulic coal slurry from the mine, the tailings pond and the general plant site including the coal processing system and the coal stockpiles.

Sediment escape during mine operation will be minimal. Present plans call for excess mine water to be passed through settling ponds before discharge into No-name creek. Retention ponds are planned to accommodate flume slurry in the event of an unexpected plant shut down. Water used in mining will be recirculated through the system; losses will be minimal but will include seepage and evaporation from the tailings pond. Plant site areas will be protected upslope by ditches which will divert overland and shallow subsurface flow into No-name Creek. The plant site will be contoured to collect run-off and divert it via a surface retention pond to the tailings pond.

Few chemical agents which could potentially contaminate surface waters will be present during mine construction and operation. Fuel and lubricating oils will be present in relatively small quantities at any given time and should be handled carefully. Supplies of (reusable) absorbent material (such as 3M oil sorbent) should be maintained at the mine and process sites and at transfer points for cleanup of minor spills.

In the coal treatment process, a flotation circuit is included which uses methylisobutylcarbonol and kerosene as flotation reagents. These chemicals have a very high affinity for coal particles and it should not be possible to detect any significant amount of either chemical in the process water. Some of the reagent will be deposited in the tailings pond absorbed on fine coal and waste particles, while the bulk of the reagents will remain with the clean coal product.

To assist the precipitation of the small particles in the refuse thickener, flocculants will be used to separate the non-ionic particles (coal) and ionic particles such as clay. These reagents will remain with the precipitated materials and will also end up in the tailings pond.

In the preparation plant, all process effluents end up in the refuse thickener and in the refuse sump. In the thickener, the bulk of the water is separated for reuse in the plant while approximately 2500 gal/min will flow with the tailings into the tailings pond.

Sewage treatment facilities will consist of a self-contained 28,000 gallon/day aerated treatment plant. Effluent from the treatment plant will be chlorinated and discharged into the tailings pond. With a maximum daily discharge of 28,000 gallons of sewage and 3.6 million gallons of coal process water, a dilution factor in the tailings pond of about 128:1 is expected. This ratio is better than existing government standards of 100:1 for sewage disposal into tailings ponds (Section 4.2.7 PCB objectives, 1967).

As tailings pond water will be recycled the processing plant should have no impact on surface water quality.

The biological and chemical leaching properties of the refuse material have not been assessed, but acidic drainage from mine wastes should not be a problem since the material contains less than 0.6% sulfur. In addition, the pH of the subsurface waters under a similar tailings pond at the Elkview plant at Sparwood are basic and varied (1974) from pH 7.2 to 8.0 while the pH of the tailings pond supernatant varied between 7.8 and 8.3.

Leaching tests (see Water Quality, ENVIRONMENTAL DATA) on drill cores have indicated that no significant quantities of chemicals will be introduced into watercourses by leachate.

The high levels of phenols discharged by Sparwood coking operations (Appendix F) will not occur at the Hosmer-Wheeler operation as the latter operation will not have coking facilities.

GROUNDWATER QUALITY

Although process water recirculation is planned for the tailings pond, some loss to ground water is assumed. Losses will be greatest during early operations but will decrease as the tailings pond fills with fines. Dissolved metals occur in the ground water of the proposed tailings pond area (see Groundwater, ENVIRONMENTAL DATA); tailings pond seepage is not expected to contribute significantly to existing levels. The quality of subsurface water samples obtained from under the similar tailings pond at the Elkview Plant is better than that required by the most stringent of government regulations. Therefore it would seem that even if a large portion of the net 3 million gallons/day (about 5 cfs) discharge to the tailings pond were lost to seepage the impact on existing groundwater quality would be minimal. Unlike the present operation at Elkview, however, the Hosmer-Wheeler tailings pond will receive a continuous input of chlorinated treated sewage.

The closest drinking well is in the Elk Valley Provincial Park picnic stop across Highway 3 directly opposite the projected tailings pond location (Figure 2); other wells are located in the community of Hosmer. Although present designs for discharging sewage to the tailings pond are within P.C.B. objectives and the remoteness of most of the wells (community of Hosmer), and the adsorbent qualities of coal tailings which will probably provide sufficient filtration of escaping seepages, a remote possibility exists that potential problems to groundwater quality may occur due to chlorinated hydrocarbons, increased nutrient levels and alteration of groundwater equilibrium.

Regular monitoring of the wells in the area as well as groundwater immediately downslope of the pond should be carried out to insure that domestic wells remain potable.

Increased groundwater discharge as a result of tailings pond seepage is not expected to create environmental problems. On the basis of the report on groundwater by R.M. Hardy and Associates (Appendix 1), the beaver ponds and downstream reaches of No-name Creek may receive groundwater from the development area. If, indeed, this is the case increased groundwater flow due to seepage from the tailings pond would merely increase surface water flow in these areas.

FISH HABITAT

Road and rail crossings of No-name Creek, tailings pond and rail loop construction and operation, and the water intake on the Elk River represent the only direct disturbances to fish habitat.

The tailings pond and rail loop lie adjacent to a section of No-name Creek containing spawning ground for cutthroat trout and eastern brook trout. Construction of facilities and crossings should be accomplished so as not to permanently interfere with the fish habitat of No-name Creek. Disturbance during construction of crossings should be minimized. Neither the tailings pond dam nor the rail loop should be located so as to confine No-name Creek or unduly restrict its lateral movement.

The water intake system will be designed to conform to government regulations to prevent damage to fish resources. The Elk River is confined at the proposed water intake site (Figure 4 and 72): impact on fish habitat will be minimal.

TERRESTRIAL FACTORS

SOILS

Impacts on soil are fundamental; soil disturbances may have long term or even permanent effects on general land use capability. Minor soil impacts have already occurred in the upland areas as the result of coal exploration. The major soil impacts will occur during the construction phase of the Hosmer-Wheeler coal project (Table 21); only very minor soil impacts are anticipated for the operational phase of the development.

Lowland developments

By far the largest proportion of the development soil impacts will be caused by the tailings pond and dam (121.4 ha); soils not removed will be buried by the tailings and dam. Tailings pond disturbance will occur mainly in soil mapping units 2a, 3a and 5a with a much smaller amount of disturbance occurring in unit 4b. Soil mapping units 2a and 3a consist of a sandy loam to loamy sand fluvial capping (approximately 30-100 cm) overlying stony gravel and are well to rapidly drained. When exposed or worked the surface fines will have a dusting potential. The surface erosion potential of the fines is counteracted by the level to very gently undulating topography. The fluvial capping of fine materials is the basis for the relatively higher agricultural and forestry land capabilities of these soil map units.

Soil map unit 4b (and 4a) consists of stony gravelly fluvial fans having a relatively thin discontinuous silt loam to loam fluvial capping (0-20 cm). The material is rapidly drained and has a very gently sloping topography. Erosion potential is low due to high porosity and low fines content. Shallow soil depth limits the general land use capability of this soil map unit.

Soil mapping unit 5a consists of gravelly sandy loam fluvial terraces. The soil is rapidly drained and erosion potential is low.

Reclamation of the tailings area will not begin until completion of mining operations. It is not recommended that topsoil from under the tailings dam and pond be conserved expressly for reclamation of these areas; reclamation of the tailings dam and pond will depend upon some other method such as prolonged and heavy applications of fertilizer. Further, there is no place on the development area to store such an enormous pile of soil as would result from stripping the tailings area. In addition, it is likely that such stored soils would seriously deteriorate over the intervening years.

The topsoils of the tailings dam and pond area are however a valuable natural resource and should be stripped and conserved. The topsoil should be used on the development area as follows:

- landscaping of the plant site.
- reclamation of the fresh spoil slopes formed at portals, fan sites, water reservoir and pumping station.
- reclamation of borrow pits located nearby the development area - these include the borrow pits by the highway between the Elk Valley Provincial Park and Olson crossing and the borrow pit near the junction of Highway 3 and the mine access road.
- establishment of a small topsoil stockpile at the plant site for small landscaping and revegetation projects which may occur during plant operation.

The railway loop occupies 76.9 ha but as only part of this area will be railway right-of-way, the area of impact will be considerably lower. The soil map units involved (2a and 3a) have already been discussed. Topsoil should be stripped from the right-of-way prior to construction and used to revegetate the ditches and embankment slopes. Soil impacts caused by the railway loop are generally expected to be low.

The plant site will occupy 46.5 ha; no serious soil impacts are anticipated. The soil mapping units involved, 2a, 3a, 4a and 5a have all been discussed previously. Topsoil should be stripped and conserved during plant construction and used to landscape the plant site. Additional topsoil salvaged from the tailings dam and pond area should be utilized as necessary.

Road construction will involve all the lowland soil mapping units. Prior to construction, topsoil should be stripped from the rights-of-way and later used to reclaim the ditches and borrow areas. No significant soil impacts are expected from road construction.

The water intake and pipeline will involve the fluvial terrace soil mapping units 1a, 1b and 2a. Topsoil over the ditch should be stripped prior to ditching and replaced. Excess subsoil from the ditch should be removed, as should stones turned up during ditching operations. Due to the high spring water tables in soil mapping units 1a and 1b, construction should occur in summer, fall or winter; serious damage to soils on the right-of-way could be done by heavy equipment operating in mud. Surface drainage should be restored. With the preceeding reservations, no serious soil impacts are anticipated for the water pipeline.

R.M. Hardy and Associates (Appendix 1) have shown that a lacustrine clay layer varying in thickness from a few feet to more than 50 ft is present under the southern part of the tailings pond area. Although hydrological implications exist for this clay layer, no problems are anticipated for surface construction.

The subsurface stony gravels of the soil mapping units of the lowland development area (soil mapping units 2a, 3a, 4a, 4b and 5a) should provide a good base for the proposed development. However, some excessively stony inclusions can be expected.

Upland Developments

In the upland areas approximately 8.9 ha will be disturbed during the construction of portals 52 and 202, fan sites, water head tank and pumping station. With the exception of portal 202 which will occur in soil map units 8a and 9b, these developments will occur in soil map unit 9a. Soil map unit 9a consists of a high elevation bedrock controlled ridge covered by one metre or less of rapidly to moderately well drained variable textured colluvium. The topography is extremely steep. Serious potential soil impacts are possible for this soil map unit. Impacts can be reduced by the following procedures:

- construction should not occur when surface materials are excessively wet
- the upslope cut should be stabilized to prevent slumping
- no surface material should be allowed downslope as this will increase the potential for slumping and surface erosion and cause siltation in No-name Creek
- surface material should be saved where possible for topsoiling and revegetation of the fresh slopes
- there should be no interference with surface drainage; drainages should be inventoried prior to construction and restored after construction
- further on-site investigation of surficial materials should be made prior to construction.

Soil map unit 9b (portal 202) is similar to soil map unit 9a previously discussed; problems and recommendations are generally similar. Soil map unit 8a, however, is a very steep to extremely steep old slide track draining into No-name Creek. Colluvial materials up to 6 metres in depth can be expected. As large quantities of surface and seepage water, particularly during snow melt, move down over and through the snow track soils, serious problems in soil stability will occur if drainage is interrupted. Additional on-site engineering studies are recommended for this area. The general mitigation procedures suggested for soil map units 9a and 9b apply to soil map unit 8a as well. The proposed road network in the upland area will involve most of the upland map units. However, few new roads will be built; present exploration roads will be upgraded to meet the traffic demands anticipated for the construction and operation of the mine. Any soil related problems on the exploration roads can easily be corrected during upgrading. Particular attention should be directed toward areas which receive appreciable amounts of seepage or have seasonal or permanent drainage channels. Present tendencies to slumping, surface erosion and siltation should be remedied.

VEGETATION

The vegetation of the study area is typical of the general area. No rare or unusual plant communities or plant species were identified in the study area. No vegetation map unit or vegetation type was found to be relatively more valuable or ecologically sensitive than any other and to warrant avoidance or special treatment.

The vegetation of the lowland and lower upland areas of the study area consists of early-to-mid-successional vegetation stages which have resulted from the human disturbances of fire, logging, clearing and grazing. The older upland vegetation of the study area is as yet largely undisturbed, although logging has just begun. Thus the vegetation of the study area and of the Upper Elk Valley generally already has a tradition and future of human disturbance.

Lowland vegetation will be most affected by the development; 209.7 ha (518 ac) will be directly affected as development area, while another 92.8 ha (229 ac) are required as buffer areas (Table 22). Relatively little upland vegetation will be affected, although the upper edge of the tailings dam and pond and the portals and associated facilities will require 44.0 ha (109 ac). The buffer areas include very little upland vegetation.

At the end of mining operations, the choice of vegetation for reclamation will depend upon priorities existing then. Alternatives may be similar to those of today and may include: the establishment of meadow for domestic forage and pasture, the establishment of early successional shrub vegetation for wildlife production, the planting of trees for timber production or some combination of these or other alternatives. It is, however, certain that the future level of resource management will be much more intensive than that of today, which will then preclude re-establishment of much of the present development area vegetation which has relatively low productivity for human use.

Lowland Developments

The development of the tailings pond and dam, railway loop, water pipeline, and road network will require the localized removal or alteration of vegetative cover. At the facility sites, soil disturbance will occur which will, in many cases, reduce the future capacity of these sites to support vegetative cover. In addition, the vegetation near the facility sites may require modification for purposes of access, visibility and fire suppression. In most instances, however, such modifications will consist only of tree and shrub removal and will not affect the original capacity of the land to support vegetation.

The tailings dam and pond will all occupy lowland areas now vegetated in meadow, tree-meadow, coniferous forest and mixed forest and upland areas vegetated by mixed forest and low elevation young forest (Table 22). After reclamation, the tailings pond may be expected to have an equal or better average vegetation production capability for agriculture, forestry and wildlife than the present site.

The tree and shrub vegetation present between the tailings pond dam site and the highway, including that present between the railroad and highway, will be extremely important in screening the tailings pond facility from highway travellers. As the tailings pond dam will be built progressively from the inside out (downstream method), the clearing of screening vegetation around the tailings pond should be progressive and done only as required for immediate construction needs. The screening vegetation present between the railroad and the highway should also be preserved.

The railway loop will occupy areas now in mainly lowland deciduous forest and mixed forest, although small amounts of other vegetation units will be utilized as well (Table 22). Vegetation will be removed along the right-of-way, although the center of the loop should remain relatively unaffected. Some clearing of the loop center may be necessary to give better visibility, although as many trees and shrubs as possible should be left to screen the plant site and tailings area from the highway. Additional tree plantings should be established as necessary both within the loop and between the railroad and the highway to conceal the plant area from highway travellers.

The plant site will occupy areas which are now coniferous forest, mixed forest and meadow (Table 22). In addition, forested areas near the plant site will need to be cleared or thinned for access and fire suppression; tree and shrub screens should be retained to conceal the plant site from the highway.

The water supply line from the Elk River to the plant site will require right-of-way clearing. In addition, right-of-way will have to be maintained in meadow or shrub and small tree cover for easy inspection and access. Right-of-way clearing should be narrowed at the highway crossing and a screen of trees and shrubs should be left to mask the right-of-way from highway travellers; additional plantings of screening trees may be necessary.

The main plant access road from the highway will require a widened right-of-way and clearing of vegetation. It appears that much of this work will be done by Crows Nest Industries which is upgrading the present access road for logging. Care should be taken to prevent repetition of the tree clearing at the junction of the access road and the highway. This clearing removed a screen of trees which would have hidden Portals 1 and 2 from highway travellers passing the access road turnoff.

The routine operation of the mine is not expected to directly affect vegetation. However, thinning, underbush disposal and grazing may be necessary fire suppression practices in the buffer areas around the plant site and associated facilities.

Upland Developments

The portals and associated portal facilities will be located in mid-elevation older forest. Merchantable timber should be salvaged when these sites are cleared.

The exploration road system extends through the mid-elevation older forest into the upper elevation forest. Thus far, Kaiser has located, constructed and reclaimed their exploration roads to minimize impacts on vegetation. All available timber has been salvaged.

The upland access road will be located in low elevation young forest, mid-elevation older forest and upper elevation older forest. As present exploration access roads will form much of the basis for this road network, the impact on vegetation has largely already occurred and has been duly minimized.

MAMMALS

Mine development will affect mammals in two ways: habitat will be removed through clearing, and, the physical presence and operation of the mine will alienate additional habitat thus reducing the carrying capacity of the area for mammals. There is, however, evidence in other neighbouring coal mining operations that some mammals, particularly ungulates, if unmolested will become accustomed to the presence of industrial facilities and human activity and will utilize habitat quite near to such facilities. The effect of the mine operations on furbearers is less clear.

Generally, the impact on mammals and wildlife can be reduced by minimizing the amount of habitat to be cleared and by protecting wildlife, particularly ungulates, from human interference. A "no-shooting" area around the mine development should be established for the protection of both workers and wildlife.

Mule Deer and White-tailed Deer

Mine development will remove productive summer range capability (Class 3) for mule and white-tailed deer in the lowland areas and the lower slopes of the upland areas. The most seriously affected deer summer range: tree-meadow, deciduous forest, mixed forest map units and the edge areas of the coniferous forest map unit. The same vegetation map units serve as deer winter range, but in general have a lower capability. The potential for restoration of the habitat alienated by mine development at completion of the project is excellent.

Moose

The lowland areas are not rated by CLI as moose range, although many of the vegetation map units (meadow, tree-meadow, tree-shrub, and deciduous and mixed forest) have some capability for moose production. The upland area is rated as moderate moose summer range (Class 3 and 4); little of this area will be disturbed by mine development. Localized areas of utilized moose range which will be affected include the riparian vegetation along No-name and Transmission Line Creeks as well as the tree-shrub vegetation along No-name Creek and in the proposed tailings pond area. However, moose numbers in the study area are generally considered low and the mine is expected to have little effect on the moose population of the area. The restoration potential for the tailings pond area as moose range is fair while the restoration potential along No-name Creek is excellent.

Elk

Of the three ungulate species found on the study area, the greatest production is for elk; in our estimation elk is the most important wildlife species in the area. All the vegetation map units of the valley bottom development area and the upland mixed forest vegetation map unit of the upland area are considered good elk summer range (Class 3). These areas are also rated by CLI as elk winter range (Class 3W). The upland coniferous forest areas of the study area are also considered satisfactory elk summer range.

Summer elk range is sufficiently common and widespread to be considered not limiting for elk populations in the area. Although mine development may interfere with patterns of summer range utilization, summer impact on elk will be minimal.

In severe winters, deep snow prohibits the use of hillside summer range by elk and the herds crowd into the limited winter range areas. In severe winters loss of any of these areas could reduce the winter elk survival. Mine development will reduce elk winter range and will reduce the carrying capacity of the area for elk. Restoration potential of the mine area for elk winter range is excellent.

Furbearing mammals

As grizzly bears are not known to be present in the area, mine development will have no direct impact on these animals. At least two black bears are known to use the development area in spring and early summer. Mine development will reduce the carrying capacity of the area for bears and perhaps cause a reduction in bear populations. Properly planned waste disposal during mine construction and operation will reduce the possibility of human interaction with black bears; bears which become a nuisance around the site should be removed.

The status of the other furbearers in the study area is not clear although the removal of habitat and the presence of the mine will reduce the carrying capacity of the area for coyote, wolf, mountain lion, bobcat, lynx, wolverine and marten. The effect of this reduction on these populations is unknown.

Many of the lowland map units represent good habitat for long-tailed weasels and mink and these populations may be slightly reduced. No direct effect is expected on beaver and muskrat populations in No-name Creek and the beaver ponds west of the highway.

The potential for furbearer habitat restoration of the development area at the termination of the project is generally good.

Small mammals

Mine development will cause loss of habitat and reduce populations of small mammals in the mine area. The most affected species will be: Columbian ground squirrels, yellow pine chipmunks, red squirrels and deer mice. Carnivourous mammal populations which utilize these smaller mammals as food may also be slightly affected. Impact of the development on small mammals will be slight and the restoration potential of the mine area for small mammal habitat is excellent.

BIRDS

In the same manner as described for mammals, the carrying capacity of the development area for birds will be reduced by the destruction of habitat. Many smaller species of birds appear to be able to co-exist quite well with development activity although many larger species such as hawks, falcons, eagles, ospreys and owls respond adversely to development and human presence.

Raptors

The mine development area appears to be suitable habitat for ospreys, goshawks, american kestrels and red-tailed hawks (species frequently observed on the study area and nearby areas). Raptor populations in the study area appear typical for the general area. Impact of the development on raptors is expected to be low; the active osprey nest along the Elk River will not be affected.

Waterfowl

Waterfowl habitat in the study area is limited to the lower reaches of No-name and Hosmer Creek and the beaver pond complex west of the highway; impact of the mine development on waterfowl is expected to be minimal.

Upland game birds

Mine development in the lowland and lower upland areas will remove ruffed grouse habitat, mainly in the lowland deciduous and mixed forest vegetation map units. In the upland areas the facility installations and road network will cause a slight reduction in spruce grouse habitat. Very little blue grouse habitat will be affected. Grouse populations in the study area appear low. The development will have little effect on present populations. Restoration potential for grouse habitat is excellent.

Song birds and other small birds

Mine dèvelopment will reduce breeding habitat for song birds and other small birds. Impact importance is low; habitat restoration potentials at project completion for song birds and other small birds is excellent.

HUMAN USE

LAND TENURE

The majority of the surface development area is located on CNI lands although the uplands facilities are to be located on Block 69 which belongs to the Province of B.C. Negotiations are proceeding between Kaiser Coal Canada Ltd., CNI and the B.C. Government to reach agreements for surface rights in the development area.

PRESENT AND POTENTIAL RESOURCE USE

Present land use

The impact the proposed development land use on present land use will be greatest in the lowland areas. Lands mapped by CLI (Figure 68) as open grassland and immature productive woodland will be alienated by the lowland development. The present use of the development area is well below its capability for forestry and agriculture. At present, cattle are grazed and CNI over the last winter (1975-76) has harvested most of the merchantable timber from the lowland development area. Restoration of the development area to the same general capabilities at mine completion is a realistic objective.

Present land use of the upland development areas is shown by CLI (Figure 68) to be mainly mature productive woodland and non-productive woodland on non-productive sites. At present CNI is logging in the general development area. Impact of upland development on present land use will be minimal.

Agriculture

The impact of the proposed development on agriculture will occur only on the agriculture land reserve (Figure 67) on the valley bottom; upland developments occur in areas classified by CLI as non-productive (Class 7) or suitable only for natural grazing (Class 6). The general agricultural capability of the development area is not fully utilized; grazing practices as now carried out are poorly managed.

The proposed plant site will occupy 46.5 ha (115 a) of Class 5 and Class 4 agricultural land. On completion of the mining operation the plant site can be restored to similar general agricultural capability.

The proposed 121.3 ha (300 a) tailings dam and pond will occupy 45.6 ha (115 ac) of Class 2 agricultural land, 56.7 ha (140 ac) of Class 4 and Class 5 agricultural land and 12.2 ha (45 ac) of Class 6 and Class 7 agricultural land. Although the restoration potential of the steeply sloping tailings dam will be low, it is probable that the tailings pond surface can be restored to an equal if not greater agricultural capability than the lands it will occupy.

The railway loop encircles 76.9 ha (190 ac) of Class 4 and Class 5 agricultural lands; with the exception of disturbances along the right of way the impact of the railway loop on agricultural land will be low.

A further 92.8 ha (129 ac) will be removed from the agricultural land reserve as a buffer zone. Although perhaps withdrawn from agricultural production during the life of the mine, no impact on the agricultural capability of the buffer area is expected.

Forestry

Forest cover will be removed from much of the development areas to make way for the facilities. CNI have already logged the merchantable timber in the lowland development area. In some areas such as the railway loop and plant site, land capability for forestry will scarcely be affected: but on areas such as the tailings dam, the land capability may be greatly changed. Acreages of the various forest types to be affected by the development are shown in Table 23.

In the lowland areas the plant site will cover 46.5 ha (115 a) of which about 21 ha (52 a) is permanently open range land. Most of the remainder is in immature lodgepole pine forest on a good site (Table 23; Figure 70) with forestry capability ranging from Class 3 to Class 4 (Figure 69).

About one-third of the proposed tailings dam and pond area is in range land.

Of the remaining area, 30 ha (75 a) are lodgepole pine and Douglas fir on good sites, 40 ha (100 a) are cottonwood and aspen on moderate sites and 7.3 ha (18 a) are aspen and lodgepole pine on poor sites (Table 23); Figure 70). Forestry capabilities for these areas range from Class 1 to Class 4 on a variety of soils (Figure 69). After reclamation the tailings pond will have similar forestry capability although the forestry capability of the tailings dam slopes will be much reduced.

Of the 76.9 ha (190 a) enclosed by the railway loop, 47 ha (116 a) is presently forested in aspen, cottonwood and white spruce on moderate sites, 26 ha (64 a) are lodgepole pine on good sites while the remaining 4 ha (10 a) is open range land. Forest capabilities are Class 3 and Class 4. Much of the railway loop will remain uncleared.

The lowland impact of mine development on forestry values and forest land capabilities will be generally low. Clearing of lowland forest should be minimized where possible. Trees should be left to form screens to hide the development from the highway travellers. As already mentioned, some additional screen plantings may be necessary.

Coal exploration in the upland areas, because it has affected such a relatively small area, has had little direct impact on forestry values or capability. Merchantable timber has been salvaged from roadways and the road network has generally a good restoration potential for forestry. It is, however, very likely that indirect effects of coal exploration on forestry have been much greater; increased interest, better access and a chance for forest ground inspection have probably contributed to the recent initiation by CNI of logging in the upland development areas.

The construction of Portals 52 and 202, the Water Tank and Pumping Station will involve the clearing of 8.9 ha (22 a) of mature lodgepole pine, Douglas fir and western larch (Table 23; Figure 70) on a site with Class 2 complexing to Class 5 forestry capability (figure 69).

Recreation

Recreation capabilities (Figure 74) for the development areas are not high; lowlands have moderate recreation capability (Class 4) while uplands have low recreation capability (Class 6). With the exception of hunting, angling and the use of the Elk Valley Provincial Park which are discussed separately, recreational use of most of the study area is generally low.

The major general impact to recreation will be the aesthetic detraction the development will cause to the landscope as seen by Highway 3 travellers. Typical views of the surrounding mountain panorama as seen by highway travellers are shown in Figure 71.

The tailings pond dam will be highly visible where it parallels the highway. The approximate location and height of the dam as visible from the rest stop turn off is marked in Figure 71.

Most of the coal processing plant will probably be concealed from the highway but the loading silos and main portal will be visible above the trees. Most of the upland developments will be hidden by a timbered ridge.

The impact of the development on the human aesthetic use of the area is difficult to assess. Highway 3 is a major tourist highway but on the other hand such coal developments are typical and expected in the Upper Elk River Crowsnest Pass area. To help hide the development from highway viewers as little forest as possible between the highway and the development should be removed. Plantings of screen trees should begin immediately this spring in the open areas between the highway and the railway along the length of the development. Large tree stock (10+ years or older if possible) should be planted in sensitive areas such as directly opposite the rest stop. Nursery stock or wildlings could be planted; a mixture of Douglas fir, white spruce and poplar should be used. Some site preparation, mostly drainage will be necessary; trees should be fertilized and tended.

Elk Valley Provincial Park

The Elk Valley Provincial Park, which may soon be a regional park will be impacted by the proposed developments. However, no large scale changes in present recreational use patterns of the park due to mine development are anticipated. The tailings pond dam and other plant facilities will be visible from the park picnic/rest site and may detract from the highly scenic (Figure 71) qualities of the site. Plans for screening as much of the development area as possible from the provincial park and from the highway have already been discussed. It should be noted that it will be several years after operations begin before the tailings pond dam reaches a noticeable height, by which time screening vegetation should be in place to reduce visual impact.

Noise and dust impacts on the park area through the construction and operation of the mine facilities are not anticipated to be high. No deterioration in the water quality of the park well or reduction in the surface water flow to the beaver pond wildlife habitat complex is anticipated.

Hunting

The exploration road complex on Hosmer-Wheeler Ridge has opened a wide new area to the general hunter with the general result that the area resident elk population is probably now subjected to increased hunting pressure.

During mine construction and operation, however, as with similar facilities elsewhere in the Province, a no-shooting zone should be established around the development site. As current levels of hunting use of the area are unknown, it is not possible to estimate number of hunter days, kill, or revenue from hunting activity which will be lost due to the development. The potential restoration of the area for hunting after operations have ceased is excellent.

Angling

The impact of the development on angling will be minor as the impacts on fish habitat and water quality of No-name Creek will be minimal.

Guiding

As the study area is not part of a guiding territory, there will be no impact on guiding.

Trapping

No registered trapline will be directly affected by the study area. However, the development will affect the trapping area of one trapper who traps by permit from CNI. As no trapping records exist for the area, it is not possible to estimate the loss, if any, in trapping revenue which will occur due to the development.

HISTORIC AND ARCHAEOLOGICAL SITES

Mr. W.T. Choquette of the Archaeological Sites Advisory Board has identified two sites (Appendix B) in the study area, neither of which is in the development areas. He recommends that site DjPrH1, a three building complex of high value, should not be destroyed and that site DjPrH2, a log loading ramp of medium value, should not needlessly be destroyed. He also recommends that the construction of these structures be documented. We recommend that Kaiser follow the first recommendation. Unfortunately, site DjPrH2 has already been destroyed in CNI logging operations.

RECLAMATION

Kaiser Resources Ltd. has the expertise and facilities required to reclaim and revegetate the proposed Hosmer development: B.C. Research has provided limited input to the reclamation plan.

B.C. Research input has involved a documentation of the suitability of surface soils for reclamation use, a description of reclamation objectives based upon a detailed assessment of pre-mining land use capabilities and an estimation of post operational land use capabilities.

RECLAMATION CAPABILITY OF SURFACE SOILS

An assessment of the reclamation capability of surface soils based upon soil depth, texture, water holding capacity, calcareousness, salinity and fertility is presented in Table 24.

The lowland soil mapping units consist of fluvial terraces and fans. In these units, only the surface fine textured fluvial capping is suitable for landscaping and reclamation purposes. Soil mapping units 2a and 3a are preferred for stock-piling soils for landscaping and reclamation. On-site decisions during soil removal will be required to determine if soil depth is sufficient to strip and conserve the topsoil.

Other lowland soil map units are less suitable as soil depth, texture, drainage, stoniness or fertility factors reduce their usefulness as topsoil. However, these soils can be utilized for on-site general landscaping needs. Fertilizer application of NPK will be required to ensure initial growth and where necessary, to sustain optimum nutrient levels in the soil.

In the upland areas, soils have developed on colluvium and till materials. These soils are often difficult to save due to the steep slopes. However, reclamation potential is generally moderate to high due to relatively high fertility status and fine textured soil fractions.

RECLAMATION OBJECTIVES OF SPECIFIC DEVELOPMENTS

A summary of the reclamation objectives is presented in Table 25. The mine developments will not generally be amenable to sequential reclamation: other than cosmetic revegetation, the major reclamation will not take place until project completion. In assessing land use capabilities and revegetation feasibility (table 25), it has been assumed that no surface soils will be available for reclamation. Where surface soils are available, the reclaimed land use capabilities will be correspondingly greater.

The tailings dam will cover approximately 14.3 ha. The sides of the dam will be constructed of coarse mine waste progressively outward as the tailings level rises. The continual process of dam construction will prohibit final revegetation until the tailings dam is complete. The final dam will be 83 ft high and will have a slope of 26°. With this configuration, wildlife and forestry land use capabilities should not be severely affected. Agricultural capabilities will, however, be reduced greatly (Table 25).

The tailings pond will cover a much larger area (107.1 ha). At abandonment, the tailings pond will be level and contain fine coal wastes. As there is no reason to expect that these wastes will differ greatly physically and chemically from the tailings from the nearby Elkview plant no revegetation difficulties are anticipated. Because of the level surface configuration and fine texture, land use capabilities are expected to increase for both forestry and agriculture (Table 25).

The railway loop encircles a total area of 96.9 ha although the actual disturbance will be confined to the right of way and will be much smaller. At abandonment, revegetation should pose no problems although the land use capability of the roadbed and embankment will be reduced.

The plant site will be constructed from portal waste rock and existing gravel subsoils, and will cover a total of 46.5 ha. Revegetation of this site following abandonment does not appear to present major difficulties at this time. It is likely that the site will be gravelly and heavily compacted and will require considerable site preparation at the time of abandonment. Forestry and agricultural capabilities will probably be reduced slightly from their present levels.

The upland developments (portals 52 and 202, fan sites and water reservoir and pumping station) together account for a total disturbance of 8.9 ha. All these developments will be constructed on steeply sloping areas of a westerly exposure, and present plans call for a final maximum slope angle of 25°. Fresh slopes can be reclaimed immediately. Kaiser Resources has had good success with their revegetation of exploration areas at this elevation and the planned upland developments should pose no additional problems. Surface soils should be salvaged on site if possible and augmented as necessary with topsoil salvaged from the tailings dam and pond area.

RECOMMENDATIONS

RECOMMENDED FURTHER STUDIES

Further studies are not recommended for hydrology, fisheries, soils, vegetation, wildlife or human use. However, we recommend that monitoring studies continue on air and water quality.

RECOMMENDED MONITORING PROGRAM

Air

We recommended that the present sampling stations be operated to obtain data for at least one year. Sampling stations should be maintained on a continual basis with possible minor changes in location. One such change would likely be Station No. 2 which may have to be relocated depending on the eventual final layout of the plant.

Water

We recommend that during construction and start-up a regular sampling and analysis schedule should be maintained to monitor and assess impacts of activities on water quality in the area.

Surface water

Recommended sampling sites are: HW12, HW8, HW9, KG, TLA, HW15, HW14, HW13 and HW11. Samples should be collected at intervals of six weeks and analysed for the following variables:

Temperature	TOC
pH(field, laboratory)	Sulphate
Suspended solids	Calcium
Volatile suspended solids	Magnesium
Turbidity	Dissolved iron
Alkalinity	Dissolved Manganese

Hardness	Phenols
Specific conductance	Oil and grease

Total and dissolved solids have been omitted from the list of analyses previously used in the Stage 2 program because of the better precision obtainable with other water quality analyses (McGirr, 1974; Aspila, 1976). Several of the heavy metal determinations carried out during Stage 2 monitoring have been omitted as unnecessary.

Continued monitoring of sediment characteristics will be important during construction, start-up and operation of the mine. Samples should be collected post-freshet, in August, and in April immediately prior to spring runoff. Sites should be chosen at or near to road crossings, downstream of waste facilities, near the tailings pond and in areas where construction may adversely affect stream sediment composition. Sediments should be analysed for the following variables:

Particle size
Organic carbon
Microscopic examination
Zinc
Lead
Copper
Iron
Manganese

Groundwater

At least two wells upslope of the tailings pond and three wells downslope, together with wells upslope and downslope of other waste disposal areas should be monitored at 6 week intervals. At least for the remainder of the exploration program, 4 household wells in the community of Hosmer and the picnic stop well in the Elk Valley Provincial Park should be monitored at the same frequency to obtain adequate baseline data on natural groundwater quality.

Groundwater samples should be analysed for the following variables:

pH(field, laboratory)	Dissolved lead
Alkalinity	Dissolved copper
Hardness	Dissolved iron
Specific conductance	Dissolved manganese
TOC	Dissolved mercury
Sulphate	Phenols
Calcium	Ammonia
Magnesium	Nitrate
Dissolved Zinc	

Although analysis of Hosmer-Wheeler adit coal samples indicated little in the way of extractable metals, additional leaching studies on Hosmer-Wheeler coal tailings should be done when they become available. Acid leaching should be carried out in order to represent the worst possible conditions, even though such conditions are unlikely to occur in the tailings pond. Leachates should be analysed for:

Zinc
Lead
Copper
Iron
Manganese
Mercury

REFERENCES

American Public Health Association. 1971. Standard Methods for the Examination of Water and Wastewater. 13th Ed. American Public Health Association, New York. 874 p.

Annual Book of ASTM Standards. 1974. Gaseous Fuels; Coal and Coke; Atmospheric Analysis (November) Part 26.

Aspila, K.I. 1976. Interlaboratory Control Study. No. 14. Major ions. Canada Centre for Inland Waters. In preparation.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto. 438 p.

Block, C.A., et al. 1965. Methods of Soil Analysis. Am. Soc. Agron., Madison, Wisconsin.

B.C. Department of the Environment, Water Resources Service. 1976. Kootenay.

B.C. Fish and Wildlife Branch. 1975. British Columbia Hunting Regulations. Synopsis - 1976/1977. Dept. of Recreation and Conservation, Victoria. 52 p.

B.C. Forest Service. 1976. Forest Classification and Sampling Manual. 246 p.

B.C. Water Resources Service. 1st ed. 1973 2nd ed. 1976. A Laboratory Manual for the Chemical Analysis of Water, Wastewaters and Biological Tissues.

Canada Department of Agriculture. 1974. The System of Soil Classification for Canada. Queen's Printer for Canada, Ottawa. 249 p.

Canadian Wildlife Federation. 1970. Endangered Wildlife in Canada. Canadian Wildlife Federation. Ottawa. 15 p.

REFERENCES

American Public Health Association. 1971. Standard Methods for the Examination of Water and Wastewater. 13th Ed. American Public Health Association, New York. 874 p.

Annual Book of ASTM Standards. 1974. Gaseous Fuels; Coal and Coke; Atmospheric Analysis (November) Part 26.

Aspila, K.I. 1976. Interlaboratory Control Study. No. 14. Major ions. Canada Centre for Inland Waters. In preparation.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press. Toronto. 438 p.

Block, C.A., et al. 1965. Methods of Soil Analysis. Am. Soc. Agron., Madison, Wisconsin.

B.C. Department of the Environment, Water Resources Service. 1976. Kootenay.

B.C. Fish and Wildlife Branch. 1975. British Columbia Hunting Regulations. Synopsis - 1976/1977. Dept. of Recreation and Conservation, Victoria. 52 p.

B.C. Forest Service. 1976. Forest Classification and Sampling Manual. 246 p.

B.C. Water Resources Service. 1st ed. 1973 2nd ed. 1976. A Laboratory Manual for the Chemical Analysis of Water, Wastewaters and Biological Tissues.

Canada Department of Agriculture. 1974. The System of Soil Classification for Canada. Queen's Printer for Canada, Ottawa. 249 p.

Canadian Wildlife Federation. 1970. Endangered Wildlife in Canada. Canadian Wildlife Federation. Ottawa. 15 p.

Carl, G.C., W.A. Clemens and C.C. Lindsey. 1959. The Freshwater Fishes of British Columbia. B.C. Provincial Museum Handbook No. 5. 192 p.

Carlander, K.D. 1969. Handbook of Freshwater Fishery Biology. Iowa State University Press.

Clark, L.J. 1973. Wild Flowers of British Columbia. Gray's Publ., Sidney, B.C. 591 p.

Conard, H.S. 1956. How to Know the Mosses and Liverworts rev. ed. W.M.C. Brown Publ. Dubugue, Iowa. 226 p.

Cordone A.J. and D.W. Kelly. 1961. The Influence of Inorganic Sediment on the Aquatic Life of Streams. Cal. Fish and Game. 47: 189-228.

Cormack, R.G.H. 1967. Wild Flowers of Alberta. Dept. of Industry and Development, Govt. of Alberta. Edmonton. 415 p.

Cowan, I. McT. and C.J. Guiguet. 1973. The Mammals of British Columbia. B.C. Provincial Museum Handbook. No. 11. Queen's Printer, Victoria. 414 p.

Craighead, J.J., F.C. Craighead, Jr., R.L. Ruff, and B.W. O'Gara. 1973. Home Ranges and Activity Patterns of Nonmigratory Elk of the Madison Drainage Herd as Determined by Biotelemetry. Wildl. Monogr. 33:1-50.

Daubenmire, R.F. 1959. A canopy coverage method of vegetation analyses. Northwest Science 33: 43-64.

Demarchi, R.A. 1967. A general wildlife capability inventory of Crows Nest Industries Limited Lands in the East Kootenay Region of British Columbia. B.C. Fish and Wildlife Branch. 11 p.

Durfor C.N. and E. Becker. 1964. Public Water Supplies of the 100 Largest Cities in the United States, 1962. U.S. Geol. Survey Water Supply Paper 1812. p. 27.

Environment and Land Use Committee. 1975. Guidelines for Coal Development. 33 p.

Environment and Land Use Committee Secretariat. 1976. Terrain Classification System.

Environment and Land Use Committee Secretariat, Resource Analysis Unit. Canada Land Inventory Manuscript Maps 82G-NE and NW for Forestry, Agriculture, Recreation, Present Land Use, and Waterfowl (scale 1/126,720). Victoria, B.C.

Geological Survey of Canada. 1970. Geology and Economic Minerals of Canada. R.J.W. Douglas ed. Queen's Printer. Ottawa. 838 p + maps.

Godfrey, W.E. 1966. The Birds of Canada. National Museum of Canada. Bull. No. 203, Biol. Series No. 73. Queen's Printer. Ottawa. 482 p.

Guiguet, C.J. 1970. Birds of British Columbia: (7) Owls. B.C. Provincial Museum Handbook. No. 18. Queen's Printer. Victoria. 62 p.

Herrington, R.B. and D.K. Dunham. 1967. A Technique for Sampling General Fish Habitat Characteristics of Streams. U.S. Forest Service Research Paper INT-41. 12 p.

Hitchcock, A.S. 1951. Manual of the Grasses of the United States. U.S. Dept. of Agri. Misc. publication No. 200; U.S. Govt. Printing Office, Washington. 1051 p.

Hitchcock, C.L. and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. of Washington Press, Seattle. 730 p.

Hubbard, W.A. 1969. The Grasses of British Columbia. B.C. Provincial Museum Handbook. No. 9. 205 p.

Hynes, H.B. 1970. The Ecology of Running Waters. University of Toronto Press. 555 p.

Jonkel, C.J. and I. McT. Cowan. 1971. The Black Bear in the Spruce-Fir Forest. Wildl. Monogr. 27:1-57.

Kelley, C.C. and P.N. Sprout. 1955. Soil Survey of the Upper Kootenay and Elk River Valleys in the East Kootenay District of British Columbia. Report No.5. B.C. Department of Agriculture. 99 p.

Knight, R.R. 1970. The Sun River Elk Herd. Wildl. Monogr. 23:1-66.

Krajina, V.J. 1969. Ecology of Western North America. Department of Botany, U.B.C. 2(1):1-146.

Lawton, E. 1971. Moss Flora of the Pacific Northwest. Nichinan, Miyazaki, Japan, Hattori Botanical Laboratory. 362 p.

McGirr, D.J. 1974. Interlaboratory Quality Control Study No. 6. Specific Conductance, pH, colour and residue. Report Series No. 28. Canada Centre for Inland Waters, Burlington, Ontario. 6 p.

Mather, J.R. 1956. Climate Classification for Environmental Biologists. Publications in Climatology 19(4):312-17.

Moss, E.H. 1964. Flora of Alberta. Univ. of Toronto Press. 546 p.

National Academy of Sciences. 1972. Water Quality Criteria - 1972. A Report of the Committee on Water Quality Criteria. Washington, D.C. 594 p.

Porsild, A.E. 1974. Rocky Mountain Wild Flowers. Natural History Series, No.2. National Museums of Canada, Ottawa. 454 p.

Runka, G.G. 1969. Lands of the East Kootenay - Their Characteristics and Capability for Agriculture and Forestry. A Report to the B.C. Soil Capability for Agriculture and Forestry Committee.

Schofield, W.B. 1968. A Checklist of Hepaticae and Anthocerotae of British Columbia. Syesis. 1: 157-162.

Schofield, W.B. 1968. A Selectively Annotated Checklist of British Columbia Mosses. Syesis. 1: 163-175.

Schofield, W.B. 1969. Some Mosses of British Columbia. B.C. Provincial Museum Handbook No. 28. 262 p.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Bull. 184. Ottawa, Ont. 966 p.

Soper, J.D. 1971. The Mammals of Waterton Lakes National Park. Cdn. Wldl. Ser. Dept. Queen's Printer, Ottawa.

Stanlake, E.A. and M.G. Stanlake. 1975. Ungulate Use of Some Reclaimed Strip Mines in Southeastern British Columbia III. Progress Report. B.C. Fish and Wildlife Branch, Dept. of Recreation and Conservation. Victoria. 61 p.

Taylor, T.M.C. 1970. Pacific Northwest Ferns and Their Allies. Univ. of Toronto Press, Toronto. 247 p.

Taylor, B. and C. Hayward. 1974. Ungulate Use of Some Reclaimed Strip Mines in Southeastern British Columbia I. Preliminary Report. B.C. Fish and Wildlife Branch, Dept. of Recreation and Conservation. Victoria. 74 p.

Thiel, R. and G. Carpenter. 1970. Dosage Photométrique de traces d'arsenic dans les eax naturelles. Bull. Centre Rech. Pau 4(1), 243-246.

U.S.D.A. 1954. Saline and Alkali Soils. Agriculture Handbook No. 60. U.S.D.A.