Paper No. 1

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Title of Paper: "Combined Overburden Revegetation and Wastewater Disposal in the Southern Alberta Foothills"

ABSTRACT

A method for rapid reclamation of overburden resulting from the construction of a wastewater lagoon will be presented.

A clay/gravel overburden material, where groundwater movement had been adversely affected by associated construction activities, was revegetated, permitting the harvest of a hay crop three times the local average. This process was aided by irrigation with a moderately saline plant wastewater, thereby solving a water disposal problem as well.

Although the wastewater permitted rapid revegetation, it induced certain changes in the soil chemistry. These changes in soil characteristics, methods of overcoming these, and resulting groundwater changes will be discussed.

COMBINED OVERBURDEN REVEGETATION AND WASTEWATER DISPOSAL IN THE SOUTHERN ALBERTA FOOTHILLS

by

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CHEMEX RECLAMATION & SUMP DISPOSAL LTD.
CALGARY, ALBERTA

INTRODUCTION

The revegetation of overburden soils resulting from a variety of excavation activities in Alberta is a subject of on-going interest to the resource industries. The coal and oil industries especially have funded or initiated a variety of reclamation studies related to this problem.

The soils under consideration in such studies may fail to revegetate by natural invasion of plant species for a variety of reasons, such as salinity or trace element deficiencies and toxicities, a lack of nutrients and an absence of organic matter, with the latter two contributing in almost every case.

This paper summarizes the results of the first three years of a study conducted at Imperial Oil's Quirk Creek Gas Plant, 10 miles west of Millarville, Alberta.

BACKGROUND

The construction of a wastewater evaporation lagoon at the Quirk Creek Gas Plant a number of years ago resulted in the creation of a six acre area of overburden consisting of heavy clay, gravel and rocks. Until the beginning of a pilot reclamation study in 1974 and 1975, virtually no vegetation had invaded this area. Elevation of the site ranges from 4440 to 4490 feet above sea level, with a mean annual precipitation of 26.28 inches. Land in the surrounding area is used predominantly for cattle grazing.

The water lagoon, covering some 5 acres to a depth of 20 feet is fed by plant discharge resulting mainly from boiler blowdown.

INITIAL DATA

The results of the chemical analysis of composite overburden samples collected prior to revegetation are shown in Table 1. It is evident from these that a salinity or alkalinity restriction to the growth of forage did not exist. N and P nutrients were absent, and even K_2O was low in comparison with most Alberta soils. Organic material was virtually absent also.

Lagoon water quality had been monitored periodically prior to the initiation of overburden reclamation. The data in Table II, although gathered in 1976, serves well to illustrate the range of ion concentrations found.

It will be recognized that, with the exception of sodium and bicarbonate ions, all species present are essential for plant growth, and in principle the water could be used as a continous low-level source of nutrients during the revegetation period. If establishment and maintenance of a grass-legume cover were possible by this method, soil organic matter would be rapidly restored.

Amounts of water application could not be governed by nutrient requirements of vegetation alone, however. The United States Salinity Laboratory classifies waters of the quality in Table II as possessing a low sodium - high salinity hazard for irrigation pruposes (1), although this classification is based on data gathered in regions more arid than the southern Alberta Foothills. Consideration of these factors and the required moisture balance suggested the following procedure.

TABLE I

COMPOSITE SOIL ANALYSIS PRIOR TO REVEGETATION (SATURATED EXTRACT)

pH		7.9
Conductivity	umho/cm	170
Na^{+}	ppm	5
Ca^{++}	ppm	155
Mg^{++}	ppm	27
Cl^{-}	ppm	<5
$SO_4^{=}$	ppm	<5
HCO_3^{-}	ppm	37
S.A.R.		0.1
NO_3-N	lb/acre 6"	0
P_2O_5	lb/acre 6"	0
K_2O	lb/acre 6"	38

TABLE II

1976 LAGOON WATER QUALITY

		May	July	August	September	October	Comments
pH		7.6	7.8	7.4	7.7	7.0	a) Nitrate-N
E.C.	umho/cm	1390	1550	1410	1500	1730	b) Total N
Na^{+}	ppm	230	120	180	190	200	
Ca^{++}	ppm	65	65	65	71	82	
Mg^{++}	ppm	25	40	33	32.4	40	
K^{+}	ppm	3	5	3.6	4.9	4.5	
HCO_3^{-}	ppm	322	346	312	342	361	
$SO_4^{=}$	ppm	265	60	428	210	349	
Cl^{-}	ppm	177	187	156	139	208	
NO_3^{-}	ppm	0.04[a]	0.04[a]	0.03[a]	9.5[b]	0.055	
PO_4	ppm	0.812	0.3	0.125	0.14	0.21	
NH_3	ppm	1.4	---	---	---	---	
Fe	ppm	2	3	4	---	---	

There appears to be a relationship between changes in lagoon water quality and the concentrations of sulphate and choride ions in the groundwater, as might be expected for ions with high mobility within soil profiles. However, a statistical evaluation of this relation must await further data.

Changes in soil analyses were in part unexpected. In contrast with the above mentioned U.S.D.A. water classification, it was found that salts did not accumulate in the root zone to any large extent, presumably owing to the large volumes of water the site receives annually.

Instead, sodium was found to accumulate. By the end of 1975, the sodium absorption ratio (S.A.R.) of a saturated soil extract had increased from the original value of 0.1 to a value of 3.0. Since it was not known to which extent this rise in the S.A.R. might continue, the S.A.R. has since then been stabilize with minor additions (approximately 500 lbs/acre) of gypsum or calcium nitrate to the soil each spring. Changes in the S.A.R. and specific conductance of the soil are shown graphically with time in Figure II.

Present soil organic matter is in excess of 10% of soil weight, and the black soil layer extends to a depth of eight inches

EXPANSION OF THE IRRIGATION SYSTEM

Following the initial favourable results of 1975, the irrigated area was expanded to include some 2 1/2 acres to the sout of the lagoon, where soil had been disturbed by construction of a pipeline in the spring of 1976 (Figure I).

The approach to revegetation of this area was essentially similar to that described above, except that ploughing was not necessary and that sweet clover and brome only were seeded.

THE REVEGETATION PROGRAM

In 1975 the site in question was ploughed thoroughly, and N and P nutrients added at the rate of 54 lbs. of nitrogen and 28 lbs. of P_2O_5 per acre. Following this, the site was seeded to a grass-legume mixture containing 45% brome, 45% timothy, 5% sweet clover and 5% alfalfa.

This mixture was chosen for the relative salt or moisture tolerance of its constitutents.

Lagoon water was then applied by means of a sprinkler system at the rate of two inches per week during a 100-120 day irrigation season.

A groundwater observation well was drilled for monitoring of groundwater, which, together with the lagoon water and soils, was periodically sampled and analyzed. The design of the irrigation system is shown in Figure I.

RESULTS

In the first season, during which 6 acres were irrigated, excellent germination of grasses and legumes was found, and in the fall of that season the field was cropped for hay with a yield of 2 1/2 tons per acre, as opposed to 1 ton per acre for pastures in the vicinity. While cropping was neglected in 1976, a yield of some 3 1/2 tons per acre is anticipated for 1977. Groundwater quality was unknown prior to irrigation, but has shown little change over three years under a variety of conditions including lengthy periods of rainfall when irrigation temporarily ceased. The 1976 groundwater data are shown in Table III, and are comparable to those from other groundwater wells in the southern Alberta Foothills.

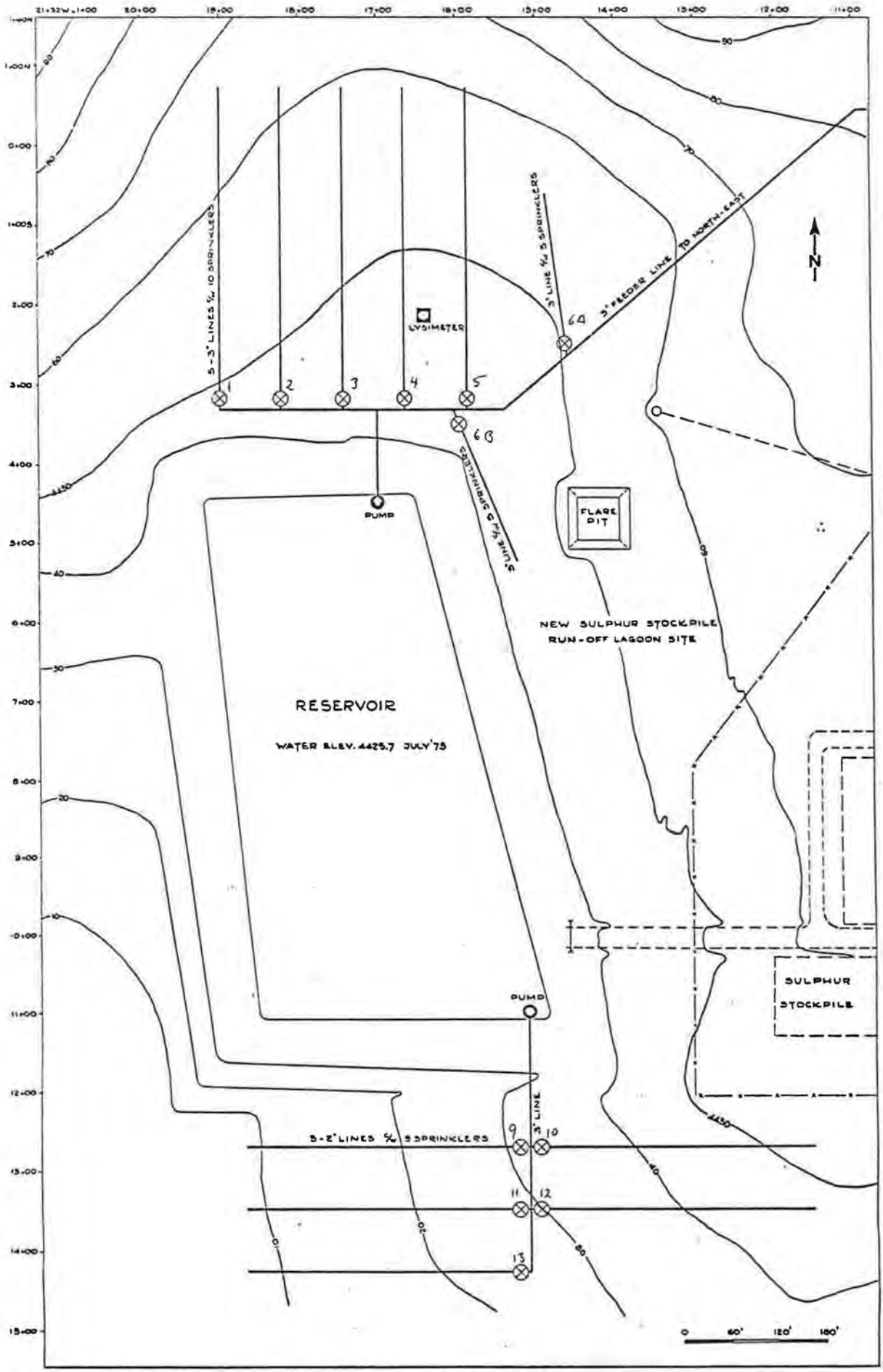


FIGURE 1 NORTH AND SOUTH PLOTS

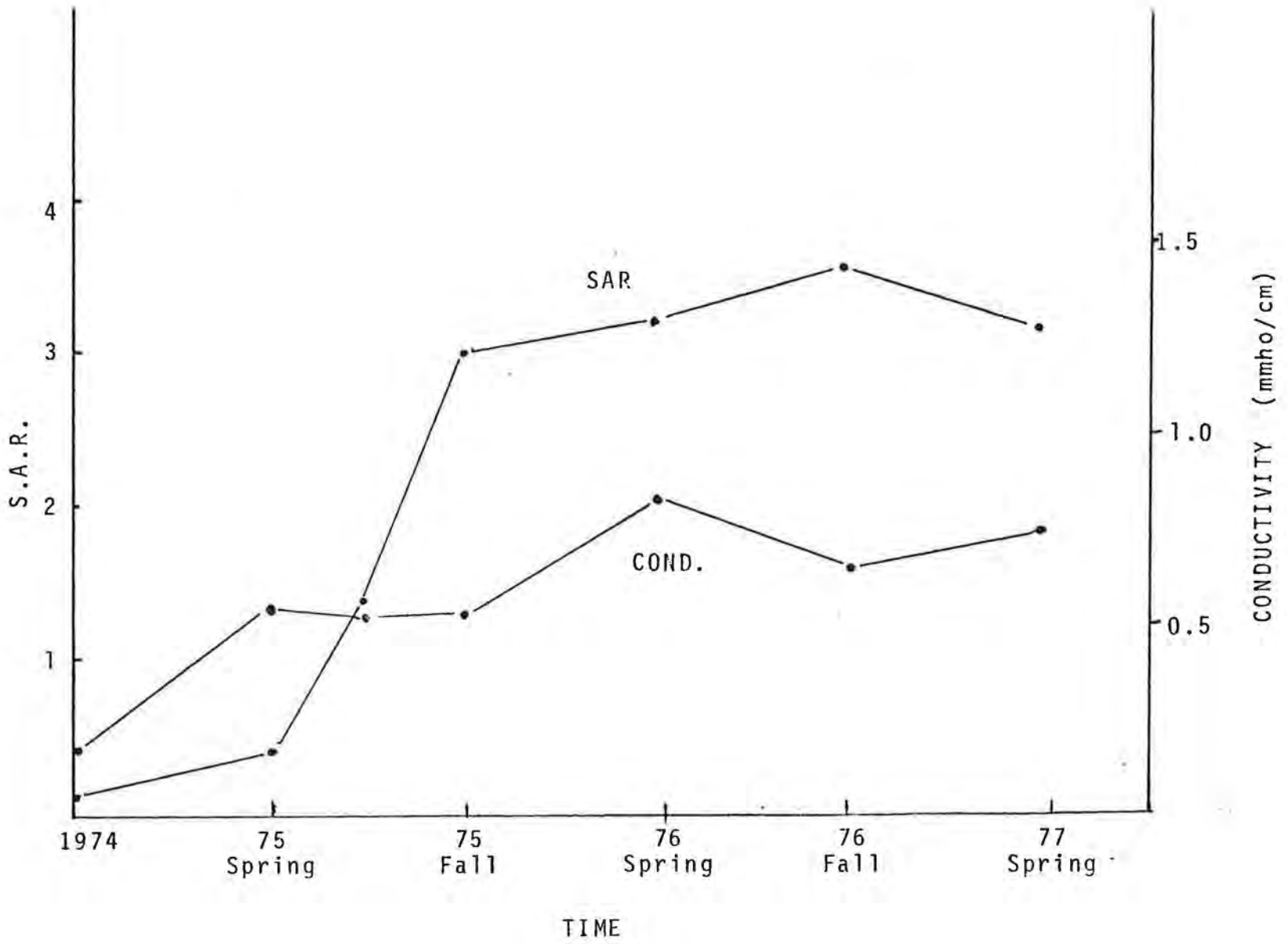
TABLE III

1976 GROUNDWATER QUALITY

		May	July	August	September	October	Fall 1975
pH		7.2	7.9	7.4	7.5	7.6	7.1
E.C.	umho/cm	1450	1550	1440	1500	1500	1300
Na^{+}	ppm	130	240	105	110	95	160
Ca^{++}	ppm	125	80	130	125	120	69
Mg^{++}	ppm	80	90	78	78	80	75
K^{+}	ppm	3	3	3	3.4	3	1.5
HCO_3^{-}	ppm	493	738	566	549	537	566
SO_4	ppm	188	143	338	100	248	160
Cl^{-}	ppm	128	128	124	99	119	125
NO_3^{-}	ppm	0.04[a]	0.08[a]	0.06[a]	4.2[b]	0.03[a]	<0.1
$PO_4^{\equiv}$	ppm	0.01	0.39	0.12	0.35	0.32	0.075
NH_3	ppm	1.3	---	---	---	---	0.32
Fe	ppm	---	6.0	5.4	---	---	<1

a) Nitrate - N

b) Total N


SAR
COND.
S.A.R.
CONDUCTIVITY (mmho/cm)
4
3
2
1
1.5
1.0
0.5
1974
75 Spring
75 Fall
76 Spring
76 Fall
77 Spring
TIME

An additional two acre area to the northeast of the lagoon was included also. This area, covered by a variety of deciduous trees and brush, had not been disturbed, and its inclusion merely reflects a change of emphasis from revegetation to an economically attractive method of wastewater disposal. Although only limited data are available for these two areas at present, it appears that soil changes in the south plot are essentially similar to those already described, while in the sandier soil of the north-east plot no chemical changes have as yet been discernible.

SPECIES PERFORMANCE

The progression of grass species in the north and south plots is of some interest.

In the north plot, the density of the vegetation has increased each year since 1975. Although a condensate spill occurred on a major portion of this site in the spring of 1977, after burning and the usual calcium addition (calcium nitrate was used), no detrimental effects were observable one month later.

The species abundance has changed greatly since 1975. In July 1977, an approximate abundance estimate of 80% timothy, 5% sweet clover and 5% brome was made. The remaining 10% is made up of intermediate wheatgrass and Canada bluegrass which have invaded the site. Alfalfa is completely absent.

In part of the south plot, the soil material was superior, in terms of organic matter content, to that originally present in the north plot. However, only patchy emergence of smooth brome and sweet clover were found after the 1976 seeding, with a large variety of annual weeds covering most of the site. This area, with the exception of a narrow band immediately above the pipeline, was not reseeded in 1977. The result has been that the clover and brome seeded in the spring of 1976 did not germinate until the spring of 1977. A crop of 1 1/2 tons per acre of hay is expected this year.

Monitoring of relative species abundance is continuing.

A recent report by Steward and Macyk (2) from work in the Grande Cache area mentions alfalfa, brome and timothy as successful species for overburden revegetation in the Alberta foothills, although no indication of changes in species abundance is given.

Under our conditions, which differ significantly from those of the Steward and Macyk study, at least the initial success with brome and timothy was high, even though timothy was eventually found to be superior. Sweet clover, however, was found to be a much superior legume to alfalfa.

ACKNOWLEDGEMENTS

The authors are indebted to Imperial Oil Limited for funding this study and for granting permission to publish.

LITERATURE CITED

1. "Saline and Alkali Soils", Agriculture Handbook 60, U.S.D.A., L.A. Richards (Ed.) 1969.

2. J. Steward and T.M. Macyk, Coal Industry Reclamation Symposium, Banff, 1977.

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.