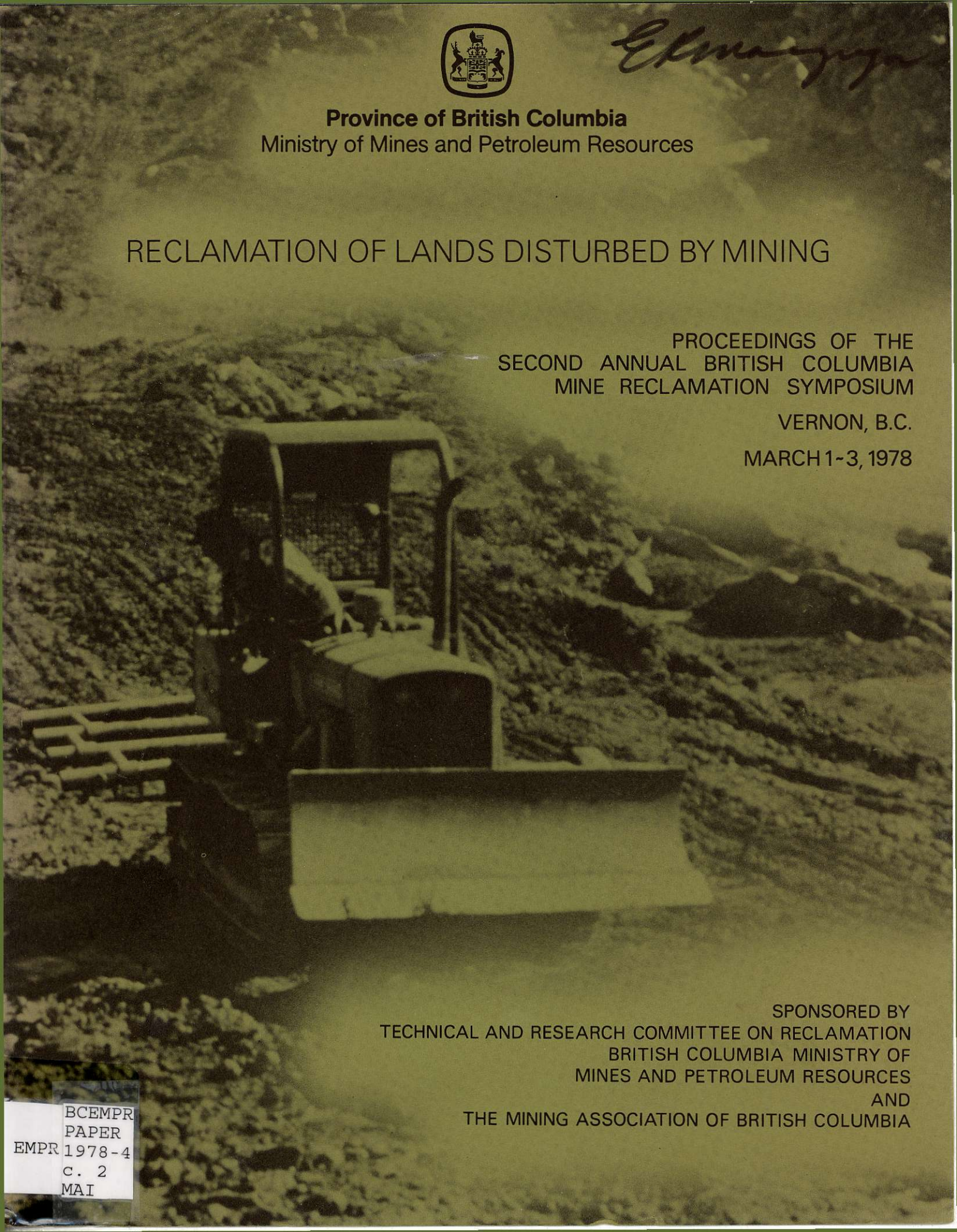

Province of British Columbia
Ministry of Mines and Petroleum Resources

RECLAMATION OF LANDS DISTURBED BY MINING

PROCEEDINGS OF THE
SECOND ANNUAL BRITISH COLUMBIA
MINE RECLAMATION SYMPOSIUM

VERNON, B.C.

MARCH 1-3, 1978

SPONSORED BY
TECHNICAL AND RESEARCH COMMITTEE ON RECLAMATION
BRITISH COLUMBIA MINISTRY OF
MINES AND PETROLEUM RESOURCES
AND
THE MINING ASSOCIATION OF BRITISH COLUMBIA

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Convened at

Vernon Lodge

Vernon, British Columbia

on

March 1, 2, and 3, 1978

Sponsored by

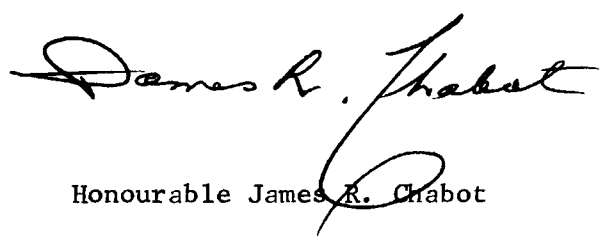
Technical and Research Committee on Reclamation
British Columbia Ministry of Mines and Petroleum Resources
and the
Mining Association of British Columbia

PREFACE

The Ministry of Mines and Petroleum Resources is pleased to have played an active role in sponsoring the Second Annual Mine Reclamation Symposium.

This year the program was directed towards attracting a larger representation from industry. It is gratifying to see how many participants are in attendance to express the mining industry's point of view.

I am certain that greater industry commitment and participation in all aspects of reclamation will result in the continued development of rational programs of environmental protection and reclamation in British Columbia.



Honourable James R. Chabot

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EDITOR'S NOTE

These proceedings present the Symposium events in chronological order. Presented papers have received minor editing and have been typed. Time constraints prohibited final text proofreading by individual authors, consequently, the editorial staff accept responsibility for any errors.

Question and answer periods were tape recorded. Transcripts of these discussions are given at the end of each presented paper within the proceedings. Severe editing of the transcripts was sometimes necessary to curtail the length of the question and answer dialogue. We apologize for any unwitting alterations in meaning.

Comments made during the two round-table workshop sessions have also been noted and transcribed. Findings which achieved consensus at the individual tables were read out at the conclusion of each session. There was a considerable variety of opinions expressed and, within the proceedings, an attempt has been made to include all points of view. The opinions most often expressed are listed first.

OPENING REMARKS
by the
SYMPOSIUM CHAIRMAN

R.T. Gardiner

Chairman

Technical and Research Committee

As the Chairman of the Technical and Research Committee I am pleased to welcome you to this Mine Reclamation Symposium. This is the second consecutive year our Committee has organized and sponsored a symposium and I must admit that there was considerable debate among Committee members concerning the desirability of having a symposium again this year. The reasoning behind the Committee's decision to convene a second annual symposium may require some explanation.

The primary purpose for the symposium is to promote communication and conversation among industry, government, academics, consultants and other groups or individuals concerned about the impact of mining on land and related resources. The Committee felt that communication and interchange of information are necessary to improve our knowledge and understanding of the impacts of mining, and that discussion among concerned peoples is essential for the development of effective policies, guidelines and technologies which will minimize any adverse impacts and restore disturbed areas to a stable and useful state. The "round table" workshop sessions, which followed each series of lectures during the first symposium, will be employed again this year to facilitate these important discussions.

There are many inter-related aspects to mined-land reclamation, more than can be adequately discussed within the time limitations of a symposium of this type. The Committee felt, therefore, that it was possible to organize a program which would be both interesting and informative without being repetitive. Judging by the large number of delegates registered, the Committee has been successful in choosing topics which are both timely and of broad interest.

And finally, it was considered important to organize a symposium which would attract a larger representation of mine management personnel than attended the first symposium.

Participation by mining industry representatives responsible for formulating and implementing mine reclamation policy for the mining companies is essential if these symposia are to achieve the purpose for which they are intended.

A highlight of the symposium again this year will be the presentation of the Reclamation Award in recognition of outstanding achievement in mined-land reclamation and two Citations for merit in mined-land reclamation. We shall be honoured by the attendance of the Honourable James Chabot, Minister of Mines and Petroleum Resources, who will present the awards during the banquet on Thursday evening.

In conclusion, I would like to take this opportunity to thank the Committee members, in particular John Errington, symposium convenor, for their contribution in making this symposium a reality. I would also like to welcome the large contingent of students who are assisting us again this year in the presentation of the symposium. And last, but by no means least, I would like to extend the appreciation of the Committee to those delegates who accepted our invitations to present papers or to act as session chairpersons.

"IF YOU COULD DO ONE THING TO IMPROVE RECLAMATION IN BRITISH COLUMBIA, WHAT WOULD IT BE?"

The symposium participants were asked to consider the above fundamental question and provide a written answer on the back of the Wednesday night banquet ticket.

The participant's answers, some of them meaningful evaluations of the question and others succinctly humorous, are presented under the classification grouping of respondent occupation. No attempt has been made to identify individual answer and respondent, although minor editing has been done to ensure clarity and good taste, where necessary.

ACADEMIC

Increase public awareness of the importance of mining to the economy of British Columbia, and ensure that with cooperation and communication the mining industry will carry forth a responsible reclamation programme as a part of mine planning.

Hire me!

Do not grant licences until a proper reclamation plan has been filed.

Emphasize reclamation in the university system to provide new ideas.

Have all reclamation projects sculptured (in the image of Mt. Rushmore, etc.).

Insist that all specs for reclamation complete with budget allocation be submitted prior to any development, plus a commitment on the part of the company that it will spend that budget on reclamation.

Establish a method of communication between all the different groups that are working on reclamation related problems (i.e., share the knowledge and research).

Educate the people actually involved in the field on the necessity of preserving the environment as much as possible during the mining operation.

Reslope.

Improve the methods of disposal and placement of spoil piles with respect to reclamation, sloping and revegetation.

CONSULTANTS

Increase the number of revegetation trials funded by Government and industry cooperatively.

Formulate unilateral reclamation legislation and create a controlling body covering all resource uses which disturb land. (Not blind opposition to development - just opposition to blind development).

Provide a "primer" explaining reclamation concepts for the "Mining Industry", "Consultants" and Government agencies. Introduce reclamation seminars at mining and engineering colleges, etc.

Correlate exploration and core sampling with the reclamation programme.

Improve storm water management on all mines. No other improvement would enhance the environment more.

Hire a good consultant.

Plant more timber trees.

Provide tax incentives to industry for high quality scientific evaluation of their reclamation programmes. Evaluations should include: yield and quality of vegetation; species performance; evaluation of fertilization programme; overburden and soil quality. (Test water quality of the stream running through this hotel!)

"Love"

Plant native grass.

Common sense.

Instil the concept of reclamation planning as a primary and inseparable part of mine development planning; thereby avoiding or at least realizing the problems to be encountered in the final reclamation effort. (Prepare an outline of general goals and factors influencing the end results).

Collate, to a central data bank, all reclamation results (good or bad) and permit access by all interested parties.

Need some material selection (e.g. rock type, soil type). Material should be differentiated and assessed to assure maximum success of revegetation.

"Hydroseed with Algenol"

Investigate Federal research on seed and plants for use in reclamation.

On good growth media start with agronomic species, then as they die out introduce native trees, shrubs, and deciduous trees. Finally, introduce the climax species of the area. e.g., reproduce natural succession with reclamation.

Be reasonable and realistic in terms of reclamation scale and costs.

Plan earlier to reduce water problems and costs.

To meet the coming reclamation need, press for a realistic budget for the Ministry of Mines and Petroleum Resources so that both internally and through sponsored research, they can provide a 'commercial' supply of native seeds (grasses and legumes) for alpine revegetation.

Use native species for high elevation areas for self-sustaining cover.

Do more trials using native ecotypes.

GOVERNMENT

More mines gives more practice (Learn from the experience of others).

I would suggest that reclamation be laid out and higher bonding be made mandatory from day one, as far as gravel pits are concerned.

Employ more people in the Ministry to study and administer the reclamation programme in the Province of British Columbia.

Control Mother Nature.

Encourage Government to take responsibility for abandoned reclamation sites and let industry be responsible for existing operations.

God, that's a good question!

Divide the Provincial Inspection Branch into (1) a Mine Safety Branch, and (2) an Operations Planning Branch. The latter should be responsible for integrating resource management on land being used for mining purposes. It should also be regionalized to the same degree that the safety component is currently regionalized (i.e. need more staff).

Establish strict funding of reclamation sections by mining companies (i.e. a per cent of gross income).

Promote the following attitudes: reclaim or maintain (mining industry); maximum success or a reasonable alternative (Government agencies).

Give the Provincial Mines Reclamation section more staff!

Incorporate land capability into final design.

Make the mining company post a bond or security to cover 50 per cent of the present cost of reclamation as a requirement to obtain a mining licence.

Train the staff of the mining companies in the skill of reclamation (if I knew these skills).

Consider reclamation of tailings by applying topsoil.

Improve tailings disposal methods.

Have your environmentalists work in extractive industry for a while.

Proper mine planning is essential for short-term and long-range reclamation.

Discard overburden and tailings into Alberta - they have a slush fund for this.

Increase the number of reclamation symposiums.

More reclamation pre-planning to control the end result. It is easier to reclaim with a goal in mind.

Request reclamation plans prior to mine opening.

Put more teeth in the Mines Regulation Act to ensure "pre-planning" and follow through.

Reclamation should be an ongoing process during a mining program. This is particularly applicable to exploratory work where cat roads are very susceptable to excessive erosion.

Fire all the exploration party chiefs who say they will do the clean-up later.

Improve mining management's and engineer's sensitivity with regards to the beauty of nature's landscapes and vegetation. In that way, these people would have increased enthusiasm for reclamation, in the hope of emulating nature's beauty.

Achieve a concensus of the parties involved in order to speed up and simplify the reclamation review and approval processes.

Utilize domestic sewage sludge to provide organic material and nutrients for regrowth (i.e. recycle).

INDUSTRY

Get all people to agree on what reclamation really means.

The do-gooders have had their day. The message has been heard. Now a reasonable approach must be made. The cost to the environment must be measured against the benefits to the public at large.

Time will cure everything - it has made the vegetation the way it is - it will cure everything if given the time. Sun, wind, and time will definitely do it again. Meanwhile, the human being can live.

Increase the incentives towards reclamation - making it economically favourable towards industry. After all, industry is economics.

Early planning of reclamation projects.

Policing the operations of the Department of Highways (in the northeast coal areas to be specific).

Bring into political perspective the work of nature of which man is only a small part and mining an insignificant part.

Continuity of reclamation (revegetation, recontouring, etc.) in accordance with exploration and development.

A continuation of cooperation between Government and Industry along with more publicity about this cooperation and things done or being done to the general public.

Relocate Province to Hawaii.

Clean up the Elk valley at Natal thereby removing an oft observed bad image of the coal industry. Action to include relocation of people living on strip, modernization or removal of coking plant and reclamation of spoil (or refer the problem to Department of Highways and move the scenic route to another valley).

Convince everyone that reclamation is a legitimate and desirable part of a mining plan and operation.

Incorporate reclamation planning at the feasibility stage, provided that guidelines relative to reclamation are clearly spelled out and/ or known at mine planning stage.

Development of commercial seed supplies of native shrub species.

Legislate that all reclamation will be done by the Government out of taxation funds derived from the mines that have to be reclaimed.

The emphasis by Mr. McDonald on de-regulation rather than over regulation is a very favorable attitude to continue in industry and Government relations.

Other industries (i.e. forestry) should reclaim their disturbed areas to the same degree as mining companies. You cannot have two completely different rules for two different industries that disturb land in the same areas.

Effectively reduce mining taxation, federally and provincially, on condition that at least 50 per cent of the net reduced taxes are spent on additional improved technical stewardship and implementation of land restoration.

Attend the mine reclamation symposium regularly.

Let industry know what the reclamation rules are.

Do more research into viable long lasting ground cover.

Take the theoretical approach and apply it on a practical basis.

Increase cooperation between Government and industry in reclamation planning.

Develop methods for maintaining vegetation on low phosphorus growth media.

Reclamation must be practiced, not just preached.

My first response would be to suggest that logging reclamation be improved considering that logging disturbs vast areas. However, your question is directed to mining I am sure. I would increase the tax write-off value of every dollar spent on reclamation.

Reduce Federal, Provincial income taxes and eliminate B.C. sales tax so that mines operate over a greater life span, thereby reducing the reclamation dollars/ton extracted.

Quit blaming mining for all the problems of pollution and lack of reclamation. Much can be done by mining but costs and benefits must be balanced. The real (not imagined) damage is minimal.

Land should be reclaimed to a useful state.

Reclamation planning should be advanced into the second or third stage of exploration drilling (i.e. it should not be left until the mine feasibility studies have started).

Need to optimize the handling of materials. The reclamation program must be fully integrated with the mine plan, in cases where it is not already being done.

Emphasis on the economical utilization of proposed sites (i.e. stay away from "clear cutting" sites and preserve islands of natural growth within an area). This would be of significant assistance in ultimate site restoration especially with gravel borrow pit operators (e.g. Dept. of Highways).

Develop a grass/legume cross which would grow under all environmental, physical and climatic conditions.

Promote a close but not restrictive liaison between industry and government.

Establish bioregional native species seed collection and a distribution centre.

Re-define the definition of reclamation.

Change attitudes and expectancies - nature can only be pushed so fast.

Better co-operation between government and industry.

Reinforce Mr. McDonald's pragmatic approach to site specific problems.

Make reclamation an integral and automatic part of the design, planning and production functions in all mines.

Further educational seminars of this nature will increase reclamation knowledge and bring about improvement.

Include a course at B.C.I.T., preferably in the evening, dealing specifically with reclamation.

Improve "front line" communication.

Dr. Errington mentioned that topsoil replacement showed good result. Perhaps more research should be conducted to determine optimum and minimum depths of regolithic material to be replaced over mine spoil in each climatic zone.

Put stricter regulations on the logging industry and B.C. Ministry of Highways. Symposiums such as this one help to provide better communication between industry, government and consultants.

Need greater communication between industry and government. Also should know what the effects of not reclaiming are to the environment.

Educate the public to appreciate the environment and learn how to expect and get more from the mining industry in this regard.

Increase the use of available technologies through greater increase in available funds for implementation of techniques.

Provide more funds for serious reclamation research.

Improve communication between the mining companies and other agencies who are currently gaining experience in reclamation, so that all knowledge becomes common knowledge and can be applied wherever appropriate.

Increase full time job opportunities in the field of reclamation. From a practical point of view, decreasing government tax levels on mines may promote availability of monies for reclamation as required.

Improve upon the acquisition of native species for revegetation of disturbed areas rather than strictly utilizing agriculturally employed species.

Let "Mother Nature" show the way - and then give her every possible aid.

Explore use of native species in replanting and mine reclamation. Investigate the use of weathering acceleration agents on bare rock wastes.

The cost of reclamation should be offset as a credit against the royalty.

Encourage reclamation planning at the earliest possible stages of mineral development.

Determine a method of removing heavy minerals from runoff and groundwater from a mine tailing (before and after vegetation reclamation).

MINISTRY OF MINES AND PETROLEUM RESOURCES' RECLAMATION POLICY AND ACTIVITIES

Chairman of the Afternoon Session
Wednesday, March 1, 1978

E. Macgregor,
Associate Deputy Minister,
B.C. Ministry of Mines and Petroleum Resources,
Victoria, B.C.

AIRPHOTOS AND COAL EXPLORATION PROCEDURE

Paper Presented
by:

D.M. Galbraith
Reclamation Inspector
B.C. Ministry of Mines and Petroleum Resources
Victoria, B.C.

AIR PHOTOS AND COAL EXPLORATION PROCEDURE

INTRODUCTION

In the last few years, aerial photography has seen increasing use in the mining industry. Air photos have been used in both exploration and development for planning and documenting work and access and in making topographic maps. Air photos clearly show topography, vegetation patterns, and ground detail as opposed to the topographic map which only indicates general topography. As such the air photo shows considerable promise with respect to environmental planning and government approvals.

Legislation states that industry shall submit plans of work which protect the environment and that bonding be set to cover the extent of disturbance created. Air photos are the best means of documenting these disturbances as it is possible to calculate from them directly the extent of a disturbed area. Another advantage with air photos is that other Ministries must be consulted in the approval of an exploration programme, and the air photo base is a format from which an appreciation of an area can be rapidly obtained.

MINISTRY OF MINES & PETROLEUM RESOURCES AIR PHOTO INVENTORY SYSTEM

The two major coal areas of B.C. are the Northeast Coal Block and the Southeast Coal Block (Figure 1). Both areas are mountainous with the Northeast having extensive alpine terrain. Coal licences of the Northeast are shown in Figure 2.

The objective of the 1977 Northeast project was to produce air photo mosaics of the major coal properties and document the exploration disturbances to date. The total mosaic coverage is shown in Figure 3. The photography and mosaics came from a number of sources. Black and white photography of Carbon Creek and East Mount Gething was provided by Utah Mines Ltd. and the mosaics with the licence boundaries were prepared by T.M. Thompson and Associates. Black and white mosaics with the licence boundaries for the Sukunka-Bullmoose, Bullmoose West Fork and Mt. Spieker properties were provided by Teck Corporation. Denison Mines Ltd. provided color mosaics with licence boundaries for the Quintette properties.

Completed mosaics showing coal licence boundaries were photographed and chronaflexes produced that were suitable for making blueprints. Mosaics were uncontrolled and the boundaries of the individual licences were therefore distorted. Controlled mosaics (ortho-photography) are costly and time consuming and the extra expense was not justifiable for this project.

Disturbances within the licence areas were interpreted and indexed on the chronaflex (Figure 4). The area of each specific disturbance was measured using a digitized planimeter and the results were summarized according to coal licence number (Figure 5).

FIGURE 1

LOCATION OF MAJOR BRITISH COLUMBIA

COAL BLOCKS

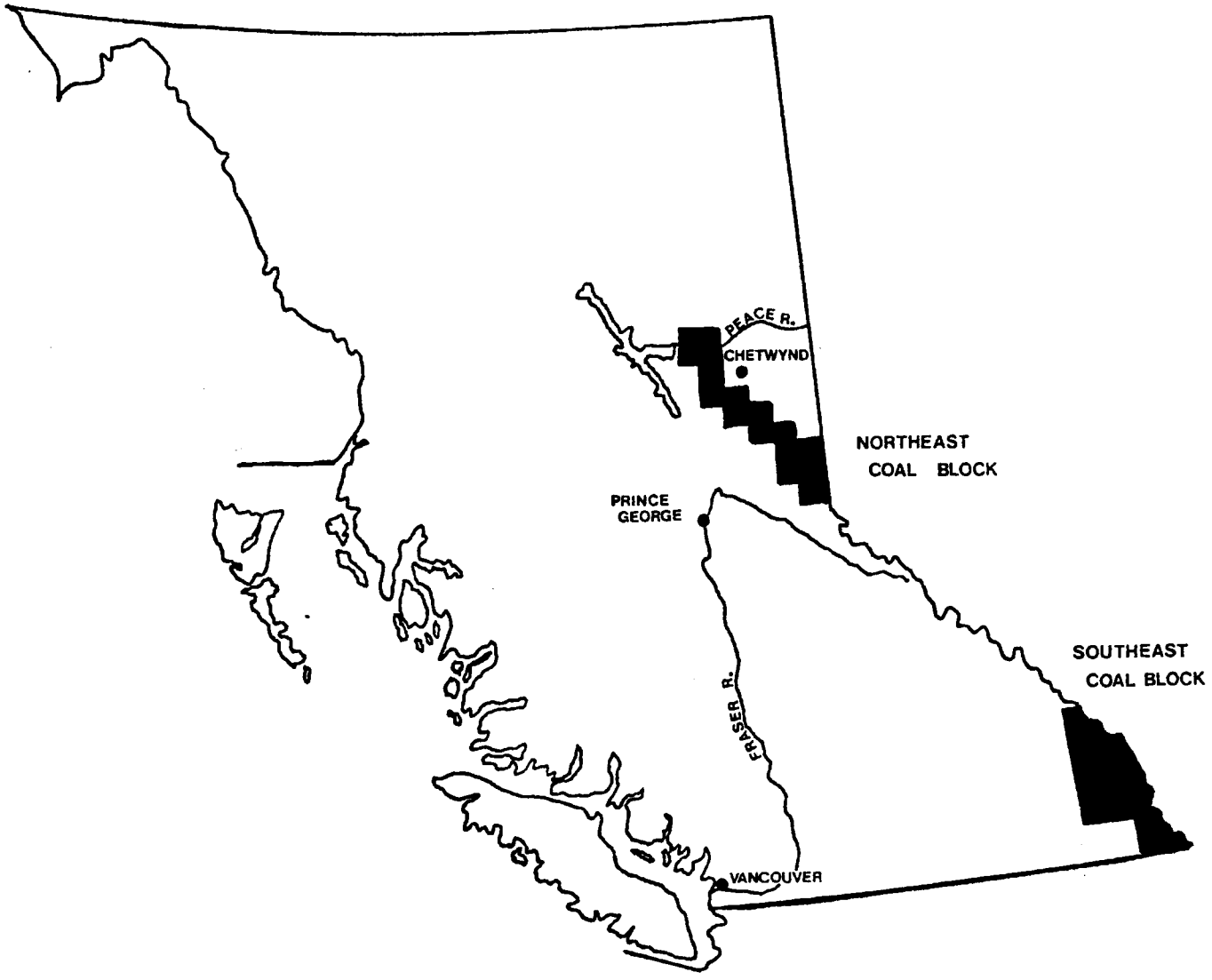


FIGURE 2

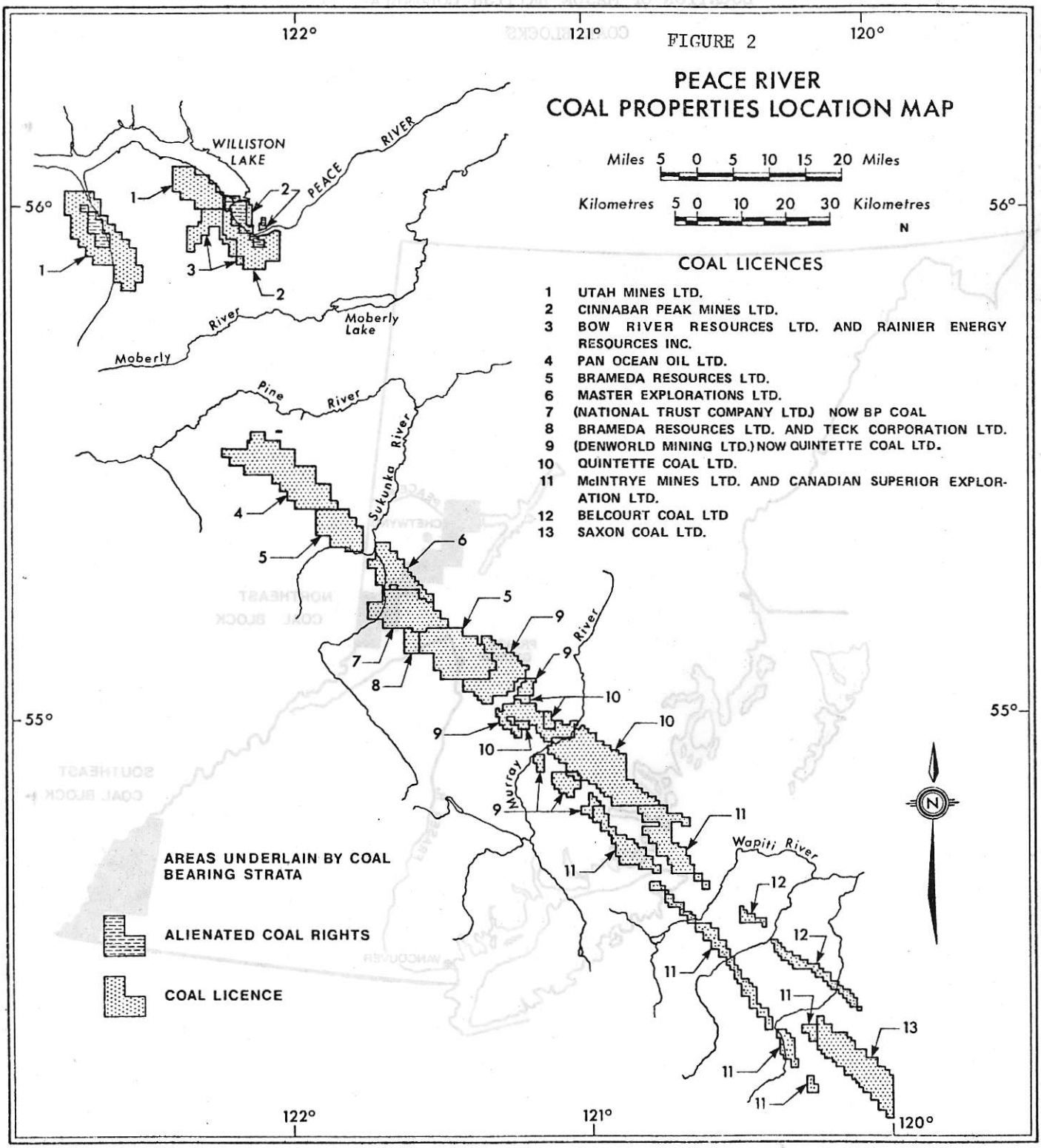
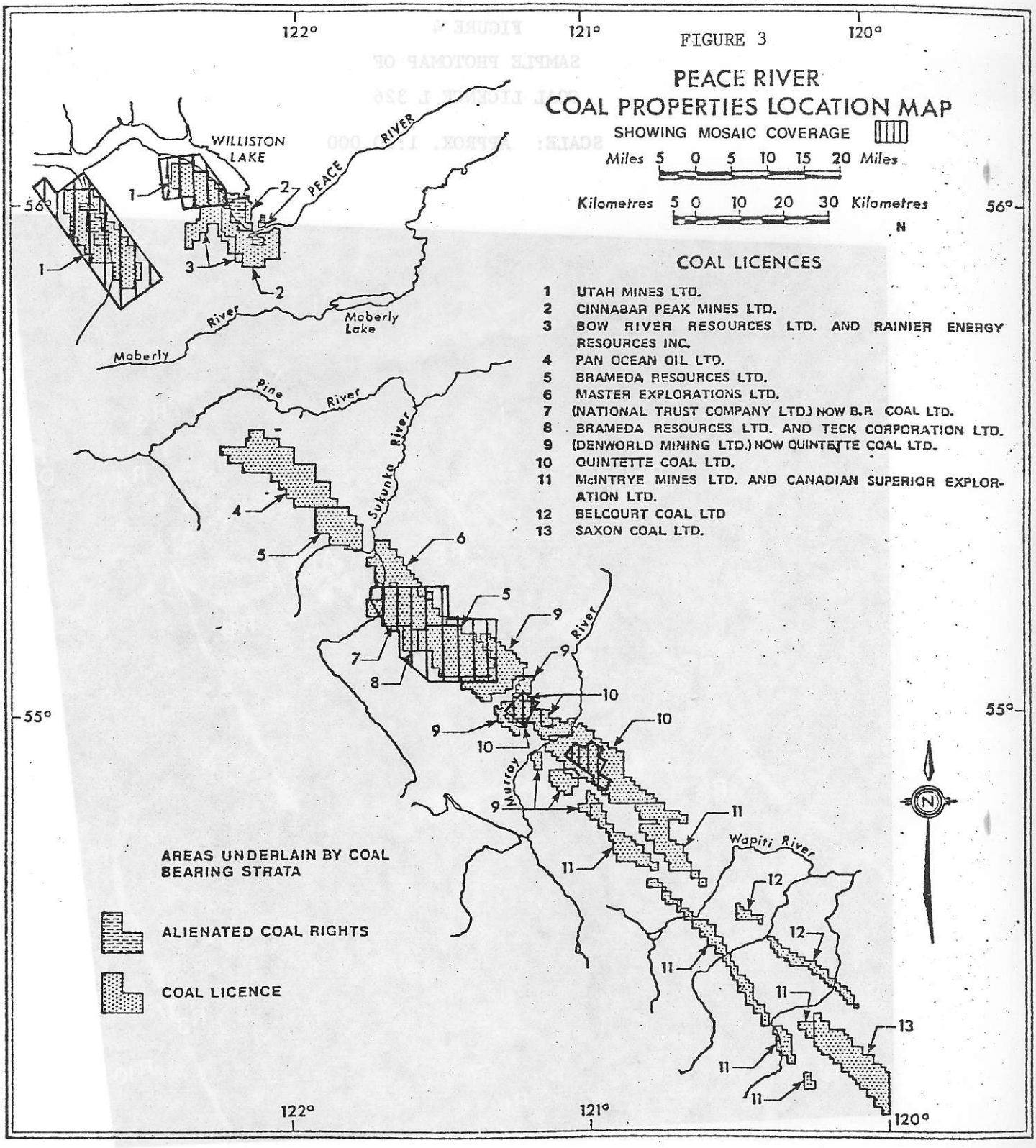

PEACE RIVER
COAL PROPERTIES LOCATION MAP
Miles 5 0 5 10 15 20 Miles
Kilometres 5 0 10 20 30 Kilometres
N
122°
121°
120°
56°
55°
WILLISTON LAKE
PEACE RIVER
Moberly River
Moberly Lake
Pine River
Sukunka River
Murray River
Wapiti River
COAL LICENCES
1 UTAH MINES LTD.
2 CINNABAR PEAK MINES LTD.
3 BOW RIVER RESOURCES LTD. AND RAINIER ENERGY RESOURCES INC.
4 PAN OCEAN OIL LTD.
5 BRAMEDA RESOURCES LTD.
6 MASTER EXPLORATIONS LTD.
7 (NATIONAL TRUST COMPANY LTD.) NOW BP COAL
8 BRAMEDA RESOURCES LTD. AND TECK CORPORATION LTD.
9 (DENWORLD MINING LTD.) NOW QUINTETTE COAL LTD.
10 QUINTETTE COAL LTD.
11 McINTRYE MINES LTD. AND CANADIAN SUPERIOR EXPLORATION LTD.
12 BELCOURT COAL LTD
13 SAXON COAL LTD.
AREAS UNDERLAIN BY COAL BEARING STRATA
ALIENATED COAL RIGHTS
COAL LICENCE

FIGURE 3


PEACE RIVER
COAL PROPERTIES LOCATION MAP
SHOWING MOSAIC COVERAGE
Miles 5 0 5 10 15 20 Miles
Kilometres 5 0 10 20 30 Kilometres
N
122°
121°
120°
56°
55°
WILLISTON LAKE
PEACE RIVER
Moberly River
Moberly Lake
Pine River
Sukunka River
Murray River
Wapiti River
COAL LICENCES
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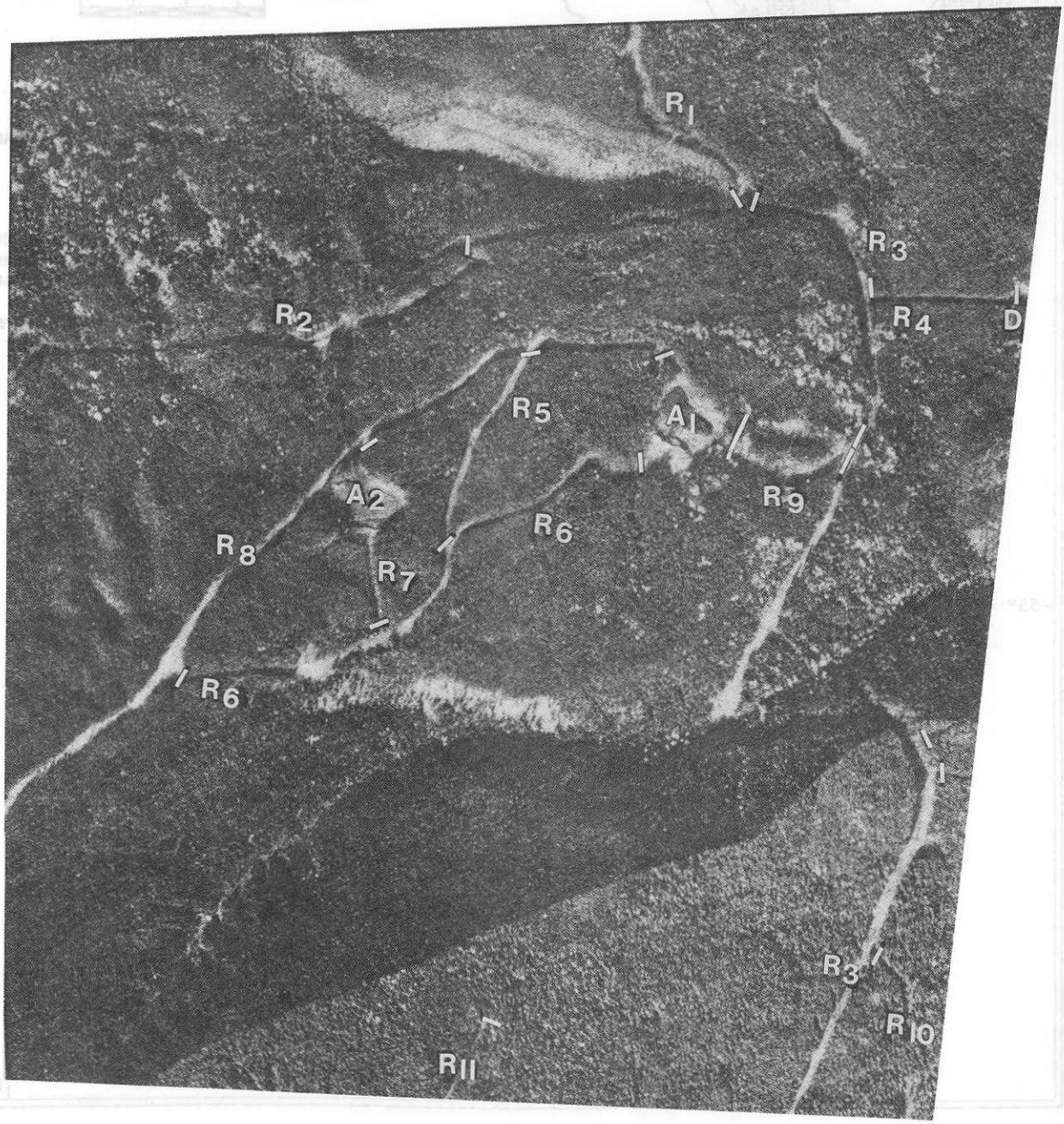
12 BELCOURT COAL LTD
13 SAXON COAL LTD.
AREAS UNDERLAIN BY COAL BEARING STRATA
ALIENATED COAL RIGHTS
COAL LICENCE

FIGURE 4

SAMPLE PHOTOMAP OF

COAL LICENCE L 326

SCALE: APPROX. 1:10,000



DATE OF PHOTOGRAPHY: SEPT. 1976 DATE OF INVENTORY: APRIL/MAY 1977

FIGURE 5

SAMPLE FORM USED TO RECORD EXTENT OF DISTURBANCE ON EACH COAL LICENCE

COAL LICENCE NO. Lot 326

Photomap based on airphoto McElhanney 14: 95

For stereo coverage use photos BCC 143: 86, 87

Types and acreages of disturbed areas

(Mining)

ROADS				DRILL SITES		ADITS		TRENCHES		OTHER	
Sec.	Length m	Width m	Area m^2	Sec.	Area m^2	Sec.	Area m^2	Sec.	Area m^2	Sec.	Area m^2
1	380	8	2,900	1	1,850	1	14,730				
2	1,270	4	5,010			2	8,730				
3	2,120	8	16,810								
4	230	4	920								
5	560	4	2,230								
6	840	5	4,120								
7	130	3	410								
8	1,360	6	8,260								
9	460	11	5,470								
10	250	3	770								
11	150	3	460								
Total			46,860		1,850		23,460				
Grand total											72,170

7.2 ha

Disturbances caused by other operations

Sec.	Area m^2	Remarks

The cost of the program was $10,800. It was done under contract by T.M. Thompson & Associates of Victoria. Some of the details and results of the program are as follows:

Number of licences in the Northeast Coal Block = 721

Number of licences reviewed = 212 which included most of the activity.

Number of licences with exploration work done = 129 (out of 212)

Total disturbance measured = 408.7 ha (There may be another 100 ha outside the areas surveyed)

Disturbance per worked licence = 3.2 ha average

Non-mine related disturbance (seismic, forestry) = 1.2 ha average per licence

These figures summarize only disturbances within the actual coal licences and not those which lie outside. The areas of disturbance calculated by this program were found to be similar to those submitted by the companies.

REVISED PROCEDURE FOR DOCUMENTATION OF COAL EXPLORATION

Permit procedure requires that a "Notice of Work on a Coal Licence" must be submitted prior to the actual starting of field work, preferably one month in advance, in any calendar year. As well, a "Programme for Protection and Reclamation" (to be available in 1978 but presently called "Application for a Reclamation Permit"), must also be submitted where the employment of mechanical equipment is likely to disturb the surface of the land. Currently 12 copies of 1:50,000 topographic maps are requested to accompany these forms. After the summer of 1978, the "Programme for Protection and Reclamation" will be required to be documented on 2 copies of a 1:10,000 air photo base as well as the 12 copies of a 1:50,000 topographic map.

Permit procedure also requires that a "Notice of Work on a Coal Licence" be submitted within one month of completion of work. A 1:50,000 topographic map documenting the year's activities must accompany the Notice of Work. A "Reclamation Report" which describes reclamation work which has been completed for the calendar year must be submitted subsequent to cessation of exploration activities. A 1:10,000 air photo base documenting reclamation activities must accompany two copies of the Reclamation Report. Formerly, a 1:50,000 topographic map was required.

The above requirements were recently reviewed in conjunction with the Geology, Titles and Economics sections of the Ministry which also make requests for information to industry. A common form of work reporting is being aimed at which will satisfy the legislative requirements of both the Coal Act and the Coal Mines Regulation Act. The objective is to have a single submission reporting on work after it is completed. The air photo base appears to be the key to integrating reporting of surface work as it allows for a reduction in the required text, maps and drawings.

The Reclamation Section of the B.C. Ministry of Mines and Petroleum Resources is optimistic that much of the currently available air photo coverage can be utilized by operators who are engaged in mine exploration or production. The Airphoto Services of the Ministry of the Environment have extended their co-operation, and both color and black and white photography of twenty mine sites should be completed by the summer and be available by late fall, 1978.

Included at the end of this paper is an Information Bulletin that outlines the procedure to be used to select and obtain available aerial photography.

Further experience with air photos subsequent to the Vernon Symposium suggests a considerable improvement is possible to the use of mosaics. This involves obtaining original photography at scales of 1:25,000 or larger (thus covering several licences simultaneously) and blowing up to produce prints at a scale of 1:10,000. This procedure has been discussed with several companies in the Northeast Coal Block, who will use it in 1978 reporting of work and reclamation done. Results will be discussed at the 1979 symposium.

INFORMATION BULLETIN

GENERAL INFORMATION

The federal and provincial governments are the major sources of air photography in British Columbia. General keys to indexes of B.C. photography are available in a publication by the Surveys and Mapping Branch of the B.C. Ministry of the Environment entitled "Map and Air Photo Catalogue".

In cooperation with the National Air Photo Library, Ottawa, microfilm of federal air photography with the relevant air photo indexes and catalogues for British Columbia, Yukon, and Northwest Territories, is available for viewing at the Provincial Air Photo Library, 533 Superior Street, Victoria. These indexes are retained on 1:500,000 map scale. Air photographs shown on them can be ordered from Ottawa by writing to:

National Air Photo Library,
Dept. of Energy, Mines and Resources,
615 Booth Street,
Ottawa, Ontario. K1A 0E9
Tel. (613) 998-9900 - Telex 053-4328

Provincial air photographs are indexed under block photography and special projects. The bulk of photography is contained in the block system and is available in a number of scales. These scales are 1:10000, 1:15840, 1:20000, 1:31680, 1:40000, 1:50000 and 1:63360. The special projects index is a guide to special air photography comprising several hundred projects of varying scales. Each special project has an individual index.

Two types of photography are available: colour and black and white. Most of the available photography is black and white. Colour photographs have been flown only over certain special projects; there is no general colour photography in British Columbia, and it is not

possible to obtain a colour print from a conventional black and white photograph. Colour is very useful for obtaining ground detail and vegetation patterns.

Mosaics can be made from colour or black and white photographs. Colour mosaics are a one-of-a-kind production as currently copies of mosaics can be made only in black and white. A great deal of detail and clarity is lost in duplicating colour mosaics.

Enlargements of the standard 23 cm x 23 cm air photograph are available from the B.C. Provincial Surveys and Mapping Branch. The largest blow-up for a complete photograph is a 4X enlargement measuring 92 cm x 92 cm. Portions of a standard air photo can be blown up to 6X enlargements. Air photograph qualities begin to decrease with blow-ups 4 times and greater.

Air photo mosaics are available for portions of B.C. The Map and Air Photo Catalogue previously mentioned has a key showing the areas covered by these mosaics. A more detailed key showing the location of available mosaics can be obtained by stating the exact geographical reference of your area and writing to:-

Director,
Surveys and Mapping Branch,
Ministry of the Environment,
Parliament Buildings,
Victoria, B.C. V8V 1X5
Attention: Map & Air Photo Sales Office

SELECTION OF AIR PHOTOS

The following series of steps should be followed to obtain air photographs:

Scale

Before ordering any air photos, it is necessary to determine what scale is best suited to your requirements. Mine exploration and

development usually require large scale photography to plan and document reclamation activities. For use in making 1:10,000 mosaics, 1:20,000 photography is best as it only requires 2X enlargement.

Date of Photography

The most recent photography is usually desirable.

Flight Lines and Photo Numbers

Block and special project photography are shown on index maps available at $1.00 each from the B.C. Provincial Map and Air Photo Sales Office. These index maps are also mounted on sets of aperture cards. Aperture card indexes and readers are available at the following locations:

Map and Air Photo Sales Office,
553 Superior Street,
Victoria, B.C.

Geological Survey of Canada
100 W. Pender Street,
Vancouver, B.C.
V6B 1R8

Simon Fraser University,
Geography Department Library,
Vancouver, B.C.

University of British Columbia,
Geography Department Library,
Vancouver, B.C.

If one of these locations is readily accessible then the following procedure should be used to find air photographs:

1. Locate area of concern in the appropriate air photo key in the Map and Air Photograph Catalogue. The choice of key depends upon the scale of photography.

2. Determine the geographical reference from the map.

3. Aperture cards are indexed according to scale and geographical reference. Use the geographical index for the area of concern to select the appropriate aperture card.

4. View the card in the reader. Locate exactly the desired area and record the flight lines and photo numbers that cover the area. Air photos along a flight line are plotted with approximately every 10th photo centre numbered. To determine the photo which covers an area between numbered centres, it is necessary to interpolate along the line between those centres.

5. Order air photos following the procedure outlined under ORDERING AIR PHOTOS.

If these index and reader locations are not readily accessible then photos may be obtained through the Map and Air Photo Sales Office in Victoria. Phone the office (Telephone (604) 387-3174 or 3175) and describe to them where the area is and what type of photographs are desired. They will send by mail a photo copy of the relevant index for the scale of photography required. Because several indices may cover an area, to get the correct index the area must be located by geographic place name or by the District Lot numbers within a 15' latitude/longitude square, based on the National Topographic Numbering System.

The necessary flight lines and photo numbers can be read from the index sent by the sales office.

ORDERING AIR PHOTOS

Orders for air photos should be in writing and addressed to:

Director,
Surveys and Mapping Branch,
Ministry of the Environment,
Parliament Buildings,
Victoria, B.C. V8V 1X5
Attention: Map and Air Photo Sales Office

Appendix I* shows the form to be filled out when ordering air photos. The flight numbers and air photo numbers must be included. If stereoscopic cover is not required, it is only necessary to order alternate photos along a flight line. Appendix II lists the prices on materials. Air photographs are printed to order and have NO RETURNABLE VALUE. Prepayment is required and 5% sales tax is applicable for orders within British Columbia. Cheques or money orders should be made payable to the Minister of Finance.

Portion enlargements are possible for squares off a photo as listed in Appendix II. To obtain a partial enlargement, mark the area required on a xerox copy of the air photo, in black, to be sent in with the order. The marked square must he parallel to the edges of the photograph.

It is also possible to get a blow-up to exact scale, provided the total blow-up does not exceed 4X. To do this a bar scale on a piece of mylar film of two known points on the air photo is needed, with another bar scale below it to show the desired final scale of these two points.

Diapositives of photographs are also available. Their main use is in photogrammetric mapping but they can also be used in overhead projectors to illustrate on screens, or diazo-printed to provide cheap multiple copies. For information on diapositives contact the Map and Air Photo Sales Office in Victoria.

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*The Appendices referred to are presented at the end of this seminar paper.

ORDER FORM FOR MAPS AND AIR PHOTOGRAPHS

Your Name ..... Date .....

Address .....

.....

.....

Please send me the following maps and or air photographs

Quantity	Index No.	Map No./Flight No.	Map Name/Photo Nos.	Unit Price	Amount

Add $1.00 if maps desired rolled _____

For orders delivered in B.C. add 5 per cent sales tax _____

total remittance enclosed _____

Address orders to:
Director, Surveys and Mapping Branch,
British Columbia Lands Service,
Victoria, British Columbia.
V8V 1X5
Attention: Map & Air Photo Sales Office.

Tear Here

Second Order

ORDER FORM FOR MAPS AND AIR PHOTOGRAPHS

Your Name ..... Date .....

Address .....

.....

.....

Please send me the following maps and or air photographs

Quantity	Index No.	Map No./Flight No.	Map Name/Photo Nos.	Unit Price	Amount

Add $1.00 if maps desired rolled _____

For orders delivered in B.C. add 5 per cent sales tax _____

total remittance enclosed _____

Address orders to:
Director, Surveys and Mapping Branch,
British Columbia Lands Service,
Victoria, British Columbia.
V8V 1X5
Attention: Map & Air Photo Sales Office.

Tear Here

First Order

APPENDIX II

Prices of Reprints:

Black and white	- paper	23cm x 23cm	Price per Print $1.25
Black and white	- film positive	23cm x 23cm	Price per Print $3.00
Colour	- paper	23cm x 23cm	Price per Print $3.00

Prices of Enlargements:

Black and white	- paper	23cm x 23cm	Price per Print $3.00
Black and white	- paper	46cm x 46cm	Price per Print $5.00
Black and white	- paper	68cm x 68cm	Price per Print $10.00
Black and white	- paper	92cm x 92cm	Price per Print $15.00
Black and white	- film positive (clear or matte)	23cm x 23cm	Price per Print $5.00
Black and white	- clear or matte	46cm x 46cm	Price per Print $10.00
Black and white	- clear or matte	68cm x 68cm	Price per Print $15.00
Black and white	- clear or matte	92cm x 92cm	Price per Print $20.00

Examples of Prices of Partial Englargements:

	Finished Size	Cost
3X of a 7.7 cm square	23cm x 23cm	$3.00
6X of a 7.7 cm square	46cm x 46cm	$5.00 *
2X of a 11.5 cm square	23cm x 23cm	$3.00
4X of a 11.5 cm square	46cm x 46cm	$5.00
6X of a 11.5 cm square	69cm x 69cm	$10.00*

* only possible when the centre of the photograph falls within the boundary of the marked square.

DISCUSSION RELATED TO D.M. GALBRAITH'S PAPER

Hubert Maxwell - O.K. Syndicate. Do you have an approximate cost of the program born by the government of B.C., the cost of photography and of making this information available?

ANS. Yes. We have accurate figures for the N. E. Coal Block. It was done on contract for $10,800.00. For this sum, the photography was assembled, two mosaics and chronoflexes were made, and the disturbed area was identified and then measured using an electronic planimeter.

The Ministry of the Environment undertakes photographic assignments for other government departments. In the future, I think that this photographic capability will see increased use. We are certainly going to press for it. Provincial aerial photography already has a variety of uses such as forestry and agriculture, and I think it is time we made a case for photographic coverage by the provincial government of mining and exploration areas.

The cost to us of photography, as far as the Ministry is concerned, is merely the cost of the film. To photograph a mine site through a contracting service the cost may be in the neighbourhood of $5,000.00. It varies with the site. You can't compare the cost for a mine site that requires one photo to an exploration area that covers 100 square miles. The cost of the film, the prints and everything else is very minor compared to the cost of aircraft and aircrew rental. I can't foresee many mines paying more than two to three thousand dollars for a complete flight and print development programme.

The Ministry has a program that includes 20 major operating mines and this will be made available to industry for use in reporting reclamation activity.

At the moment we are feeling our way, but it appears that if we are going to coordinate the reporting of work, reclamation and other activities of concern to the Ministry, then the airphoto base is the optimum approach.

James Meier - Byron Creek Collieries. How often are you going to fly?

ANS. We have no plans other than the 20 mine sites that we have requested so far. If companies are contracting out their own photography, the frequency of flying will depend upon their rate of activity. For example, if a given coal exploration programme covers 40 licences (40 square miles), it may be that the activity is covered in only two square miles. In this case, the initial flying of the exploration area for the base mosaic will be the major cost. Updating of photographic data will then only require flying over the area where activity has taken place.

For an operating mine, flying every second year would be adequate, although some fly annually for their own purposes.

Ralph McGinn - O.K. Syndicate. For these 20 mine sites you are going to fly, will you be establishing survey targets on the ground?

ANS. No. For our purposes, an uncontrolled mosaic is suitable. If you want a geometrically exact mosaic, you have to go to an expensive process that is called orthophotography where you have to establish ground control. However, what we are after is a documentation of what is on the ground, and whether or not it is geometrically accurate, is beside the point. You can get ten uncontrolled mosaics for the price of a controlled one.

Martin Bik - Elco Mining Ltd. Do you have to repeat the flying and prepare a mosaic annually?

ANS. No. Photography every second year in the average case would be quite adequate for documenting a reclamation programme.

Marv Mitchell - Ranger Oil. What degree of correlation did you actually get between the aerial photography and what you found on the ground when you went in to check?

ANS. I don't know because we never checked it. However, we found that the disturbed areas as submitted, in total, were in the same "ballpark" as that measured from the maps.

EVALUATION OF CURRENT REVEGETATION TECHNIQUES USED IN B.C.

Paper Presented
by:

J. C. Errington
Reclamation Inspector
B.C. Ministry of Mines and Petroleum Resources
Victoria, B.C.

EVALUATION OF CURRENT REVEGETATION TECHNIQUES USED IN B.C.

INTRODUCTION

The Ministry of Mines and Petroleum Resources, during the summer of 1977, began a program to evaluate current revegetation techniques in several regions of British Columbia.

The regions, characterized by a common climate as well as similar mining operations, were Crowsnest Coalfield, Peace River Coalfield, and metal mines in the southern interior.

This paper discusses two of these regions:- the Peace River coalfield and the metal mines in the southern interior.

REGIONAL ASSESSMENT OF RECLAMATION IN THE PEACE RIVER COALFIELD

The Peace River coalfield is located in the foothills on the eastern slopes of the Rocky Mountains. There are no active mines in this area but exploration activity has intensified in recent years and, should the economics of coking coal improve, there is promise of several major coal developments proceeding in the near future.

In terms of revegetation the climate presents a considerable challenge. The treeline occurs at elevations of 5,000 feet (1,500 m) in the Peace River coalfield compared to 7,000 feet (2,133 m) in the southeast.

The Peace River coalfield lies in a remote wilderness which has limited access. However, with incursions by coal interests, seismic activity and petroleum drilling as well as forestry industries, the character of the region is rapidly altering.

Most of the coal licences fall within the Engelmann spruce-subalpine fir zone at lower elevations and the Alpine tundra zone at higher elevations. In terms of reclamation, areas of both Alpine tundra and the area of stunted trees between the alpine and true forest (termed krummholz vegetation) have similar restrictions to successful revegetation. Often the areas are combined and referred to as "areas above treeline".

FACTORS DETERMINING REVEGETATION

Experience in revegetation of disturbances in the Peace River coalfield has been gained through reclamation during exploration programs and from several field trials set out by mining companies, their consultants, and the Ministry of Mines and Petroleum Resources.

The major problems associated with revegetating disturbances caused by exploration occur above the treeline. Here the climate is severe and plant growth and survival is limited by an extremely short growing season, high wind velocities, and low nutrient levels.

The extreme climatic conditions above the treeline severely restrict the number of species available for use in reclamation programs. Although there are several grass species that perform adequately in the short term, no legume species have survived longer than one year. As sites are generally low in nitrogen and phosphorus, and nutrients cannot be supplied by legume growth, fertilizer additions are necessary for successful revegetation using grass species alone.

In areas below treeline, revegetation of exploration disturbance presents no major problems. Many species of grass and legume grow successfully and are available for reclamation programs. Generally, sites have low nitrogen availability and rely on legume growth for several years in order to inject enough available nitrogen into the system to allow grass survival. Low soil moisture on coarse textured sites, occasionally limits legume growth which affects the growth of the entire grass legume mixture. These areas require applications of fertilizer for successful establishment of a grass sward.

REVEGETATION PROCEDURES

Three broad types of seeding techniques have been tried in the Peace River coalfield. These are broadcast seeding, harrowing after broadcast seeding, and hydroseeding.

Broadcast seeding is the most common method used, consisting of scattering seed on the surface of the ground.

Broadcast seeding without fertilizer applications has resulted in satisfactory growth at most sites below the treeline. Above treeline, this method of seed application has generally resulted in poor growth, but this failure may be attributed to lack of fertilizer rather than seeding technique. Results of plot trials above treeline indicate that fertilizer applications must accompany seeding for successful growth and germination, and that, given adequate fertilizer, most of the grass species used in seeding programs will grow well.

Harrowing and fertilizing all disturbed areas above treeline has been recommended by the Ministry of Mines and Petroleum Resources since 1976. It is too early to see if methods involving harrowing have been successful, however, preliminary observations indicate that seed catch will be largely improved over former broadcasting techniques.

Hydroseeding was used in an experimental way in the alpine areas of Bullmoose/Chamberlain. Initial results indicate favourable growth over the first summer and good survival is anticipated next year.

ASSESSMENT OF SPECIES PERFORMANCE

In the Peace River Coal Block a total of 34 species (or varieties) consisting of 21 grasses and 13 legumes has been seeded at various times. At the present time it is not possible to assess the performance of more than half of these species with any degree of certainty as data on overwintering success is unavailable (Table 1).

Above treeline, grass species performance was excellent for meadow foxtail, good for creeping red fescue and timothy, and moderate for meadow fescue, Canada bluegrass, slender wheatgrass, and bromegrass. Red top grows well the first season but has a poor ability to overwinter. Legume growth was very poor above treeline. The only two legume species which grew at all were alsike clover and red clover and these grew only in sheltered moist pockets.

Below treeline, growth of grass and legume species was generally good for the majority of species tested. Growth was excellent for creeping red fescue and red top; good for Canada bluegrass, slender wheatgrass, and timothy; and moderate for meadow fescue, bromegrass and meadow foxtail. Legume growth was excellent for alfalfa, alsike clover, red clover, sweet clover, and white clover. Birdsfoot trefoil and sainfoin grew poorly.

Table 1

Preliminary evaluation of species performance in the Peace River Coal Block, 1977

	Above treeline						Below treeline					
	Excel-lent	Good	Mod.	Poor	Dead	Un-Known	Excel-lent	Good	Mod.	Poor	Dead	Un-Known
Creeping red fescue		*					*					
Meadow fescue			*						*			
Hard fescue						*						*
Chewing fescue						*						*
Kentucky bluegrass						*						*
Canada bluegrass			*					*				
Perennial ryegrass						*						*
Annual ryegrass						*						*
Tracenta bentgrass						*						*
Colonial bentgrass						*						*
Crested wheatgrass						*						*
Pubescent wheatgrass						*						*
Intermediate wheatgrass						*						*
Slender wheatgrass			*					*				
Streambank wheatgrass						*						*
Bromegrass			*						*			
Orchard grass						*						*
Red top				*				*				
Reed canary grass						*						*
Russian wild rye-grass						*						*
Timothy		*						*				
Meadow foxtail	*								*			
Alfalfa - beaver						*						*
Alfalfa - rambler						*						*
Alfalfa - ceres						*						*
Alfalfa - drylander						*						*
Alfalfa				*				*				
Alsike clover				*				*				
Red clover				*				*				
Birdsfoot trefoil				*							*	
Sweet clover					*			*				
White clover			*					*				
Cicer milk vetch						*						*
Crown vetch						*						*
Sainfoin			*								*	

The Ministry of Mines and Petroleum Resources also established plots to test seeding rates. In the past, the Ministry has recommended a minimum application rate of 50 lb/acre (56 kg/ha) for use in alpine areas. A rate of 25 lb/acre (28 kg/ha) has been recommended for forested areas. These rates are approximations and, depending upon a number of factors, should be increased and decreased accordingly.

The forested rate of 25 lb/acre does not allow for any harrowing, therefore seed should not be lost by burying too deep. However, there is little margin for the uneven spread of seed; consequently, if seeding is done without due care and attention, the seeding rate should be increased to 40 lb/acre (45 kg/ha). The results of these trials should confirm whether these recommendations are valid.

A second set of tests plots was established last fall to see if seed coated with micronutrients would outperform normal uncoated seed.

REGIONAL ASSESSMENT OF RECLAMATION ON METAL MINES IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA

INTRODUCTION

Copper mining occurs throughout the southern interior of British Columbia. These mines are generally involved in extraction of low grades of copper through open pit operations. A total of eight properties were visited; Bethlehem, Brenda, Craigmont, Lornex, Newmont, O.K. Syndicate, Phoenix and Placid Oil.

These mine sites generally occur in dry climates with vegetation ranging from the Ponderosa pine bunch-grass zone to the interior Douglas fir zone to the Engelmann spruce and subalpine fir zone. Precipitation ranges from a low of 18 cm/yr. at Craigmont to around 90 cm/yr. at Phoenix. Summers are hot and dry.

Last summer's work involved a field assessment of the results of revegetation programs.

At the present time, the data have not been analysed in detail and only preliminary impressions are presented. This discussion will be limited to waste dump materials; the discussion of tailings will be left until another time.

FACTORS DETERMINING REVEGETATION

There are three major factors apparently inhibiting growth on metal mine wastes: low soil moisture, low soil nutrient levels and steep unstable slopes.

Low levels of soil moisture are one of the major barriers to successful plant growth. This appears to be a general phenomenon and there have been a number of seeding failures at most mine sites. Many areas that had growth failures were re-seeded and growth became satisfactory. In general, once growth has been established it appears that it can be maintained.

The data are currently being analyzed to document those conditions that lessened or hastened drought related failures.

Deficiency symptoms caused by low soil nutrient levels contributed to slow plant growth and establishment at about half the mines visited. There tends to be a reluctance to add fertilizer at the initial rates suggested and then apply maintenance applications as well. Consequently, many of the reclaimed areas are returning to uniform stands of creeping red fescue, and species that are more demanding of nutrients are dying out.

Steep slopes, especially those that lack surface stability, are also a barrier to plant growth.

The importance of waste material type in the ultimate reclamation of a mine site should be emphasized. In our surveys, plant growth success or failure could be often related to the kind of material left on the surface. Many open pit operations have had to remove considerable quantities of unconsolidated surficial materials which are very

often the best medium for plant growth. This material was frequently dumped in one location or was lost by burial beneath waste rock. Many of the dumps visited had configurations established long before mine reclamation legislation was enacted. For currently operating mines we recommend that greater attention should be paid to materials aspects.

Some examples of instances where differences in waste material types have made a significant difference to growth patterns include: excellent growth of coniferous species on the "topsoil" covering of waste rock at Phoenix; excellent growth of grass and legumes on the "till" dump at Phoenix and Craigmont; and excellent growth of alfalfa on volcanic waste rock at Craigmont, even on steep slopes. This waste rock type weathers rapidly and provides a much better growth medium.

REVEGETATION PROCEDURES

In the mines visited there was quite a variety of techniques employed to establish vegetation. Seed has been applied generally by broadcast and hydroseeding. The merits of each method are difficult to assess as the methods themselves have rarely been tested. There are as many success stories for each method as there are failures. No one method should be used exclusively at any mine site.

There should be a maximum degree of site preparation before seeding and, unfortunately, methods of seeding have been often employed to omit this phase of the operation.

For flat surfaces on dumps the compaction should be lessened by harrowing. If this is done then any form of seeding can be employed successfully.

Irrigation has been used to establish growth at Newmont and Craigmont. There was concern expressed a few years ago that this method was supporting species that would not persist when irrigation ceased. At Newmont however irrigation of several areas stopped two years ago and plant growth has continued.

ASSESSMENT OF SPECIES PERFORMANCE

A preliminary evaluation of species performance on dry mine waste material has been made (Table 2). The best grass species appear to be crested wheatgrass and creeping red fescue. Alfalfa was by far the best of the legume species. Tall fescue, smooth brome and timothy all grow well under certain conditions. The only wheatgrasses other than crested wheatgrass to perform adequately were Intermediate and Pubescent wheatgrass.

Invasion of native species was relatively non-significant.

TABLE 2

PRELIMINARY EVALUATION OF SPECIES PERFORMANCE AT EIGHT METAL MINES IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA, 1977

TYPE OF WASTE	WASTE ROCK						OVERBURDEN						TAILINGS						No. of Mines where seeded
SPECIES \ RATING	Excellent	Good	Moderate	Poor	Dead	Absent	Excellent	Good	Moderate	Poor	Dead	Absent	Excellent	Good	Moderate	Poor	Dead	Absent	
Creeping Red Fescue		X						X					X						7
Tall Fescue			X						X									X	6
Smooth Brome			X						X					X					6
Timothy			X						X						X				5
Crested Wheatgrass	X							X						X					7
Intermediate Wheatgrass			X						X							X			3
Pubescent Wheatgrass			X						X									X	5
Slender Wheatgrass				X						X								X	4
Spreading Wheatgrass						X				X								X	1
Streambank Wheatgrass				X						X						X			5
Tall Wheatgrass				X								X						X	6
Thickspike Wheatgrass				X								X						X	1
Western Wheatgrass				X						X								X	2
Altai Fescue				X								X						X	1
Hard Fescue						X						X						X	2
Kentucky Bluegrass			X							X						X			3
Canada Bluegrass						X						X						X	4
Red Top			X									X						X	2
Highland Bentgrass						X						X						X	1
Italian Ryegrass						X						X						X	4
Perennial Ryegrass				X						X								X	5
Orchard Grass						X				X								X	1
Tall Rye					X						X						X		2
Alfalfa Ladak						X						X						X	1
Alfalfa Rambler			X						X						X				4
Alfalfa Rhizoma			X						X						X				2
Alfalfa Vernal						X						X						X	2
Alsike Clover				X						X								X	5
Red Clover						X						X						X	2
White Dutch Clover				X						X						X			6
Birdsfoot Trefoil						X						X						X	3
Cicer Milkvetch						X						X						X	2
Crownvetch						X						X						X	2
Sainfoin				X						X							X		5
White Sweet Clover					X						X						X		5
Yellow Sweet Clover					X						X						X		6

DISCUSSION RELATED TO J.C. ERRINGTON'S PAPER

Dave Headdon - University of Calgary. You mentioned alfalfa and sainfoin but not cicer milkvetch. I worry about bloat with alfalfa. Why would you use alfalfa instead of cicer milkvetch for reclamation in general?

ANS. Cicer milkvetch has been tried but it hasn't shown to be that successful. I'm not recommending these particular species. I'm just saying what has and what has not worked.

Stan Weston - Wesago Consulting. At Craigmont the program was pretty well cut off about three to four years ago and without the adequate nutrients you are not going to get growth. Also, with legumes, it looks as if at the start of a seeding program you will get certain species, some of which you mentioned. These will degenerate until you get the desirable deeper rooting permanent ones. It takes about five years to get the final species. There is also a variation in growth due to the season as species which are present when you visit an area may not show at other times. Your presentation is excellent, but I think that a follow-up should be made on your program and it could be subject to some variation.

ANS. We plan to follow up and revisit these areas the year after next to see what changes have occurred. I agree with your comments about Craigmont where fertilizer had not been applied for a number of years. In fact, that situation occurred at about half the mine sites. Mining companies are reluctant to keep applying fertilizer for a number of years. Nevertheless, Craigmont is a good example of an area that has persisted fairly well for four years without maintenance fertilizer and to me it looks quite promising.

Don Graham - Lornex Mining Corporation. I know your group visited Lornex where we are very much in an experimental stage. We look forward to seeing the results of your work and are a little disappointed that they are not yet available. Perhaps you could tell us when they will be available. We also noticed that it is definitely advantageous to plant on glacial till rather than rock. As you pointed out, the nature of the mining operation precludes this in a lot of cases. For example, with till on top you take it off first then put it on the bottom, so that when the rock comes off next it is placed on top of the till. In many cases with a large operation considerable distances are involved if stockpiling material is considered for later use. Often there are difficulties in finding sites to stockpile which can represent appreciable increases in transportation costs.

ANS. A draft of the report will be sent to you by the end of May 1978. It will not be ready for general circulation in May, but we feel it should be sent to the mines we visited for feedback. We are in the

process of computerizing all the data now and it is that process which has held us up.

With regards to the waste material types, I appreciate Lornex's problems in handling their material; however, as long as people are familiar with the response in growth using different materials, that is a large step in the right direction.

Herman Vaartnou - Vaartnou and Sons. Did you evaluate the diseases in these plants? You mentioned 25 agronomic species, perhaps you meant varieties.

ANS. No we didn't evaluate the diseases. And yes, I meant varieties. There will be a list of the species tested (Tables 1 and 2) included in my paper in the symposium proceedings.

Duane Johnson - R. M. Hardy and Associates. Was the aerial seeding done by helicopter or fixed wing? Have you compared the relative success of each method?

ANS. Aerial seeding was done by fixed wing. Success rates have not been compared.

BRITISH COLUMBIA MINISTRY OF MINES AND PETROLEUM RESOURCES RECLAMATION POLICY

Paper Presented
by:

J.D. McDonald
Senior Reclamation Inspector
B. C. Ministry of Mines and Petroleum Resources
Victoria, B.C.

BRITISH COLUMBIA MINISTRY OF MINES AND PETROLEUM RESOURCES RECLAMATION POLICY

INTRODUCTION

Legislation governing mine reclamation was introduced in 1969 and is covered under Section 8, Coal Mines Regulation Act, and Section 11, Mines Regulation Act. Any land disturbed by mining prior to April 1969 is exempt from the legislation.

Since legislation was introduced, reclamation has been dealt with on a site-specific basis. It is the purpose of this presentation to outline certain guidelines which will be more specific and will allow industry to deal with those specifics relating to reclamation and abandonment of a mine.

Reclamation in British Columbia cannot be defined by a set of regulations or legislation, because of the extreme variances of physiography, biogeoclimatic zones and elevations. We have mines in the dry belt of the Okanagan, the rain belt of the coast having 240 inches of rainfall a year, elevations of up to 7,000 feet and in nearly all cases, little or no topsoil. It is in this realization that we have dealt with site specifics with little input from industry or government in the initial years. We have now arrived at a point in time where there is a considerable amount of information available, from industry, government and universities. One of the purposes of this symposium is to establish a forum for exchange of this information.

One of the directives of "The Technical & Research Committee on Reclamation" is to determine where research should be directed by industry and government in conjunction with the universities. It is established that the key areas in reclamation research are tailings

ponds, waste dumps and drainage. The Ministry of Mines and Petroleum Resources has supported a research program on tailings ponds both from long-term impact and revegetation techniques.

British Columbia mining companies have responded to the challenge of reclamation. Cominco reclamation department has conducted an outstanding research program. Placer Development Ltd. at Salmo and Bull River Mine of Placid Oil Ltd. have both reclaimed mine areas on completion of mining to a high degree of excellence. During the past two to three years, Kaiser Resources Ltd. and, lately, Fording Coal Ltd. have advanced reclamation technology in mountainous areas to a point where they are recognized by the coal mining industry in North America as leaders in this field of reclamation in this difficult terrain.

The Ministry of Mines and Petroleum Resources has taken the pragmatic approach to reclamation because of the many variables associated with mines in British Columbia. This type of approach is superior to specific legislation and regulations which often cannot be enforced because they don't fit the conditions of a mine. The presence of so many people from government and industry at this symposium indicates we are seriously working toward a common goal.

The main emphasis on reclamation during the past three years appears to have been directed towards coal mines. The many proposed coal projects have necessitated a strong emphasis being placed on coal mine reclamation. Considerable progress has been made in this area. It is the opinion of the Ministry of Mines and Petroleum Resources that metal mining companies have not placed the emphasis on reclamation to the degree that the coal industry has done.

Mine reclamation is an essential part of mine planning and it is necessary that mine engineering be an integrated part of reclamation.

The largest single cost of mine reclamation is in site preparation and, if this is done at the least cost because of good mine planning, then the total cost of reclamation is considerably reduced. Engineers, agrologists and foresters must work as a team.

TERMS OF RECLAMATION PERMITS

It has been proposed (and now approved by the Minister of Mines and Petroleum Resources) that reclamation permits be issued for the life of the mine instead of the present one-to-three year period. Administration and control of the permit system would be improved. Presently we have permits which run out of their three-year time limit and to renew requires a process of obtaining the recommendation of the Advisory Committee on Reclamation, approval of the Minister of Mines, and an Order-in-Council. In some cases, this can take two to three months.

In issuing a permit on a permanent basis there would be no loss of control of any mining operation as the present legislation ensures that the Ministry of Mines and Petroleum Resourees can enforce strong penalties on an operation if the terms and conditions are not complied with. Control of reclamation activities and additional development which disturbs land is reviewed on a yearly basis. Annual reports are submitted each year. The reports include a breakdown of disturbed land, future disturbed land, present and future reclamation activities, reclamation research and other related fields. With an increase in staff in the Reclamation Section of the Ministry of Mines and Petroleum Resources, an improvement in on-site inspection has been possible. Increases in the security deposit can be recommended on the basis of the annual report. Performance and increase in disturbed areas would be considered.

EXPLORATION GUIDELINES

For metal and coal exploration the Ministry of Mines and Petroleum Resources has issued "Guidelines for Coal and Mineral Exploration" which governs reclamation and protection of the environment. The only recent addition to these guidelines is that companies must now reclaim within one year of the disturbance all exploration areas except those areas that will be used during exploration the following year.

GUIDELINES FOR MINE RECLAMATION

The guidelines that follow are preliminary. I would like to have input from industry and government agencies before they are finalized and your representations at this meeting or in the immediate future would be appreciated.

MINE ABANDONMENT

(A) When a mine is shutdown and the entire plant is left on the property it shall be considered a temporary shutdown. Reclamation of the disturbed areas shall be done on the basis determined by the Reclamation Section of the Ministry of Mines and Petroleum Resources.

(B) Where a mine is shutdown and the mine plant removed the following shall be done:

General

(1) The mining company shall submit to the Senior Reclamation Inspector a plan of total reclamation prior to shutdown.

(2) All buildings, machinery, mobile equipment shall be removed. All scrap material shall be burned or buried. Open holes shall be filled in and revegetated.

(3) Concrete foundations and slabs shall be left intact and covered by overburden and revegetated where possible.

(4) All provisions of either the Mines Regulation Act or Coal Mines Regulation Act shall be complied with to the satisfaction of the District Inspector or Resident Engineer.

Tailings ponds

(1) A plan shall be submitted showing the proposed drainage controls for the tailings pond and surrounding drainage area.

(2) Where necessary a permanent spillway is required on or adjacent to the tailings dam to provide for excessive run-off of water. Details and design shall be submitted to the Chief Inspector of Mines and Petroleum Resources and the District Inspector for approval.

(3) The tailings pond shall be contoured where necessary to control run-off.

(4) The tailings pond shall be revegetated to a condition approved by the Reclamation Section of the Ministry of Mines and Petroleum Resources. Vegetation must be established to a point where no maintenance of the vegetation is required and there is no dangerous accumulation of toxic constituents. A minimum of three years experience is necessary to determine the quality of vegetation.

(5) Ultimate land use of the disturbed areas shall be specified. The reclaimed land shall be equal to or better than the original area which was disturbed.

Waste Dumps - Metal

(1) Where possible waste dumps should be sloped to an angle where vegetation can be maintained. If overburden is available,

flat areas of the dumps shall be covered to a depth of three to six inches of overburden or top soil.

(2) All flat areas on the dumps shall be revegetated and vegetation shall be established to a point where no maintenance is required. A minimum of three years experience is necessary to determine the quality of vegetation.

(3) A plan of the drainage area surrounding the dumps shall be submitted to the Senior Reclamation Inspector. Where possible all drainage should be directed away from the dumps.

(4) Ultimate land use of the disturbed dump area shall be specified.

Waste Dumps - Coal

(1) Final slope of coal waste dumps shall be 26 degrees or at an angle where the dump is physically stable and vegetation can be maintained on the slope of the dumps.

(2) All coal waste dumps shall be revegetated to a point where vegetation is free of maintenance.

(3) A plan of the drainage area surrounding the dump area shall be submitted to the Senior Reclamation Inspector. Where possible all drainage should be directed away from the dumps.

(4) Ultimate land use of the reclaimed dumps shall be specified.

(5) A minimum of three years is necessary to determine the quality and the permanence of the established vegetation.

Pit Area

(1) Pits shall be backfilled whenever possible.

(2) A plan shall be submitted to the Senior Reclamation Inspector showing how the pit area shall be left after completion of mining.

(3) Where the pit area is going to be designated as a lake, a report shall be submitted to the Senior Reclamation Inspector outlining source of water, drainage area, maximum level of water, water quality, access to lake, plans for stocking of the lake.

(4) Where the pit floor will be free from water, where possible overburden shall be used to provide sufficient cover to establish vegetation.

(5) Pit walls shall be left in a safe manner to the satisfaction of the District Inspector of Mines.

DISCUSSION RELATED TO J.D. McDONALD'S PAPER

Hubert Maxwell - O.K. Syndicate. How do we go about evaluating the cost of reclamation over an undetermined period until the reclamation will support itself?

ANS. You evaluate the cost through the mining plan. You must consider where you place the waste material. If you place the material properly, you don't have to come back to recontour the whole dump before covering with stockpiled topsoil. Consideration must be given as to what type of materials are available for surface dressing the top of the dump. For example, Afton did a survey which showed that the first 10 feet of till and overburden should be buried because it has a very high pH and a high salt content. So, in their case they couldn't stockpile. This shows the value in following planning procedures such as soil testing.

The cost can vary anywhere from $500/acre up to $10,000/acre. The coal companies are looking at a cost in the neighbourhood of $5000/acre. In other areas where there is lower relief, it will be considerably less.

Hubert Maxwell - O.K. Syndicate. In the project evaluation you can go the high road and do the impact studies and the whole bit and if you are looking at $125,000 a mile for a power line, that's a figure. These are things which must be determined whether you have a project or not. My impression is that you have to look after reclamation to eternity. I know some places where there were steep sided waste dumps which have been there for 30 years and now it is hard to find them. Over a period of time they will restore themselves to some effect. And now you are talking about posting bonds before you start production to look after reclamation for X number of years, and that's an unknown quantity.

ANS. Well, I'm not talking about anything new. This has already been done. We have examples in the province today where companies have posted bonds, done their reclamation and closed down. Some of them have done a very fine job.

Hubert Maxwell - O.K. Syndicate. I realize that and I'm not against reclamation, I'm all for it. In my particular endeavour we are looking at bringing an old mine into production. I don't have enough money left in my operations after paying 57% in taxes to look after reclamation after cessation of operations for an undetermined period until the vegetation becomes self sustaining.

Are we reaching a point in our evaluation where we should have an impact study first before we go out looking for minerals?

ANS. Well, this is almost the way coal mines do it in B.C. today. In their feasibility studies they look at what has to be done to meet the requirements. My proposals set forth a pragmatic approach which has been gained from experience and used in the past. We like to maintain our approach as a set of guidelines so we have room to maneuver and deal with things on a site-specific basis.

Afton Mines, for example, has done an impact study and we feel that they have come up with a good scheme. They have taken reclamation into consideration in their mining plan and have stored material - some topsoil and some overburden - for future use. They are also in the cattle ranching business. Their proposed dump and tailings sites comprise a large area which could be reclaimed and used for grazing purposes. Also with some irrigation they could establish very good hay crops. What I am trying to say is that a little initial planning can go a long way and save a lot of money later on.

Pat Mahoney - Montreal Engineering Co. Ltd. Who decides what the land use should be?

ANS. The land use depends upon where the mine is located. If it is in a forest area then it should be re-established as a forest area. The same applies if it is in wildlife habitat. We haven't really dealt with agriculture here in B.C. because very little of our mining is done in agricultural areas. Most of our mining is done on mountain tops where there is very little vegetation.

Where we can improve the previous use of land, we do. For example, it has been demonstrated in the East Kootenay that reclaimed areas are more productive as wildlife habitat than they were previous to mining.

Pat Mahoney - Montreal Engineering Co. Ltd. You are saying that better is an improved version?

ANS. Yes, when compared to what was there before. We don't necessarily return to previous use especially if it can be put to a better use. Alberta has different problems in their particular areas, because they have a lot of agricultural land and it is essential that they return the land to as good or better state than before they strip mine it. They are dealing with a set of specifics that we have not encountered yet in B.C.

Pat Mahoney - Montreal Engineering Co. Ltd. If a company decides on an alternative land use, who evaluates and decides the merit of the alternative proposal?

ANS. I had better be specific about this. In coal mining there is a set of guidelines for coal development in B.C. which is under the authority of the Environmental Land Use Committee. These guide-

lines outline the process that you go through for a coal development. It is in the Stage I and Stage II reports where land use after mining is proposed. The Coal Development Steering Committee examines these reports and sends copies to all concerned agencies for comments. If you propose a better land use then I'm sure the committee will go along with it.

In metal mining, the decision on land use is basically up to the Reclamation Section of the Ministry of Mines and Petroleum Resources who receive input from other agencies through the Reclamation Advisory Committee.

J. Johnson - Craigmont Mines Ltd. Will your guidelines be published shortly?

ANS. Yes. They should be issued in six weeks to two months providing industry doesn't object strongly.

KEYNOTE ADDRESS
of the
SECOND ANNUAL
MINE RECLAMATION
SYMPOSIUM

March 1, 1978

Given by:

Mr. Tony Petrina
Vice-President of Mining Operations
Placer Development
Vancouver, B.C.

Mr. Chairman, Ladies and Gentleman, and Learned Experts in the field of reclamation, I must admit to not being an expert on reclamation. In fact, of all the people in this room, I am undoubtedly one of the least knowledgeable on reclamation. All of which naturally raises the question, why am I, instead of any of the formidable number of authorities on reclamation, speaking to this group tonight? The answer is really quite simple. About ten days ago, while I was in Toronto, my good friend, Jake McDonald, phoned my boss, looking for a speaker. My boss, long renowned for his magnanimity in such matters, very kindly volunteered my services in absentia.

Nevertheless, in spite of my lack of expertise, I want it clearly understood that I am in favour of reclamation--whatever that means. I am also in favour of motherhood, nuclear disarmament, peace in our time, and numerous other issues.

My problems in preparing a speech for you were, first, my lack of knowledge of the subject, and second, the lack of time for preparation. After going through a pile of technical papers about two feet high on the weekend, I asked myself what can I possibly tell these experts that they don't already know, or has not already been said "Ad Infinitum"?

While I was trying to outline this talk on Sunday, my wife asked me what "Reclamation" meant — and you know, I really couldn't give her a straightforward answer. So I thought this is at least a good start for a speech — I will define "Reclamation" for the experts! Easier said than done!

After pouring over the technical literature for many hours, I didn't come up with a definition to end all definitions -- but I sure learned some good buzz-words. How about:

Biogeoclimatic
Ungulate

Early Seral
Bayonet Blade Technique
Limnological.

In desperation, I finally turned to my trusty Oxford Universal Dictionary, which gives several definitions for reclamation:
"The action of protesting" - Well, that seems to fit, as far as it goes.
"The action of calling or bringing back from wrongdoing - The action of reclaiming from barbarism." Unfortunately, there are too many people who would accept that definition.
"The making of land fit for cultivation" - That might fit somewhere, but certainly not in Northern B.C. or the Yukon, where very little of the land occupied by mines was fit for cultivation in the first place.

None of these definitions really seemed to describe reclamation as it applies to mines in British Columbia; clearly, I had to seek the answer elsewhere. I would ask people who were involved in reclamation in some way or other.

I ASKED THE MANAGER OF A MINE: He said, "Reclamation is when I spend $500 an acre to turn land that was originally worth $25 an acre into land that will be worth $25 an acre."

I ASKED A GOVERNMENT M.L.A: He said, "Reclamation — That's how you sell B.C. Hydro bonds."

I ASKED A TRADE UNION OFFICIAL: He said, "Reclamation is something the company should spend a lot more money on — unless they're willing to pay higher wages!"

I ASKED A RESIDENT OF A SMALL REMOTE NORTHERN MINING COMMUNITY: He said, "Reclamation — That's what the mine does to keep the tourists from the Lower Mainland from complaining."

I ASKED AN AGRONOMIST Who occasionally does consulting work for mining companies: He said, "Reclamation: That's how you make $500 a day selling grass seed."

Obviously, reclamation means different things to different people. It reminds me of that familiar old expression —"Reclamation is in the eye of the beholder."

Anyway, since I have failed to define it for you, let me at least make some observations on various attitudes towards reclamation, and indeed towards mining itself.

A few years ago, not long after the reclamation amendments were added to the Mines Regulation Act, I was operating a mine in the Southern Interior, and we had recently gone to some trouble and expense to get a pretty fair growth of Alfalfa on the downstream slope of our tailing dam. I was rather proud of this feat (although my own contribution was negligible) because in my opinion, we had actually improved upon the original land. The neighbouring rancher liked it too, because he was continually cutting our fence to let his cattle graze on it. At any rate, a young man employed by the Department of Mines dropped in one day to see this biological marvel, and I personally escorted him through the waist high verdure, taking care to avoid the numerous cow-flaps. Bursting with pride I said, "Well, what do you think about that?" He replied in a deprecatory manner, "Well — It's O.K. — as far as it goes. I mean, it's green all right, but it's only cosmetic reclamation."

Completely shattered, I asked what that meant. If I understood correctly, his view was that the land should be returned as nearly as possible to its original state — not improved upon!

A constant source of amazement to me is the difference in attitudes held by many people concerning land alienated by Highways, and land used by Mining. In Canada there is about two hundred times as much land occupied by Highways, in perpetuity, as is temporarily occupied by mines. Not much mining is done on arable land; much of our

Highways System, especially in B.C., is on prime agricultural land. The Government seeks accolades for its plan to alienate forever, thousands of acres in the construction of the Coquihalla Highway. Another way of looking at it is that a postage stamp on the floor of a large living room would represent the proportion of Canada occupied by mining; in B.C. there is probably not more than 80 square miles disturbed by mining. For those who claim that mining has a significant impact on wildlife because of its removal of wildlife habitat, compared to other forms of land use, I say that you are stretching your credibility well beyond the breaking point.

I read recently about a mining operation being built on remote mountainous terrain in the United States, the power lines to the mine were installed in a zig-zag pattern to hide them from view; utility poles were painted green to match the scenery in this remote area; horses rather than bulldozers were used where trees had to be felled. Naturally, these activities added to the cost of the venture and were borne by the mining company. When I read this, I thought of the great hydro transmission lines so artfully concealed from view in the Fraser Canyon.

In 1972, just prior to that Provincial election in which the electorate of B.C. decided to sample for a time the hitherto forbidden fruits of Socialism, I had the interesting experience of attending in Kamloops, a public hearing at which a consortium of three mining companies presented, and defended, a proposal to erect a copper smelter at Clinton, B.C. The only people who spoke in favour of the proposal were the spokesman for the mining companies and some residents of Clinton. The people who spoke against it, and there were many, were mainly residents of the Lower Mainland; they spoke passionately and with conviction against the construction of a smelter in Clinton or anywhere else in B.C.

Was their eloquence prompted by concern for the people of Clinton, or by a desire to keep the interior of the Province a perpetual

Parkland for the occasional use of the city - dwellers from the South?

The application for the construction of the smelter was never acknowledged by the newly elected Government, and of course it was not built. I don't really know whether the people of B.C. wanted a smelter at that time, or not, but certainly the very vocal, very articulate group of Vancouverites parachuted into that hearing did not want one.

In pursuing my career in the B.C. mining industry over the last 18 years, I have had occasion to see a lot of the Province from the windows of airplanes. If one directs his attention to man-made disturbances of the surface, one reaches a few inescapable conclusions:

FIRST: Agriculture and grazing land occupy quite a lot of area.

SECOND: So do towns and cities. Highways, roads and rights of way are also highly visible.

THIRD: The things I've mentioned so far occupy land that is usually well suited for agriculture and is, in many cases, prime bottom land.

FOURTH: As you might expect, forest operations and the roads associated with them are very much in evidence.

FIFTH: Something else that catches your eye, is the impressive power distribution system — huge metal towers stretching in straight lines as far as the eye can see, through denuded aisles in the forests; lots of land used up, but you can't get along without electricity — any more than you can get along without the products of mines — metals. There is a pretty good likelihood that you would see all of the things I've mentioned. However, you more than likely would not see a mine — because there aren't many around, and those that are, don't occupy much space. Less than 2/100% of the province's land areas as a matter of fact!

Why does mining, with its comparatively miniscule use of land deserve the intense scrutiny that it receives?

It should be apparent to you that mining companies are subject to different rules while performing the same functions as other endeavours.

Do you recall a few years ago, many mining companies were enjoying, for a time, unusually good profits — referred to by some as "Windfall" or "Rip-Off" profits — although I cannot fathom how searching diligently for something, at great expense, for many years, can be called a "Windfall" when you find it — that's like saying Sir Edmund Hillary had a windfall when he reached the top of Everest. Well, when those profits were being made, quite a large element in our society wanted to nationalize the mines; others wanted to, and did confiscate much of the profits; some mines eventually were nationalized.

Yet, a few short years later, when mining is not so good — many mines are closing with resultant lay-offs — profits are down and in some cases there are losses — guess what? Those same bards of economic wisdom again say — We must nationalize the mines! No other industry that I know of is subjected to this form of idiocy! Even now, mines are the most highly taxed form of industry. There are other examples of the preferential — or should I say, discriminatory, treatment received by the mining industry.

Who reclaims forest fires?

Have you ever seen the Hope slide? Do you think it is pretty? Why doesn't someone reclaim it?

Where do you think the tons of chemical fertilizers used by farmers in B.C. end up? A large portion ends up in the watershed as the

annual bloom of some of our lakes.

Do you think municipalities are required to deal with domestic sewage in the same way the mines are?

Are the same reclamation standards applied to the forest industry as to the mining industry?

I am not the slightest bit ashamed of the record of the mining industry in this Province with regard to reclamation, pollution, or conservation. I began to work here in 1960 when the Craigmont mine was being constructed; that was 10 years before the Pollution Control Board or regulations on tailing dams. When the Legislation was introduced, not one change was required in our waste treatment system at Craigmont.

To quote a good friend of mine: "The B.C. Interior was first opened up by placer miners during the 19th century. They prospected every river and stream in the Province and they worked every gravel deposit that showed a colour of gold. In the process, they dirtied the water, consumed forests, built towns and roads, and in the first 70 years produced $700,000,000 of new mineral wealth."

Today, scarcely 100 years later, there is barely a sign that they passed through history. This is evidence that nature, if left alone, will in time heal the scars of man's occupation. Reclamation of disturbed land surfaces should be directed toward accelerating the natural healing process of nature." End of quote.

Incidentally, I actually did find a definition of reclamation that seems to be appropriate to British Columbia. I found it in a short article in the April, 1977 Western Miner, entitled "Reclamation of Surface Coal Mines". I commend the article to your attention.

Here's the definition.....

"Surface mining can affect the environment by interfering with the quality of air, land and water, and through these, animal and plant life. Reclamation is considered to comprise those remedial measures necessary to alleviate or eliminate conditions arising from surface mining. Rehabilitation is the next stage, comprising land development for specialized and more productive uses contributing to the economic or social improvement of an area."

Reclamation is a "Motherhood" issue. It is impossible to argue against it, nor do I want to. British Columbia can have any degree of reclamation it wants — for a price. You can have Butchart Gardens, if you want, in abandoned pits — for a price. You can take reclamation standards that are applied in populated agricultural areas in the U.S. and apply them to B.C. mountain tops — for a price. The industry will pay the price in the short run, but will the people of the Province benefit in the long run?

Most of the people attending this conference have a vested interest in reclamation. By that I mean you earn your living from it — the more reclamation is required, the more money you make, or the more important you become. But let me remind you of the law of diminishing returns — if reclamation, and other regulatory constraints become increasingly onerous — if clearing permit requirements for mining projects through the bureaucratic maze takes longer and longer — up to two years as is now the case — then reclamation will cease to be a concern — there will be nothing to reclaim.

Do you remember not too long ago, Bryce MacKasey, Federal Minister of Labour, boasting that Canada had just introduced the most generous unemployment scheme in the world?

Well, there is a tendency for the makers of rules in various jurisdictions to try to outdo each other in the toughness of their rules — (by that I mean toughness to industry). I remember a Provincial civil servant in B.C., who shall remain unnamed, when referring to a certain section of the mines regulation act boasting, "We have the most stringent regulations in North America."

I suggest to the makers of rules that you should strive to have, not the most stringent rules in North America, but the most sensible — bearing in mind what the country can afford, and what its citizens are willing to sacrifice for. I refer you to a headline in the Vancouver Sun, on the 21st of February — "Put Jobs Above Environment". The lead paragraph said, "With almost one million workers unemployed, it would be an act of criminal irresponsibility to place jobs at risk, even for serioue environmental considerations, the Canadian Labour Congress said." This is an extreme veiw, but I suspect it is held by more people than you think.

The rules that govern our industry should be appropriate to British Columbia, and to the times in which we live, but they should not single out mining for greater punitive action than other disturbances to the environment.

Reclamation of disturbed land surfaces should be directed toward accelerating the natural healing process of nature — and the degree of acceleration should depend on the location of the disturbance.

In closing tonight, I ask you to interpret my remarks, not as a criticism of what has been done in regulating the reclamation of mining land in B.C., on the contrary but as a caution to the makers of rules to resist the pressures of certain minorities, whether they are sincerely well-meaning, or are motivated by self-interest, to regulate our industry out of existence.

Finally, I would like to read to you a short parable I clipped out of a magazine quite some time ago. I'm sure many of you have read it, but please bear with me for the sake of those who haven't.

In the beginning god created heaven and earth.

He was then faced with a class action lawsuit for failing to file an environmental impact statement with HEPA (Heavenly Environmental Protection Agency), an angelically staffed agency dedicated to keeping the universe pollution free.

God was granted a temporary permit for the heavenly portion of the project, but was issued a cease and desist order on the earthly part, pending further investigation by HEPA.

Upon completion of the construction permit application and environmental impact statement, God appeared before the HEPA council to answer questions.

When asked why he began these projects in the first place, he simply replied that he liked to be creative.

This was not considered an adequate reason and he would be required to substantiate this further.

HEPA was unable to see any practical use for earth since "The earth was void and empty and darkness was upon the face of the earth."

Then God said, "Let there be light."

He should never have brought up this point since one member of the council who was active in the Sierrangel Club asked "How was the light to be made? Would there be strip mining? What about thermal pollution? Air pollution?" God explained the light would

come from a huge ball of fire in the sky.

Nobody on the Council really understood this, but it was provisionally accepted assuming (1) there would be no smog or smoke resulting from the ball of fire, (2) a separate burning permit would be required, and (3) since continuous light would be a waste of energy it should be dark at least one-half of the time.

So God agreed to divide light and darkness and he would call light day, and the darkness night. (The Council expressed no interest with in-house semantics).

When asked how the earth would be covered, God said, "Let there be firmament made amidst the waters; and let it divide the waters from the waters."

One ecologically radical Council member accused him of double talk, but the Council tabled action since God would be required first to file for a permit from the ABLM (Angelic Bureau of Land Management) and further would be required to obtain water permits from appropriate agencies involved.

The Council asked if there would be only water and firmament and God said, "Let earth bring forth the green herb, and such as may seed."

The Council agreed, as long as native seed would be used.

About future development God also said, "Let the waters bring forth the creeping creature having life, and the fowl that may fly over the earth."

Here again, the Council took no formal action since this would require approval of the Fish & Game Commission coordinated with Heavenly

Wildlife Federation and Audobongelic Society.

It appeared everything was in order until God stated he wanted to complete the project in six days.

At this time he was advised by the Council that his timing was completely out of the question...HEPA would require a minimum of 180 days to review the application and environmental impact statement, then there would be the public hearings.

It would take 10 to 12 months before a permit could be granted.

God said, "To hell with it!"

RECLAMATION PLANNING AS A PART OF MINE PLANNING

Chairman of the Morning Session
Thursday, March 2, 1978

J.D. Graham,
Chief Engineer,
Lornex Mining Corporation
Logan Lake, B.C.

FORDING RIVER DIVERSION

Paper Presented
by:

J.A. Wood
Vice President
Kerr Wood Leidal Associates Ltd.
North Vancouver, B.C.

FORDING RIVER DIVERSION

INTRODUCTION

The Fording Coal Limited minesite and processing facilities began production in 1972. By late 1976 it was estimated that approximately 1.5 years storage capacity remained in the existing tailing pond. Fording Coal therefore initiated a development program to construct a new tailing pond, tails disposal line, and clarified water return system downstream from the existing coal processing complex. The deadline for having these facilities operational was the Fall of 1978.

SELECTION OF SITE

The Fording Coal minesite is situated in the southeast corner of British Columbia, approximately 18 miles north of Elkford. The coal process and maintenance complex is located on the east bank of the Fording River at about El. 5400.

The existing open-pit mine operation extending on both sides of the Fording River presently covers an area of about 1250 acres. Exploration work is ongoing in other nearby areas totalling about 1000 acres.

The Fording River Valley and tributary areas have extensive populations of wildlife, and the Fording River has abundant stocks of cutthroat trout. Since the mines opened in 1972, improved access to many areas of the river have resulted in increased hunting and sport fishing. Thus, any construction activity proposed for the valley must consider the wildlife and recreational aspects of the area.

Some of the considerations in choosing the site for the new tailing pond have been summarized below:

(1) proximity to the coal process facilities for conveyance of tailings and return of the clarified water, (Due to the large quantities of water used in the coal process, all water is reclaimed from the tailing pond.)

(2) favourable topography to minimize the construction of dikes for the impoundment of tailings,

(3) proximity to the railway for future reclaim of the tailings as either thermal coal or possibly for the extraction of aluminum,

(4) minimum disturbance to the environment.

The site immediately downstream of the process facilities was ideal for the tailing pond as the area only required one major dike to be constructed at the south end of the pond. A low dike was also required on the west side of the pond and the other two sides were formed by the natural topography of the valley. However this site necessitated diverting the Fording River for approximately 4000 feet.

Five other tailing disposal options were also investigated but were not economically feasible due to limited storage life, or because the construction of the dikes required extensive quantities of imported material. The fill required for the impervious zone of the dikes was located in relatively thin layers in isolated locations along the west bank of the Fording River. Any major earth quantities obtained from borrow would require large areas of land to be stripped and reclaimed at a later date.

The site immediately downstream of the mine was finally chosen and an extensive geotechnical program indicated the proposed river

diversion would produce approximately 80 percent of the fill materials required for the dikes. The balance of the material which consisted primarily of pervious (gravel) borrow could be obtained from the basin of the tailing pond. Other than the area required for the tailing pond and the river diversion, no other land would be disrupted.

RIVER DIVERSION - DROP STRUCTURES

The slope of the Fording River averages about one percent for a distance of approximately four miles through the mine area. In some sections, the river has natural grades of two to three percent for short distances. The portion of the river cutoff by the diversion generally was around 0.8 to 1.2 percent slope. This latter section of the river also had three or four large natural pools which were rearing and holding areas for cutthroat trout as well as good "fishing holes" for the angler.

Because the diversion was shorter than the portion of the river bypassed, nine drop structures were required to maintain the average slope of 1 percent. The criteria for design of the drop structures was basically as follows: the drop structures must not pose a barrier to migrating trout at any flow and maintenance must be minimized, or preferably eliminated.

The writer has completed a number of river diversions throughout the Province, the majority of which were completed for the Federal Department of Fisheries in connection with their various salmon enhancement programs. Over the years many materials were used for both drop structures and channel lining. These materials included cast in place concrete, timber, quarry rock, reinforced shotcrete, precast concrete sections, and combination of reinforced concrete and structural steel. The most successful of

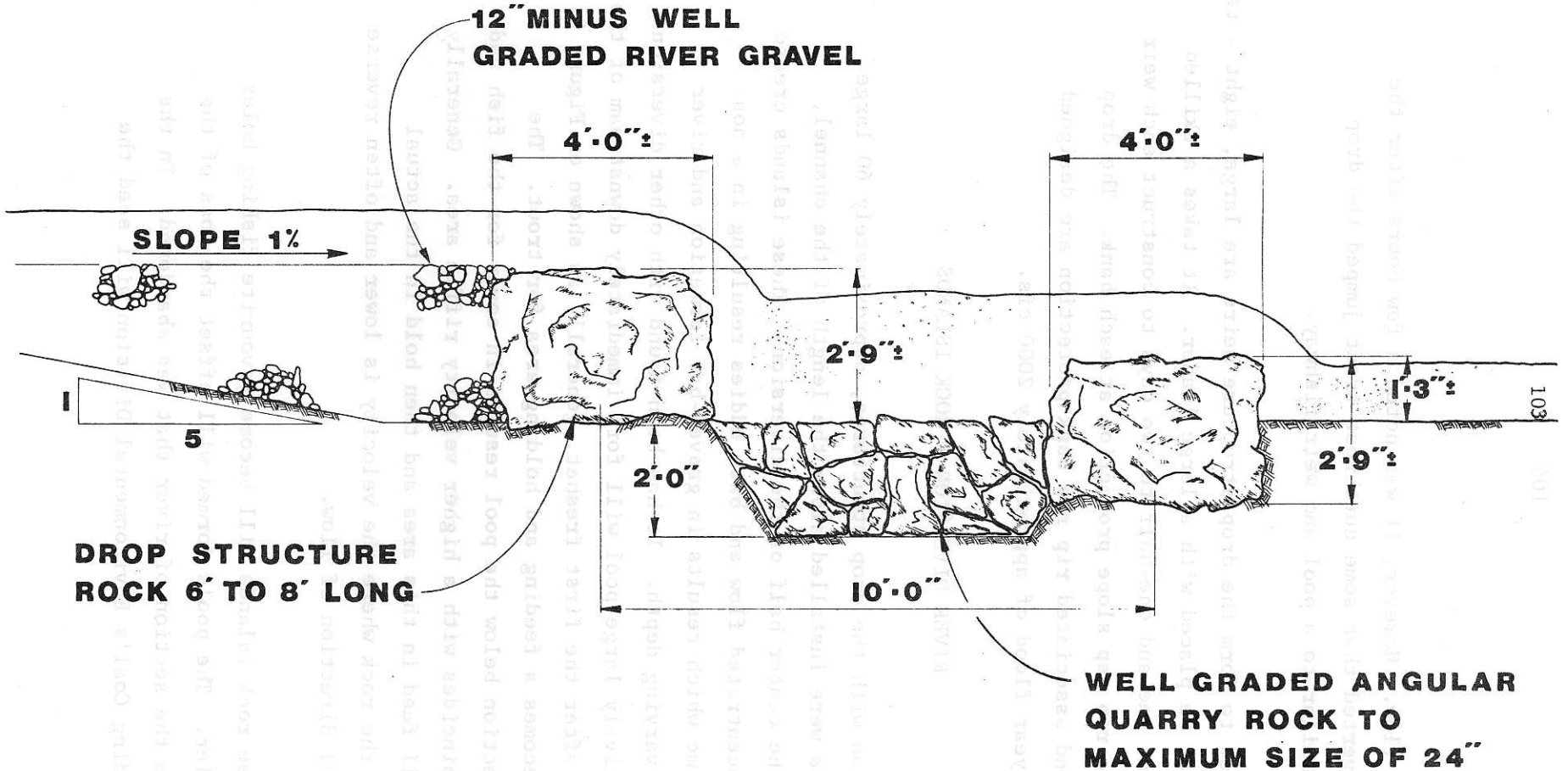
these materials was custom quarry rock carefully selected or broken into a reasonably uniform shape.

In northern British Columbia it was found that reinforced concrete structures, when used for channel invert controls and similar water control structures, suffered ice damage as early as two or three years after being put into operation. Steel structures aggravated any frazzle ice problems and, in some cases, caused blockages of an entire river channel. On the other hand, rock structures including rock linings have operated successfully and required no maintenance after 14 years of operation.

For the Fording river diversion dense sandstone blocks were selected and stockpiled over a three month period and were used to form the drop structures and "rock islands" in the Fording river diversion. Samples of the rock were laboratory tested for durability and resistance to hydraulic erosion and were found to be ideal for the proposed application.

The sandstone boulders were obtained from the open pit overburden waste and, because of the predominance of waste shale, the selection process was carried out on a periodic basis over a three month period in order to obtain the type and shape of stone when it became available.

The drop structures were constructed generally as shown on Figure 1. The overall drop across each structure was 2'9", generally in two equal steps. At very high flows the drop structures will simply form a relatively uniform bump in the water profile which fish will swim through. At low flows the irregularities in the rocks form a combination weir and slot type fishway which most fish will swim through at the point of



TYPICAL DROP STRUCTURE

FIGURE 1

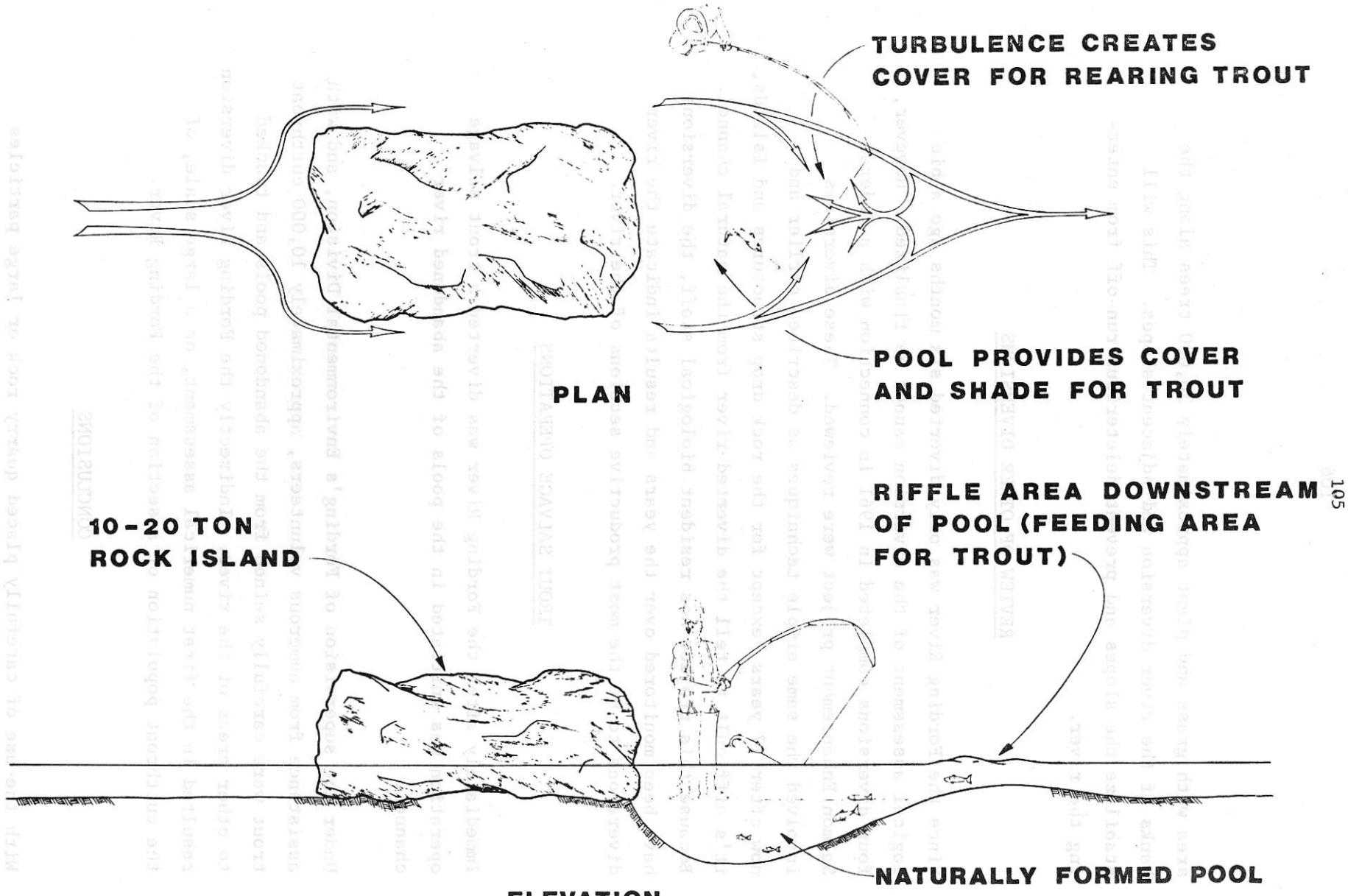
concentrated flow. However, it was noted a few hours after the river was diverted that some cutthroat trout jumped the drop structures similar to a pool and weir fishway.

The rocks used to form the drop structure weirs are large, eight - ten tons, and must be placed with a large loader. It takes a skilled operator about one and one-half to two days to construct each weir including the rip rap slope protection at each bank. The drop structures and associated rip rap bank protection are designed for the 100-year flood of approximately 2000 cfs.

RIVER DIVERSION - ROCK ISLANDS

In conjunction with the drop structures, approximately 60 large rock islands were installed along the length of the channel, roughly in the center half of the diversion. These islands create areas of concentrated flow and back eddies resulting in a non-uniform regime which results in gravel-bar formation and river sections of varying depth. It has been found with other diversions that a relatively large pool will form immediately downstream of the rock island after the first freshet, generally as shown on Figure 2. This area becomes a feeding and holding area for trout. The turbulent section below the pool results in cover for the fish and generally coincides with a higher velocity riffle area. Generally the fish will feed in this area and then hold in the actual pool behind the rock where the velocity is lower and often reverse to the normal direction of flow.

In time these rock islands will become favourite fishing holes for the angler. The pools formed will offset the loss of the pool area in the section of river that was abandoned. In the spring, Fording Coal's Environmental Division will seed the



TYPICAL ROCK ISLAND

FIGURE 2

area with grass and plant approximately 30,000 trees along the banks of the river diversion and adjacent slopes. This will stabilize the slopes and prevent deleterious run-off from entering the river.

REVIEW OF OTHER DIVERSIONS

Since the Fording River was only diverted six months ago a biological assessment of the diversion cannot be finalized. However, four diversions completed in 1961 in connection with a Federal Salmon Enhancement project were reviewed. These diversions involved the same simple techniques as described earlier and now after 17 years, except for the rock drop structures and islands, it's difficult to tell the diverted river from the natural channel. Because this project has resident biological staff, the diversions have been monitored over the years and results indicate the river diversions to be the most productive sections of the river.

TROUT SALVAGE OPERATIONS

Immediately after the Fording River was diverted a trout salvage operation was initiated in the pools of the abandoned river channel.

Under the supervision of Fording's Environmental Division, and with assistance from numerous volunteers, approximately 10,000 cutthroat trout were carefully seined from the abandoned pools and trucked to other areas of the river. Indirectly the Fording river diversion resulted in the first numerical assessment, on a large scale, of the cutthroat population of a section of the Fording River.

CONCLUSIONS

With the use of carefully placed quarry rock or large particles of dense mine overburden waste, a river diversion can be care-

fully stabilized with a minimum of maintenance. The addition of large rock islands will create rearing and holding areas for resident trout as well as provide cover and shade. With some assistance from Man the river diversion can be returned to a natural state.

DISCUSSION RELATED TO J.A. WOOD'S PAPER

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. How was the actual diversion carried out?

ANS. That's a good question. We did it at night for aesthetic reasons. There are a tremendous number of sportsmen on the river fishing and hunting, and when you divert a river you can't avoid silting the water. In a diversion of that size, the water would be coloured for two to three hours.

At the start only half of the river flow was channelled through the diversion. Then the old channel was slowly cut off. This allowed the fish to move into the large pools in the original river. Ray Speer from Fording then went in and pumped the pools down and removed all the cutthroat trout. There was an enormous number of trout. I was surprised that they took 10,000 fish out of roughly four pools.

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. At what point, with streams the size of the Elk or Fording rivers, would you anticipate significant downstream aggravation of flooding by channel straightening? I'm thinking more of the potential diversion that may be carried out in the Elk Valley by the Elco Mining operations.

ANS. That can be assessed. It did happen on Vancouver Island when they straightened out the Cowichan River. They straightened the river towards a bridge abutment and it took the abutment out. But you can assess this.

There won't be any downstream problems if you look downstream and find out what you are actually going to create. We had to do that. The Ministry of Mines and Petroleum Resources asked us to review the downstream conditions as far as five miles both from the point of view of the stream diversion and also in case of a disaster with the tailings pond itself.

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. You didn't get any significant aggravation of high flows?

ANS. No, because we duplicated the velocities coming out of the channel so that we didn't change anything. We widened the lower end of the diversion channel to 160 feet, so as far as the river knows the diversion doesn't even exist.

RECLAMATION PLANNING AT HAT CREEK, B.C.

Paper Prepared Jointly

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RECLAMATION PLANNING AT HAT CREEK, B.C.

ABSTRACT

B.C. Hydro is presently investigating the possibility of developing the Hat Creek coal deposit in south central British Columbia to produce coal for a thermal electric power plant. As part of the reclamation planning for this project, studies have been undertaken to examine the site specific factors likely to influence the future revegetation of waste piles. The rationale for this test program is described. Test plots have been constructed using a variety of discrete waste materials excavated during a bulk coal sample excavation program undertaken during the summer of 1977. In addition, plots to test revegetation at various slopes have been developed. A wide variety of revegetation species, suitable for establishment of vegetation in the dry climate at Hat Creek were examined and twelve were selected for testing. Three seed mixes of four species each were prepared. Each material was tested for nutrients and appropriate fertilizer was added during seeding. Material test plots were hand seeded with the three different seed mixes while plots to test revegetation at different slopes were hydroseeded using only one seed mix, a mulch and binder. A monitoring program will be undertaken to determine emergence success and productivity of species under each field test condition.

RECLAMATION PLANNING AT HAT CREEK, B.C.

INTRODUCTION

The Hat Creek Valley lies within the Interior Dry Belt of British Columbia, approximately midway between the towns of Cache Creek and Lillooet (Figure 1). The floor of the upper valley ranges in elevation from 850 m (2800 feet) at the north end to about 1220 m (4000 feet) at the south end. The valley is approximately 26 km (16 miles) in length and 3-6 km (2-4 miles) in width.

The area is typically warm and dry through the summer and cold and dry throughout the winter. The total precipitation is relatively low, mean annual precipitation being 32 cm (13 inches), about half of which falls during the growing season. Mean snowfall for the area is 133 cm (52 inches). The extreme minimum temperature in the winter is -40°C, and the extreme summer maximum is 34°C.

Two major types of vegetation occur in Upper Hat Creek Valley. A steppe zone lying below the forest and occupying the valley floor, and a dry forest which comprises the lower zones of the montane forest.

PROPOSED DEVELOPMENT

There are two major coal deposits in the Upper Hat Creek Valley (Figure 2), the #1 deposit contains proven and probable reserves of 585 million tonnes (645 million short tons) whilst 8 km (5 miles) to the south the #2 deposit is estimated to contain approximately three times that amount. The coal is low grade but suitable for thermal use in coal fired electric power plants. The present

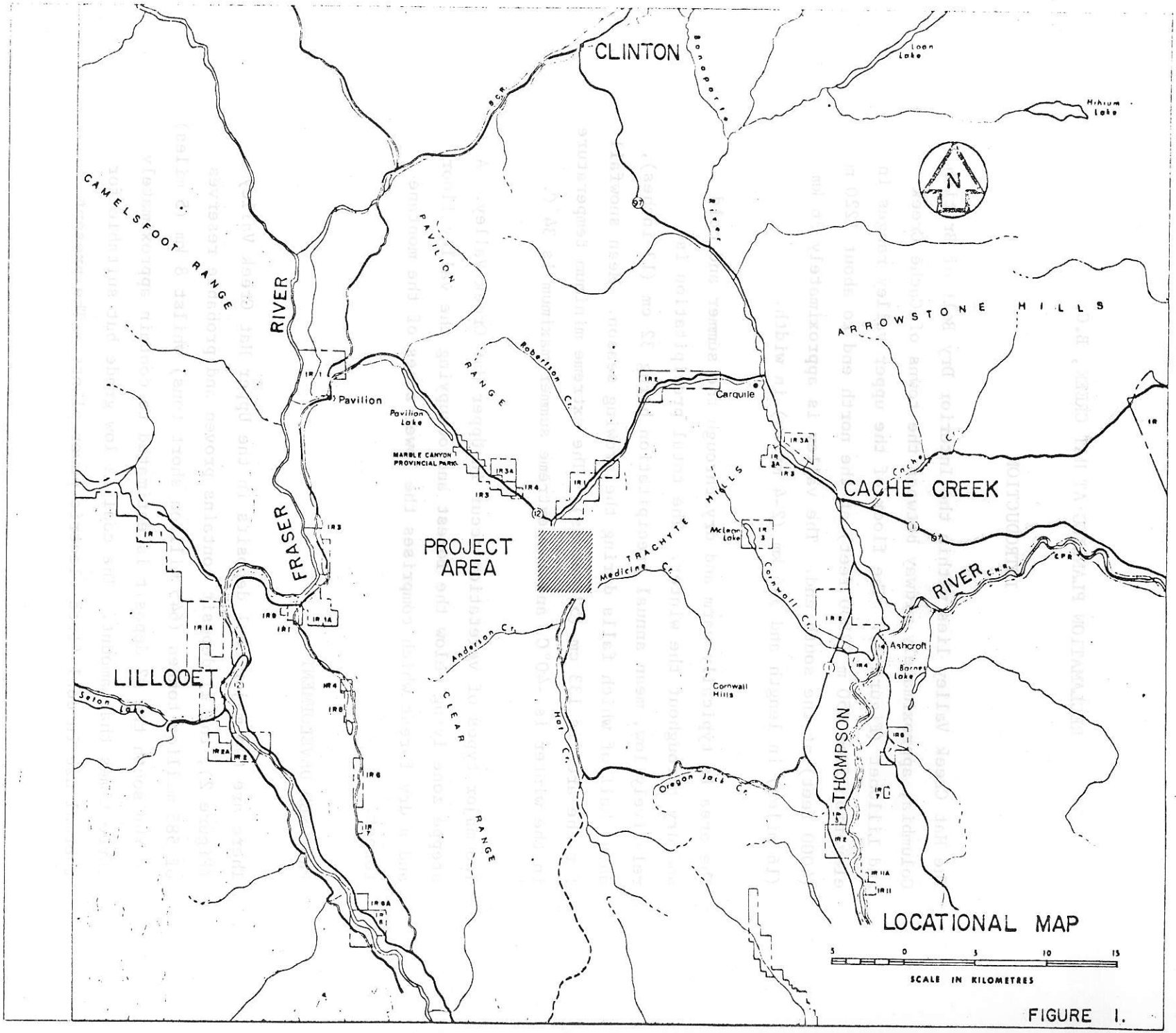

CLINTON
Loon Lake
Hihium Lake
N
CAMELSFOOT RANGE
RIVER
PAVILION
Bonaparte River
ARROWSTONE HILLS
Pavilion
Pavilion Lake
Robertson Cr.
RANGE
Carquile
MARBLE CANYON PROVINCIAL PARK
CACHE CREEK
PROJECT AREA
TRACHYTE HILLS
Mclean Lake
Medicine Cr.
Cornwall Cr.
FRASER RIVER
LILLOOET
Seton Lake
Anderson Cr.
CLEAR RANGE
Hat Cr.
Cornwall Hills
Ashcroft
Barnes Lake
THOMPSON
Oregon Jack Cr.
LOCATIONAL MAP
SCALE IN KILOMETRES

FIGURE 1.

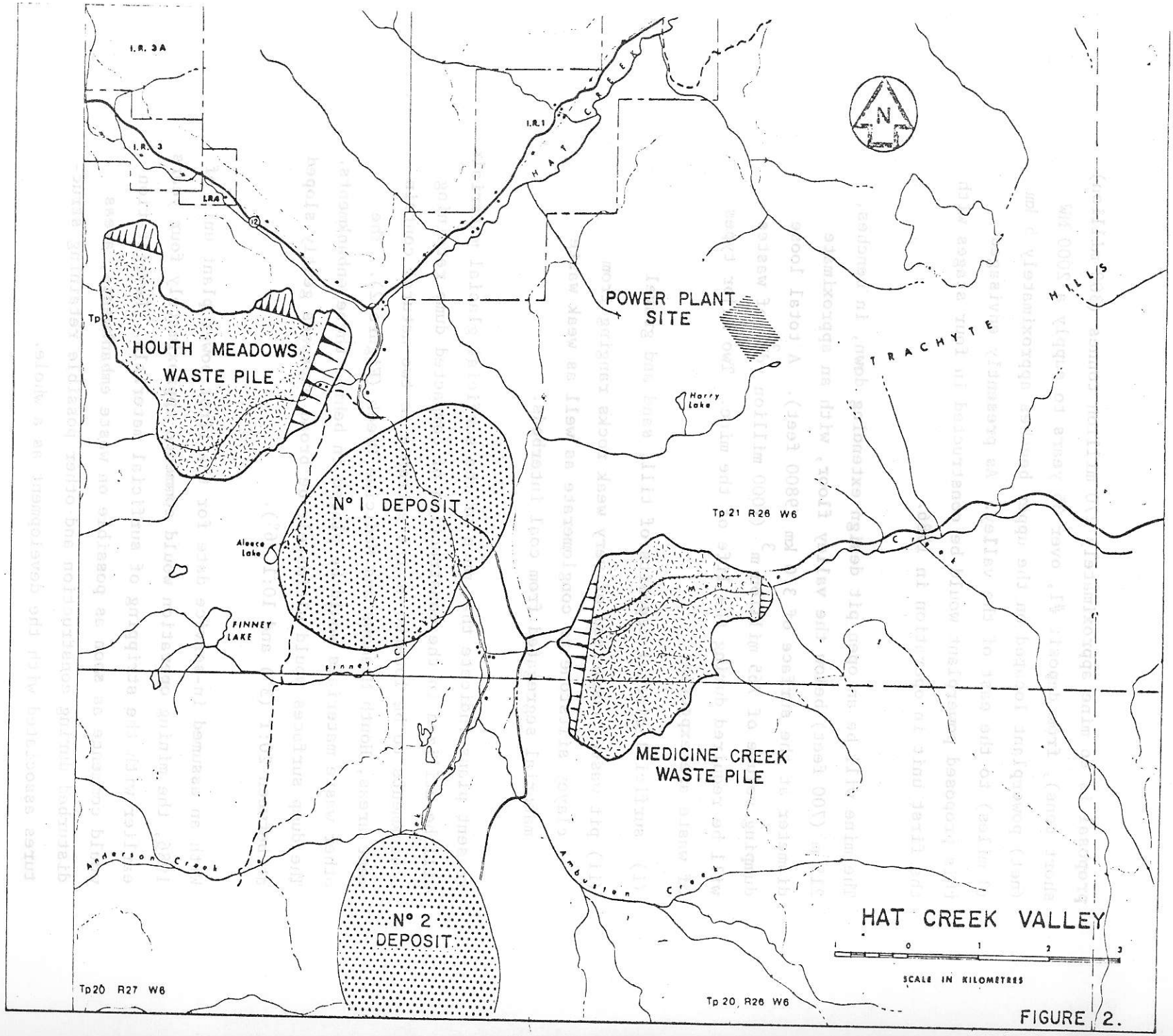

I.R. 3A
I.R. 3
I.R. 1
I.R. 4
HAT CREEK
POWER PLANT SITE
HOUTH MEADOWS WASTE PILE
TRACHYTE HILLS
Harry Lake
Tp 21
N° 1 DEPOSIT
Tp 21 R26 W6
Alsace Lake
FINNEY LAKE
MEDICINE CREEK WASTE PILE
Anderson Creek
Ambusion Creek
N° 2 DEPOSIT
HAT CREEK VALLEY
SCALE IN KILOMETRES
Tp20 R27 W6
Tp 20, R26 W6

FIGURE 2.

proposal is to mine approximately 270 million tonnes (300 million) short tons), from deposit #1, over 35 years to supply a 2000 MW (net) powerplant located on the upper benches approximately 5 km (3 miles) to the east of the valley. As presently envisaged this proposed powerplant would be constructed in four stages with the first unit in operation in 1986.

The mine will be an open pit design extending down, in benches, 215 m (700 feet) below the valley floor, with an approximate diameter at the surface of 3.0 km (9800 feet). A total loose dumping volume of 765 million m^3 (1000 million yd^3) of wastes will be required during the life of the mine. Two major types of waste are expected:

(i) surficial glacial deposits of till, sand and gravel

(ii) pit waste, comprised of very weak rocks ranging from clayey siltstone to conglomerate as well as weak waste material segregated from coal interbeds.

Present plans indicate that much of the surficial glacial materials will be utilized in the construction of compacted dump retaining embankments to be located at the entrance to two natural containment areas, Houth Meadows and Medicine Creek (Figure 2). The other waste materials would be placed in behind these enbankments. The dump surfaces would ultimately be broad expanses gently sloped at between 20:1 (3°) and 10:1 (6°).

With an assumed in-service date for the first power plant unit of 1986, the mining operation would commence approximately four years earlier with the stripping of surficial materials. Revegetation would commence as soon as possible on waste embankments, areas disturbed during construction and other possible retaining structures associated with the development as a whole.

OBJECTIVES OF RECLAMATION

In devising this aspect of the reclamation program B.C. Hydro has considered both long and short term objectives.

The rapid establishment of vegetation on the disturbed area is the primary short term goal. This is required to improve surface stability, by preventing wind or water-borne erosion and to enhance the aesthetics of the waste piles. In the long term, vegetation should be self sustaining and not require continued additions of fertilizer or water (irrigation).

An essential aspect of reclamation planning is the determination of the ultimate land use of the disturbed areas following reclamation. In general terms, the potential land use should not be less than that prior to disturbance.

The present land use in the Hat Creek Valley is primarily directed towards cattle ranching. There are 13 independent ranching operations in the valley of which six would be directly affected. In total, approximately 3300 hectares (8300 acres) would be disturbed by the mine and associated waste dumps of which the vast majority is presently unimproved range land. Long term use or exploitation of the revegetated waste dumps has been examined. Several alternatives have been considered; for example, wildlife habitat, recreation, agriculture (ranching) and forestry. At present B.C. Hydro favours a mixed agriculture (ranching) and wildlife habitat alternative since these activities constitute the primary land use in the area of development.

RECLAMATION FOR THE HAT CREEK PROJECT

In June 1976, B.C. Hydro retained Acres Consulting Services Ltd. to

examine the waste materials to be generated from deposit number one and to study the characteristics of these materials and their potential for revegetation.

At that early stage only laboratory scale studies were undertaken. However, during the summer of 1977, a bulk sample of coal was mined in order to examine its combustion characteristics in an existing large scale power plant. Three trenches were excavated, two to extract coal and a third to test slope stabilities in weak (clay) material. In total 27,000 cubic meters of waste materials were generated. This program afforded an ideal opportunity for examining in greater detail the different waste materials likely to be encountered in the full-scale operation.

PLANNING

A number of years are required before definite trends in revegetation success can be evaluated, especially in an environment such as that found at Hat Creek. For this reason field revegetation tests have been undertaken at this early stage in conjunction with the Bulk Sample Program. These early investigations will form the basis of future reclamation planning and will be used in the development of the optimum site specific methods thereby reducing the future costs, both economic and environmental, of reclamation.

Two specific test programs have been undertaken at Hat Creek. One is designed to test the revegetation potential of slopes of different steepness. The second study is intended to examine the many waste materials likely to be generated and to determine their characteristics as growth media.

From drilling data there are known to be a wide variety of waste materials which would be exposed during the life of this mine.

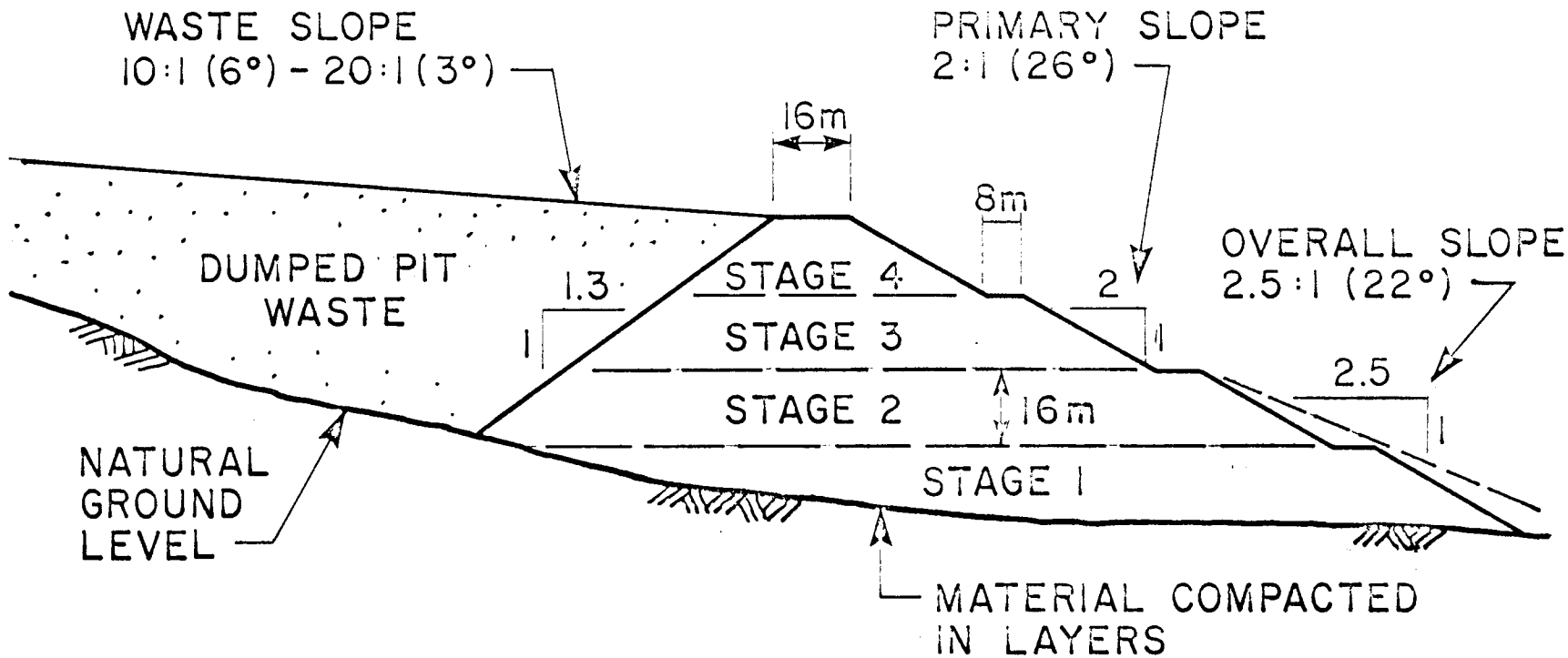
Each of these materials would be expected to display different characteristics as growth media. B.C. Hydro considers it important to examine these characteristics so that these data may be used in designing the waste pile construction sequence and mine excavation plans.

Embankment Plots

The bulk of the waste at each dump will be stored behind a competent retaining embankment constructed in stages (Figure 3). The preliminary design indicates a vertical rise of 16 m (50 feet) and a bench width of 8 m (25 feet) common to each lift. With such an arrangement it is expected that reclamation of the embankment faces may be carried out as the dump is constructed. The types of materials selected for these embankments have been identified as glacial till at Medicine Creek, and recent gravels at Houth Meadows. These material selections were made on the basis of their availability, geotechnical properties and location with respect to the mine and waste dumps.

Preliminary embankment design indicates a slope between benches of 2:1(26°) for each lift stage, this being the recommended guideline from the B.C. Department of Mines and Petroleum Resources. This slope, based on reclamation studies in the Kootenay Coal fields, is recommended as that at which vegetation can readily establish and at which slope stability may be assured. Geotechnical consultants for B.C. Hydro have examined the materials proposed for embankment construction and have indicated their stable angle of repose to be approximately 35°.

The design slope angles of the embankment faces are under consideration for two practical reasons. First, the economics of this plan indicate that by using a steeper slope between lifts, less overall



SCHEMATIC OF A SECTION THROUGH A RETAINING EMBANKMENT

FIGURE 3.

material and time would be required and therefore the cost of the embankment would be less. Second, if less construction material were required, a greater flexibility would be provided to the mining operation; separate excavations for suitable embankment material may thus be reduced or avoided entirely.

B.C. Hydro has therefore undertaken the construction of test plots to examine the potential for revegetation embankment materials at slopes of 22°, 26°, and 30° under Hat Creek climatic conditions.

Locations for these test areas have been carefully selected to simulate as closely as possible, conditions to be encountered by the embankments proper, e.g. aspect, elevation.

Waste Material Plots

It is apparent that there will be a number of different waste materials generated at this mine. It is as yet uncertain which materials will be present, or desirable, on the waste dump surfaces at the completion of the project.

The Bulk Sample Program provided the opportunity to obtain suitable quantities of waste sufficient for field plots. The field plots were designed to test the potential of the various media to support plant growth and to determine optimum vegetation species/waste material combinations. The results of this work would be used in the selection of materials for surfacing the waste dumps.

PROGRAM

Waste Materials

Preliminary Evaluation

Prior to the commencement of excavation for the Bulk Sample Program a preliminary soil survey was undertaken with the assistance of

Mr. A. Dawson and Mr. R. Kline of the B.C. Ministry of Agriculture. Soil parent materials likely to be encountered during the trenching program were examined. Tests on selected samples were carried out at the Ministry of Agriculture's Soil Testing Laboratory in Kelowna.

The results indicated that these soils were generally alkaline with the presence of free carbonates at 20 cm or deeper and that nitrogen and phosphorus were the common limiting micronutrients. Extreme variability was noted both vertically and spatially between the soil profiles sampled. In addition the topsoil thickness for stripping purposes was identified.

The soil survey in combination with the information obtained from the drill core and drill core logs was used in selecting, for stockpiling, individual waste materials from the trenches during excavation.

Detailed Material Selection

Seven different materials were selected from the excavation of the three bulk sample trenches, and approximately 300 cubic metres of each type were separated and stockpiled for further testing.

Material selection was based on such gross soil characteristics as colour, preliminary textural data, pH, electrical conductivity and carbonate presence. This information was generated on site at a small field laboratory.

The following seven waste materials were selected: bentonitic clay, baked clay, colluvium, carbonaceous shale, coal waste, (reject), glacial gravels and a gritstone/siltstone mix. In addition to these wastes, a large sample of fly ash produced from coal combustion tests was returned to the valley and included in the waste material test program.

Materials to be utilized in the construction of waste embankments were located and characterized in a similar manner as above.

All these materials were subsequently analyzed in greater detail at the Ministry of the Environment and the Ministry of Agriculture laboratories in Kelowna. Table 1 indicates some of the properties of these materials and the recommended fertilizer application rates.

TABLE 1

ANALYSIS OF SUBSURFACE SOIL MATERIALS

DESCRIPTION	ORGANIC MATTER %	pH (H_2O)	SALTS mmho/cm	AVAILABLE PLANT NUTRIENTS kg/ha N	P	K	Ca	Mg	ppm S	NUTRIENTS TO BE APPLIED FOR A GRASS-LEGUME CROP NUTRIENT RECOMMENDED kg/ha N	P	K
Aleece Lake												
Colluvium	0.6	8.7	6.00	35	8	242	11127	1120+	30+	22-34	135	67
Carbonaceous shale	30.4	4.5	3.00	108	18	263	6686	1120+	30+	22-34	112	56
Bentonitic clay	0.9	7.9	8.60	6	11	1100	10154	1120+	30+	22-34	135	0
Baked clay	0.8	7.8	3.30	2	36	898	10503	1120+	30+	22-34	67	0
Glacial gravels	1.7	8.0	0.48	6	12	423	10005	1120+	30+	22-34	135	0-45
Coal Waste	30+	5.0	3.20	18	19	662	4968	1120+	30+	22-34	112	0
Gritstone	0.5	8.4	3.00	1	25	608	4027	1120+	30+	22-34	90	0
Fly Ash	2.8	7.7	2.95	62	63	185	3690	253	N.A.	22-34	78	90
Topsoil	7.0	7.4	0.60	17	45	1053	11200+	1120+	30+	22-34	45	0
Houth Meadows												
Recent gravels	0.9	8.1	0.24	4	19	219	5990	734	10.6	22-34	112	78
Topsoil	3.9	7.7	0.40	40	33	553	10979	1120+	13.4	22-34	78	0
Medicine Creek												
Till	1.2	8.2	0.32	2	11	388	9215	1120+	19.4	22-34	135	0-45

N.A. - not analyzed

Material Characterization

A list of the parameters chosen to assist in characterizing the waste materials is presented in Table 2.

TABLE 2

SELECTED SOIL PARAMETERS FOR WASTE CHARACTERIZATION

- pH	- cation exchange capacity
- electrical conductivity	- exchangable cations
- macronutrients	- selected trace element
- boron	analysis (available)
- organic matter	- soluble salts
- texture	- carbonate presence
- colour	

Generally the waste materials exhibit alkaline soil reaction; coal waste and carbonaceous shale are exceptions and are acidic. The favoured pH for soil supporting most types of vegetative cover is near neutral. Values ranging between 6.0 and 8.0 have been reported as the range preferred by most grass species.

The electrical conductivity of the majority of the waste materials is moderate to high. Soil conductivity is a measure of the concentration of soluble salts in the soil solution. High salt contents cause adverse soil conditions and result in poor establishment of vegetation. The limiting value for suitable soil conductivity, depending on the vegetative species grown, is from 2 mmhos/cm to 8 mmhos/cm.

Deficiencies in soil nitrogren and phosphorous are common to all the waste materials tested. Applications of potassium are required for optimum plant growth on a number of the materials. Other macronutrients, calcium, magnesium and sulphur are available in adequate amounts.

The organic matter content of the coal waste material and the carbonaceous shale is very high, approximately 30%. The majority of the waste materials, however, contain very little organic matter, in the order of 1% or less. Organic matter has a high cation exchange capacity and therefore has the ability to hold plant nutrients in the soil. It is also composed of potential nutrients required for plant growth. Depending on the degree of decomposition, it can act to provide some surface protection and stabilization of the soil structure.

The wide range of colours exhibited by the waste materials at Hat Creek is striking. The colour of the waste materials directly affects the heat absorption of the material. Under hot, dry conditions the waste materials exhibiting very dark colours (low colour values) may be limiting in the establishment of vegetation due to excessive temperature stress.

A diversity of soil textures is common to the waste materials tested. The texture of the soil material plays a major role in the storage of available water as well as being a major parameter in determining the erosion characteristic of a material.

Vegetation

In preparation for seed selection for the revegetation test plots, a survey of existing vegetation in the Hat Creek Valley was undertaken with the assistance of Messrs. A. Bawtree and J. Ryder of the B.C. Ministry of Agriculture in Kamloops. A wide variety of herbs, forbs and shrubs typical for this area's climate and soils were identified. Follow up discussions were held and proved invaluable in the evaluation and selection of candidate species for revegetation tests.

The selection of vegetation species was based on the following considerations: Species had to be suitable for the long cold winters and hot dry summers prevalent in the Hat Creek Valley. Species under consideration were reviewed taking into account the properties of the waste materials to be encountered. In addition, seed had to be available in sufficient quantities and in a viable state; agronomic species were therefore chosen rather than native species.

Seed was applied in mixes of four species each. Whilst a diversity of rooting systems would aid in the stabilizing of a surface, care was exercised when making up seed mixes, to ensure that the various species were compatible in terms of rooting competition.

Each seed mix contained at least one perennial legume and one grass species which made up approximately 25% and 40% of the mix, by number of seeds, respectively. The remaining 35% of the mix was made up with species that may establish quickly or be suitable under a variety of soil conditions. It was reasoned that the annual species would die out after the first year by which time the perennials would be sufficiently established to take their place. Legumes were included with grasses in the seed mix since they have the ability to fix atmospheric nitrogen and would be most useful in the nitrogen deficient soils, typical of Hat Creek. The seed mixes utilized at Hat Creek are presented in Table 3.

The total seed application rate of approximately 2,150 seeds per square metre (200 seeds per square foot) was arbitrarily established. Assuming an 80% germination rate the number of seedlings per square metre would be 1,720 (160 seedlings per square foot). This rate should be adequate to supply sufficient ground cover and yet avoid excessive competition between plants for the limited available moisture and nutrients. The suitability of this application rate will be further evaluated when results from field trials are obtained.

TABLE 3

EXPERIMENTAL SEED MIXES

GRASS OR LEGUME (VARIETY)	% BY NUMBER OF SEED	
SEED MIX I		
CRESTED WHEATGRASS (NORDAN)	41	
CANADA BLUEGRASS	29	
ALFALFA (DRYLANDER)	26	
FALL RYE	4	
APPLICATION RATE		57 KG/HA
SEED MIX II		
RUSSIAN WILD RYE GRASS	39	
SLENDER WHEATGRASS	18	
SAINFOIN (MELROSE)	25	
SWEET CLOVER	18	
APPLICATION RATE		108 KG/HA
SEED MIX III		
SMOOTH BROMEGRASS (MANCHAR)	19	
STREAMBRANK WHEATGRASS	39	
CANADA BLUEGRASS (RUBENS)	14	
DOUBLE CUT RED CLOVER	28	
APPLICATION RATE		48 KG/HA

The test plots were all seeded in the fall in order that maximum use could be made of moisture accumulated over the winter months, for early growth in the spring.

Test Plot Design and Construction

Slope Test Plots

General Considerations The test plots were designed to simulate, as closely as possible, an expanse of waste embankment. As previously mentioned preliminary design of these structures calls for construction of 16 m (50 feet) lifts. Therefore the test plots have common 16 m vertical rises with the slope lengths differing depending on gradient.

Three different slopes, 22°, 26° and 30° were selected to provide a wide range. The 22° slope was included in order to avoid a bias toward steeper slope. Plot widths were restricted to 16 m (50 feet) per slope. This was chosen arbitrarily as a sufficient width to prevent any edge effects from distorting the results. Slope lengths were as follows:

Slope	Slope Length (m)	(ft)
22°	40.5	133
26°	34.7	114
30°	30.5	100

All sloped areas were hydroseeded. One seed mix was used on all plots to avoid excessively complicating the experiment. Seed mix I, mulch (2242 kg/ha Silva Fibre), chemical binder (Dowell J197 13.5 kg/ha) and fertilizer (Table 1) were "hydro" spread in one application.

Test plots were fenced to ensure that grazing livestock did not interfere with the experiments.

Houth Meadows The plots are located immediately to the north of the proposed embankment location, elevation, 900 m, and aspect, ESE, are therefore duplicated. These areas were prepared by clearing and recontouring an expanse of hillside and trucking in sufficient

gravel from Trench B, to provide approximately a 1 m deep layer. Each 16 m wide plot was divided into two halves, one half being treated with a thin layer (5 cm) of topsoil.

Most of the lower "bench" area was also hydroseeded. Again seed, fertilizer and mulch were spread in one application, however, the mulch rate was reduced to 1350 kg/ha (1200 lb/acre) and the binder was omitted.

Medicine Creek The Medicine Creek Valley is located on the east side of Hat Creek Valley. The proposed embankment would therefore face almost due west. It was considered that an embankment with such an aspect would be warmer and therefore drier. Consequently it may be more difficult for vegetation to establish. An area of similar elevation, 1035 m, and aspect close to the location of the proposed waste embankment was selected. The surficial material in this location is glacial till, and since this would be the material of which the embankment would be constructed, there was no need to import material for the test plots. The vegetated area was already quite steep, 22°-26°. Topsoil was stripped from the area and, following ripping to a depth of about 0.7 m (2 feet), the slope was recontoured to the required dimensions. As a result of the difficulty in delivering topsoil, this treatment was omitted from the Medicine Creek test plots.

The entire area was hydroseeded as before. Again the lower "bench" areas received a smaller mulch application and no binder.

Waste Material Test Plots

Growth tests of vegetation on a wide variety of waste materials is being conducted at a site near Aleece Lake. This location was

selected for the following reasons:

(a) it has an elevation approximately equal to that of the final stages of the waste piles.

(b) it is located in a relatively flat and open area to expose it more reasonably to the prevailing elements.

(c) it is a location unlikely to be disturbed by the proposed mining operation for several years.

The Aleece Lake site is to the west of the proposed mine. The area has an elevation of 1067 m (3500 feet) and is presently located on the ultimate boundary of the open pit. The area around the plots was fenced to prevent damage by cattle.

The plots were designed to have dimensions of approximately 16 m x 16 m x 1 m. Topsoil was spread over half the surface area to a depth of 5 cm. In order to test each seed mix independently the plots were further divided into three subplots. Thus each seed mix was applied to an area of 16 m x 5 m, half of which was dressed with topsoil. Plots were seeded and fertilized using a hand held cyclone seeder. To prevent cross contamination, adjoining test strips on each plot were overlain with plastic sheets.

Monitoring and Evaluation

A program is being established to monitor vegetation progress at the various test areas. This program will be designed to obtain information on the success of seedling emergence, by late spring, and to estimate the productivity of these soil materials by determining the aerial biomass production at the end of the growing season.

Studies to determine vegetation quality are being devised. Analysis of the major constituent and selected trace elements in plant

tissue are being considered in order to evaluate the uptake of elements by vegetation from the waste materials.

DISCUSSION RELATED TO F.G. MATHORN AND D.K. McQUEEN'S PAPER

There was no discussion about this paper.

RECLAMATION PLANNING FOR THE LINE CREEK PROJECT

Paper Presented
by:

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Crows Nest Industries Ltd.
Fernie, B.C.

RECLAMATION PLANNING FOR THE LINE CREEK PROJECT

The proposed Thomas F. Gleed Mine, part of the Line Creek Coal Project, will be located on Line Creek Ridge in the Crowsnest Pass area of southeastern B.C. It is approximately 12 miles northeast of Sparwood and 9 miles southeast of Elkford, and lies at an elevation, at its highest point, of 6800 feet. The planned wash plant will be adjacent to the C.P. Rail Fording Spur in Elk Valley at an elevation of 4200 feet, near the confluence of Fording and Elk Rivers, $5\frac{1}{2}$ miles downstream from the mine site.

Crows Nest Industries, a recently acquired wholly-owned subsidiary of Shell Canada Resources, holds fee lands and coal licences in this area. A total of 18,650 acres of coal licences are dedicated to the Line Creek Coal Project, of which approximately 350 acres will actually be mined.

In 1976 C.N.I. signed an Option Agreement with Mitsui Trading Company of Tokyo, Japan to jointly undertake a feasibility study of the proposed plan. This study was completed in October 1977, and Mitsui has recently exercised their option to acquire up to 49 percent equity interest in the Line Creek Project.

Considerable effort and expense has gone into exploration and evaluation of the Line Creek Project over several years, and it now stands at a point where it has received government approval of the Stage II Environmental Study which was completed by B.C. Research. Stage III of the Coal Development Assessment Procedure is now being prepared. A comment will be made on the Coal Guidelines procedure later in this presentation.

Reclamation planning has been a major part of the total develop-

ment effort for this project. Mine design has included regularly scheduled reclamation activities to keep temporary negative environmental changes to a minimum. In other words, reclamation was included from the original concept rather than it being an afterthought.

The mining method will be a conventional shovel-truck operation for removing waste materials. Coal will be recovered with hydraulic excavators and truck hauled to an in-pit breaker station that will discharge onto a belt conveying system for transporting coal from Line Ridge to a series of bins located in the upper valley of Line Creek. Product will be reclaimed from these bins with a 17-yard front-end loader into 70-ton bottom dump trailers hooked two in tandem per truck, and hauled over a 40-foot wide, paved road, a distance of 5.5 miles to the wash plant. Approximately 40 million raw metric tons of coal will be mined over the 20-year life of the project.

Mine design calls for removing 240 million bank yards of waste from mine pits into an area we have labelled West Line Creek Canyon, on the west side of Line Ridge. The existing small stream in the dump canyon will be diverted into a stage-constructed $1\frac{1}{2}$ mile channel to keep the stream and runoff water from eroding dumps. Final discharge of this diversion channel will be designed after experience has been gained from previous stages.

In order to minimize solids input, a series of settling ponds will intercept drainages from the west side of Line Creek in the area of mining activity. These ponds will be constructed first in the development. Water draining from the dump and pit areas will pass through a system of settling ponds prior to entering Line Creek. Alum will be added when necessary at the inflow to appropriate ponds to accelerate settling of suspended material.

A major effort has gone into designing waste dumps to obtain stability, minimize erosion potential, and establish early restoration of wildlife habitat. Initial waste disposal will be directly off the ridge to the west of the mine, but as working room is developed, the dump will be worked northward to the head end of West Line Creek. When the northernmost extent of the dump is reached, its face will be turned to the south, which direction it will follow for the remaining life of the project. This design makes the dump somewhat unique in that three sides will be contained by existing undisturbed terrain with only the south advancing face left unsupported. Movement monitors will be installed along the active south face to predict potential areas of weakness. Dump sites may be closed temporarily to allow for improved stability. A porous toe dam will be constructed in the mouth of West Line Creek to contain any slides that may occur in the dump face and yet allow for flow of water into the last setting pond. The pervious section will be constructed from selected sandstone excavated during prestripping.

The reclamation plan includes progressively replanting each section of the dump during spring and summer as the dump becomes dormant. Although true topsoil is scarce in the area, those surface soils which are now supporting vegetation will be spread over the finished waste dump to encourage regrowth. This material will be stockpiled as it is encountered during the normal sequence of mining.

To provide a root zone with decomposable material, for future soil development, a two-foot blanket of Kootenay shale and decomposed common overburden material will be spread over the finished disposal site prior to spreading topsoil. These materials have been

extensively tested in B.C. Research's lab and supported good growth characteristics of plant species assessed. There are about 39,000,000 bank yards of this waste available from total overburden yardage. Approximately 400 acres of dump surface and slopes will be replanted during the life of the project. A detailed schedule has been prepared which shows where decomposable material will originate each year, showing distance to be hauled and amount of material to be used. A portion of the dump surfaces will be replanted each year, the location and area of which is detailed in the reclamation schedule.

All finished slope sections will be dressed to an angle of 26 degrees. All top surface dump areas will be sloped at a $\frac{1}{2}$ percent downgrade to the west where a collection ditch is located. These ditches will place runoff water from the dump surfaces into the diverted West Line Creek diversion canal at appropriate intervals.

A monitoring program will be maintained to assure that revegetation will promote wildlife habitat as soon as possible after the dump areas become dormant. This program will also take into consideration changes that may have to be made in the original plan.

Since 1973, C.N.I. has been actively engaged in conducting reclamation trials. Initial programs included reclamation of two test pits and some exploration roads. Further studies have included a detailed assessment of soils, potential waste materials, natural revegetation, candidate reclamation native species survey, native seed collection and testing. Extensive native and agronomic species test plots have been established in the subalpine zone. This will be augmented with further native species tests which will also include shrubs. Continuous long-term site specific studies have been formulated to develop reclamation techniques to provide a self sustaining cover for the proposed mining area.

The overall reclamation plan deals also with the following concerns:

Open pit highwalls - The north highwall which lies roughly at right angles to the strike will be benched. The west side footwall will also form the finished slope and will utilize rock fences on slopes down to 26 degrees.

Main haul roads, shop and parking areas - These areas will require little reclamation except that steps are to be taken to ensure no adverse effects arise from runoff water during and following road construction.

Plant site facilities - Immediate cosmetic reclamation will take place following construction to reduce the possibility of dust and erosion.

The reclamation plan will receive top priority and commitment by project management. Direction of the plan will come from an environmental superintendent with responsibility and authority to carry it out. This individual will be an environmental biologist with adequate staff and will report directly to the project general manager. By reporting to the head man, he will have more independence and latitude to make the reclamation plan accomplish proposed objectives.

When I was asked by Dr. Errington to make this presentation, he thought it would be germane to comment on our experience with the guidelines for development of coal; I, therefore, would like to make some comments relative to this experience.

Line Creek Stage II Environmental Study was the first to receive approval from the Coal Guidelines Steering Committee. My overall opinion is that the procedure is fundamentally sound and designed to minimize negative environmental, social and economic impacts. Our observations indicate at least two major difficulties, keeping in mind that the procedure itself is, and must be both analytical

and critical, designed to take issue with a development plan and point out inadequacies. However, problems I allude to are: First, there appear to be no priorities set by government which would rationalize the differences between agencies, such as, Economics and Mining on the one hand and Environmental and Fish & Wildlife on the other. For instance, what are the overall benefits accruing from coal development as opposed to the alienation of winter range and some displacement of wildlife. This controversy is still under discussion.

Second, and this is a generalization, there is a lack of liaison or differences of opinion between and within governmental agencies which tends to preclude resolution of problem areas.

After submission of Stage I, several questions and comments pertinent to Stage II were brought to our attention which were responded to both verbally and in writing or were covered in Stage II volumes. Yet many of the same points surfaced again following assurance that they had been satisfactorily answered. We must assume from this, there had been lack of consensus among involved governmental branches.

Sometimes I get the feeling that you can't get there from here because industry is always wearing the black hat and the environmentalist is always wearing the white hat. Problems as mentioned lead to costly delays and, in this competitive market, could actually result in a loss to foreign competition.

I would repeat that the Coal Guidelines procedure is sound, however, implementation has been cumbersome, slow and more expensive than necessary.

A first go-around is always a learning experience for both sides. Despite the fact that no two submissions can be identical, the Line Creek Project presentation will, in all probability, result in further applications being dealt with more expeditiously — at least we hope so.

DISCUSSION RELATED TO R.H. CROUSE'S PAPER

Dave Polster - Techman Ltd. What do you intend to do with the basal sandstone you strip?

ANS. It will be put primarily at the bottom and in the center of the dump. The sandstone represents about 25-30% of the total overburden.

Dave Polster - Techman Ltd. What about the final pit floor?

ANS. On the west side we are not going to use benches as they would become unstable, so we are using what we label rock fences. These consist of six-inch pipe, ten feet long, embedded six feet into the basal sandstone, with wire mesh and backed by two-inch cable set in forty-foot sections. These rock fences will be installed on all pit slopes greater than 26°. Below 26° there should be no problem.

Dave Polster - Techman Ltd. What about reclamation of that pit?

ANS. We have not been able to develop anything at this particular time. After we have exposed some of it, we hope to formulate some kind of reclamation plan. At least in our schedule at this particular point we have no way of replanting it. I am sure it wouldn't support growth by itself.

Hubert Maxwell - O.K. Syndicate. How does the average haulage distance for waste disposal in the manner you described, compare to previously accepted methods of just dumping it in the handiest spot?

ANS. I'm sure the amount of travel is increased. If we had just dumped it at edge the distance would have been considerably less. How much less we never investigated. I don't know if that answers your question. We are also considering the possibility of conveying the material out of the pit.

Hubert Maxwell - O.K. Syndicate. Do you have a dollar value percentage of cost covering all of the additional work and the length of time that has been involved up to the point of being able to make a production decision?

ANS. In our feasibility studies we only made a financial analysis of the plan that we had existing. We did not look into any alternate plans so we have no way of comparing. I'm sure it's more expensive but how much more I can't say. We know it has to be done this way and so we have not looked at alternates.

Hubert Maxwell - O.K. Syndicate. I believe you made the comment that, as you went along, you found that your mine plan resulted in considerably more expense than you had first visualized.

ANS. I don't think I made that comment. If I did, I made it erroneously. When I say it's more expensive, I know from my past experience that there are cheaper ways to mine that coal than we designed. But the plan we designed satisfies not only the economics but also the environmental problems. So we haven't looked back and said, "look what we could do at Line Creek if we didn't have to do this." So I didn't know the answer to the question. All I know is that from past experience, this is a more expensive way to do it.

Jon O'Riordon - Assistant Director Environment and Land Use Committee Secretariat (also Chairman of the Coal Guidelines Steering Committee). I'd like to say that we appreciate your comments or any other comments from any developers on the guidelines' program. We recognize that it is a learning process both for ourselves and the developers.

ANS. Concerning my comments about the procedure itself - we worked very hard at designing the words and that is why I read it word for word. We don't want to throw rocks at any individuals or any groups of individuals, but there are some problems and we know that the committee is aware of them.

Ken Crane - Luscar Sterco Ltd. Why will the coal hauling road be paved?

ANS. Mainly for economic reasons even though there is a considerably larger construction cost. We feel that the extra money put into paving the road will be much less than the maintenance cost of a gravel road over a 20-year period. The road is now designed to be 40-feet wide - we have received some criticism that the road might be too wide. My own experience with similar type hauls is that if you do have a road 40-feet wide, you get a little more speed out of the trucks and you have less chance of a collision. In the overall haulage system, we will save money with the paved road.

Ken Crane - Luscar Sterco Ltd. How long did it take you to get from the prospectus stage to your present stage?

ANS. I don't know the actual date of the original prospectus but it's close to two years ago. We handed in the Stage II in August of last year and we received approval in early December. We thought that the steering committee was very expeditious. An important deadline had to be met because we had to go to Tokyo with a technical presentation and they got the approval to us before we left.

WORKSHOP SUMMARIES

RECLAMATION POLICY AND PLANNING

Thursday, March 2, 1978

Following completion of the first two technical sessions of the Symposium agenda, participants entered into Workshop groups to debate a series of Workshop Questions. This section of the proceedings summarizes their findings.

QUESTION 1. WHAT ITEMS SHOULD BE INCLUDED IN RECLAMATION POLICY IN B.C?

FINDINGS RELATED TO QUESTION 1.

GENERAL CONCEPTS

Need stronger guidelines, which should be reviewed, updated and improved rather than a reclamation policy which is inflexible and not site-specific. A policy dictating what industry has to do is too restricting.

Policy should favour motherhood, development and reclamation. Guidelines should be developed on a site-specific basis. Policy must remain as guidelines so that flexibility remains for unique problems. These guidelines should be formulated in consultation with industry. However, the government should have the overall control of reclamation, since it must integrate all land use types and remain responsible to future generations.

The word "Policies" is too rigid, suggest "Guidelines" as it infers more leniency. The end product should be acutely defined, but how it is obtained should be dependent upon an individual situation, while allowing flexibility in obtaining it.

Reclamation policy should remain as guidelines and should not be allowed to become regulations or strict legislation. These guidelines should be applied to the mines on a site-specific basis because many variations exist in the operational parameters at individual mine sites. A framework for these guidelines should be constructed and published so that operators can consider all important cost factors before mining begins. A dollar cost value should be placed on all involved factors; however, it is not clear who should make these judgements and evaluations.

Guidelines are preferable to regulations, due to the biogeoclimatic variations in the province.

Guidelines have to be general rather than specific check lists of acceptable reclamation.

Specific guidelines should be set forth regarding areas having similar reclamation problems.

Guidelines should be site-specific and separated from the law.

The people preparing guidelines are often extremely unfamiliar with the physical realities of mining.

Giving definite values for the angle and thickness of topsoil is questionable if the site-specific nature of reclamation is considered.

FLEXIBILITY OF POLICIES

Reclamation policies should be flexible and take into account the unique conditions encountered at each mine i.e., climate, topography, soil, etc. Mine reclamation is site specific.

When establishing reclamation policies, flexibility is needed in some areas, as all situations requiring reclamation are unique in one or more ways. Other characteristics are consistent in all situations, therefore to maintain control, stringent policies need to be established as well.

POLICY GOALS

The major emphasis of reclamation policy should be to return the land as closely as possible to its condition before industrial activity took place.

Reclamation policy must maintain a site-specific nature.

Most of the policy regulations have already been compiled and enforced in the United States. B.C. seems to be adopting the U.S. policies.

A site-specific reclamation policy is necessary for the metal mines scattered throughout the province; but such a policy need not be necessary for the East Kootenay coal block where the various mines all deal with similar terrain and conditions. Therefore, a general wildlife and reclamation policy should be developed for this area.

After completion of a mining operation the stability of the spoil is the primary goal of a reclamation policy. The integrity of watersheds and shadow areas should be guaranteed.

EQUALITY OF RECLAMATION STANDARDS

Guidelines should be equally enforced for all resource industries (i.e. petroleum, forestry, etc.) as well as being addressed to small exploration operations. Reclamation should not pertain only to the mining industry.

Policy should apply equally to all (i.e. hydro, highways, mining, forestry) and should recognize the special case -- small operators.

Guidelines for gravel pits are insufficient. Gravel companies may strip an area to hold the land and prevent rezoning when they have no immediate intention of mining.

BONDING

Bonding should be reduced after three or five years if a company has proven its intentions.

Bonding should reflect "land value" or use.

Bonding is nominal and practically inadequate but should not be increased. Perhaps a progressive bonding system should be implemented with the amount being dependent upon the area of mining site. The bonds should be made permanent and should be reviewed annually.

SEED MIXES

The provincial government should not prescribe mandatory seed mixes. Major land disturbers need to carry out their own work to determine the appropriate site-specific seed mixes.

LENGTH OF RESPONSIBILITY

The reclaiming of an area to a self supportive state within three years is, in some cases, unrealistic. The programs should be more long-term and not as intensive. Where possible the types of vegetation used for reclamation should be native species.

Length of time that mining company is responsible for reclamation should be determined by the state of the mining company.

ADEQUACY OF GOVERNMENTAL REGULATORY PROCEDURES

Generally both the government procedures and the people administering them are first rate.

A chief criticism is that the length of time required to gain approval for a mining project is far too long. Small operators in particular are handicapped in this way.

There is poor communication between various government agencies. One agency that could weigh the priorities of economic necessity against environmental requirements would be useful.

There is also insufficient education of government employees (e.g. mine inspectors), as to their specific responsibilities concerning reclamation.

A better distribution of trained people throughout the province is necessary.

Consolidate authority on the local level to deal with exploration.

GOALS FOR RECLAMATION

Assuming that mining can take place, reclaim to a condition equivalent to the natural state — one resource should not be sacrificed for another.

Reclamation should keep biological systems in a stabilized position.

Reclaimed areas should be maintained in perpetuity if necessary.

Reclamation to be progressive during the life of mine.

EVENTUAL LAND USE

Present and alternative land uses should both be considered in a reclamation program.

Prior to operation commencement, the land use after mining should be defined (i.e. watershed, wildlife habitat, agriculture) so that progressive reclamation can be performed. The most suitable use of the land should be assessed.

There is little point in focusing on low use areas.

Develop a land use policy which has flexibility (on site specific basis).

ECOLOGICAL PRIORITIES

Much of the damage to the ecology of an area resulting from exploration activities is due to the presence of access roads. Such roads allow locals to hunt, fish, etc., in places previously unavailable to them; therefore, these roads should be erased or at least barricaded in some way.

There is a need to identify special wildlife areas prior to mining exploration.

Consider the ecological priorities of the area.

COMMUNICATION OF RECLAMATION RESULTS

Industry has considerable expertise in reclamation and often has the most valid ideas on how the area can best be restored.

Reviews of reclamation activities carried out throughout the world could be well utilized.

Information derived from reclamation investigations should be easily accessible to other mining companies and to the public.

PUBLIC INPUT

The public wants clean and aesthetically pleasing sites.

The choice or reclamation should reflect the interests of people in the area. The problem in this regard is that the varied interests of people will make them want to look for different things in reclamation.

QUESTION 2. WHAT ARE THE BENEFITS OF PLANNING RECLAMATION BEFORE COMMENCING MINING ACTIVITIES?

FINDINGS RELATED TO QUESTION 2.

Know clearly what is to be done and have objectives stated so that planning can be done before development begins.

Planning results in a more economical and effective reclamation program.

More integration exists between the future reclamation requirements and the planning of a mine.

Reclamation planning before mining activity begins is a must. The benefits include: Cost advantages, saving of time, assurance of reclamation success, and easier project approval.

Compels one to take a look at the overall long-term reclamation. Planning produces economic and environmental information and the benefits of such knowledge are obvious.

Specific requirements of government should be made known early in the planning stages of an operation. These should include:

1. An exact definition of completed reclamation.
2. A statement of necessary cost/acre of that reclamation.

Helps to solve the problems of separating the costs and benefits of reclamation from the engineering cost etc. It is essential to define the economic solution to identify the costs.

Technical planning should be up to industry and the specialists they employ.

Operational planning may bring in the view of the public and government during the early stages, but the choice of who should be called upon should be up to the developer. The final decisions should rest with the company. There is a need for a central data or information bank so that all participants can draw upon it during the planning process.

QUESTION 3. SPECIFICALLY, WHO SHOULD HAVE INPUT TO PLANNING? HOW MUCH SHOULD EACH CONTRIBUTE?

FINDINGS RELATED TO QUESTION 3.

Industry should have the largest input (with co-operation in research from Universities).

Government should have a regulatory role.

Inputs to planning should be by the developer and their appointed consultants.

Government should approve mine development plans.

Industry often prefers to bring in consultants on a time basis.

Often it is mandatory that outside consultants be brought in even though in-house consultants are capable.

Government should set goals and outline procedures that are attainable. The mining company should develop procedures then carry them out during operations. Public should be kept involved and informed.

QUESTION 4. HOW CAN THE COSTS OF RECLAMATION BE BALANCED AGAINST THE RESULTS? FOR INSTANCE, HOW DO YOU RATIONALIZE THE EXPENDITURE OF $35,000/ACRE TO REVEGETATE LAND VALUED AT $1,000/ACRE?

FINDINGS RELATED TO QUESTION 4.

There is need for a sliding scale governing reclamation costs. Smaller

operations should be given tax credits or some other assistance to help them meet reclamation costs.

Perhaps, in cases of high expenditure, the money would be better spent to help out wildlife in other areas.

Such a question cannot be rationalized by generalization. Individual cases must be assessed on their own merit.

Cannot rationalize this expenditure if the disturbance will stay localized (e.g. - if the tailings will not silt streams.)

The cost of reclamation is irrelevant since reclamation should be an integral part of mine planning and should not be separated from other aspects of the producing mine.

QUESTION 5. WHAT ARE THE REASONS FOR SITE PREPARATION? ARE PRESENTLY KNOWN PROCEDURES FOR THIS ADEQUATE?

FINDINGS RELATED TO QUESTION 5.

The reason for reworking a site is to return it to a state consistent with a predetermined land use. Currently known procedures are inadequate.

QUESTION 6. WHAT IS THE RATIONALE FOR RECONTOURING SLOPES BACK TO 26° IF VEGETATION CAN BE ESTABLISHED AT A STEEPER ANGLE?

FINDINGS RELATED TO QUESTION 6.

Since vegetation can re-establish on slopes steeper than 26°, the need to recontour spoil piles to 26° slope must be based on ensuring long-term slope stability.

A 26° slope should not be a general rule, but the slope requirements should be site-specific and subject to modification dependent upon the materials and evidence presented by the engineers to show that a steeper slope is feasible.

Rationale should be on a site-specific basis with the primary objective being slope stability. The material, climate and future land use should be factors for deciding a reasonable slope angle. Length of slope and its visual impact should be considered.

QUESTION 7. IS IT WORTH IT TO REDUCE A SLOPE IF IT MEANS SPREADING OUT THE PILE AND RUINING EVEN MORE NATURAL VEGETATION?

FINDINGS RELATED TO QUESTION 7.

In these cases, where the slopes are stable (hardrock mining) perhaps the top plateau should be revegetated for grazing and forestry.

QUESTION 8. SHOULD GOVERNMENT BE RESTRICTED TO A REGULATORY ROLE OR SHOULD IT BE INVOLVED IN DEVELOPING NEW PROCEDURES FOR RECLAMATION?

FINDINGS RELATED TO QUESTION 8.

Government need not be restricted to regulatory functions but should act as a clearing house for new reclamation procedures.

Government should be restricted to a regulatory role. Industry should be responsible for carrying out research and outlining to government what should be done.

Government should not be restricted to a regulatory role but should participate in a mutual effort with industry in researching procedures. Better co-ordination between government and industry is necessary as this allows a greater understanding of industries' problems and costs.

Government should definitely provide advice to the mining companies. Government ministries are in touch with several different mining companies and have therefore seen the results of different measures taken.

At this early stage of development of mine reclamation expertise, government should be involved in:

i) information collection and dissemination (avoids duplication of research effort).
ii) regulation of reclamation.
iii) advising companies on reclamation plans. Field research and development should be done by industry.

Government should give a mining company a detailed land-use program for the area after it is mined. The Workshop group recognized that mining roads make areas accessible to recreational land uses and this should be considered in a reclamation plan. The time of filing a proposed land-use study is critical. A proper time for bringing up such a plan is after the filing of a prospectus and before the submission or implementation of a stage one report.

Government advice should be streamlined by resolving inter-governmental inter-departmental conflicts. A clear mandate should be given to one authority.

Government should spell out procedures for approval including; procedural steps, time schedules, and degree of commitment.

QUESTION 9. IS GOVERNMENT TOO STRICT OR TOO LAX?

FINDINGS RELATED TO QUESTION 9.

Government is confused. This results in erratic and unpredictable behavior.

Government is too erratic.

In general, the referral system whereby the mine permits are channelled through the Ministry of Mines and Petroleum Resources seems to work well. Current regulations under some Acts are strict, but are seldom enforced rigidly. Discretion in enforcement seems to strike an appropriate balance between strictness and laxness.

There seems to be a consensus that there should be more regular visits by the Reclamation Division of the Department of Mines and Petroleum Resources, to be able to let the mining company know if the company is on the right track.

OTHER FINDINGS DETERMINED AT THE WORKSHOP

There is too little communication between groups involved in the decision to mine and industry felt that this too lengthy liaison process inhibited it from taking advantage of present world markets. The Fish and Wildlife Branch and the Environmental agencies felt the time was not long enough. A more concise approach and process is required.

The confidentiality of coal reports for the duration of the term of the licence, as specified in the Coal Act, could hinder the spread of reclamation related information. By limiting the length of confidentiality to perhaps two to five years and using the ministry as a clearing house, the availability of information would be increased.

Government should promote reclamation research by funding corporations, universities and research companies and should insure that access to all research is available by acting as a clearing house.

Reclamation is needed near habitation, but areas far removed and of little land use should not have vast amounts of money spent on reclamation. Too much money spent where it is not needed has the potential of putting people out of work.

Reclamation is working in B.C. However, reclamation should not be treated as something separate, but should be included and accepted as part of the decision making plan.

A major fault in the present system is that so few government inspectors exist. Reclamation activities should be monitored much more closely and government officials should be much more specific and definite about what they want. The average mining company official must be pushed before any extra money will be spent.

It is necessary for government branches to integrate themselves and obtain one single objective for reclamation that all can follow. Possibly a department could be set up which would deal specifically with reclamation.

The provincial forest service might aid in reclamation by the reforestation of mined areas once the company has left. However, the mining company should provide some financial assistance, if this were to occur.

The amount of time a company must wait before obtaining permits is too lengthy. Valuable time and money may be lost by the company. Mineral prices may fluctuate and time may be lost, hence dollars, before a mine can become operational.

The lack of public willingness to participate in open meetings makes it difficult to gauge public opinion. Certain pressure groups were more influential than was commensurate with the size of their constituency.

There should be more communication between the public and industry to alleviate misunderstandings. Flare-ups can be avoided if the public is kept informed. However the media can distort and misrepresent issues.

Natural regeneration sometimes alleviates reclamation costs

Measures for reclamation might better be carried out during the operation of a mine rather than waiting till the mine is depleted of its resource.

Before any development begins, drainage, soil, climate and environmental factors should be established for the area. This will help in deciding methods of development and reclamation.

Most soils in mountainous terrain are not of good quality. But, if economically feasible, top soil should be stockpiled so that it can be put back on top of the rock fill when the final clean-up measures are being carried out.

SITE PREPARATION

Chairman of the Afternoon Session
Thursday, March 2, 1978

R.T. Marshall
Project Manager
Fording Coal Ltd.
Calgary, Alberta

SITE PREPARATION METHODS EMPLOYED AT COLEMAN COLLIERIES LIMITED

Paper Presented by:

J. Lant
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SITE PREPARATION METHODS EMPLOYED AT COLEMAN COLLIERIES LTD.

INTRODUCTION

Coleman Collieries is a relatively small coal mining firm located in south western Alberta. The company mines and exports to Japan one million tons of metallurgical coal yearly. The coal is extracted from three mines: one underground mine, and two surface mines both located on Tent Mountain. One of these mines is situated directly on the boundary between British Columbia and Alberta, and at all times the operation is governed by two sets of Provincial Regulations. Fortunately the conditions are quite similar.

In the field of reclamation there are a number of differences, the major one being in the site preparation of exploration roads. In the following sections I will briefly review the site preparation methods utilized by Coleman Collieries during the treatment of their exploration roads, refuse dumps and mine sites.

TREATMENT OF EXPLORATION ROADS

In Alberta, on certain programs, total recontouring is specified as a condition of approval. We recontour using a small dozer and an excavator to move the downhill side cast material back into the road cut. In general, work usually begins on the furthest most drill site and regresses back to the main access road. On side hill slopes greater than 23° and in forested areas, the excavator is utilized. The small crawler tractor is employed on slopes it can negotiate freely and in pushing back switchbacks.

At Coleman we have employed two types of excavators - a tracked Warner Swasey Gradall 880 and a Case Drott Cruz Air 40 on rubber.

Both have some advantages and disadvantages and a brief comparison chart follows.

	Gradall 880	Drott Cruz Air 40
Mobility	Poor	Excellent
Reach	Slightly Longer	Slightly Shorter
Production	Equal	Equal
Cost/Hour	More Expensive	Less Expensive
Mechanical Problems	Virtually None	Some
Stability	Excellent	Fair (Requires a good road crown to operate from.)

The second step after recontouring is a treatment which we call "combing". Basically this is similar to scarification with striations being formed by the teeth on the excavating bucket. These striations are parallel to the contour and are created in the following manner:

1. The boom and bucket assembly are fully extended.
2. The bucket is set parallel to the hill.
3. The boom is lowered so that the teeth enter the soil (approximately 4").
4. The boom is retracted toward the operator with the result being the formation of striations.

These striations act as wonderful moisture and seed entrapments.

The immediate application of seed and fertilizer is the third step. After each day's mechanical production a selected grass and fertilizer mix is manually applied. Past observations indicate that prompt dispersal of seed and fertilizer results in greater seed germination. The suspected reason being that the seed is able to settle into the freshly loosened soil, resulting in a reduced seed loss to wind. The seeding employees, while in the area, also measure and map each day's production and lay out the following day's seed and fertilizer requirement on the high side bank. This format is continued until the program has been completed.

The amount and type of fertilizer is determined by soil analysis. Seed mixtures vary but generally are a combination of grasses and legumes. We have found that Fescues, Brome Grass, Blue Grass and Timothy do quite well.

We apply our seed at rates between 50 to 100 lbs. per acre. This may seem high, but we have discovered that our seed losses are at times excessive because of the ever present wind.

Our cost per foot of treatment varies between 75¢ to 98¢ per foot. These values include pre-organization, mechanical, administration, seed, fertilizer and dispersal costs.

SITE PREPARATION OF REFUSE DUMPS

The first operation is to lower the slope from the angle of repose (37°) to the biological angle of repose or lower (26°). This is necessary to obtain slope stabilization. We have utilized D8 Caterpillars equipped with U blades to perform this function. In future programs we intend to use larger crawlers equipped with a U blade or modified blades because we feel we can accomplish the recontouring in a more efficient manner.

Again, as in the treatment of exploration roads, we employ, in the second step, a local treatment termed "tracking". This is accomplished by running the crawler tractor up and down the recontoured slopes to create track cleat marks or indentations in the slope which act as moisture and seed entrapments. Inspection of all past programs indicate that the seed establish better in these indentations than on flat unmarked areas. This site preparation treatment was recommended by our local Energy & Natural Resources Land Use Officer, Mr. Harold Ganske.

The third stage is the application of seed and fertilizer. Coleman has applied seed by both the manual and hydroseeding methods. Once

applied manually, the seed is harrowed in to reduce the loss to wind. Large industrial harrows drawn by a small crawler tractor have accomplished this quite well.

On slope areas that cannot be worked manually conventional hydroseeding is employed. During the past summer Coleman Collieries Limited conducted an interesting trial by hydroseeding raw sewage in combination with seed and fertilizer onto a refuse pile. Germination was excellent in the fall. As a note of caution, if you ever intend to utilize sewage, apply it directly if possible and do not store or impound the substance; re-handling problems are a reality.

TREATMENT OF OLD MINE SITES

The site preparation treatment employed by Coleman Collieries Limited on old mine sites is basically a combination of exploration road and refuse dump reclamation procedures. The main differences are the larger size and composition of the materials to be recontoured, and the road systems are generally wider and more compacted. These factors dictate the use of larger machines and, in most cases, a ripping treatment must precede recontouring. Again careful co-ordination of the machines is necessary to insure that one machine does not impair the production of the other. For example, in blocking access to areas.

CONCLUSION

I must emphasize that project timing is one of the greatest influences of whether or not the site preparation will be successful. Moisture, temperature and wind are the most critical factors in our area and they are all inter-related.

Programs initiated and conducted at the factor extremes are most likely to fail and should be carefully studied beforehand. In closing, the old adage with an added phrase applies completely, "You will reap what you sow on the basis of when and how you prepare and sow it".

DISCUSSIONS RELATED TO J. LANT'S PAPER

John Railston - Student, University of British Columbia. How did you break up the roads?

ANS. We used rippers.

John Railston - Student, University of British Columbia. How deep did you go with a ripper?

ANS. On some of the main haul roads we had to rip down to three feet to break the compaction.

Nick Agnew - B.P. Canada Ltd. You indicated that you were manipulating the site to create microrelief, have you done anything with a dozer basin or with gouging on an experimental basis? You also mentioned using a binder, what type did you use?

ANS. No, we have not done anything with gouging. The binder we used was a Dow Chemical Binder. I think it's a latex chemical called J197.

Don Graham - Lornex Mining Corporation. I would like to add a comment as a private citizen who has worked and grown up in remote areas. My first impression when I see someone filling in a road is one of shock. I know when living in remote areas you depend a lot on resource roads for fishing and hunting. In the Kootenays we often used the logging roads to go berry picking. Even though realizing that the mining industry leaves a lot of scars, I hope you are letting a few roads stay open because they are important to the general enjoyment of British Columbians.

ANS. Your comment is taken to heart. Lately, we have had some meetings to discuss the use of forestry roads, and some very good representations were made by four-wheel drive clubs. They strictly oppose the closure of all the roads. Believe me, we are experiencing pressure to leave a lot of roads open.

SPOIL DUMP RESLOPING
AT FORDING RIVER OPERATIONS

Paper Presented
by:

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SPOIL DUMP RESLOPING AT FORDING RIVER OPERATIONS

ABSTRACT

Much research work has been done on the suitability of materials and the selection of plant species for revegetation purposes. This work is well documented and research is continuing. Limited work, however, has been done on the actual physical preparation of reclamation sites. Fording Coal Limited has undertaken research on optimum resloping techniques. The first phase of this work, completed in 1977, covered the physical resloping of waste dumps from the natural angle of repose (37°) to a range of slope angles from 26° to 34°. Associated costs were closely monitored to determine the effect of resloping requirements on the economics of spoil construction (formed versus free dump spoils).

This paper discusses preliminary results of the resloping test work, specifically equipment limitations, economics of dump construction and planned follow-up work. Also discussed is the integration of these results with mine planning.

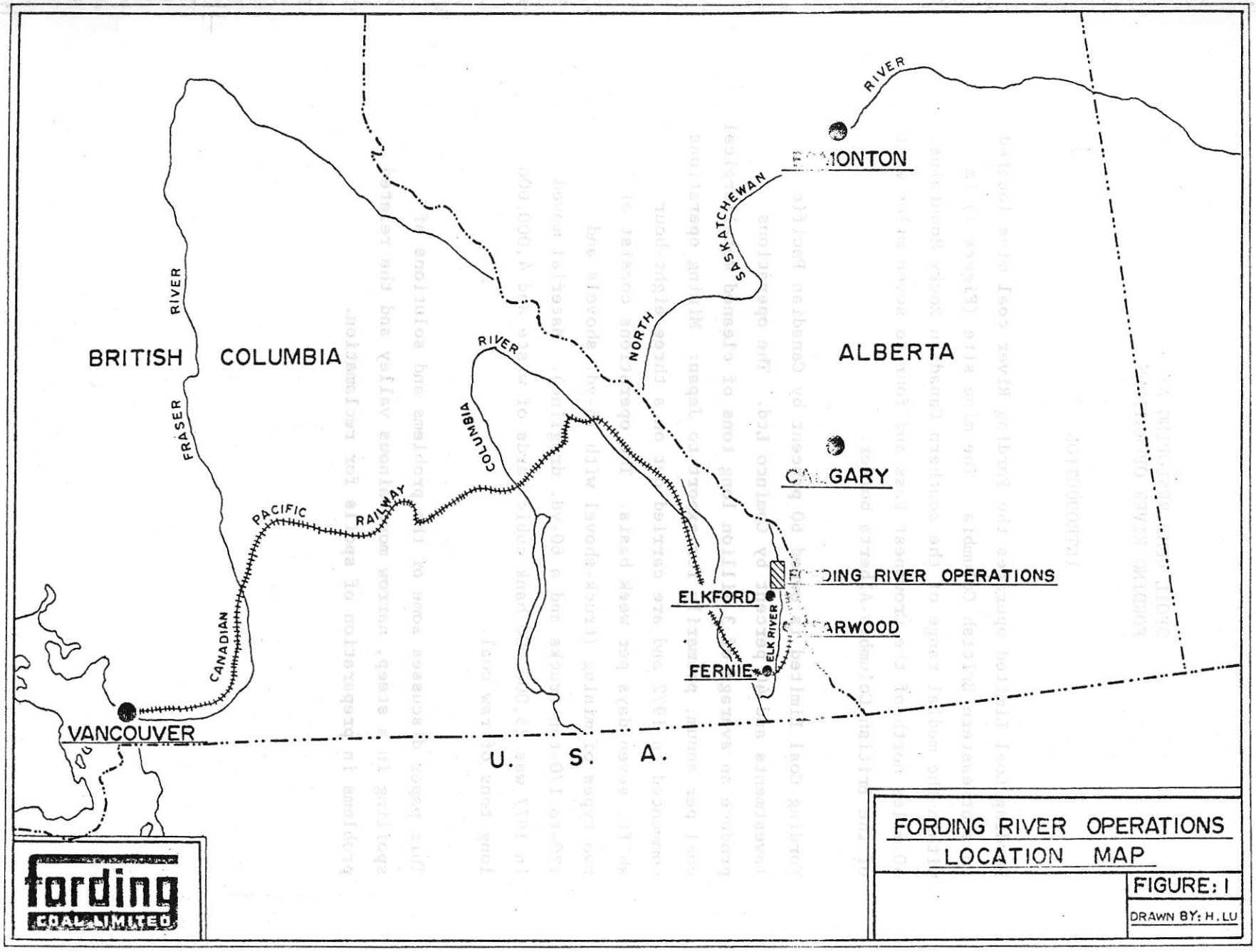
SPOIL DUMP RESLOPING AT FORDING RIVER OPERATIONS

INTRODUCTION

Fording Coal Limited operates the Fording River coal mine located in southeastern British Columbia. The mine site (Figure 1) is within the medial range of the southern Canadian Rocky Mountains, 40 miles north of the Crowsnest Pass and four to seven miles west of the British Columbia-Alberta border.

Fording Coal Limited is owned 60 percent by Canadian Pacific Investments and 40 percent by Cominco Ltd. The operations produce an average of 3 million long tons of cleaned metallurgical coal per annum, primarily for export to Japan. Mining operations commenced in 1972 and are carried out on a three eight-hour shift, seven days per week basis. The operations consist of two types of mining (truck-shovel with 15-yd. shovels and 120-to 170-ton trucks and a 60-yd. dragline). Material moved in 1977 was 25,000,000 bank cubic yards of waste and 4,000,000 long tons of raw coal.

This paper discusses some of the problems and solutions of spoiling in a steep, narrow mountainous valley and the related problems in preparation of spoils for reclamation.


RIVER
EDMONTON
SASKATCHEWAN
NORTH
RIVER
BRITISH COLUMBIA
ALBERTA
FRASER RIVER
COLUMBIA
CALGARY
PACIFIC RAILWAY
CANADIAN
FORDING RIVER OPERATIONS
ELKFORD
ELK RIVER
FERNIE
VANCOUVER
U. S. A.
fording
COAL LIMITED
FORDING RIVER OPERATIONS
LOCATION MAP
FIGURE: 1
DRAWN BY: H. LU

BIOGEOCLIMATIC ASPECTS

Fording Operations lie within the continental temperate climate zone. Average annual precipitation is 34 inches with temperature extremes of -40° C in winter to 35° in summer.

Mining operations take place from approximately 5000 feet to 7400 feet above sea level.

Vegetation cover on the valley bottom and lower slopes is mainly forest with dominant coniferous species being Engelmann spruce, lodgepole pine and minor amounts of balsam fir and western larch. Grass-shrub communities exist on south and southeast aspects.

The high elevation grassland is classed as moderate winter range for elk and sheep. Elk and moose populations inhabit the valley bottom. Black bear abound in the area and are often seen feeding on reclaimed areas.

Land use in the area is primarily forestry, hunting, fishing and general outdoor activities. Ultimate land use objectives for the mining operations consist of the development of spoils to permit restoration to forest cover as well as open high elevation wildlife grazing areas.

STRUCTURAL GEOLOGY AND MINE LAYOUT

Metallurgical coal seams occur in the lower 2000 feet of the 4000-foot Kootenay formation on both sides of the Fording River valley. Figures 2 and 3 show the existing mine layout and geological sections. The major structural features are two sub-parallel synclines - one on each side of the valley running north-south and a regional (Erickson) fault along the west side of the Fording River.

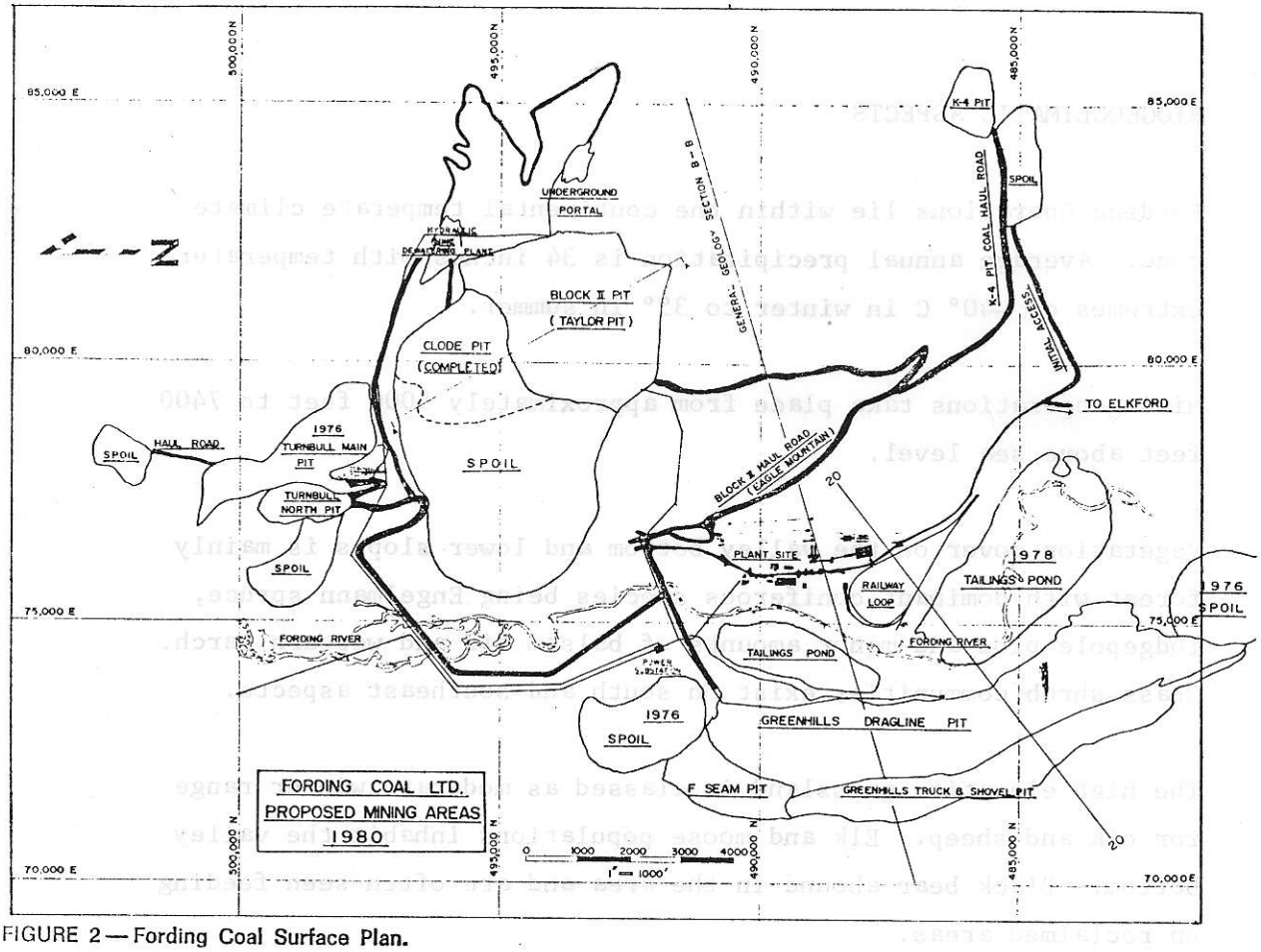


FIGURE 2 — Fording Coal Surface Plan.

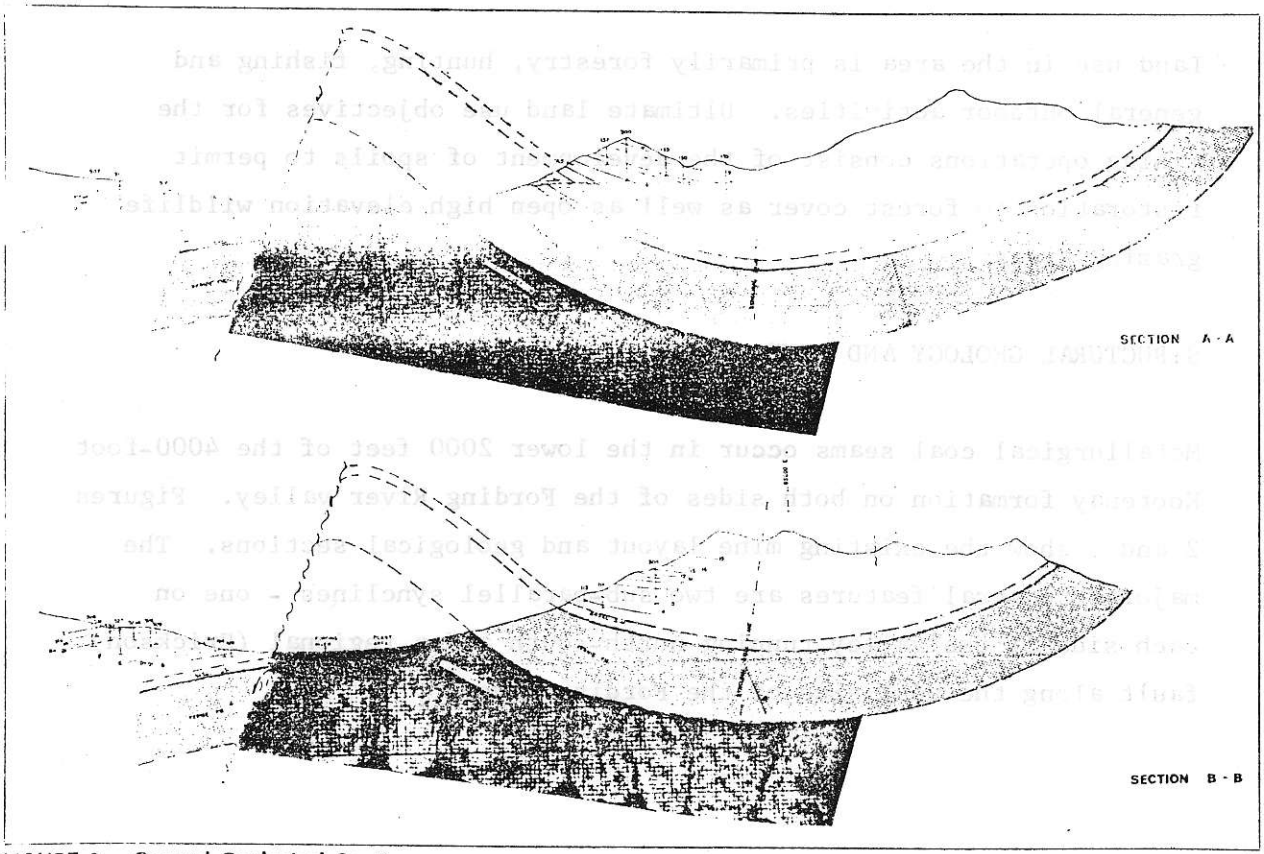


FIGURE 3 — General Geological Section.

Truck-shovel operations exist on the eastern side of the valley in Clode and Turnbull pits. Dragline mining with truck-shovel prestrip exists on the western side of the valley. Both operations create massive quantities of waste which will require extensive site preparation for reclamation purposes.

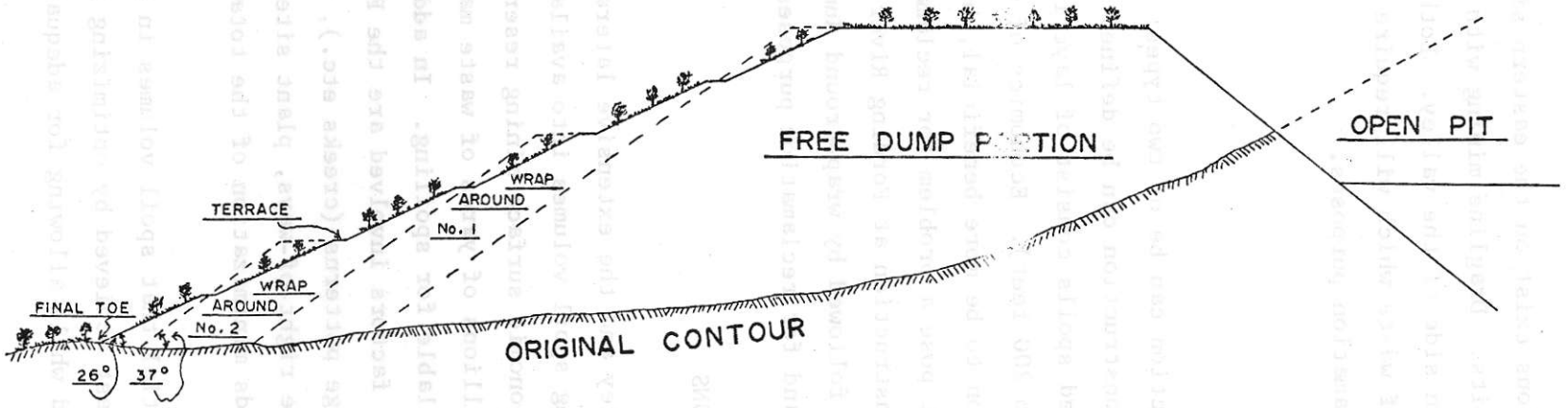
SPOIL CONSTRUCTION

Normal spoil construction can be of two types: free dump or formed spoils. Free dump construction can be defined as dumping waste from any elevation. Formed spoils consist of layering waste materials in lifts (i.e. 100 to 200 feet). Economics of mining normally show free dump construction to be more beneficial, however, dumps greater than two hundred feet pose a problem for reclamation. Figure 4 shows normal dump construction at Fording River operations. Free dumping is maximized followed by wrap-around dumping to provide for spoil stability and for reclamation purposes.

SPOILING CONSIDERATIONS

The narrow steep valley and the extensive lateral coal deposits result in problems of fitting spoil volumes into available areas. It is necessary that all economic surface mining reserves are recovered before being buried under millions of yards of waste material. Figure 5 shows the surface area available for spoiling. In addition to basic space considerations, other factors involved are the Fording River meander belt, regional drainage patterns (creeks etc.), wildlife corridors, haulroad and powerline right-of-ways, plant site location, tailings ponds — in other words minimization of the total land disturbance.

It is therefore essential that spoil volumes in any given area be maximized. This is best achieved by optimizing the slopes at which spoils may be reworked while allowing for adequate reclamation.

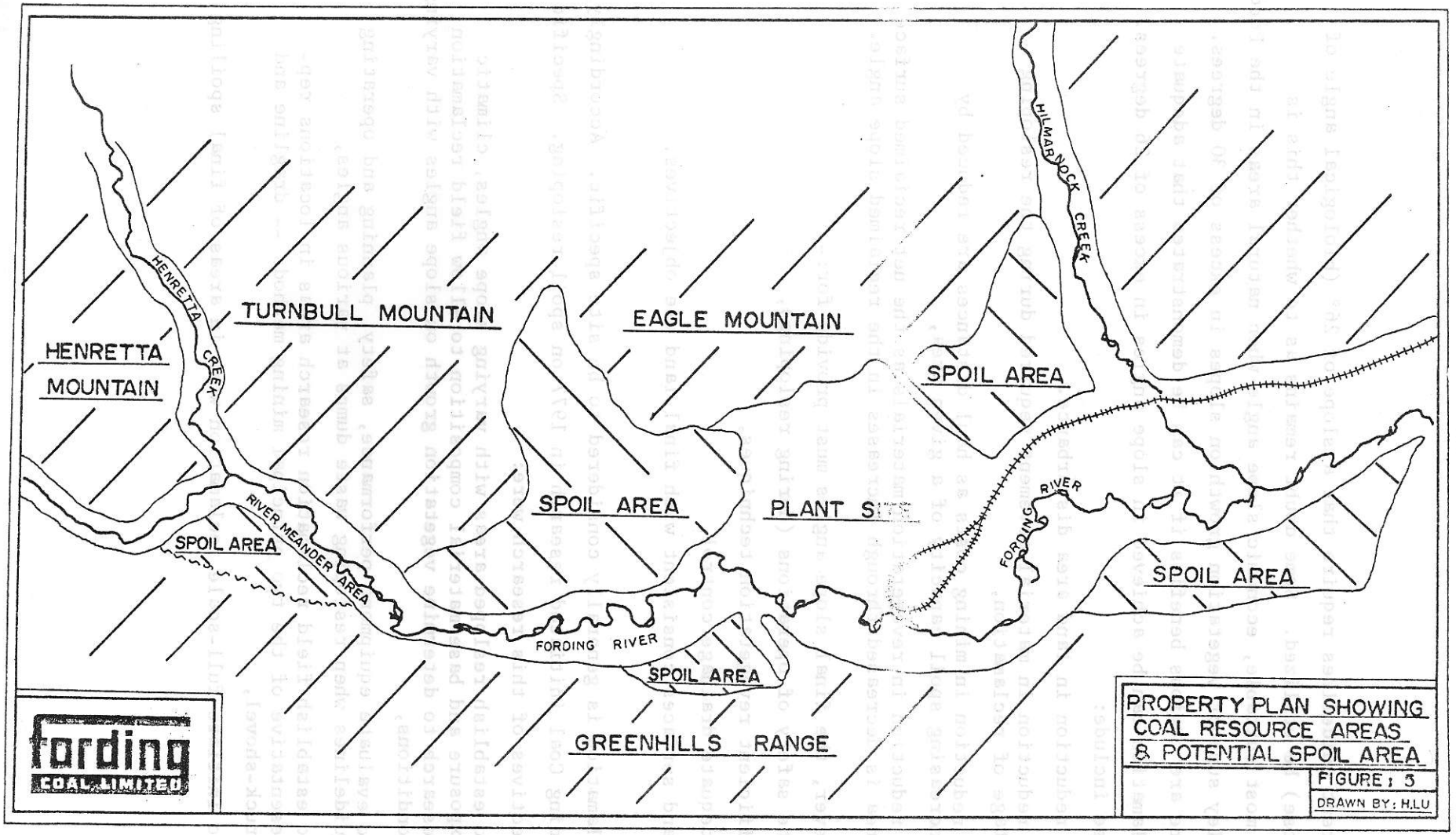


fording COAL LIMITED

IDEALIZED SECTION
SPOIL CONSTRUCTION
& FINAL RESLOPING

FIGURE : 4

DRAWN BY : H.LU


HENRETTA MOUNTAIN
HENRETTA CREEK
TURNBULL MOUNTAIN
EAGLE MOUNTAIN
HILMARNOCK CREEK
SPOIL AREA
SPOIL AREA
PLANT SITE
RIVER MEANDER AREA
SPOIL AREA
FORDING RIVER
FORDING RIVER
SPOIL AREA
SPOIL AREA
GREENHILLS RANGE
fording
COAL LIMITED
PROPERTY PLAN SHOWING
COAL RESOURCE AREAS
& POTENTIAL SPOIL AREA
FIGURE : 3
DRAWN BY: H.LU

Current guidelines require that a slope of 26° (biological angle of repose) be utilized. Some doubt remains as to whether this is the most suitable, economic slope angle when natural areas in the Fording valley support vegetation growth on slopes in excess of 30 degrees. There are obvious benefits if it can be demonstrated that adequate reclamation can be achieved in slope angles in excess of 26 degrees. These include:

- a reduction in land area disturbance.
- a reduction in material movement required during the resloping stage of reclamation,
- a reduction in mining costs as haul distances are reduced by increasing spoil capacity of a given area,
- a reduction in revegetation materials as the net reclaimed surface area is decreased through increases in the reclaimed slope angle.

However, the final slope angles must provide for:-

- the safety of operations (during resloping),
- efficient revegetation techniques,
- adequate drainage control,
- land surfaces consistent with final land use objectives.

Reclamation is generally considered to be site specific. Accordingly, Fording Coal initiated research in 1977 on spoil resloping. Specific objectives of this research were:

- to establish resloped areas with varying slope angles, climatic exposure and base material composition to allow field reclamation research to determine vegetation growth on slope angles with varying conditions,
- to evaluate equipment performance, safety, planning and operating guidelines when resloping waste dumps at various angles,
- to establish field reclamation research areas in locations representative of the two principal mining methods -- dragline and truck-shovel,
- to initiate full-scale reclamation work in areas of final spoiling.

FIELD WORK - 1977

Two spoil areas for research were chosen: Greenhills south (dragline) and Turnbull (truck-shovel). The Greenhills area was at the final spoil limits, and the Turnbull area is not planned for additional spoiling for several years allowing for long-term research.

Local contractors were hired for the initial resloping as mine operations did not have sufficient equipment required for this work. Details of the project were discussed with equipment operators so they could contribute effectively to the project. This approach was very successful in obtaining operational data on equipment limitations and operator safety.

Project parameters were as follows:

- development of panels with slope angles of 26° to 34° (use of crawler dozers only),
- development of a 20-foot wide terrace at approximately mid-point on the spoils face. This terrace would have a 2° cross-sectional slope for drainage purposes,
- use of the terrace for access for top-soiling and revegetation purposes (hydroseeder and light vehicle access). It is important to note that spoils at Fording can exceed 1000 feet in vertical height,
- use of the terraces for research into drainage considerations primarily to determine the effects of runoff on seed and fertilizer retention on the spoil face,
- provision of slopes having varying facing aspects (all directions),
- variation of surface materials (glacial till, peatmoss or natural mudstones and shales),
- detailed cost collection,
- use of various equipment sizes (D-6, D-8 and D-9's).

SPOIL COMPOSITION

Waste materials consist basically of sandstone, carbonaceous mudstone, siltstone and some glacial till. Normal dump construction results in the more competent sandstone rolling to the bottom of the spoil area; while the less competent materials (shales and mudstones), remain at the crest (or top) portion of the dump. The coarse sandstone provides for good drainage at the base of the spoil. Resloping pushes the finer crest materials (which degrade quickly - less than two years) over the face of the spoil giving an excellent surface for revegetation.

REVEGETATION PRACTICES

It is Fording's intention to use natural materials as much as possible. Research work has been extensive with numerous test plots being studied both for vegetation species related to material types and altitude as well as maintenance (fertilization) requirements.

Vegetation materials were based on previous test results with an application of the seed mixture at 40 lbs. per acre and complete fertilizer, 13-16-10, at 300 lbs. per acre.

The seed mix applied by hydroseeder oonsisted of:

10% Alsike Clover	5% Red Top
35% Rambler Alfalfa	10% Canada Blue Grass
25% Creeping Red Fescue	15% Climax Timothy

RESLOPING RESULTS

Most of the resloping was conducted during ideal weather conditions. Work was held up during short periods of moist conditions for reasons of operator safety.

Equipment Limitations

It was found that dozers worked most effectively on slopes up to 28° to 30°. High productivity was obtained. The equipment had a natural tendency to cut the slopes at 28°. Slopes from 30° to 34° resulted in cross pushing (low productivity) and deep grouser or crawler track markings.

At angles above 28° it was found that the dozers would climb efficiently in a forward position only. Reverse climb was possible but resulted in a low productivity.

Clinometers mounted on the dozers are required to maintain grade control.

No mechanical difficulties were encountered.

Spoil Stability

Minor crescent-shaped failures occurred on slopes of 32° to 34°. Failures were of the surface material only (less than a foot deep) and were related to fine wet material. In general, these were not a problem and are not expected to pose future problems.

Analysis of the slope material showed good subsurface drainage.

Terrace Development

Spoils at the Fording River mine can be up to 1000 feet high. Experience has shown development of spoils of this height to be safe provided material placement procedures and spoil stability monitoring are followed. However, resloping of such spoil introduces other factors such as operator safety, cost of dozing (rehandle), and lack

of access for reclamation work.

Spoil heights resloped during the 1977 program varied from 100 to 200 feet high. Terraces of 20-feet width were created at approximately the mid point of the spoil face (50 to 100-foot intervals). Development of these terraces proved effective both from the operation point of view, drainage control, and access for revegetation. The hydroseeder was able to distribute vegetation materials over all of the faces encountered.

Development of spoils in less than 200-foot layers would result in additional spoiling costs during operations (maintenance of spoil faces, berms, etc.) More work is required on terrace interval.

Terraces will also provide for wildlife migration.

Drainage Considerations

Limited information has been obtained to date. Pure dozer work results in a major down dip drainage pattern as a result of the final slope surfacing. Minor cross-dip patterns are created by grouser marks.

Spoils with terraces at 75 to 100-foot intervals provide for development of major cross-face drainage patterns. Two dozers, operating in parallel on the terraces, can move harrows across the face. This would also facilitate the mixing of revegetation materials into the subsurface.

Terrace construction should allow for drainage away from the spoils to prevent gullying or down dip erosion. Cross-dams on the terraces

can be constructed to prevent major erosion along the terrace. However, drainage must be adequate to prevent failure of the crest of the terrace.

Cost Results

Costs for resloping varied with the push distance involved (between $1,000 and $5,000 per plan acre). Costs for dozing varied from $0.30 to $0.40 per loose cubic yard. Comparison with haulage costs indicate that vertical lifts for spoil development should be in the order of 200 feet. However, more work is required due to site-specific conditions such as relation of pit area to spoil location, use of larger equipment for resloping, balance of the correct materials for revegetation, and availability of resurfacing materials if correct on-site materials are not available.

CONCLUSIONS

Preliminary results indicate that spoil resloped angles can be increased to at least 28° with a possibility of 30°. Operator safety appears to be adequate. Drainage and revegetation considerations are satisfied. Surface stability of the spoils appears adequate.

The 1978 follow-up work will include monitoring of surface drainage patterns and vegetation growth with respect to plant species and aspect. Major spoil stability is being analysed utilizing internal angles of friction to determine the factor of safety for the spoil heights and spoil composition encountered at Fording Coal.

Current spoiling plans at Fording utilize 26° reslope angles. Planning revisions are underway to determine the effect of 28° and 30° reslope faces on spoil volumes available. The 1977 field work has indicated that it is essential that reclamation planning be integrated with all stages of mine planning and mine development.

DISCUSSIONS RELATED TO J. POPOWICH'S PAPER

Dave Headdon - University of Calgary. What about internal stress deformation and hydrologically caused problems of slumping?

ANS. I can't answer that in detail. We have consultants who are looking into those problems at this time. I assume they are using all factors involved.

Lionel Jackson - Institute of Sedimentary and Petroleum Geology. Have you any estimates of what the related costs would be if the intervals of wrap-around terraces were changed?

ANS. No. If we construct our dumps with 200-foot intervals then the costs would be consistent with the numbers I've indicated today. If we decide to reslope from 300-foot intervals then the costs would change. The cost differential would increase quite quickly.

Allen Lamb - Interior Reforestation. Could the slope angle be changed from 26° to 30° by the use of rip rap at the toe of the slope and, if so, would the cost of moving the rip rap into place be justified?

ANS. That, in fact, is happening right now, because in our spoiling operations we get a definite segregation of the materials. The more competent sandstone blocks, some of which are 8-10 feet across, end up at the bottom of the spoil at the toe. To answer your question, I think that it would require some engineering analysis to determine whether that particular type of toe stability would help the overall dump stability. We are not really concerned with the toe. Our concern is where you may get failures three-quarters the way up a slope, especially on a dump 1200 feet in height.

WASTE DUMPS - DESIGN, CONTOURING, AND VEGETATION
KAISER RESOURCES LTD. OPERATIONS

Paper Prepared
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WASTE DUMPS - DESIGN, CONTOURING, AND VEGETATION KAISER RESOURCES OPERATIONS

INTRODUCTION

The coal bearing property owned by Kaiser Resources Ltd. is situated in the southeastern corner of British Columbia. This property consists of two separate areas: the Crows Nest Coal Basin and the Elk River Basin. The Crows Nest Coal Basin is some 30 miles in length and approximately 12 miles in width near the centre of the basin. This coal field contains about 12 mineable seams that outcrop within a 2,500 foot stratigraphic sequence, primarily along the western slopes of the Rocky Mountains. The second field is a portion of the Elk River Basin and is approximately 8 miles in length and 2 - 3 miles in width and contains between 7 and 14 mineable seams that outcrop within a 2,000 foot sequence of coal bearing measures. The coal seams in both fields range in thickness from 5 to 50 feet and vary in elevation from 3,500 feet to 7,000 feet in the Crows Nest Basin and from 4,500 feet to 7,500 feet in the Elk River Basin.

On both coal fields the overburden is composed mainly of sandstone, siltstone, mudstone, and carbonaceous mudstone with some conglomerate. In pH this material ranges from 4.2 to 7.8. The coal ranges from low to high volatile bituminous type with a sulphur content of 0.3 to 0.4%.

At present 80% of the total raw coal mined by the company is mined by surface methods. The remainder is extracted from underground using mainly hydraulic techniques. Total raw coal production in 1977 was 75 million tons.

The main area of mining at present is centred on Harmer Ridge where there are recoverable reserves of 64 million short tons of metallurgical coal. To mine this coal approximately 300 million bank cubic yards of overburden will have to be moved. That means that annually 40 million bank cubic yards must be moved to release 6 million short tons of coal to meet the company's contractual commitments.

The Mine Planning Department is responsible for providing a practical mine plan for the recovery of coal for the company's spoil to facilitate the final reclamation of the area. This waste dump site selection has to include such factors as economics and safety.

MINING METHODS

The first stage in implementing the mine plan is the drilling and blasting of the overlying rock. This overburden is removed in 50-foot high benches parallel to the strike of the coal seam. Rock is loaded by 25 and 15-yard shovels into 200, 170, and 100-ton trucks.

The waste rock is hauled to disposal areas clear of the pit limits and clear of future mining operations.

WASTE DISPOSAL

Development of each waste dump is commenced by placing waste rock to form a bench extending outwards from the topographic contour that corresponds with the design elevation of the working surface of the waste dump. The overburden is hauled from the pit and end dumped at the crest of the waste pile. Some rock spills over

the crest and the remainder is pushed over with dozers. For safety reasons trucks do not back to the very edge. The result of this method of placement is that the face of the waste pile remains at the angle of repose and advances outwards from the natural slope by the gradual accumulation of material on the face of the dump.

Materials deposited at the crest are distributed down the length of the face and are segregated by gravitational sorting, accumulating at the toe of the dump. As the face of the dump advances outwards from the slope, this coarse layer becomes covered. This situation creates an effective underdrain which prevents build up of high pore water pressures within the dump and the subsequent loss of dump stability.

With the continuing development of the open-pit mine the mining operations are carried out at progressively lower levels and new dumps are established at elevations corresponding to the level of mining. These levels at Harmer occur at 50 or 100-foot vertical intervals. Dumping at these new levels is continued along the contour below the dumps previously established. This method of spoiling is referred to as wrap-around.

The terrace width along the top of each wrap-around dump is at least 100 feet. This is to allow the spoil trucks to proceed safely in and out to the dumping site.

For wrap-around benches having vertical separation of 100 feet this construction has the effect of reducing the average overall slope at the top of the pile from 37° to 23°. For 50-foot vertical

separation between benches and minimum bench widths of 100 feet, the average slope angle is further reduced to 17°. This reduction in slope angle within the upper region increases the total stability of the spoil pile.

As the existing open-pits are mined to lower elevations this continuing wrap-around technique will further contribute to the dump stability. The spoil dumps are composed of siltstone, mudstone, sandstone, and conglomerate. Siltstones and mudstones comprise 60% of the waste material and are the fine fraction, while sandstones form the coarse fraction with blocks ranging in size up to 10 feet.

Dumping of waste material is deliberate and is handled as it occurs during the mining operations. In the past no attempt was made to segregate the unconsolidated and weathered surface rock during dump construction which lead to potential dump instability, basically because this material did not allow percolation of water and therefore became saturated. At present this unconsolidated material is spread as uniformly and as thinly as possible throughout the dump, thus preventing the development of localized areas of instability.

RECONTOURING

EARLY ATTEMPTS

With the inception of full-scale surface mining on Harmer Ridge in 1968, field-scale resloping activities have primarily been concentrated on smaller worked out surface mines up to 50 acres in size.

Resloping operations involved the use of D-8 or D-9 dozers fitted with U-blades which were used primarily to restructure relatively

short overburden dump slopes from their 37° angle to a maximum of 26°. Dump slopes were typically not longer than 200 feet so pushing of overburden down these slopes was practical on a small scale.

Other important design criteria included drainage control and aesthetics. Both of these were satisfied by attempting to reslope the dumps in such a way as to blend them into the natural surroundings. Also, by using a maximum angle of 26° successful vegetation using grasses, legumes, and shrubs was possible.

At this time in the development of reclamation techniques, other facts came to light as the result of experimentation. It appeared that direct seeding and planting on slopes exceeding 26° had markedly reduced survival. Also, attempts to use the same resloping procedures used on small dumps on long dump slopes proved impractical. Long reversing distances for dozers and the large volumes of material to be moved necessitated a change in resloping concepts.

PRESENTLY USED TECHNIQUES

Born from a need to reduce reversing distances and provide breaks in otherwise long monotonous slopes, the bench or terrace configuration arose.

Simple in both design and construction this concept involves a dump surface stability design incorporating benches with 50 feet of vertical separation with a connecting slope of 26°. Bench widths vary depending upon local conditions but are typically 20 feet resulting in an overall dump angle of 22°.

To accomplish large-scale benching programs, larger dozers including Fiat-Allis HD41B's and D-9G Cats were used.

Field-scale experiments have also shown that slope angles of 30° can be successfully vegetated, depending upon the materials, inherent dump stability, and other related local factors.

Another technique, the terrace configuration, is used where either the original ground or limited space does not allow for benching.

This concept involves construction of successive terraces without an initial slope between them. The resulting "stair-step" to 4 feet high and up to 8 feet wide, depending upon local conditions and the nature of materials.

The governing principle behind the use of this technique is the assumption that at least 30 - 40% of the terrace will slough onto the terrace below, thus forming very short, steep slopes between relatively narrow terraces.

Vegetation is then possible on both the terraces and the short slopes and because movement of materials is reduced on the short slope surfaces, vegetation can spread onto them as they stabilize.

In all cases, the overall angle of the terrace configuration cannot exceed the natural angle of repose of the materials in question. However, reducing the angle of a gravel pit from 37° using terraces to an overall angle of 30° has allowed for vegetation. A continuous slope of 30° on gravel, however, has continually frustrated vegetation attempts.

MINE PLANNING AND RECLAMATION

Only in recent years has the full potential of reclamation been appreciated with the incorporation of concrete requirements for reclamation in mine plans.

Having these requirements, based on experience both locally and around the world in recent years, has enabled mine planners to more effectively deal with reclamation needs while still maintaining an economically viable mine plan.

One major contribution to the art of dump stability is the concept of wrap-around dumping. Not only is overall stability improved, but in many cases greater efficiency of waste disposal is realized. From a recontouring point of view, the effort required to achieve a satisfactory slope angle is much reduced because material is never pushed more than from one bench level to the next. Depending upon wrap-around dump design, resloping effort can be reduced by as much as 80% over conventional benching on a free dump.

Other criteria to be considered in planning overburden dumps from stability and vegetation standpoints are a) dump location with respect to underground water sources, b) spoil materials with respect to slip plane effects, and c) drainage control.

Subsurface drainage control can be addressed for example by consolidating coarser drainage materials in the lower layers of the dump. Slip planes can be avoided by pre-stripping and avoiding localized dumping of unstable material. Surface drainage

can be controlled by judicious alignment of benches. For example, in a basin dump, benches are usually sloped towards the centre where rip rap reinforces the watercourse. If water is to be prevented from running across dump material, benches can be sloped away from the centre to both or one side such as is the case on an even slope or ridge. Insloping or outsloping benches or terraees is another drainage control technique used depending upon whether the priority is to shed water off the surface of the slope or drain it through the slope.

CONCLUSIONS

Site preparation must be the single most important factor for the successful reclamation of a spoil dump. Initially the main areas of concern have to be dump stability and erosion control. But allied to these factors must be an awareness of the spoil characteristics so that surficial stability may be achieved. For although a dump may be basically stable, surface creep may inhibit the establishment of vegetation and may not be successful even with the use of costly binders or mulches.

The final slope angles may also vary with the type of spoil, vertical distances between benches, and specific local conditions.

The state-of-the-art of waste dump design with regard to reclamation at Kaiser has greatly improved since the commencement of mining in 1967.

It is now possible to accurately determine and plan for the reclamation requirements that were previously not fully understood. In developing this approach, the economic benefits of planning

dump slopes for reclamation over the conventional "after thought" approach can be fully realized especially in the light of spiralling costs of manpower, equipment, and supplies.

Indeed the old adage that "Reclamation be an Integral Part of Mining" must still apply.

DISCUSSIONS RELATED TO A.W. MILLIGAN'S PAPER

Ken Crane - Luscar Sterco Ltd. Are you still fertilizing areas which you have revegetated and, if so, are the fertilizer applications decreasing in quantity?

ANS. There are some areas that were revegetated a few years ago, which we are leaving now. We haven't decided on a definite time when to stop maintenance. However, in some sites we believe it could be as long as ten years.

Neil Duncan - Energy Resources Conservation Board. We noticed that Kaiser has tree nurseries in the valley. What success have you had with planting some of the trees, and have you given any thought to planting them on the terraces?

ANS. Yes, this is something that we will be doing. We used to plant using the old forestry standard square planting method. Now, we have changed the whole approach to the business of planting trees and shrubs. Where we are developing a site for wildlife habitat we plant selected sites with groups of cover trees. The overall success up to this point is about 85-90% survival of all trees planted.

Now, instead of planting the 1+1's, we are transplanting them into the nursery and holding them for up to four years. We feel that by doing this they will have a better chance of survival. If we put them out into the field too early they do not grow because they need to develop better root systems. If we hold them in the nurseries and root prune them, we will be able to put a tree in the field that will grow readily.

Dave Headdon - University of Calgary. I noticed that you terraced slopes. To me it looks like your slumping problems are caused by too much internal moisture. If you increase the area and hence the amount of infiltration, you may continue to have internal slumping problems. Have you ever thought of burying pipes in the toe of slopes to channel the water thereby act as hydraulic dissipators?

ANS. I'm not sure that we are still having slumping problems since we recently changed to wrap around dumps. In the old days when the spoil was just dumped over the edge we had more than slumping problems. At present these dumps are fairly stable.

PRESENTATION OF THE 2ND ANNUAL

RECLAMATION AWARD

March 2, 1978

MINE RECLAMATION AWARDS

Terms of Reference

Under the auspices of the British Columbia Ministry of Mines and Petroleum Resources, and the Mining Association of British Columbia, a Reclamation Award has been established to recognize outstanding achievement in mine reclamation in British Columbia. In addition to this award, two citations are given to recognize merit in mining reclamation. The guidelines for these awards are as follows:

1. Nominations will be solicited from Ministry of Mines and Petroleum Resources' Inspectors. In addition, nominations may be made by companies with respect to their own work, or work done by individuals or organizations familiar with the goals of reclamation.

   Nominations should be submitted in writing to:

   Chairman, Awards Subcommittee
   c/o Technical and Research Committee
   Ministry of Mines and Petroleum Resources
   Mineral Resources Branch
   1835 Fort Street
   Victoria, B.C. V8R 1J6.

   In the nomination, documentation of the reclamation achievement must be outlined and reasons proposed why the project or program merits recognition.

2. The reclamation project may be major or minor in extent and may be the result of one person's activities.

3. The Technical and Research Committee will decide the winner of the Reclamation Award and the two Citations.

4. The Reclamation Award and Citations will be awarded each year at the annual Mine Reclamation Symposium.

5. The Reclamation Award cannot be won by a mining company two years in succession - Citations may.

6. Deadline for receipt of nominations for the awards is January 31 of the year the award will be given.

Report of the Awards Subcommittee
Technical and Research Committee
British Columbia Ministry of Mines and
Petroleum Resources
and
The Mining Association of British Columbia

The Awards Subcommittee received a total of 12 nominations for the Reclamation Award and for Citations. These nominations came from the mining industry, Ministry of Mines and Petroleum Resources' Inspectors, related industrial representatives, university personnel and the general public. The Awards Subcommittee evaluated the nominations and decided there would be two citations, one honorable mention and the award for 1978.

The Committee wishes to express their thanks to Continental Jade Ltd. for donating the jade for the Reclamation Award.

Reclamation Award for 1978

The 1978 Reclamation Award is presented to the Reclamation Research Department of Cominco Limited at Trail, British Columbia. The Reclamation Research Department, formed in 1970, has made an outstanding contribution to mine reclamation research in British Columbia. This group has conducted research towards the development of reclamation techniques for Cominco and its subsidiary companies. Cominco has been prominent in information exchange and has made its research information available to the British Columbia mining industry.

Their research program has been thorough and well documented and is a blend of field trials, laboratory experimentation and chemical analyses. Cominco's mines research has been conducted towards a detailed assessment of waste materials as a plant growth medium, identification of growth limiting factors, selection and testing of plant species, and an assessment of cultural techniques. Cominco Reclamation Specialists have identified and are monitoring accumulation of potentially toxic metals by vegetation and are studying methods of overcoming potential problems.

Cominco Ltd. should be recognized for their continuity of effort, overall approach and results obtained.

SECOND ANNUAL RECLAMATION AWARD

PRESENTED TO

THE RECLAMATION RESEARCH DEPARTMENT

OF COMINCO LTD.

Bob Gardiner (right) reclamation agronomist receiving the award from the Hon. James Chabot (left) Minister of Mines and Petroleum Resources on behalf of Cominco Ltd.

Two Citations for 1978

1. Elco Mining Limited

Elco Mining reclamation specialists have done an effective and satisfactory job of reclaiming and rehabilitating disturbed terrain.

Trenching was carried out by back-hoe thereby reducing the amount of land area disturbed in contrast to trenching by bulldozer. All disturbances including drill sites, camp sites, and roads were constructed and revegetated in compliance with the guidelines and field inspection instructions of the Reclamation Branch of the Ministry of Mines and Petroleum Resources.

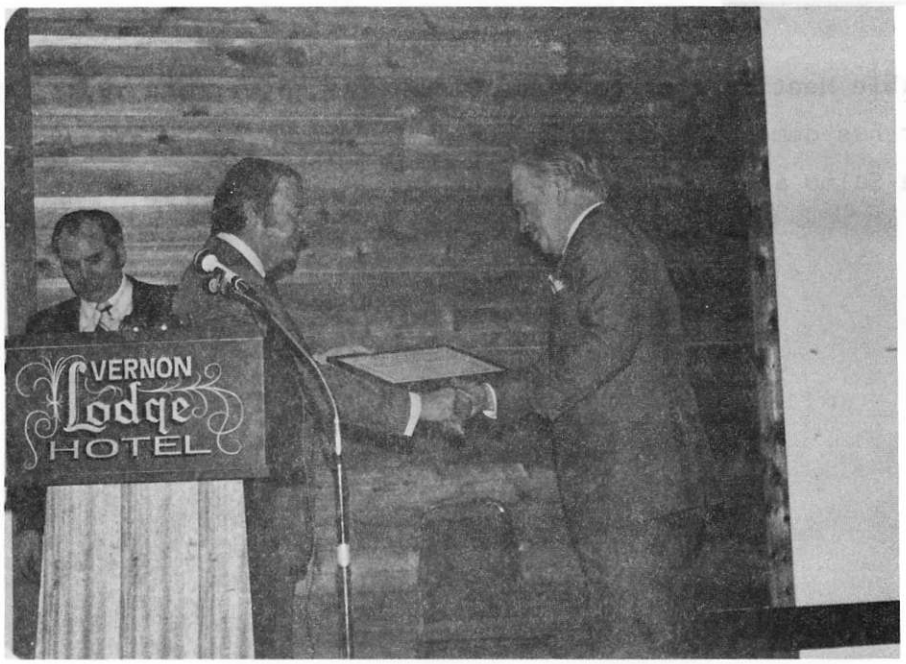
Procedures for soil stabilization and erosion control were excellent and revegetation of disturbed sites was carried out during the same season that disturbance took place. The company cooperated fully with the Ministry of Mines and Petroleum Resources and worked well with other ministries in restoring wildlife habitat.

2. Kaiser Resources Ltd.

Kaiser Resources Limited at Sparwood B.C., winner of last years' Reclamation Award, has continued to excell in reclamation procedures and practices and in the application of technology and research to coal mine reclamation. The leadership demonstrated by their reclamation specialists in adopting new reclamation techniques and the evaluation of vegetation species, including native species, deserves special mention. In addition, Kaiser Resources Ltd. have shared their successes and failures with everyone concerned with reclamation.

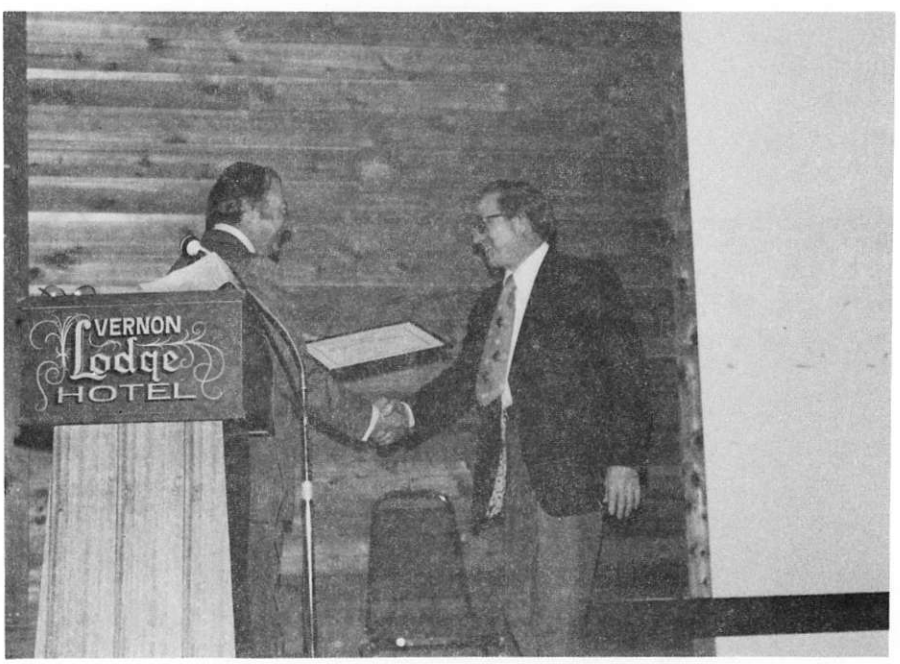
CITATIONS
PRESENTED TO

ELCO MINING LTD.



Dr. Martin Bik (right) Superintendent of Environmental and Town Site receiving the award from the Hon. James Chabot (center) Minister of Mines and Petroleum Resources on behalf of Elco Mining Ltd.

KAISER RESOURCES LTD.



Lou Cherene (right) Manager, Environmental Services, receiving the award from the Hon. James Chabot, Minister of Mines and Petroleum Resources on behalf of Kaiser Resources Ld.

Honorable Mention

Honorable Mention goes to Canex Placer Ltd. Over the years Canex Placer has demonstrated their genuine concern for reclamation in the Salmo area of British Columbia.

RESOURCE PROBLEMS AND SOLUTIONS

Chairman of the Morning Session
Friday, March 3, 1978

J. O'Riordan
Assistant Director
Special Projects
ELUC, Secretariat
Victoria, B.C.

HABITAT PROTECTION AND ENHANCEMENT FOR WILDLIFE

Paper Presented

by:

D.R. Hurn
Assistant Director
Habitat Protection
Fish and Wildlife Branch
Ministry of Recreation and Conservation
Provincial Government of British Columbia
Victoria, B.C.

HABITAT PROTECTION AND ENHANCEMENT FOR WILDLIFE

The utilization of renewable or nonrenewable natural resources by modern industrial methods invariably upsets the equilibrium of natural systems of which wildlife is a part. For this discussion, I will consider wildlife to mean terrestrial and aquatic animals and their environments. To set the stage for my comments a statement of the objectives and principles guiding the Fish and Wildlife Branch is in order.

Objective 1 - to attempt to ensure that the wildlife resources and their uses within management units are identified, measured and evaluated.

Objective 2 - to attempt to ensure that the methods of resource extraction are respectful of the resource base - the land and the water, its vital associations and its wildlife productivity.

Objective 3 - to attempt to modify the activities of resource extraction so as to reduce the invariably disruptive effects on the animal populations and the uses thereof.

Objective 4 - to attempt to monitor and regulate an array of other pressures on the resource base and/or animals themselves, arising from but secondary to the activities of the prime resource user.

Objective 5 - to attempt to develop restorative or enhancement prescriptions which may, following prime resource extraction, return the resource base to a new productive optimum in wildlife.

Objective 6 - to uphold the provisions of the Fisheries and Wildlife Acts and their regulations.

Your symposium, so far, has touched on the technologies of exploration, extraction, marketing, reclamation, and even politics. Most of

these aspects have developed considerably during the last decade, and there is little I can add to your existing knowledge. However, I wish to share with you some thoughts about a critical element of resource management related to mining; that of the legislative, regulatory and planning systems of government - a vehicle upon which the economic future of this province is based. Within these government systems the technology is weakest, and in spite of considerable gains in recent years, these systems may constitute the most serious impediment to the realization of wide base benefits to the people of this province. Obviously you must know and share your various mine related sub-technologies, likewise you must appreciate the fast-working institutional technology. Despite a few persistent Victorian notions, the affairs of government as co-managers in resource use are no longer to be tolerated as the exclusive and private preserve of the public servant operating from "little cloisters" of control. Put simply, it is not a matter of whether a mine goes into production but HOW!

Our government has given a clear statement to the public, to industry, and its resource managers, that the mineral industry in general, and coal and petroleum sectors in particular, are both necessary and desirable for the economic well-being of the people of this Province. This mandate, together with those supporting other resource economies, is increasingly conditioned by requirements that prime resource uses will be projected and executed with due regard for other resource values and socio-economic realities. To those of you in the private sector resource development represents an opportunity, while safeguarding socio-economic factors is likely seen as a cost. But how is the conditioned mandate viewed by the line resource agency which, by legislation, policy and procedure, is charged with administration of the mandate? What is the status of the management

planning technology which now requires a horizontal rather than a vertical rendition of responsibility and for which there are few models, fewer terms of reference and virtually no legislation? In short, the historical position of the line agency of government performing singularly at the interface with its industrial, commercial or private "public" is almost extinct or at best, endangered. What we now see is an apparent plethora of pre-planning, planning and even managerial systems which are characterized by:

1. Their interdisciplinary nature - representation of other resource agencies.
2. A notable lack of over-riding legislation to commonly guide the conduct of resource managers.
3. A standard process by which the relative values of competing or affected resource values may be objectively examined.
4. A peculiar mix of centralized and decentralized resource agencies.
5. No common forum or level of decision-making.

While that may appear a litany of ills which foretells of failure, quite the opposite is true. It is beginning to work and work well to the common good over the long haul. Why?

Firstly, our legislation and our management institutions were designed and brought into practice in the people-thin, resource-thick hours at the dawn of the century. But as the people demand grew and the resources dimished, those institutions were increasingly incapable of dealing with the concomitant conflict. Secondly, many of the resources now valued were then uncosted and unsung and commonly in such excess as to have been thought limitless. Others have achieved social and economic value by changes in social attitudes.

This society requires more from less, and the managers know that they must, with public involvement, develop better ways.

Each line agency, still armed with single purpose legislation and internal delivery systems, must now perform as a planning head to an interagency body of advisors. Then, having got the input to a plan, they must make the first line judgements on the relative resource values and make allocations in the context of public interests. Finally, they must provide, monitor, and enforce operational guidelines in that public interest. Few, if any of us, were trained in such complex large-group planning systems, and in the relative lack of multi-disciplinary planning expertise, the only real hope is the freedom to explore, innovate and value.

You heard about THE RECLAMATION ADVISORY COMMITTEE from Mr. Jake McDonald better than I could describe it. But in the context of my thoughts, I'll venture some observations about any of the referral or co-planning arrangements which have recently evolved on the resource scene.

Technological shortfall - Many of the resource agencies whose resources are accommodated in a given utilization plan, are themselves unknowledgable about managerial options of the prime industry and are therefore not able to project, for the prime manager, the possible conditions by which to mitigate or compensate for "his" resource. If they can't, who will? Frequently, this lack of understanding of the other guy's ways leads him to the graveyard route - be so restrictive that reasonable and economic means of accommodation are denied. This is a rejection of the mandate. We must free the various managers to innovate and apply management solutions without penalty.

Economic shortfall - In a conflict between the use of land area for (say) forest production and water storage, with the other values of agriculture and wildlife and recreation, the challenge of developing a co-management position is often impeded by the more visible economic pervasions of the proponent, stalwartly countered by not so equal economic rhetoric of the defender. In want of solid economic validation of cost and benefit, cause and effect, we have seen and still suffer from past allocation decisions.

To come to the co-planning table, to assist the prime manager to generate a plan for the multiple use of resources, one must bring equivalent inventories of resource, with up-to-date evaluations of use and potential. In this regard, the hard resources of forests, water and minerals lend themselves more readily to measurement than do the extensive or soft resources such as wildlife, recreation and aesthetics. Yet the line manager is taxed with accommodating these hard and soft values in a management plan and administrative matrix to ensure that the mandate is served, consistent with the retention of other resource options and economic viability. He must manage "chalk and cheese". We must make the top priority the design and execution of resource inventories which will bring forth comparable resource data to the planning and decision tables.

A great number of examples have already been developed in the preplanning, multi-disciplined resource game in which the line manager was unable, unwilling or unauthorized to make the ultimate allocative decisions. Most commonly, the breakdown occurred at levels superior to himself. What is now starting to evolve is a system of upward referral of macro-judgements which will be

economically reasonable, technically feasible, socially acceptable and politically saleable. The key is not so much the forum and participants in the final allocation decision so much as the need to place the exploration of planning options and management solutions at the working level - on the ground, in public visibility and in the stimulating climate where the action is.

Finally, planning races are often just that; with some contestants hobbled by staff inadequacies, others by inappropriate professional equipment. The handicaps are weird, and there appears to be numerous starting lines with only one fuzzily perceived finish.

These are some of the difficulties faced by the prime resource planner in streaming the needs of other resources into a management prescription for resource extraction. Yet the systems are proving productive as this symposium attests.

What then is the challenge in the immediate future? What parts must the various components play in sharpening the act? The industrial sector will be compelled by the vigors of the market to always seek less costly ways of realizing a return to the investor. But the investor and his industry must also insist that the activities of the government planning system are equally cost effective in terms of the mandate from government. The manager in government must be given freedom from the narrow strictures of his own legislation in order to be able to fully participate in the co-planning process. He must be counselled by a wider variety of in-house expertise which reflects the dispersed resource and social values being accommodated. And he must have, together with his industrial partner, a clear understanding of a stable decision-making process.

I shall not apologize for failing to deliver a technical paper for I have dealt in part with one of the most salient technologies which we are now employing in resource management. The wide portfolio of investments which the people of this province have in natural resources and their beneficial uses is the best assurance for our future as a society; and the effort which goes into portfolio management will, as with the individual person or corporation, dictate the investment return. All partners must be effective in the common husbandry of resources.

In conclusion, it is not whether there shall be reclamation, but how and to what ends shall it deliver.

DISCUSSIONS RELATED TO D.R. HURN'S PAPER

Time did not permit discussion about this paper.

MINING AND ARCHAEOLOGICAL RESOURCES: CONFLICTS AND MITIGATION PROCEDURES

Paper Presented
by:

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MINING AND ARCHAEOLOGICAL RESOURCES: CONFLICTS AND MITIGATION PROCEDURES

INTRODUCTION

When first contacted about presenting a short paper at the Second Annual Conference on Mine Reclamation, I felt very apprehensive. The key word in the conference title which caused this apprehension was "reclamation". How could I relate heritage resources, or more specifically, archaeological resources, to the concept of reclamation when such resources are in fact non-renewable? An archaeological site, once damaged or destroyed by any land altering activity, such as mining, cannot be replaced or reclaimed.

However, I overcame this problem once the conference organizers pointed out that I did not necessarily have to deal exclusively with reclamation matters but rather, I was asked to specifically "...outline my ideas on problems associated with conflicts between mining and archaeological sites and possible solutions to these conflicts."

HERITAGE RESOURCES

What then can be called a historical or heritage resource? The recently enacted British Columbia Heritage Conservation Act, which is administered by the Heritage Conservation Branch of the Ministry of Recreation and Conservation, defines "heritage" as anything of "... historic, architectural, archaeological, palaeontological or scenic significance ..". "Heritage Site" is further defined as "land of heritage significance." All of these definitions are very broad. For example, an entire coal deposit could be considered a heritage site as it has palaeontological significance. However, such interpretations were clearly not intended and the Act goes on to provide much more specific descriptions concerning the types of

sites which are to be protected or managed through various means.

Archaeological sites, whether located on Crown or Private lands, are fully protected by the Act. Historic sites, on the other hand, may only be protected through a process of "designation", either by Order in Council should the site be one of Provincial significance, or by a Municipal Council if the site is considered only of local significance.

To my knowledge, there has never been an action taken under the powers of the Heritage Conservation Act or its fore-runner the Archaeological and Historic Sites Protection Act, to ensure that mining activity did not damage archaeological sites. However, there has been considerable input by the Provincial Archaeologist's Office into such coal development related proposals as the Northeast coal project, Hat Creek thermal generating facilities, Carbon Creek coal development proposal, Hosmer-Wheeler proposals and so on. All of this involvement has arisen from our participation in general Environmental Impact Assessments that have been carried out, or which are still taking place, with respect to these projects. There was, however, no involvement of my office in the preliminary assessment of large coal extraction projects such as the Kaiser Resources operation in the East Kootenays.

The lack of heritage resource assessments in these projects has meant that there is no possibility of mitigating the loss of such resources, which were undoubtedly present in large numbers prior to mining activity. Since the opportunity to identify and assess these potential resources was either not taken or not made possible, we are not in a position to reclaim this loss by any means.

At this point, it might be fair to ask why heritage resources, and in particular archaeological resources, should be protected, or at least should be considered as a serious and relevant part of any mining development and reclamation process.

All of us, as well as our environment, are the products of the past. By gaining knowledge of this past we can better understand the cultural and non-cultural forces which operate in the present and to gain a perspective of the development of our own civilization. Because this knowledge belongs to all of us, no individual or organization should deprive us of essential segments of this knowledge. Yet, that is what happens when an archaeological site or a historic site is destroyed without an adequate record having been made of the information contained within that site.

The value of an archaeological site is then in the information and material culture remains that are contained within it. This information can only be retrieved by properly conducted archaeological investigations.

MEASURES TO BE TAKEN TO IDENTIFY CONFLICTS

What measures can be taken to ensure that valuable heritage resources are either protected for future study or are subjected to adequate investigations designed to retrieve information and materials of value? The following is a list of actions and procedures that should be applied to all proposed mining developments:

1) A thorough systematic inventory of all areas within the proposed development area should be undertaken in order to identify and classify a representative sample of heritage sites.

2) These resources should then be evaluated in terms of their significance to our understanding of the area's history or prehistory.

3) The project impacts, (both direct and indirect) upon these resources should be identified.

4) Basic terms of reference and criteria should be developed to ensure that a meaningful program of mitigation can be carried out before, during, and after the active development phase. Such mitigative measures might include the following options:
   a) site avoidance by redesigning part of the planned development,
   b) partial or complete capping or sealing of heritage sites until development of mine resources is completed,
   c) retrieval and conservation of information and materials contained within sites to be impacted.

COMMENTS AND SOLUTIONS

The options listed above provide the basis for the solutions to the problem of conflict between proposed mine development and heritage resources. There must, of course, be adequate funds allocated so that such options can be exercised; there must be adequate lead time provided; an adequate legislative base to ensure that the various options can be exercised; and a willingness on both the developer's and the resource manager's side to cooperate toward achieving these goals.

In terms of reclamation, there are in fact some means by which the mine developer can provide for a legacy of heritage resources that might be physically destroyed by mining operations. These

are, however, entirely contingent upon the procedures and options outlined above and may include one or more of the following:

1) A small museum facility, interpretive or a historic reconstruction centre can be provided in the area of the development to present displays relating to heritage resources and objects identified during the various assessment and mitigation stages.

2) Information boards and historic site markers can be erected to identify and interpret heritage values within the development area.

3) Published information in the form of pamphlets and books can be produced whose contents and impact would be much the same as an interpretive centre.

4) Archaeological and historic investigations in the development area during the assessment and mitigation stages quite often have a positive effect upon local residents. Such projects have often provided the impetus for the formation of historical societies in local areas.

5) The long-term potential for increased tourism to areas that have developed heritage resources in ways as described above, is excellent.

Lastly, it should not be forgotten that all or any of the above actions or consequences of a well-planned program of heritage conservation can be of great value to a developer in terms of public relations and the image of the developer in the eyes of government and public.

DISCUSSIONS RELATED TO B.O. SIMONSEN'S PAPER

Time did not permit discussion about this paper.

RECLAMATION IS MORE THAN KEEPING B.C. GREEN

Paper Presented
by:

B.P. Churchill
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Fish and Wildlife Branch
Ministry of Recreation and Conservation
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RECLAMATION IS MORE THAN KEEPING B.C. GREEN

INTRODUCTION

When asked to speak at this meeting, I referred to last year's proceedings to gain an understanding of the purpose and scope of the symposium. I then decided to change my presentation slightly to a topic that seemed more appropriate.

It seemed, both from reading last year's proceedings and from the individuals I have met from industry and government, that the concept of reclamation - returning land disturbed by exploration or mining to a productive state - has like motherhood, been almost universally accepted. However, an encompassing definition of productive state is most illusive. For the wildlife resource, making mine sites green is just the beginning, as reclamation includes the re-establishment of wildlife populations to their former abundance and productivity.

I will briefly outline the types of problems that mineral exploration and mine development create in the protection and management of the fish and wildlife resources, followed by an outline of the approaches being taken to mitigate and compensate for the problems in fish and wildlife management caused by the mining industry. Some examples from the Northeast Coal Block will serve to illustrate my point.

THE PROBLEMS

Mineral exploration and mine development can have direct and indirect impacts and create problems for fish and wildlife.

Mineral exploration generally results in two types of problems:
1) Road construction and surface disturbances often directly affect

water quality so essential for fish, and also cause loss of habitat for wildlife.

2) Often, of greater importance, is the provision of access into previously inaccessible remote areas of the province. This indirect impact on fish and wildlife can create two problems; (a) an influx of personnel who become familiar with the area often causes an overharvest of fish and game animals before appropriate management steps can be taken. (b) wildlife is unaccustomed to the activity of men and machines. Such disturbance and harassment, from the animal's point of view, result in lowered net productivity of the wildlife populations.

Mine development also creates four types of problems:

1) Surface disturbance and the use of lands for infrastructure are direct losses of habitat for wildlife. The loss of habitat is significant and the loss to infrastructure developments is usually greater than the loss to the mine itself.

2) The development of highways and railroads to service mine development, not only results in a loss of habitat to wildlife and stream disturbance for fish, but also causes significant mortality of wildlife through collisions.

3) Losses of fish and wildlife can occur indirectly through accidents such as oil spills, settling pond breakage, and overburden slippage. These accidents often occur even though the best precautions have been taken, and <u>invariably</u> occur when little care has been exercised.

4) Mine development, infrastructure, and ancillary developments dramatically increase the human populations of the region. The effect of this increased population is two-fold: (a) there is a decrease in fish and wildlife populations due to habitat

loss, disturbance, etc., and (b) the increased population creates a much greater demand for hunting, fishing, photography and other wildlife related recreation.

THE APPROACH

The mandate of the Fish and Wildlife Branch is to protect and manage the fish and wildlife resources for the people of British Columbia, including mine industry personnel. If mining company investments in recreational developments are any indication, then providing sufficient wildlife related recreation is important in stabilizing any work force.

When mineral exploration or mine development create the problems for the fish and wildlife resources such as those I have mentioned, the Fish and Wildlife Branch must first take steps to protect the resource and then effectively manage what remains. My work in the North East Coal Block is an attempt to plan fish and wildlife protection and management concomitantly with the planning of developments. I think that it has been quite clearly shown with mine vegetation reclamation, that it is more efficient and effective to plan "reclamation" with the development rather than try to "recontour" later. Our approach in the North East Coal Block has been to open direct lines of communication with the development companies involved and then draft a fish and wildlife management plan. Frank and open discussions allow for this co-operative approach.

At this stage I would like to be able to present a nice tidy fish and wildlife management plan for the North East Coal Block; however, coal development in the area is only at an advanced exploration stage, so the management plans are still in the formative stage. I will there-

fore just give some examples of the co-operative approach we are taking, explain how the process works, and illustrate the type of things we can and are doing.

I should state that these types of fish and wildlife management strategies are based on the assumption that reclamation and environmental controls, as stated in the coal guidelines, are already being effectively administered by the Ministry of Mines and Petroleum Resources.

During exploration, loss of habitat to wildlife by surface disturbance is often not that significant, but it can be reduced. The presentation by Mr. Geoff Jordan of Denison Mines at this symposium last year, is one example of trying to reduce surface disturbance and, incidentally, reclamation costs. Pacific Petroleum's initial program in the North East Coal Block is another way of reducing surface disturbance and the problems of access. Pacific Petroleum, in the first year of their exploration program, relied heavily on helicopter transported drilling over a very extensive area. The next year they used more conventional techniques over a smaller area.

The severest impacts on wildlife caused by exploration have resulted from the sudden development of access into wilderness areas. The problem is that too many animals are being killed, both legally and illegally, with an accompanying decline in productivity resulting from levels of human activity to which the animals are not behaviorally adapted. The approach to solving this problem has been undertaken at several levels.

a) Restrict the legal kill by closing the hunting seasons. Although this option was exercised in the North East Coal Block, it came too late to save the Mountain Goat population on Bullmoose Mountain;

but it was more successful in other cases. This option however denies hunting recreation to the people, often mine industry personnel, in the area. Again, for emphasis, I would stress the role of wildlife oriented recreation in the mining community.

(b) Tougher enforcement to regulate legal and illegal kills is another option, but it is expensive and only partially effective. When we have sufficient notice of work in an area we do try to strengthen enforcement, but it is often too late.

(c) Tighter management such as limited entry hunting is an option that needs a great deal of base line information and adequate time to implement. Often, by the time there is sufficient information to implement refined management measures, the fish and wildlife populations have decreased to levels that make it an exercise in futility. However, this tighter management coupled with options (a) and (b) is the approach being taken in the Saxon area.

(d) The only preventative measure that can be taken to prevent these types of problems is dependent upon good co-operation by the mining and exploration companies. A longer planning period to anticipate the above problems and to take remedial steps is needed; this can only occur if we are told far enough in advance as to where the areas of mining activity will occur.

In summary, the approach being taken during exploration is to reduce the loss of habitat, i.e. surface disturbance and effects on water quality, and to instigate management steps to offset the impacts of newly created access.

In the long run, mine development brings more severe problems for the Fish and Wildlife resources. Our approach in the North East Coal Block has been to establish the timing and extent of the development and

then attempt to implement a long-term management strategy to protect and manage fish and wildlife. I'll just give a few examples of the kinds of actions that are to be included in these management plans.

Management must be most intensive where the greatest demands and the greatest impacts exist. In the case of the proposed townsite at Tumbler Ridge we would like to see the securing of the land base of a nearby winter range; manipulation of the vegetation by logging and burning to produce greater numbers of animals; and reduction of disturbance to these animals by controlling the road development, loss of habitat to subdivisions, etc., and the use of snowmobiles and A.T.V.'s. We feel this would compensate for the loss of winter habitat by the townsite location and the increased demand for wildlife orientated recreation.

The problems of collision mortality of moose are being approached jointly with the developer involved. A case in point is British Petroleum's Phase I development of their Sukunka Property. In this case, we are considering the establishment of artifical salt licks, offsite prescribed burning and other measures to mitigate or reduce the moose collision problem.

Finally, as the time is short, I'll mention the approach taken to compensate for the loss of the entire Mountain Goat population on Bullmoose Mountain. We are having discussions with British Petroleum about the reintroduction of Mountain Goats on the mountain and the planning of disturbance-free areas to enable them to exist.

In summary, the approach being taken in the North East Coal Block is to implement management plans, drawn in co-operation with the companies involved in the development, to mitigate and compensate

for the impacts of exploration and development on the fish and wildlife resources.

DISCUSSIONS RELATED TO B. CHURCHILL'S PAPER

Time did not permit discussion about this paper.

FEDERAL FISHERIES ACT AMENDMENTS AND THE MINING INDUSTRY

Paper Presented
by:

B.A. Heskin
Manager, Pollution Abatement Branch
Environmental Protection Service
Pacific Region

and

F.C. Boyd
Chief, Habitat Protection Unit
Fisheries Management Service
Department of Fisheries and the Environment
Vancouver, B.C.

FEDERAL FISHERIES ACT AMENDMENTS AND THE MINING INDUSTRY

This section presented by B.A. Heskin

Mr. Boyd and I appreciate the opportunity to speak to you on the Fisheries Act and more specifically, the recent amendments to the act, which became law through proclamation of Bill C-38, September 1, 1977. Through opportunities such as these, we feel that a better understanding of the amendments will be possible and we hope to be able to allay the concerns and what to us are misconceptions with the understanding of the intent of the Fisheries Act.

My comments will relate to the pollution provisions of the act, and Mr. Boyd will be covering the fish habitat section.

In general, it would appear that some segments of the mining industry saw the amendments not as merely amendments to existing legislation to make its administration more effective, but as the creation of a whole new federal power. Let me assure you this is not the case. I have with me a copy of the Fisheries Act as it existed 25 years ago and also a copy of the section of the act dealing with pollution taken from the 1868 version and these illustrate the point.

The Fisheries Act has been amended on numerous occasions to keep current with the times. In 1970 it was amended to give authority to deal with a variety of problems before they actually became problems and to give authority for setting out requirements in the form of regulations. Such regulations have been developed for a number of industrial sectors, including the metal mining industry. It was under this version of the Fisheries Act that the present mining regulations were issued. They are <u>not</u> as many seem to believe, an example of extended powers created by the 1977 amendments.

If you were to examine the general and unaltered provision of section 33 (2), you will note the broad sweeping prohibition of how, unless a regulation clarifies and authorizes deposits:

(I) Every activity of man is in potential violation, and

(II) No one knows exactly what must be achieved to operate within the law.

The current amendments as they relate to section 33, and which are likely to be of primary interest to your industry, are:

Section 33 (13) This will give authority to make regulations to allow the Minister, or other designated persons, to authorize existing plants to deposit deleterious substance while it is proceeding in taking actions to satisfy requirements set out in regulations, i.e. to give legal recognition to a compliance schedule. This section also gives the authority to handle those site-specific situations where total compliance may not be attainable for a variety of reasons.

Section 33.2 gives authority for requiring the mandatory reports of spills of deleterious substance. The reporting requirements are being designed to operate in conjunction with other existing reporting requirements.

This section will also obligate persons who cause spills or who have ownership status, to clean-up. If such clean-up is not initiated, an Inspector now has the power to direct clean-up when immediate action is necessary.

The penalty provisions of the act have been strengthened and these are summarized in a table in the little booklet Mr. Boyd will be distributing.

I would like to deal with some specific points and concerns which I believe have been of interest to the mining industry:

(A) Constitutional jurisdiction - Your industry, I believe, has considered Bill C-38 to represent an expansion of Federal powers beyond what was contemplated in the British North America Act.

In this objection your industry is really dealing with the Fisheries Act, not with the amendments. Even the 1868 version of the Fisheries Act prohibited deposits of deleterious substances. The points I made previously are very relevant to this objection. First, such an absolute prohibition requires clarification by way of regulations to enable your industry to know when it is, or is not, violating the Fisheries Act. Secondly, the recently issued regulations were not made possible by the amendments, but pursuant to an authority which has been in existence for years. Proof of this really is in the date of issuance February 1977 - six months before the amendments became law.

(B) Your industry is concerned, I believe, that the amendments created overlapping controls with provincial laws regarding pollution control.

Again, their concern and comments were in reality addressed to the existing Fisheries Act and its regulations, rather than to the proposed amendments. However, the concerns are valid. There were, and are overlapping controls, varying requirements and two separate agencies to deal with. However, the amendments were designed to reduce rather than increase this problem.

In some provinces, the provincial agency is the sole contact with industry regarding both Provincial and Federal requirements pursuant to the Fisheries Act. My service and the federal government have been striving to see such a system in place here

in B.C. Towards this end we are currently developing a federal/ provincial accord on environmental protection, which appears to be in the offing. I would like to say that as a result of recent discussions on this subject, I am very encouraged that arrangements will soon be in place whereby the provincial government will undertake to play the lead role and to implement and enforce federal requirements or their equivalent for the protection of fish. In the meantime, however, we cannot avoid our responsibilities and will continue with the implementation of federal requirements.

(C) Your association is concerned with the ministerial descretion provided in the amendments, and of the uncertainty in how the legislation will be used. Virtually all such ministerial discretion that is included in the amendments and all that was inherent from the Fisheries Act prior to amendment, is discretion allowing the Minister to permit or authorize activities or deposits that would otherwise be offenses under the previously mentioned absolute prohibitions inherent in the legislation. Such discretion allows the Minister to deal with real events in a real world rather than dogmatically "protecting fish" to the exclusion of all other uses of water. Such discretions provide a flexibility that allows the Minister to consider economics, jobs and regional priorities in applying the Fisheries Act. Such discretion provides for the very considerations that your industry must have available to it if it is to operate in conjunction with fish rather than in competition with fish.

(D) Your industry is naturally concerned that the amendments could deter new mining and threaten the continuation of existing mines. Again, I must repeat that the amendments are not new powers,

in general, the mining industry in British Columbia has operated well within the requirements of the Fisheries Act. I see no reason for any change. Many mines are on total recycle as a result of negotiations with fisheries dating back to the early sixties. Most provincial requirements reflect previous identified fisheries' requirements.

With, or without, the amendments to the Fisheries Act, new mines would be subject to requirements that reflect "state of the art" pollution abatement. This is reasonable technology where existing mines are not in a position to comply. Compliance then will be subject to sensibly scheduled improvements that reflect site specific requirements or new environmental concerns. It is recognized that some existing operations might not be able to comply. Both these situations can now be handled through the recent amendments.

As I mentioned before, I believe that the mining industry in British Columbia gets along very well with the renewable resource protection agencies. I see no reason why this should change. Certainly there will be some difficult problems associated with specific requirements to protect a valuable fishery resource that might otherwise be endangered. The track record in British Columbia over the last twenty years indicates that solutions have been possible.

An example of this is the Granisle Operation in Babine Lake which is a very important fish nursery area.

It is my sincere opinion that there will not be an arbitrary approach by the Federal Government as a result of the amendments.

Thank you for your attention.

This section presented by F.C. Boyd

I would like to express my personal appreciation to your Symposium Convenor for including Federal Fisheries on your busy agenda.

I recall that the last occasion I had to speak to the Mining Fraternity involved a slide presentation depicting salmon biology and the potential evils of placer mining and gravel quarrying. The incorporation of land and watercourse protection sections in the Mines and Coal Mines, Regulation Acts and guideline development, leads me to hope that another pictorial injection of potential resource use conflicts may be unnecessary.

Surely the potential for inter-resource problems is quite clear when one considers that there are about 2,000 salmon streams in B.C., and that hundreds of mining exploration permits, involving a wide range of activities, are issued each year. I would also like to make clear that the "Fisheries Act" has long recognized this potential by specifically identifying land clearing operations in Section 33.

Less clear, and sometimes confusing, are the jurisdictional overlaps at and between every level of government. This, I expect, is a product of our complex society, combined, I submit, with a very human (and necessary) inclination to attempt to control and conduct our own business, first and foremost.

I understand that you are interested in our most recent move to better conduct our business--the protection of fish and their environment. I refer, of course, to the Amendments to the "Fisheries

Act" which became law last September - Bill 38.

The Amendments covered a wide range of items, from Marine Plant Licensing to Seal Harvesting. No doubt of primary interest and applicability to those engaged in mining exploration and development are the Amendments concerning the fish habitat protection.

Before I review these sections, I would like to say a few words about what we in Fisheries saw as the need to have them included in the Act. Prior to the recent Amendments the Act was strong, but it had a few key shortcomings:

1) The definition of fish did not include all stages of their life cycles.
2) Those sections which addressed the protection of spawning areas and other waters used by fish were restricted in scope and punitive in nature. There was, therefore, no authority to prevent actions which were clearly destined to destroy fish or their life supporting habitats.

In recognition of this authority shortfall, over the years we welcomed, developed and encouraged co-operative referral procedures, with those agencies and industries which dominated land use and water use activities: Highways, Railways, Logging, Dredging, Flood Control, Mining, Hydro, Irrigation and others. Although these referral procedures were (and are) far from perfect, they have improved our capacity to prevent damage to the Resource simply by providing an opportunity to examine plans and proposals, and recommend mitigative procedures.

We could, however, see that this limited capacity to protect the resource would be less than adequate to sustain existing stocks and realize productive potentials <u>in the long run</u>. We became convinced that burgeoning urban and industrial development would continue to

impose and accelerate incremental and irreversible loss of many of the most unique and productive aquatic habitats. Among the most vulnerable of these are the intertidal mudflats and marshes and key freshwater spawning and rearing areas. This conviction dominated our move to more effectively conduct our business.

So, in the Amended Act:

- we re-defined fish to include all life cycle stages,
- we defined fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes",
- we provided a prohibition which could be applied to halt unacceptable activities,

and finally,

- we provided a mechanism (Authority) whereby the plans pertaining to an activity which could affect fish habitats can be reviewed, mitigative measures imposed and, if necessary, the project or development halted by Order-in-Council.

HOW THEN may these Amendments apply to the Mining Industry, particularly exploration, development and restoration activities?

FIRST, I feel that it should be more widely understood that the Minister of Fisheries assured Provincial Representatives from Government and Industry at the Canadian Council of Recreation and Resource Ministers' meeting in June, 1977, also the Commons Committee and the House of Commons, that existing referral systems would not be affected in any significant way, and that no permit system was being considered. Accordingly, I assume that co-operative arrangements and direct or indirect referral procedures now functioning would proceed essentially unchanged.

In preparation for this symposium, I spoke to our field officers about their interface with the mining industry. They indicated that

much of our information on mining activities is provided indirectly through existing arrangements with the Forest Service, Pollution Control Branch, Lands Branch and Water Resources Branch. Our officers state that the major areas of concern are road building, stream crossing, stream relocation, water intakes and draining or filling of lakes and marshes. The consensus seems to be that with some (inevitable) exceptions the present situation appears acceptable. Certainly, the development of the stream color code system for placer mining seems to be working to the general advantage of all concerned. Some of our officers, however, have a sense of uneasiness, because they are not directly involved in assessing each application, and do not have the leisure to check the effectiveness of the Schedule B restrictions.

There may, of course, be occasions when the plans for major development or access operations will be solicited by the Department.

In conclusion, I might add that the Honourable Romeo LeBlanc has publicly declared his intention to fully support the preservation of fish habitat as defined in the Amendments. The Minister has also clearly indicated his recognition of the real property and inter-jurisdicational implications of the habitat Amendments. It is his expressed wish that the widest possible proclamation of the Amendments be made, and his staff be available for discussion with government, industry and public. At this specific request, the Department has prepared an information brochure, copies of which are here today. There are also a number of copies of the Amendments available to those who wish to attempt the translation of legalese into basic English or French.

DISCUSSIONS RELATED TO B.A. HESKIN AND F.C. BOYD'S PAPER

Time did not permit discussion about this paper.

WORKSHOP SUMMARIES
RESOURCE PROBLEMS AND SOLUTIONS

Friday, March 3, 1978

This section of the proceedings summarized the findings of the Symposium's second set of Workshop sessions.

QUESTION 1. WHAT CRITERIA SHOULD BE USED TO DETERMINE IF MINING IS COMPATIBLE WITH OTHER RESOURCE VALUES IN THE SHORT TERM AND LONG TERM?

FINDINGS RELATED TO QUESTION 1.

Value and need of other resources should be considered.

Sensitivity of existing areas especially in the long term should be considered.

Planning must be complete and should integrate the mitigations for impacts identified.

The degree to which the land and renewable resource complex is reduced or impaired in the short and long term should be considered.

Compatibility should be assessed through the costs/benefits perceived by the local and regional public.

Compatibility can be assessed by first identifying the resource values. Government should be responsible for setting guidelines and broad criteria while industry should be responsible for a detailed resource inventory.

Compatibility must be viewed at all stages - long term and short term - from exploration to completion of reclamation. Different guidelines should be established for the different stages.

Criteria for compatibility should be divided into immediate and long - term impacts. Long-term criteria would consider whether other resources will recover once mining operations stop.

Criteria that should be considered include watershed values, archaeological values, ranching, industry values, fish and wildlife values, forest values, recreational values, aesthetic values, air quality and access concerns.

In the short term, criteria should be site-specific and recognize the dynamics of social and economic issues.

QUESTION 2. DO PRESENT MITIGATION PROCEDURES REALISTICALLY COVER THE AREAS OF CONCERN IN A MINE DEVELOPMENT (E.G. WILDLIFE, FISHERIES, STABILITY, PERMANENCE OF RECLAMATION)?

FINDINGS RELATED TO QUESTION 2.

Mitigation should take the form of wildlife enhancement. It should also maximize regional opportunities for recreation.

Mitigation involves designing and planning to minimize impact. It should not involve compensation.

Few examples are available from which we can assess the effectiveness of mitigation procedures.

The main problem in mitigation is putting a dollar value on displaced or destroyed wildlife.

Adequate mitigation seldom takes place during mining and sometimes cannot feasibly be made after mining.

There should be no financial compensation for wildlife.

In the short term, areas should be closed to access if conflicts are encountered between wildlife and development.

The Fish and Wildlife Branch of the Provincial Government should be given a better chance to evaluate wildlife parameters before development.

QUESTION 3. IN TERMS OF WILDLIFE CONCERNS, IS COMPENSATION AN ADEQUATE MEANS OF MITIGATION?

FINDINGS RELATED TO QUESTION 3.

Compensation is a less desirable alternative than mitigation.

Compensation is an adequate means of mitigation if you are sure it is necessary. If recovery will take place naturally or research indicates that reclamation can be achieved successfully, then compensation is not necessary.

QUESTION 4. HOW SHOULD PUBLIC ACCESS TO AREAS OPENED UP BY MINING BE MANAGED? IS CLOSURE TO THE PUBLIC A VIABLE ANSWER, ESPECIALLY IN TERMS OF WILDLIFE CONCERNS?

FINDINGS RELATED TO QUESTION 4.

Public access regulations should be site-specific depending on the threat to wildlife.

Public access should be managed as follows: Firstly, the area should be evaluated by the B.C. Fish & Wildlife Branch, company or consultants for wildlife resources. Secondly, sensitive wildlife areas should be avoided by access roads. Thirdly, if a wildlife population is to be protected then the area should be posted for a hunting closure or key access roads to the area should be manned.

Active areas could be restricted to hunting for safety reasons.

Closure to the public is not the answer to the problem.

Closure to the public is a viable answer, but legality is a problem.

QUESTION 5. HOW DO THE FEDERAL FISHERIES ACT AMENDMENTS AFFECT INDUSTRY AND THE PROVINCIAL GOVERNMENT REGULATORY AGENCIES?

FINDINGS RELATED TO QUESTION 5.

Everything is forbidden until approved by regulation.

The amendments are a retrogressive step because they are regulatory rather than dialogue.

Acts are reasonable but must be implemented with intelligence and a degree of flexibility.

QUESTION 6. ARE TWO STANDARDS NECESSARY OR DO PROVINCIAL REQUIREMENTS MEET ACCEPTABLE LEVELS?

FINDINGS RELATED TO QUESTION 6.

Standards if not mutually supportive and non-conflictory are regrettable. Provincial jurisdiction should be favoured as much as possible.

If there is conflict then two standards are not necessary. There is a need for co-ordination and communication between federal and provincial bodies.

One standard is preferable. The federal government should provide input to provincial regulations but should not direct operators.

RECOMMENDATIONS ON THE FORMAT AND CONTENT FOR FUTURE SYMPOSIA

FUTURE TOPICS

Consider tours of projects to see actual field work that is being done.

Review government policy, regulations and guidelines and look at how these are applied and integrated within government and development agencies.

Look at impacts and restoration practises in petroleum exploration and development.

Ask Afton Mines to present their reclamation proposals.

Present and discuss problems encountered by other agencies. (e.g. forestry, hydro, pipelines, gravel pits, highways).

Discuss topics such as presentation of resource data and tailings reclamation.

Bring forward senior government personnel to discuss their role in mine development, emphasizing how their co-ordinating and integrating structures are influencing the mining industry.

Follow up previous year's presentations by mines through progress reports on reclamation activities, especially Hat Creek, Kaiser, Fording and Line Creek.

Give case reports on reclamation projects including the degree of success and the economics.

OTHER COMMENTS

The theme of the symposium should be expanded to include more topics. Perhaps each annual symposium could have its own title or topic (e.g. coal reclamation, hard rock development, research).

The emphasis at the symposium should be on information (papers) rather than people selling their company.

The symposium provides good dialogue between government, industry and academics.

The symposium provides a good opportunity for meeting others involved in reclamation.

More metal mining emphasis required at the symposium.

Proceedings for the symposium should come out sooner while memories and ideas are still fresh.

Concise summaries of papers given by speakers should be available at the symposium.

Question periods are important.

Topics of speeches and discussion should be more controversial.

Need more opinionated and future orientated presentations.

Should bring in speakers from outside B.C.

Ministers or Deputy Ministers should be key speakers.

Our political representatives should be involved in the symposium Workshops.

Consider one or more keynote speakers who can relate procedures and experience from other areas (Colorado - similar climate problems).

APPENDICES

APPENDIX A

POSTER SHOW PARTICIPANTS

Air Photo Display
Map and Air Photo Sales
Surveys and Mapping Branch
Ministry of the Environment
Parliament Buildings
VICTORIA, B.C. V8V 1X5

Acres Consulting Services Ltd.
9th Floor, 850 West Hastings Street
VANCOUVER, B.C. V6C 1E1

B.C. Research
3650 Wesbrook Mall
VANCOUVER, B.C. V6S 2L2

Buckerfields Ltd.
P.O. Box 7000
VANCOUVER, B.C. V6B 4E1

Canadian Land Reclamation Association
Box 682
GUELPH, Ontario N1H 6L3

Fording Coal Ltd. (River Diversion Model)
Box 100
ELKFORD, B.C. V0B 1H0

Interior Reforestation Co. Ltd.
P.O. Box 487
CRANBROOK, B.C. V1C 4J1

McElhanney Surveying & Engineering Ltd.
200 - 1200 West Pender Street
VANCOUVER, B.C. V6E 2T3

Ministry of the Environment
RAB - Soils Section and Vegetation Section
1837 Spall Road
KELOWNA, B.C.

Multi Turf Specialists Ltd.
6455 - 64th Street
DELTA, B.C. V4K 3N3

Norwest Soil Research Ltd.
6788 - 99th Street
EDMONTON, Alberta T6E 5B8

The Reclamation Research Group
326 Lemarchand Mansions
11523 - 100th Avenue
EDMONTON, Alberta T5K 0J8

Richardson Seed Company Ltd.
Rear of 7342 Winston Street
BURNABY, B.C.
V5A 2H1

Ried-Collins and Associates
1178 West Pender Street
VANCOUVER, B.C.

R.M. Hardy & Associates Ltd.
910, 205 Fifth Avenue S.W.
P.O. Box 9237
Bow Valley, Square Two
CALGARY, Alberta T2P 2W5

Techman Ltd.
Sixth Floor, 320 Seventh Ave. S.W.
P.O. Box 2840
CALGARY, Alberta T2P 2M7

University of British Columbia
Department of Soil Science
VANCOUVER, B.C.

Verdyol Mulch of Canada Ltd.
R.R. #4
COOKSTOWN, Ontario L0L 1L0

Weston Agricultural Consultants Ltd.
(Wesago)
1850 South West Marine Drive
VANCOUVER, B.C. V6P 6B2

APPENDIX B

SYMPOSIUM PROGRAM OF EVENTS

MINE RECLAMATION

SYMPOSIUM

VERNON, B.C.
VERNON LODGE

MARCH 1, 2, 3 - 1978

SPONSORED BY:

British Columbia Ministry of Mines
and Petroleum Resources
and the
Mining Association of British Columbia
Technical and Research Committee

* * * *

COMMITTEE MEMBERS

R.T. Gardiner - Chairman
D.M. Galbraith - Co-Chairman
J.C. Errington - Symposium Convenor

M. Bell
A. Bellamy
D. Eastman
L. Lavkulich
J.D. McDonald
A. Milligan
A. O'Bryan
C. Pelletier
W. Stiles

AGENDA

MARCH 1, 1978, Wednesday

1:00 - 3:00 P.M. REGISTRATION

Afternoon Session - Ministry of Mines Reclamation Policy and Activities

3:00 Opening remarks by Chairman
R. Gardiner

3:10 Opening of session by Chairman
E. Macgregor

3:15 Ministry of Mines Exploration and Aerial Photography
D.M. Galbraith, Ministry of Mines and Petroleum Resources

3:45 Evaluation of current revegetation techniques used in B.C.
J.C. Errington, Ministry of Mines and Petroleum Resources

4:15 Reclamation Policy in B.C.
J.D. McDonald, Senior Reclamation Inspector, Ministry of Mines and Petroleum Resources

4:45 Summary by Chairman

6:00 Refreshments

7:00 Dinner and Guest Speaker
Mr. Tony Petrina,
Vice-President of Mining Operations
Placer Development

MARCH 2, 1978, Thursday

Morning Session - Reclamation planning as a part of mine planning

8:30 Opening of session by Chairman
J. D. Graham

8:35 Fording River Diversion
J.A. Wood, P.Eng., Vice-President
Kerr Wood Leidal Consultants

9:00 Reclamation planning at Hat Creek
F.G. Hathorn, Project Environmental Engineer, B.C. Hydro and Power Authority

9:30 Reclamation planning for the Line Creek Project
R.H. Crouse, Vice-President Mining, Crows Nest Industries Ltd.

10:00 Coffee at Workshops
Groups chaired by industry

11:30 Workshop Summaries

11:45 Chairman's Summary

12:00 Lunch (ad hoc)

Afternoon Session - Site Preparation

1:00 Opening of session by Chairman
R.T. Marshall

1:30 Methods of site preparation employed at Coleman Collieries Ltd.
Jim Lant
Coleman Collieries Limited

2:00 Spoil Dump Resloping at Fording Coal
J. Popowich, Superintendent, Mine Engineering, Fording Coal Ltd.

2:30 Overburden recontouring at Kaiser Resources Ltd. operations.
A.W. Milligan, Reclamation Officer

MARCH 2, 1978 - Continued

3:00 Coffee and introduction to the Poster Session

5:00 End of Poster Session

6:00 Refreshments

7:00 Banquet and presentation of the Reclamation Award by
Hon. James R. Chabot, Minister
Ministry of Mines and Petroleum Resources

MARCH 3, 1978 Friday

Morning Session - Resource Problems and Solutions

8:30 Opening of session by Chairman
Dr. J. O'Riordan

8:35 Habitat protection and enhancement for wildlife use
Dave R. Hurn, Asst. Director
Habitat Protection, Fish & Wildlife Branch, Victoria

9:00 Mining and Archaeological Resources: Conflicts and Mitigation Procedures
Bjorn O. Simonsen, Provincial Archaeologist, Victoria

9:25 Ungulate protection in the N.E. Coal Block - B. Churchill, Fish and Wildlife Branch
Fort St. John

9:50 Federal Fisheries Act Amendments and the Mining Industry
B.A. Heskin, Forbes Boyd, Environment Canada

10:15 Coffee at Workshops
Groups chaired by resource agencies

11:30 Workshop Summaries

11:45 Chairman's Summary

APPENDIX C

MINE RECLAMATION SYMPOSIUM '78

LIST OF REGISTRANTS

NAME	EMPLOYER	ADDRESS
ACOTT, G.B.	Luscar Lt.	800 Royal Trust Tower, Edmonton Centre, Edmonton, Alta.
AGNEW, F.N.	B.P. Canada Limited	335 - 8th Ave. S.W., Calgary, Alta.
AIELLO, J.	Byron Creek Collieries Ltd.	Box 270, Blairmore, Alta.
ALLEN, I.V.F.	B.C. Research	3650 Wesbrook Mall, Vancouver, B.C.
AMES, S.E.	University of B.C.	Vancouver, B.C.
ANDERSEN, E.	Bethlehem Copper Corporation	2100 - 1055 W. Hastings St. Vancouver,B.C.
ARMOUR, H.	Ministry of Mines	2226 Brotherstone Rd., Nanaimo, B.C.
BAASE, R.	Craigmont Mines Limited	Box 3000, Merritt, B.C.
BALABAS, R.	Pacific Petroleums Ltd.	700 - 6th Ave. S.W., Calgary, Alta.
BELL, M.	University of Victoria	Victoria, B.C.
BELLAMY, A.	Bethlehem Copper Corporation	Box 520, Ashcroft, B.C.
BERDUSCO, R.J.	Kaiser Resources Ltd.	Box 2000, Sparwood, B.C.
BIK, M.J.	Elco Mining Ltd.	P.O. Box 1993, Station "M" S.W., Calgary, Alta.
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