# RECLAMATION OF COAL REFUSE MATERIAL ON AN ABANDONED MINE SITE AT STAUNTON, ILLINOIS*

M. L. Wilkey
S. D. Zellmer

Land Reclamation Program
Argonne National Laboratory
Argonne, Illinois

## ABSTRACT

In the State of Illinois lands that have been abandoned after deep mining or strip mining of coal present unique land reclamation problems. One such area is the Staunton 1 Reclamation Site. Through the efforts of three agencies -- the Illinois Institute of Environmental Quality, the Illinois Abandoned Mined Land Reclamation Council and the U.S. Energy Research and Development Administration -- this 13.8 ha (34 ac) site has been transformed from an eyesore that dumped acidic runoff into the nearby watershed to a demonstration area where reclamation research is now taking place. Ultimately, the site will be a wildlife and recreation area.

The old Consolidated Mine No. 14 was located in Macoupin County, northwest of the town of Staunton, Illinois. The refuse at this mine site was creating environmental problems that are typical of refuse areas in Illinois. Among these problems are runoff pH values of 2.6; severe erosion gullies; slopes of 1:1, 1:2, and steeper; gob and slurry with pH of 2.2; poor water quality; and sedimentation of tributaries of the Cahokia Creek watershed. The area was used as a dumping ground for various junk items such as stoves, refrigerators and metal cans. Overall the site had no productive value. Preliminary observations at the Staunton 1 site indicated that extreme environmental degradation had been

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caused by various physical and chemical characteristics of the refuse material. High concentrations of available boron, zinc, sulfate, and soluble salts; low concentrations of available nitrogen and potassium; and lack of organic matter make the refuse very poor soil for vegetative growth. In addition to these chemical characteristics, the physical properties of the refuse materials inhibited plant growth and encouraged erosion.

Sediment from this pile has silted an area of about 4 ha (10 ac) immediately surrounding the pile. An earthern dam was constructed for the impoundment of water for the mining operation and allowed the coal fines and silt to settle out. Culverts at the top of the dam allowed excess water to drain from the impoundment, thus leaving the sediment to accumulate. This earthern dam was breached by erosion after the mine closed in 1923, and subsequent erosion carved deep gullies in the exposed stratified sediment. Drainage from the refuse pile flowed north through the old impoundment area and continued north-northwest where it entered Cahokia Creek.

The entire area was recontoured during the construction. All slopes were reduced to 5:1 or less. A 0.5 ha (1.2 ac) retention pond was constructed to help control runoff. Agricultural limestone was applied at a rate of 220 t/ha (98 tons/ac) on some areas. Other areas received Code L Alkali at a rate of 152 t/ha (68 tons/ac) to neutralize and stabilize the acid slurry material. The entire site was covered with 0.3 m (1 ft) of suitable cover material, limed, fertilized, and seeded.

This paper will trace the history of this land reclamation project from its early planning stages, through the construction phase, and up to the present research.

# RECLAMATION OF COAL REFUSE MATERIAL ON AN ABANDONED MINE SITE AT STAUNTON, ILLINOIS

The extraction and processing of coal is generally accompanied by the problem of disposing of large volumes of waste materials. In 1962 the State of Illinois enacted its first reclamation law for coal mining. This legislation, with its subsequent amendments, requires that all lands disturbed by coal mining and processing be reclaimed. The legislation does not carry a "grandfather clause"; therefore approximately 46,900 ha (116,000 ac) of disturbed lands in the State of Illinois are not governed by this act. Current information[1] indicates deep coal mining operations in the State of Illinois have taken place at over 4,000 locations. Approximately 700 of these sites, covering about 2800 ha (7,000 ac of gob and slurry) are seriously affecting their surrounding environment. A second study[2] reveals over 44,100 ha (109,000 ac of spoil) of Illinois lands had been surface mined prior to 1962. Roughly 6900 ha (17,000 ac) of the total surface mined land also have serious environmental problems. Therefore, nearly 9,700 ha (24,000 ac), or over 20% of these lands affected by mining in Illinois, are creating environmental problems. These abandoned lands are owned by various agencies, coal companies, private concerns, municipalities, and by the State of Illinois.

The problems posed by abandoned coal mining sites are basically non-productive use of the land, loss of aesthetic value, and the production of pollutants with their dissemination into the surrounding environments. Before it is mined the coal and associated waste material is in equilibrium with its environment. When the refuse is deposited on the land surface, an equilibrium must be reestablished with the new environment. The production of acid material, acid runoff water and sediment are all symptoms of this readjustment. The natural processes which accomplish this readjustment are very slow. Conceivably, it could take hundreds of years to reclaim an abandoned coal mine site by natural processes and adversely affect the adjacent environment during the readjustment time.

These mined areas contain the waste from coal cleaning or surface mining operations. The waste deposited on the disturbed land contains coal, slate, rock, soil and pyrites. The four basic chemical equations that represent the acid production and the major environmental problems associated with coal mining are as follows:[3,4,5]

$$2FeS_2 + 2H_2O + 7\ O_2 = 4H^+ + 4SO_4^= + 2Fe^{++} \quad (1)$$

$$4Fe^{++} + O_2 + 4H^+ = 4Fe^{+++} + 2H_2O \quad (2)$$

$$Fe^{+++} + 3H_2O = Fe(OH)_3 \downarrow + 3H^+ \quad (3)$$

$$FeS_2 + 14Fe^{+++} + 8H_2O = 15Fe^{++} + 2SO_4^= + 16H^+ \quad (4)$$

In Equation 1 the sulfide in the pyrite is oxidized by the oxygen, and forms sulfate. If this equation happends in a soil, "cat clays" or acid sulfate soils, are formed.[3] In Equation 2 the ferrous ion is changed to ferric ion. In Equation 3 the ferric ion is hydrolized to form ferric hydroxide -- a powdery whitish-yellow insoluble precipitate commonly called "yellowboy." Equation 4 represents the reduction of the ferric ion by pyrite to form the ferrous ion. This equation represents the complete cycle since the ferrous ion needed in Eq. 2 is made available by the reaction in Eq. 4.

Examination of these equations indicates that runoff occurring on any site with pyrite available for oxidation would have very low pH values. Unless the vegetation is very acid tolerant, plant growth would suffer or be nonexistent under these conditions. Since steep slopes are usually associated with spoil areas and gob piles, with little or no vegetation to slow down the runoff, severe erosion problems can result. The coal cleaning procedure generates slurry areas where the liquid refuse from the coal washing process has been discarded. The acidic nature and fine texture on slurry areas also creates potential erosion problems. The low water quality values and sedimentation problems resulting from severe erosion can seriously affect the entire watershed. Problems such as these are common to lands disturbed by coal mining and processing.

Large refuse piles, without vegetative cover and with steep-sloped sides that are deeply eroded, are generally unappealing to the eye. In many cases, these refuse areas have become general dumping grounds for discarded material of all types. Sizable spoil areas, with sparse vegetative cover and alternative ridges and valleys of overburden, are a blot on the landscape.

These abandoned lands, in their present condition, have no specific land use or potential economic value. These factors, when coupled with the aesthetic and environmental status of the sites, have a tendency to create a depressed economic market for adjacent properties.

The primary goals of all reclamation projects are to: (1) reduce the quantity of pollutants entering the environment from the site; (2) increase the economic potential of the area; and (3) improve the aesthetic quality of the locality. With these general goals in mind, two state agencies -- the Illinois Abandoned Mined Land Reclamation Council and the Illinois Institute of Environmental Quality -- and the U.S. Energy Research and Development Administration through the Land Reclamation Program at Argonne National Laboratory (ANL) developed a cooperative reclamation demonstration program. A fourth overall goal was established for the cooperative effort -- develop, demonstrate, and evaluate methods and technologies of reclaiming refuse areas to have the greatest benefit at the lowest cost. This program was initiated by the selection of the Staunton 1 Reclamation Demonstration Project as its first effort.

The program has been subdivided into the following phases:

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|---|---|
| Phase I | Planning and Design |
| Phase II | Baseline Monitoring |
| Phase III | Site Development |
| Phase IV | Post-development Monitoring |

The first task in Phase I of the program was the selection of a typical refuse pile as a research site. The abandoned Consolidated Mine No. 14, located northwest of the City of Staunton in Macoupin County, was typical of coal refuse sites in southwestern Illinois. The mine was opened in 1904 and closed in 1923.

The waste materials from the operation were still very evident, in the form of an imposing gob pile. The refuse heap covered approximately 1.8 ha (4.5 ac), extended about 25 m (80 ft) above the natural landscape and had an estimated volume of 99,000 $m^3$ (130,000 $yd^3$). The pile was steep-sided, had no vegetative cover, and erosion had cut deep gullies into its sides. Vegetation in adjacent areas had been affected by the acid runoff water, and the water courses were filled with sediment. The original concrete smoke stack from the power plant at the mine was still standing, but most of the mine structures had been removed. The concrete foundations of some structures still remained and all the mine shafts had been filled. The railroad track which serviced the mine had been removed, but the right-of-way was still very evident along the southwest boundary of the property. The site was littered with large amounts of waste building materials, discarded household goods, many tin cans, and broken glass. From outward appearances, the site had been used as a general dump for a number of years. Acid runoff drainage was prevalent on the site. The drainage was to the north into Cahokia Creek, about one half mile north of the site. The drainage was filled with acid materials that had eroded from the gob pile and slurry resulting from the coal washing operation at the site. The depth of this material reached a maximum of 9 m (30 ft) in the old slurry pond which was at the north end of the site. The dam, which created the slurry pond, was breached about 35 years ago,resulting in erosion gullies to a depth of 4.5 m (15 ft). The acid nature of this slurry material had prevented the development of any vegetative cover on this 4.5 ha (11 ac) area of the site. The vegetation on the remainder of the site consisted of volunteer herbaceous shrubs, grasses, and trees. There was also evidence of small game in the area. The total site included approximately 13.8 ha (34 ac),of which about 9.3 ha (23 ac) required reclamation.

The second task in this phase of the program was to determine the final land use of the site. Because the area is near a railroad, improved surface roads,and an area which had been developed by industry, a possible usage would have been an extension of the industrial development, which would have complemented the economic base of the City of Staunton. After a soil investigation of the site by an independent engineering firm, this final land use was determined to be impractical.[6]

Due to the nature of the material at the site and the need to control acid runoff from the refuse, any proposed land use was somewhat limited. Therefore, a vegetative cover had to be established and maintained to control erosion and runoff. Any future development which would disturb the protective vegetative cover must be discouraged. After consulting local officials, and the West-Central Illinois Valley Regional Planning Commission, and taking into account the physical properties and chemical characteristics of the site, it was determined that the area was to be developed as a recreational area, wildlife habitat, and ecological educational area. Future overall land use and type of recreation activities must be limited to maintain the stability of the area.

With these final land uses in mind, detailed engineering plans and specifications were developed. Generally, the reclamation plan included: recontouring of refuse materials, disposal of man-made structures, improvement of the water courses, development of a pond,and reconstruction of the old dam with water flow control structures. Following the recontouring of the refuse materials, agricultural limestone would be applied to neutralize the refuse material, as would 0.3 m (1 ft) depth of suitable cover material. Preparation of a seedbed would include liming, fertilizing, and seeding with a mixture of grasses and legumes.

Phase II, Baseline Monitoring, was instituted to assess the predevelopment environmental conditions of the study area. A number of groundwater observation wells were installed to establish and determine the groundwater quality of the site. Of the many samples collected, three groups of water quality were observed. Groundwater in the glacial till underlying and adjacent to the refuse pile had low pH, high concentrations of sulfate, alkaline earths,and heavy metals. These leachate constituents were not found in groundwater samples collected from wells at distances greater than 91 m (300 ft) from the refuse pile. Groundwater samples collected from wells in the saturated slurry material also had low pH, high concentrations of sulfate, alkaline earths,and heavy metals. Samples from residential wells of the area were found to contain primarily calcium, magnesium, carbonates and sulfates, but appeared to be unaffected by the refuse leachate. Table 1 shows typical groundwater quality data from one sample collection in June 1976.

Surface water collections were made at the site starting in the spring of 1976. In general, the pH of surface water was very low with high concentrations of sulfate, iron, zinc, and cadmium. Table 2 shows the analysis of four typical collections made at the site.

Table 1. Staunton 1 Groundwater Quality, June 1976

| Parameter | From Slurry Material (4 Samples) | Near Refuse Pile (6 Samples) | Unaffected Areas (6 Samples) | Max. Recommended Drink. Water Limits[a] |
|---|---|---|---|---|
| | Concentrations in PPM (except pH) | | | |
| pH | 4.35-7.10 | 2.4-4.15 | 6.55-7.25 | |
| total alkalinity | 0-546 | 0 | 90.5 -185 | |
| $HCO_3^-$ | 0-666 | 0 | 110 -226 | 500 |
| $SO_4^=$ | 230-5174 | 1258-5739 | 66-1371 | 250 |
| Acidity | 47-2604 | 372- 8370 | 14.9-62 | |
| Ca | 239-456 | 470-569 | 44-387 | 200 |
| Mg | 45-220 | 30.5-84.3 | 13.1-194 | 125 |
| Na | 89-347 | 7.7-32.7 | 12.8-229 | 200 |
| K | 7.2-17 | 0.1-66 | 0.1-5.4 | |
| Fe | 6.35-1840 | 1.02-3940 | <0.05-.14 | 1.0 |
| Mn | 0.43-41 | 4.9-51 | <0.05-1.1 | 0.05 |
| Al | <0.1-72 | 17.7-980 | <0.1 | |
| Cd | <0.02 | 0.11 -2.6 | <0.02 | 0.01 |
| Cr | <0.05 | <0.05-1.42 | <0.05 | 0.05 |
| Cu | <0.02 | 0.02 -0.72 | <0.02 | 1.0 |
| Ni | <0.05-1.15 | 0.39- 2.81 | <0.05 | 1.0 |
| Zn | 0.072-40.5 | 9.97-123 | 0.013-0.048 | 5.0 |
| Sr | 2.5-3.5 | 0.5-1.0 | 0.3-1.0 | |

[a]Recommended limits from McKee and Wolf[7] and Davis and DeWiest[8]

Table 2. Staunton 1 Surface Water Quality

| Parameter Date | 4-15-76 | 5-13-76 | 10-15-76 | 10-22-76 |
|---|---|---|---|---|
| | Concentrations in PPM (except pH) | | | |
| pH | 3.9 | 3.4 | 2.6 | 3.1 |
| Acidity | 3596 | 4092 | 6300 | 3825 |
| $SO_4^=$ | 7095 | 9058 | 7000 | 4800 |
| Al | 498 | 607 | 527 | 143 |
| Fe | 1450 | 1510 | 1175 | 879 |
| Mg | 31 | 20 | 45 | 21 |
| Zn | 75 | 71 | 0.097 | 41 |
| Cd | 0.59 | 0.66 | 0.90 | 0.28 |
| Cu | 0.49 | 0.37 | 0.47 | 0.09 |

Surface materials, to a depth of 1.2 m (4 ft), were collected from three distinct areas --- slurry area, gob pile, and adjacent farm field. Routine soil analyses were made to determine the availability of various plant nutrients and the suitability of these materials for vegetation establishment and growth. Table 3 lists the average values for a group of samples collected in June of 1976. Soil pH in water from all three areas was extremely low. Generally, field soil samples were low in available plant nutrients. Both gob and slurry samples were high in soluble salts and had excessive amounts of boron and zinc which may have interfered with vegetative growth.

Table 3. Staunton 1 Surface Material Chemical Analysis, June 1976

| Sample[a] | pH | Soluble Salts (mhos/cm x $10^{-5}$) | Parts Per Million | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | P | K | Ca | Mg | B | Mn | Zn | $SO_4$-S |
| Field | 4.0 | $20^+$ | 36 | 156 | 383 | 100 | 1.8 | 44.8 | 8.1 | 214 |
| Slurry | 2.2 | 235 | 236 | 76 | 1870 | 100 | 35.5 | 5.6 | 53 | 3412 |
| Gob | 2.2 | 354 | 52 | 103 | 9758 | 1680 | 21.5 | 7.7 | 156 | 8733 |

[a]Sample averages

In addition, physical measurements were taken on surface material collected from the various areas of the site. Table 4 summarizes this information. The bulk density of both the gob and slurry material was low (< 1.00 $kg/m^3$). The general lack of large size particles (> 25 mm) may have been due to the method of mining and the coal cleaning process. This size distribution was probably not due to physical weathering, as the same general particle size distribution was observed throughout the gob pile and slurry area during the recontouring of refuse materials.

Other monitoring activities on the site included a sampling and analysis of surface materials for soil microbes. It was observed that the gob and slurry areas lacked any form of soil microbial life. However, soils from adjacent fields did have those forms of soil microbes normally found under cultivated agricultural conditions.

Table 4. Staunton 1 Surface Material Physical Analysis, June 1976

| Sample[a] | Bulk Density (kg/m³) | Largest Particle | % > 2 mm | < 2 mm Texture Class[b] |
|---|---|---|---|---|
| Field | 1.33 | 12.5 mm | 7.02 | Silt Loam |
| Slurry | 0.88 | 25 mm | 22.34 | Sandy Loam |
| Gob | 0.93 | 22 mm | 37.64 | Loam |

[a]Sample averages

[b]Glossary of Soil Science Terms[9]

A limited wildlife inventory was made of the site. It was determined that the areas not affected by the refuse material had wildlife populations normally found in the area, but those populations made little use of the refuse area itself.

Extensive growth chamber studies were conducted at the ANL facilities to investigate the effects of various types and levels of soil amendments, as well as vegetative species which could be used in reclaiming the site. Results from these studies[10,11,12] were used in determining species to be seeded on the site and soil amendment types and rates.

During the summer of 1976 detailed engineering plans and specifications for the construction phase of the program were completed. The resources of the Illinois Department of Transportation were utilized to obtain bids for the site development work. The State of Illinois acquired title to the property and the construction contract was awarded to Marle, Inc. of Springfield, Illinois, the low bidder, on September 15, 1976.

Phase III, Site Development, began with a general clean-up of the work area. This task included the removal of mine structural foundations, the smoke stack, and disposal of accumulated debris. An on-site borrow pit was opened and suitable cover material, removed from the pit, was stockpiled. By late October the gob pile was reduced to approximately 1/3 its original height. During the rough grading in the north area of the site, the contractor experienced problems in moving equipment over the saturated slurry material. Various attempts were made to dewater the area using drainage channels, pumping, and the substitution of Code-L Alkali for ground agricultural limestone. This material was selected because of its capability to neutralize and stabilize acidic, saturated materials. Due to difficulties encountered in the slurry area, the location of the pond was changed so that the base of the pond would be in till material rather than in saturated slurry material. As work progressed on the relocated pond, the Staunton area experienced its severest winter on record. Extremely cold weather and above normal amounts of snowfall slowed progress on the project. The construction of the dam, installation of the culvert pipe, excavation of the pond, and grading on the gob pile were all delayed by uncommon winter weather. General construction ground to a halt for two weeks in February of 1977.

Upon resumption of construction activities, as rough grading neared completion, the application of the neutralizing material at the refuse-material/suitable-cover-material interface began. The equivalent of 220 t/ha (98 tons/ac) of ground agricultural limestone was applied to the exposed refuse material. The neutralizing agent was incorporated to a minimum depth of 0.15 m (6 in.) into the refuse material. Suitable cover material was then placed over the regraded refuse material at a minimum depth of 0.3 m (1 ft).

By mid-April all grading had been completed and suitable cover material was in place. The seedbed was prepared with the application of 11.2 t/ha (5 tons/ac) of ground agricultural limestone and 135 kg/ha (120 lbs/ac) each of nitrogen, phosphorus, and potassium plant nutrients. These amendments were incorporated to a minimum depth of 0.1 m (4 in). The area was then drilled using an agricultural grain drill with the following seed mixture per acre: Reed canarygrass -- 4.5 kg (10 lbs); Kentucky 31 fescue -- 6.8 kg (15 lbs); Ladino Clover -- 2.3 kg (5 lbs); Birdsfoot Trefoil -- 5.4 kg (12 lbs); and cereal (Balboa) rye -- 9.1 kg (20 lbs). Seeding was completed the last week of April as was the fencing of the site perimeter. Final clean-up and minor hand work was completed on April 29, 1977, the day the construction contractor left the site.

During the month of April various research facilities and demonstration areas were prepared for the post-construction evaluation phase of the program. On May 25, 1977, the final inspection was made of the site development work by representatives of the funding agencies. This event was also attended by local and state officials, interested parties and various media personnel.

Phase IV, Post-construction Evaluation, began on April 30, 1977. The objectives of this phase are (1) to provide an overall assessment of the reclamation effort to determine its environmental effectiveness; (2) to develop, demonstrate, and evaluate needed technologies for future reclamation efforts; (3) to investigate and ameliorate potential environmental problems which may develop on the reclamation site; and (4) to provide the economic assessment necessary to transfer the most cost-effective reclamation techniques to future projects.

These objectives will be met with the establishment and maintenance of several interrelated demonstration projects. Each project will examine a specific portion of the reclamation effort, and the combination of information from each individual investigation will provide an overall assessment of the reclamation activity.

Groundwater hydrology and surface water quality are two studies being performed to determine what beneficial effects reclamation had on surface water quality and in Cahokia Creek. It will also provide a better understanding of the hydrological system of the reclaimed site. A study of the aquatic ecosystems will assess the effects of the reclamation effort on the macroinvertebrate communities of Cahokia Creek. This study will also determine the biotic colonization and succession patterns and rates within the on-site pond, and will develop a self-sustaining sport-fish community in the pond.

Another study will determine if site-wide revegetation efforts are successful and will establish limiting factors in site vegetation problem areas. An additional revegetation study will evaluate and field test several surface treatments, suitable cover material depths, and candidate plant species for the revegetation of reclaimed area.

A soil characteristic study will determine if significant changes occur over a period of time in the physical and chemical properties of root zone material at the site. This study will also look at whether available soil moisture or temperature are limiting factors in revegetation.

The relationship of slope angle and depth of suitable cover material to erosion rate and surface runoff water quality is also being examined.

Soil microbial population changes in relationship to site characteristics and reclamation practices are being determined by a soil microbial monitoring study. This study also relates microbial groups to a plant nutrient availability. Soil fauna establishment tests are being performed to determine survival rates and activity of soil fauna on limed refuse materials, mined and layered refuse material, and suitable cover material as related to soil fertility and structure. Another study being performed is a wildlife inventory which determines the species composition, use of the reclaimed area by wildlife and quality of the site as a wildlife habitat.

An additional investigation, which will provide an economic evaluation of the project, involves determining the cost-effectiveness of the various reclamation techniques being tested and the complete reclamation effort. The post-construction evaluation will continue for three to five years.

The primary goals of all reclamation projects are to reduce the quantity of pollutants entering the environment, increase the economic potential of the area and improve the aesthetic value of the landscape. An additional ultimate objective of the Staunton 1 Site Reclamation Demonstration Project is to develop and evaluate various methods of reclaiming refuse areas to have the greatest benefit at the lowest cost. Knowledge from this demonstration can be applied to the development of a systematic reclamation plan for abandoned refuse areas.

## LITERATURE CITED

1. Nawrot, J. R., et. al., *Illinois Lands Affected by Underground Mining for Coal*, Southern Illinois University, Carbondale, Illinois (March 1977).

2. Carter, R. P., et. al., *Strip Mine Reclamation in Illinois*, Argonne National Laboratory (Dec. 1973).

3. Mahan, S. E., *Environmental Chemistry*, Willard Grant Press, Boston, Mass.(1975).

4. *Inactive and Abandoned Underground Mines Water Pollution Prevention and Control*, U.S. EPA Document #EPA-440/9-75-007 (June 1975).

5. Stumm, Werner and J. J. Morgan, *Aquatic Chemistry*, John Wiley and Sons, New York, New York (1970).

6. R. E. Zimmerman, Soil Testing Services, Inc., Northbrook, Illinois, personal communication (June 29, 1976).

7. McKee, J. E., and H. W. Wolf, *Water Quality Criteria*, California Water Pollution Control Board, Pub. No. 3, 512p (1963).

8. Davis, S. N., and R. J. DeWiest, *Hydrogeology*, John Wiley and Sons, New York, 463p (1966).

9. *Glossary of Soil Science Terms*, Soil Science Society of America, (Feb. 1975).

10. Dvorak, A.J., R.R. Hinchman and J.D. Jastrow, *Revegetation Research on Strip Mine Spoils and Mine Refuse Part II. Germination and Early Growth of Midwest Grasses on Amended Acid Gob*, Argonne National Laboratory Report (Draft) (Nov. 1977).

11. Hathaway, A.M., J.D. Jastrow, A.J. Dvorak, and R.R. Hinchman, *Effects of Low pH on Growth and Nitrogen Fixation Rates in Legumes*, Work in Progress, Argonne National Laboratory (Nov. 1977).

12. Zimmerman, C.D., J.D. Jastrow, R.R. Hinchman, and A.J. Dvorak, *Uptake of Trace Elements During Early Growth by Reclamation Plant Species Grown in Amended Gob*, Work in Progress, Argonne National Laboratory (Nov. 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 am.- 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

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| 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.

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| 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.