SURFACE RECLAMATION SITUATIONS AND PRACTICES ON COAL EXPLORATION AND SURFACE MINE SITES AT SPARWOOD, B.C.

Roger J. Berdusco
Anthony W. Milligan
Kaiser Resources Ltd.

ABSTRACT:

Kaiser Resources Ltd. ownes and operates a 5 million ton per year open pit and hydraulic coal mine near Sparwood in Southeastern British Columbia.

Since 1969, Kaiser has maintained a field scale reclamation program dedicated to reclamation of disturbances associated with past and present mining and exploration activities. Since that time, over 1400 acres have been treated using modified forestry and agricultural techniques with encouraging results.

KEYWORDS:

Coal, Reclamation, Exploration, Mining

INTRODUCTION

In 1968 Kaiser Resources Ltd. announced its intention to develop extensive coal deposits in the southeastern corner of British Columbia. The resulting public reaction against the possible damage of these wilderness areas was responsible for the formulation of provincial regulations for reclamation, specifically Section 8 of the Coal Mines Regulation Act and Section 11 of the Mines Regulation Act. At first this legislation applied, in the case of coal, only to open pit disturbances but was later ammended to include distrubances by exploration and underground mines.

No firm regulations have been established as to what constitutes a satisfactory reclamation. This is because of the wide variations of climate and topography within the province. Each operator has to determine the optimum results possible on a site specific basis.

In the summer of 1969 a Reclamation Department was established by Kaiser Resources Ltd. to determine the feasibility of reclamation and investigate the equipment, vegetative material and procedures necessary for a full scale reclamation program. In the spring of 1970 the Reclamation Department became fully operational with the hiring of two full time personnel charged with the development of a viable revegetation program for the whole property. Presently, the Reclamation Section of the Environmental Services Department has a permanent staff of 7 and a seasonal staff of up to 70.

The Kaiser Resources Ltd. property is located in the southeast corner of British Columbia. The title to a select two thirds of some 110,000 acres of coal bearing land previously held by Crows Nest Industries was acquired by Kaiser Resources Ltd. in February 1969.

The acreage acquired by Kaiser consists of two separate tracts of land, the larger being in the Crows Nest Coal Field and the second is a portion of the Elk River Coal Field.

The Crows Nest Field covers some 30 miles in length and is about 12 miles in width near the centre of the basin. The Michel mining area lies near the north end of this field and Fernie lies west of the centre. The Elk River Coal Field is about 8 miles north of Michel.

The Crows Nest 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. Similarily the Elk River Coal Field contains approximately 7 mineable seams that outcrop within a 1,500 foot sequence of

coal bearing measures. The coal seams range in thickness from 5 to 50 feet and vary in elevation from 3,500 to 7,000 feet within the Elk River Coal Field.

The overburden on both coal fields is composed mainly of sandstone and carbonaceous shale with some conglomerate and calcareous shales. The pH of this material ranges from 4.2 to 7.8. The coal itself is a low volatile bituminous type with a low sulpher content of 0.3 to 0.4%.

The vegetation of this area is comprised of three different Biogeoclimatic Zones -

a) The Interior Douglas fir zone from the valley bottom to 5,000 feet
b) The Engelmann spruce - Alpine fir zone at elevations from 4,500 to 7,000 feet
c) and the Alpine zone at elevations above 6,500 feet.

Steep topography and generally rugged terrain have broken these Biogeoclimatic zones into generally localized areas which blend one to the other. Also fires and past industrial activities have left a variety of successional stages throughout. Southern aspects tend to be composed of grasslands and shrubs whereas the more northerly slopes tend toward a conifer overstory.

MINING AND EXPLORATION METHODS

MINING

Presently, approximately 80% of Kaiser's coal production is derived from surface mining and 20% from underground methods, predominantly hydraulic. Although there is some surface disturbance which requires reclamation associated with underground mining, the majority of land disturbance is attributed to surface mining and exploration. These areas will be the basis of discussion in this report.

Kaiser's present approach to surface mining is a shovel and truck method. First the overburden is drilled and blasted and then it is excavated by large shovels, loaded into 200 ton trucks and hauled to dump sites. At the dump, the spoil material is disposed of in benches or terraces, each terrace wrapping around the slope below the preceeding one. Where feasible, spoil is backfilled into dormant areas or natural depressions.

As the overburden is removed in roughly 60 foot benches, the coal

is exposed. This is then ripped and pushed up for front end loaders which load 100 ton trucks that haul coal from the pits to be processed.

EXPLORATION

Until 1974, Kaiser's coal exploration techniques closely resembled those used by most mining concerns. The general approach was extensive access road construction followed by seam tracing, trenching and test pit and adit sampling. This approach is no longer used at Kaiser.

Since 1974, the exploration approach has changed to one of access construction followed by drilling and more intensive geological mapping. Seam tracing and trenching techniques are no longer used. Adits are still driven but these are carefully located to avoid sedimentation of watercourses. Also adit waste, previously dumped at the most convenient place, is now salvaged for sale or is dumped into natural depressions and resloped to allow revegetation. All access roads and secondary drillsites roads are plotted on sensitivity maps and altered to minimize environmental damage. The are then flagged and inspected prior to construction. All roads that encounter merchantible timber are pre-logged before final road building thus salvaging the timber resource and eliminating the fire hazard of roadside slash.

Due to a great variety of climatic and edaphic conditions encountered over this large area, reclamation problems encountered vary in intensity and kind.

The valley bottom and lower slope areas pose much less problems than the middle and high elevation sites which tend to be much steeper and contain shallower, more sensitive soils and more extreme growing conditions.

One notable exception to this general trend is the problem of the erodability of glacial silts and sands found only at elevations below 4,500 feet. However, there still exists a general trend of increased difficulty of revegetation as the elevation increases.

Some of the major problems can be discussed in terms of soil, slope and aspect and species.

RECLAMATION PROBLEMS

SOIL PROBLEMS

After industrial disturbance, soils undergo dramatic change in chemical status, color, and structure, all of which frustrate revegetation efforts.

Chemical change is a general raising of pH up to 8.5 accompanied by a lower nutrient level, especially expressed in available nitrogen. These changes of course bring the pH range beyond the desirable range for tree species and some other native plants.

One other change caused by disturbance is a color change. The incorporation of dark marine shales and coal into the disturbed soil tends to make it much darker than the native soils. This trait decreases the albedo and hence increases heat absorption causing moisture levels, in a soil that already normally lacks moisture, to decrease. In an environment where available moisture in the growing season is so critical, color change can be a significant factor limiting revegetation of desirable species.

Finally, and certainly not the least important change in soil following disturbance is structure. In general terms, large disturbed sites such as overburden dumps or roads are characterized by a reduction in both organic matter and fine particles mainly due to burying and erosion. This reduces moisture retention and decreases cation exchange capacity of the growing medium. However, there are some advantages to an exposed soil that is coarse. This soil is more well drained and its potential for erosion is significantly lower than an exposed soil with high fines content. It is also important to note that gravitational sorting takes place in dump construction, with larger particles forming a crude filter at the toe of the dump. The friable nature of the exposed shales also allows soil building to proceed at an accelerated rate, especially when revegetation occurs concurrently.

SLOPE AND ASPECT PROBLEMS

Most disturbed areas usually end up, in general terms, somewhat steeper than "in situ" soils. These steep slopes present problems for regeneration because of surface creep, erosion, and other related items.

Dumping procedures and other practices which disturb large areas of land in mountainous terrain generally tend to make slopes more uniform, that is with less microsites and less variations in aspect. Also, draingage patterns tend to be diminished by filling of gulleys and low areas. The significance of these phenomena is that it makes revegetation more difficult especially if the final aspects left after disturbance are south or southwest facing. Mainly because of temperature and related moisture stress, these aspects have been found to be more difficult to reclaim.

SPECIES

The new and markedly different edaphic and induce climatic conditions of the dump slopes have resulted in a new environment for life. Unfortunately, some of the new conditions no longer suit the requirements of some of the previous users. For example, because of the increased pH and lowered organic matter content, most native tree species do not fare well. Paper birch and Black cottonwood are two notable exceptions. As far as native shrubs are concerned this is an area where great voids exist in the information available on requirement for growth and for seed stratification and propagation methods. Much research and experimentation is required in this area.

The importance of using native grasses and legumes has been emphasized and debated by may authors in range and reclamation research. Although Kaiser has and continues to use agronomic species of both grasses and legumes, recognition is given to the theory that this approach may not be the most suitable in the long run. Presently, both native grasses and legumes collocted over the past two years are being tested for viability in germination and growth tests. The use of native species will receive greater emphasis in reclamation work in the years to come, especially at higher elevations.

RECLAMATION METHODS

MINING

The most important phase of any reclamation programme must be site preparation. The primary objective of this is to re-establish watershed values on the disturbed sites and at the same time provide favorable conditions

for the establishment of vegetation. At Kaiser Resources Ltd. the final disposition of spoil for reclamation is included in the overall mine plan. Because of the natural topography most spoil material is formed into large dumps with long steep slopes. Where this material is mainly fine spoil, a continual creep of the fine surface material prevents vegetation from becoming established. Earlier experiments indicated thet the maximum angle for successful revegetation on fine material is 28^{o}. In Kaiser's programme 26^{o} was the slope angle aimed at since it not only resulted in better seedling establishment but facilitated the subsequent operations of seeding, harrowing, and fertilizing. The angle of 26^{o} is used as a general rule where the reclamation plan is to contour the spoil dumps into the configuration of the similar surrounding landscapes. On the dumps formed by the operating mine this procedure is not feasible due to their slope lengths and massive size. An operating practice of forming dump terraces in a "wrap around" fashion as the mine is lowered greatly facilitates the reclamation plans. The incorporation of dump roads as terraces when resloping will reduce surface erosion and retain moisture for establishing vegetation. At first areas were resloped using 26^{o} as a maximum slope angle. However, as the work progressed it was felt that this particular spoil material could be left at a steeper angle. This proposal was based on the fact that the material under the dump was solid, the spoil material itself was coarse and relatively free of fines. It was felt that the underlying and dump material would be stable and the coarse surface material would prevent surface creep, thus the slope angle could be left at 30^{o} in some specific areas. After a year these specific areas had no sign of erosion and vegetation had established successfully. Obviously the steeper angle has to be a factor of the spoil material, but where possible this represents a considerable cost saving in leaving spoil material at this steeper angle.

After resloping the spoil, the standard approach is the sowing of seed and fertilizer by hand using cyclone seeders. Lately, the use of helicopters in seeding and fertilizing is becoming more prevalant. The area is then harrowed using very heavy duty harrows which are drawn across the slope. This procedure serves a dual purpose primarily covering the seed and secondly the harrows and dozer crossing the slope create a series of small terraces which aid in erosion control and contain

surface water for use by vegetation.

The grass and legume species used are all agronomic and the mixture is the result of test plot and annual vegetation assessments of reclaimed sites over the life of the programme. The aim is to cover the spoil with vegetation as soon as possible to reduce erosion, provide organic material and to provide grazing areas for wildlife. Ideally through succession native species will invade the seeded areas. Questions have been raised as to the suitability of agronomic species over the long term. To date studies carried out on reclaimed sites at lower elevations up to 5,500 feet indicate that once established agronomic species continue to reproduce and in fact ground cover and plant biomass has been on the increase. At the higher elevations it may be necessary to introduce native grasses to provide a suitable vegetation on a continuing basis. It may also be necessary to include native seeds with the initial seeding.

One optimistic note is that a test plot established in 1971 on Harmer at an elevation of 6,900 feet has shown an increase in certain agronomic species over the life of the plot.

On dark spoil the seeds require covering to protect them during germination and the methods that have proved most successful are harrowing or providing a wood fibre mulch using a hydroseeder. This approach stresses the value of an initial cover of grasses. It is felt that once this cover has been achieved then native shrubs and trees which have been grown from seed or cuttings in the greenhouse and nurseries can be planted on site. These seedlings can be held in the nurseries until they are of a suitable size to be field planted. To date approximately 350,000 trees have been planted on reclaimed sites.

The application of fertilizer to established vegetation has been on an annual basis. No definite time limit has been established as to the number of years this may be necessary until the vegetation becomes self-sustaining. Too little is known about the use of added nutrients. A better understanding of the nutrient cycle of these plant communities will allow for a more efficient use of fertilizer. To this end a study was initiated to follow the flow of nutrients through the soil, plant, and detritus compartments of the nutrient cycle. Also being studied are nutrient cycles of adjacent native grasslands to compare the 'stable'

communities with the introduced communities.

EXPLORATION

Since 1974, Kaiser Resources Ltd. has employed exploration techniques that differ greatly from the extensive land and water disturbing practices previously used. Once techniques such as seam tracing and trenching were used almost exclusively to provide geological information. The revised technique used at Kaiser eliminates the need for this and with the use of drillhole information and geological mapping, as well as planned access roads and adits, more geological information can be obtained with less unnecessary disturbance. Prior to any exploration disturbance taking place, all exploration proposals are plotted on sensitivity maps and aerial photographs. This enables Environmental Services personnel to evaluate the effects of the proposed work and to request alteration or elimination of undesirable proposals. In the field, all roads, drillsites, and adit sites are flagged and inspected prior to construction. This enables site specific changes to be made to avoid sensitive areas that did not show up on the sensitivity maps or aerial photographs. Once construction has been approved, experienced operators, most of whom have attended a Kaiser sponsered course on Environmental awareness and protective techniques in Exploration, carry out the work. Whenever accessible merchantible timber is encountered, pre-logging of the road right-of-way is carried out. Merchantible timber is decked and later sold to local mills. This technique avoids costly and dangerous slash abatement at a later date and provides a monetary return as well as the utilization of a natural resource.

Apart from pre-logging, supervision and monitoring of proposed and on-going exploration, reclamation of past exploration work is carried out by Kaiser's Environmental Services Department. Some of the work done includes slash abatement using powersaws and a woodchipping machine, ripping and seeding of dormant roads, backfilling of trenches, seam traces, test pits and adits, and re-establishment of watercourses.

CONCLUSIONS

Reclamation of a variety of mined land and exploration sites has been successful using techniques of resloping, seeding, planting, harrowing and fertilizing. Although the general approach to resloping is to aim at a maximum of 26^{o}, recent small scale attempts at 30^{o} have resulted in favorable revegetation levels.

Native trees and shrubs have been used successfully on reclamation projects, however some sites are not suitable for these plants because of changed soil conditions. On such sites, agronomic species of grasses and legumes are the only species used. The use of native species of grasses and legumes is being investigated at Kaiser. Present research on the subject in general indicates that it may be necessary to use native species more extensively at high elevations either in initial seeding or in supplementary seedings. This is expected to ensure the longevity of desirable species.

The techniques presently being used in the exploration-reclamation section, that is pre-planning of disturbances on sensitivity maps, monitoring and supervision of exploration work, resloping, terracing, ripping and seeding, and watercourse restoration are resulting in a more orderly and less damaging exploration program. Recent innovations widely used include the use of a woodchipping machine for slash abatement, pre-logging of exploration roads, terracing, and salvage of adit waste.

Most fundamental to the Reclamation program in general is pre-planning. The experience at Kaiser indicates that the most effective and productive approach to reclamation is with research programmes complementing the ongoing field programmes.

PROCEEDINGS

OF

THE SECOND ANNUAL GENERAL MEETING

OF THE

CANADIAN LAND RECLAMATION ASSOCIATION

August 17, 18, 19 & 20 — 1977 Edmonton, Alberta

(Sponsored by the Faculty of Extension, University of Alberta)

P R O G R A M

Canadian Land Reclamation Association

Second Annual General Meeting

August 17, 18, 19, 20, 1977

Edmonton, Alberta

Wednesday, August 17 (Optional Field Trips)

Field Trip No. 1 (Athabasca Tar Sands)

Leader: Philip Lulman (Syncrude Canada Ltd.)

Fee: $100.00 (covers bus and air transportation, lunch, and field trip information pamphlets)

Schedule: 7:30 a.m.- delegates board bus at Parking Lot T, located immediately south of the Lister Hall Student Residence complex. Air transportation from Edmonton Industrial Airport to Fort McMurray and return. Guided bus tour of surface mining and reclamation operations on Syncrude Canada Ltd. and Great Canadian Oil Sands Ltd. leases.
6:30 p.m.- delegates arrive back at Parking Lot T, University of Alberta campus.

Field Trip No. 2 (Aspen Parkland; Forestburg Coal Mine Reclamation)

Leader: George Robbins (Luscar Ltd.)

Fee: $25.00 (covers bus transportation, lunch, and field trip information pamphlets)

Schedule: 8:00 a.m. - delegates board bus at Parking Lot T, located immediately south of the Lister Hall student residence complex. Guided bus tour southeast of Edmonton, stopping at various points of interest (oil spill reclamation field plots; Black Nugget Park [abandoned minesite]; trench plots on Dodds-Roundhill Coal Field; solonetzic soil deep ploughing site) on the way to the Luscar Ltd. Coal Mine at Forestburg.
6:30 p.m. - delegates arrive back at Parking Lot T, University of Alberta campus.

Thursday, August 18

Events:	Opening of Formal Meeting; Presentation of Papers
Location:	Multi-Media Room, located on second floor of Education Building, University of Alberta.
8:00 a.m.	Authors of papers being presented on August 18 meet with paper presentation chairmen and audio-visual co-ordinator (Douglas Patching)
9:00 a.m.	Meeting Opened by Dr. Jack Winch (President of the C.L.R.A.; Head of the Department of Crop Science, University of Guelph). Comments by Dr. Winch.
9:15 a.m.	Welcome to delegates on behalf of the Government of Alberta by the Hon. Mr. Dallas Schmidt, (Associate Minister Responsible for Lands, Alberta Department of Energy and Natural Resources)
9:25 a.m.	Commencement of Paper Presentations. Morning session chaired by Mr. Henry Thiessen (Chairman of the Land Surface Conservation and Reclamation Council and Assistant Deputy Minister, Alberta Department of Environment).
9:30 a.m.	Paper 1. Combined Overburden Revegetation and Wastewater Disposal in the Southern Alberta Foothills by H.F. Thimm, G.J. Clark and G. Baker (presented by Harald Thimm of Chemex Reclamation and Sump Disposal Services Ltd., Calgary, Alberta).
10:00 a.m.	Paper 2. Brine Spillage in the Oil Industry; The Natural Recovery of an Area Affected by a Salt Water Spill near Swan Hills, Alberta by M.J. Rowell and J.M. Crepin (presented by Michael Rowell of Norwest Soils Research Ltd., Edmonton, Alberta)
10:30 a.m.	Coffee Recess
11:00 a.m.	Paper 3. The Interaction of Groundwater and Surface Materials in Mine Reclamation by Philip L. Hall of Groundwater Consultants Group Ltd., Edmonton, Alberta.
11:30 a.m.	Paper 4. Subsurface Water Chemistry in Mined Land Reclamation; Key to Development of a Productive Post-Mining Landscape by S.R. Moran and J.A. Cherry (presented by Stephen Moran of the Research Council of Alberta, Edmonton, Alberta).
12:00 noon	Lunch Recess

1:25 p.m. Continuation of Paper Presentations. Afternoon session chaired by Mr. Philip Lulman (member of C.L.R.A. executive; reclamation research ecologist with Syncrude Canada Ltd.).

1:30 p.m. Paper 5. Coal Mine Spoils and Their Revegetation Patterns in Central Alberta by A.E.A. Schumacher, R. Hermesh and A.L. Bedwany (presented by Alex Schumacher of Montreal Engineering Company Ltd., Calgary, Alberta).

2:00 p.m. Paper 6. Surface Reclamation Situations and Practices on Coal Exploration and Surface Mine Sites at Sparwood, B.C. by R.J. Berdusco and A.W. Milligan (presented by Roger Berdusco of Kaiser Resources Ltd., Sparwood, B.C.).

2:30 p.m. Paper 7. Agronomic Properties and Reclamation Possibilities for Surface Materials on Syncrude Lease #17 by H.M. Etter and G.L. Lesko (presented by Harold Etter of Thurber Consultants Ltd., Victoria, B.C.).

3:00 p.m. Paper 8. The Use of Peat, Fertilizers and Mine Overburden to Stabilize Steep Tailings Sand Slopes by Michael J. Rowell of Norwest Soils Research Ltd., Edmonton, Alberta.

3:30 p.m. Coffee Recess

4:00 p.m. Paper 9. Oil Sands Tailings; Integrated Planning to Provide Long-Term Stabilization by David W. Devenny of E.B.A. Engineering Consultants Ltd., Edmonton, Alberta.

4:30 p.m. Paper 10. Bioengineering. The Use of Plant Biomass to Stabilize and Reclaim Highly Disturbed Sites by H. Schiechtel and K. (Nick) Horstmann (presented by Margit Kuttler).

5:00 p.m. End of August 18 Sessions.

Friday, August 19

Events: Presentation of Papers; C.L.R.A. Annual General Business Meeting; C.L.R.A. Annual Dinner.

Locations: Paper presentations and C.L.R.A. Annual General Business Meeting in Multi-Media Room, located on second floor of Education Building, University of Alberta.
- Annual Dinner held in Banquet Room located on second floor of Lister Hall.

8:00 a.m. Authors of Papers being presented on August 19 meet with paper presentation chairmen and audio-visual co-ordinator (Douglas Patching).

8:30 a.m. Showing of Film Rye on the Rocks. This film depicts reclamation situations at Copper Cliff, Ontario and is being shown for the purpose of introducing delegates to the site of the 1978 C.L.R.A. meeting (Sudbury, Ontario).

8:55 a.m. Continuation of Paper Presentations. Morning session chaired by Dr. J.V. Thirgood (Vice-President of C.L.R.A.; member of Forestry Faculty, University of British Columbia).

9:00 a.m. Paper 11. Reclamation of Coal Refuse Material on an Abandoned Mine Site at Staunton, Illinois by M.L. Wilkey and S.D. Zellmer (presented by Michael Wilkey of the Argonne National Laboratory, Argonne, Illinois).

9:30 a.m. Paper 12. A Case Study of Materials and Techniques Used in the Rehabilitation of a Pit and a Quarry in Southern Ontario by Sherry E. Yundt of the Ontario Ministry of Natural Resources, Toronto, Ontario).

10:00 a.m. Coffee Recess.

10:30 a.m. Paper 13. Amelioration and Revegetation of Smelter-Contaminated Soils in the Coeur D'Alene Mining District of Northern Idaho by D.B. Carter, H. Loewenstein and F.H. Pitkin (presented by Daniel Carter of Technicolor Graphic Services Inc., Sioux Falls, South Dakota).

11:00 a.m. Paper 14. The Influence of Uranium Mine Tailings on Tree Growth at Elliot Lake, Ontario by David R. Murray of the Elliot Lake Laboratory, Elliot Lake, Ontario.

11:30 a.m. Paper 15. Weathering Coal Mine Waste. Assessing Potential Side Effects at Luscar, Alberta by D.W. Devenny and D.E. Ryder (presented by David Devenny of E.B.A. Engineering Consultants Ltd., Edmonton, Alberta).

12:00 noon Lunch Recess.

1:25 p.m. Continuation of Paper Presentations. Afternoon session chaired by Dr. John Railton, (Manager, Environmental Planning, Calgary Power Ltd., Calgary, Alberta).

1:30 p.m. Paper 16. The Distribution of Nutrients and Organic Matter in Native Mountain Grasslands and Reclaimed Coalmined Areas in Southeastern B.C. by Paul F. Ziemkiewicz of the Faculty of Forestry, University of B.C., Vancouver, British Columbia.

2:00 p.m. Paper 17. Systems Inventory of Surficial Disturbance, Peace River Coal Block, B.C. by D.M. (Murray) Galbraith of the British Columbia Ministry of Mines and Petroleum Resources, Victoria, British Columbia.

2:30 p.m. Paper 18. The Selection and Utilization of Native Grasses for Reclamation in the Rocky Mountains of Alberta by D. Walker, R.S. Sadasivaiah and J. Weijer (presented by David Walker of the Department of Genetics, University of Alberta, Edmonton, Alberta).

3:00 p.m. Coffee Recess; Distribution of Proceedings.

3:30 p.m. Commencement of 1977 General Business Meeting of the Canadian Land Reclamation Association. Meeting chaired by Dr. J.V. Winch, C.L.R.A. President.

7:30 p.m. Commencement of C.L.R.A. Annual Dinner in Banquet Room, second floor of Lister Hall.

Guest Speaker: William T. Plass, Principal Plant Ecologist, U.S.D.A. Forest Service, Northeastern Forest Experiment Station, Princeton, West Virginia.

Topic of Speech: Challenges in Co-operative Reclamation Research.

Note: Following the Annual Dinner and Mr. Plass's speech, delegates may retire to the adjacent Gold Room. A bartender will be on service until midnight.