Proceedings of the Conference

Reclamation, A Global Perspective

held in Calgary, Alberta, Canada

August 27-31, 1989

Organized by the

Canadian Land Reclamation Association/
Association Canadienne de Réhabilitation des Sites Degradés

and the

American Society for Surface Mining and Reclamation

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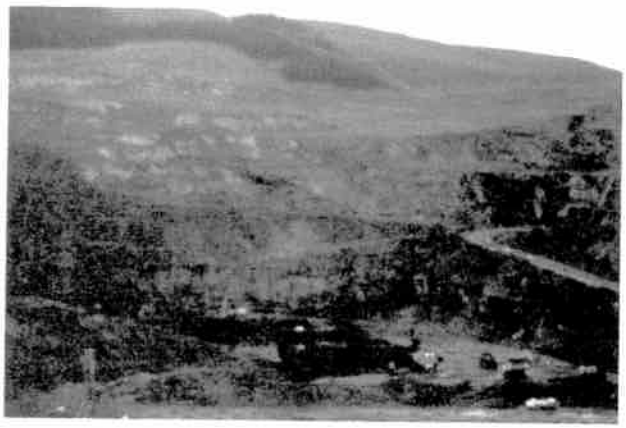
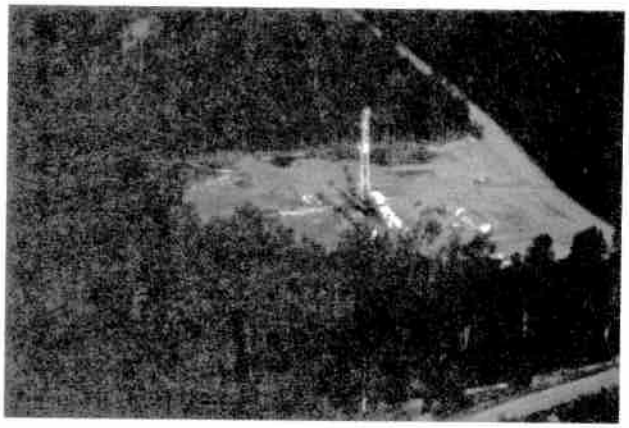
Published by the

Alberta Land Conservation and Reclamation Council
(Reclamation Research Technical Advisory Committee)

1989

Reclamation Research Technical Advisory Committee





Mission: To coordinate and foster reclamation research in Alberta.

Members: Chris Powter (Chairman) — Alberta Environment; Sharon Guenette (Secretary) — Alberta Forestry, Lands and Wildlife; Leon Marciak — Alberta Agriculture; Reinhard Hermesh — Alberta Environmental Centre; David Lloyd — Alberta Forestry, Lands and Wildlife; Sam Takyi — Alberta Forestry, Lands and Wildlife; Hugh Wollis — Alberta Forestry, Lands and Wildlife; Harry Sahay — Alberta Energy; Stephen Moran — Alberta Research Council.

Disclaimer

The papers contained in this proceedings were peer-reviewed and comments provided to the authors. However, it was the final responsibility of the authors to address these comments.

The content, recommendations and conclusions in this report are therefore those of the authors and not of the Alberta Government or its representatives.

This report is intended to provide govenment and industry staff with up-to-date technical information to assist in the preparation and review of Development and Reclamation Approvals, and development of guidelines and operating procedures. This report is also available to the public so that interested individuals similarly have access to the most current information on land reclamation topics.

Acknowledgements

This conference was jointly organized by the Canadian Land Reclamation Association/Association Canadienne de Réhabilitation des Sites Degradés and the American Society for Surface Mining and Reclamation. The following members of these organizations were particularly helpful: Stu Bengson, Richard Barth, Daniel Boivin, Jon Burley, Kent Crofts, Al Fedkenheuer, Gail Harrison, Darlene Hergott, Al Kennedy, Tom Oddie, Les Panek, Bill Plass, Mike Pole, Chris Powter, Holly Quan, Ron Ries and David Walker. Mr. Marc St.-Onges provided the French translations for the Abstracts. The success of the conference was also due to the efforts of several people who helped out on the registration desk and with the audio/visual systems.

The conference papers were peer-reviewed with the assistance of the following reclamation specialists: S. Abboud, F. Amendola, E. Baddaloo, R. Bollinger, F. Brenner, J. Burger, E. Carlson, M. Chaudry, J. Deichmann, R. DiPretoro, P. Erickson, A. Freeland, J. Friedlander, G. Halvorson, G. Harrison, S. Hasenjager, B. Hedin, L. Hendren, K. Hirsch, S. Imus, A. Janz, E. Jespersen, W. Kirk, B. Kleinmann, J. Kramer, D. Lloyd, E. Lyle, T. Macyk, D. Nilson, J. Oyler, F. Parady, M. Pole, C. Powter, R. Ramani, R. Ries, N. Safaya, D. Samuel, S. Schroeder, S. Shetron, P. Sims, P. Smith, M. Spry, S. Takyi, J. Todd, W. Vogel, G. Wade, D. Williams, N. Williamson and T. Zich.

A special note of thanks to the Reclamation Research Technical Advisory Committee of the Alberta Land Conservation and Reclamation Council for publishing these proceedings.

Finally, but perhaps most importantly, the following page lists the organizations that sponsored the conference, either in the form of a direct financial contribution, or through the donation of time, supplies or services for the organizers to complete their tasks. The support of these organizations is greatly appreciated.

CURRENT RECLAMATION APPROACH AT THE SYNCRUDE OIL SANDS PLANT[1]

by

Tony S. Dai and Martin Y.P. Fung[2]

Abstract. Syncrude Canada Ltd. is an oil sands surface mining and processing venture located at the Athabasca Oil Sands deposit in northeastern Alberta, Canada. An estimated 300 billion barrels of oil are considered recoverable from this deposit. The Alberta Government maintains that mined land be reclaimed to an acceptable end land use with a capability "equal to or better than" that which was present prior to mining. This paper presents an overview of Syncrude's current land reclamation approach. Prior to the mine overburden prestripping process, intensive sampling is conducted to assess the quality and volume of suitable reclamation materials present. These materials are then used to cap the tailings sand and the overburden disposal piles to depths of 70 cm and 100 cm, respectively. Locally grown indigenous tree seedlings are then planted on the capping materials. When reclamation is completed, the final land form, made up of recontoured undulating topography, with improved internal soil water drainage and soil properties, is expected to be at least equal to the pre-disturbed state in terms of ecological capability. The plant communities will be permanent, self-supporting and maintenance-free.

Additional Key Words: disturbed lands, afforestation, tailings sand, overburden, capping materials.

Introduction

The Athabasca oil sands of northeastern Alberta contains a vast accumulation of heavy viscous oil. The main body of the oil sands deposit covers between 31,000 and 34,000 square kilometres and contains over 600 billion barrels (1 barrel = 42 US gallons) of oil in place. Of this total, 300 billion barrels are considered recoverable; approximately 28% by surface mining technology and the remainder by other methods such as *in situ* thermal stimulation. Syncrude Canada Ltd. is the world's largest oil sands mining and processing venture, and is operating on the surface mineable portion of this oil sands deposit. It began production in 1978 and currently produces some 150,000 barrels of synthetic crude oil per day, approximately 10% of total Canadian oil consumption.

Syncrude's surface mining operations disrupt the environment. Plants are destroyed, soils are displaced and land forms are altered. Syncrude Canada Ltd. complies with requirements of the Alberta Land Surface Conservation and Reclamation Act to reclaim disturbed lands to acceptable end land uses either for forestry, wildlife, or recreation. Earlier reclamation methods used by Syncrude consisted of the amendment of overburden or tailings sand materials

[1]Paper presented at the Conference "Reclamation, A Global Perspective", Calgary, Alberta, Canada, August 27 - 31, 1989.

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with 10 cm of clay and 15 cm of peat and incorporation of these amendments to a depth of 30 cm using agricultural implements. The lands were then fertilized and seeded with agronomic grasses and legumes followed by the planting of tree and shrub seedlings. However, this method has not proven cost effective relative to results achieved to date.

This paper presents an overview of Syncrude's current approach to afforest lands disturbed by the oil sands mining operations. The two major land surfaces presently being reclaimed are overburden or oil sands disposal piles and tailings sand dykes.

Description of the Project Area

The Syncrude mining and processing plant is located approximately 420 kilometres northeast of Edmonton. The oil sands deposits on the Syncrude Leases underlies an average of 15 m of overburden. To gain access to the oil sands below, the overburden materials must be removed and disposed of.

Over the next 30 years of operation (1989 - 2018), Syncrude will feed 3.54 billion cu m of oil sands to the processing plant, and will move 1.77 billion cu m of overburden and reject materials to various disposal sites. Consequently, an estimated 14,000 hectares of land surface will be disturbed and then recreated for reclamation. In order to achieve reclamation standards, detailed documentation of the pre-mining land productivity coupled with sound reclamation planning and implementation are essential.

Reclamation Material Inventory

To evaluate and estimate the volume of materials *in situ* which are suitable plant growth media, detailed soil surveys are conducted in conjunction with Syncrude's ore-body core-hole drilling program. Soil samples are taken from drill cores 0 - 5 m deep at 1 m intervals and analyzed for physical and chemical characteristics. Soils are then rated as to their degree of suitability for plant growth. Suitability criteria are based on guidelines developed by the Alberta Soils Advisory Committee. The four rating classes are summarized as follows:

Good - None to slight soil limitations that affect use as a plant growth medium.

Fair - Moderate soil limitations that affect use, but which can be overcome by proper planning and good management.

Poor - Severe soil limitations that make use questionable. This does not mean that the soil cannot be used, but rather careful planning and very good management is required.

Unsuitable - Chemical and physical properties of the soil are so severe that reclamation would not be economically feasible or even possible.

Based on the rating results, a geological model is then drawn to depict the location of the various suitable soil types. Only materials falling in the good or fair categories which are located within 5 m of the surface are used for purposes of developing reclamation material balances. On the Syncrude Leases, the percentage of various geological units which are rated as suitable for plant growth are as follows:

- Holocene (Ho) 43%
- Pleistocene lacustrine (Pl) 30%
- Pleistocene fluvial (Pf) 63%
- Pleistocene glacial (Pg) 59%

The volume of suitable materials depends on the distribution of these geological units within the areas to be

mined. Therefore, the quantity of *in situ* Holocene and Pleistocene materials which are suitable for reclamation use can be calculated by using the geological data projected over the area to be mined. However, the actual volume of recoverable materials in the mine areas may be reduced by factors such as:

- exploration activities;
- drainage ditches;
- excavation of road construction materials; and
- not all *in situ* materials can be mined cost-effectively especially those found in lower layers overlaid by poor quality materials.

Once the geological model is drawn, a more detailed investigation of the soil profile is necessary to supplement the preliminary information gathered through the core sampling program. This is done by digging soil pits with a backhoe, documenting the soil profile in a more detailed manner, and taking soil samples for further analysis. The areas with suitable reclamation materials are then delineated. These materials are selectively stripped and hauled directly to the reclamation sites for use as capping materials.

Capping and Site Preparation

Syncrude's current reclamation specifications call for tailings sands surfaces to be capped with 70 cm (± 20 cm) and saline/sodic or oil affected overburden surfaces with 100 cm (± 20 cm) of suitable capping materials. Stripping, hauling and capping are usually carried out in the winter months. The soil is spread to the desired depth and left until the following spring. In spring, the area is fertilized using fertilizer blends consisting of N, P, and K, and then the soil is immediately disked to form furrows along the slopes. The purposes of this procedure are to relieve soil compaction, control erosion, retain soil moisture and incorporate the fertilizers into the soil.

Afforestation

Syncrude's original methodology was to reclaim lands by initially establishing a dense ground cover of agronomic grasses and legumes to prevent soil erosion, followed by the planting of tree seedlings. This did not work well. The tree seedlings were suppressed by the heavy ground vegetation. As well, dense ground cover harbours rodents which gnaw on the bark of the young seedlings. The end result is seedling mortality. Syncrude is now exploring the feasibility of planting trees directly onto newly prepared sites with no vegetative cover, or a minimum vegetative cover made up of native herbaceous species.

Tree species are selected in accordance with guidelines set by the Alberta Forest Service. Indigenous species are preferred as they are better adapted to the harsh local climate. Local seed sources of jack pine (*Pinus banksiana* Lamb.), white spruce [*Picea glauca* (Moench) Voss], red osier dogwood (*Cornus stolonifera* Michx.) and trembling aspen (*Populus tremuloides* Michx.) are used to grow seedlings in two fiberglass greenhouses located on the Syncrude site. Some field test plots are being evaluated for Siberian larch (*Larix sibirica* Ledeb.) and hybrid poplars (*Populus x Populus* species) - two non-native species relatively cold hardy and adaptable to the local climate.

Syncrude opted to grow its own seedlings primarily to achieve better seedling quality and flexibility of scheduling than was obtainable from commercial growers. Good stock quality is assured by keeping seedlings in their original containers until they are ready for planting, thereby eliminating damages resulting from repackaging seedlings and improper handling during transport and storage.

Field research experiments showed that large planting stock was preferable for planting on the Syncrude land

reclamation sites. Thus, Syncrude now grows its planting stock in 750 ml containers. The two greenhouses are capable of producing 62,000 seedlings of this size per crop and two crops per growing season. The first crop of the year is normally started in March and moved to a shadehouse in May for further growth and development. The second crop is sown in June and moved to the shadehouse in August. Seedlings are kept in the shadehouse anywhere from one to three years depending on the rate of growth of the species as well as the availability of land for reclamation. Seedlings which are not planted right away are overwintered in the shadehouse except for the more cold sensitive species, such as the jack pine, which are overwintered in a double-poly house.

With the annual two crop production, Syncrude is currently equipped to reclaim and afforest 50 hectares of land annually. Land availability is projected two years in advance in order to plan seedling production. Species to be planted are matched with the anticipated soil moisture availability on the reclamation sites, rather than soil type, because the soil types formed after capping are very heterogeneous. For example, jack pine, a drought tolerant species, is planted on the drier south-facing slopes. Planting density is 2,000 stems per hectare made up of half conifer and half deciduous species. Tree species are planted in alternate rows 2.5 m apart and 2.0 m between seedlings within a row.

Planting is done either in the Spring (May - June) or in the Fall (August - September). Planted areas are monitored annually for seedling survival and growth, ground cover development and soil chemical and physical properties. Any changes or trends are documented and results are then compared with set standards to update reclamation progress.

Summary

Construction and operation of the Syncrude Oil Sands Plant will eventually disturb a total of over 14,000 hectares of land surface. The disturbance began in 1973 with localized clearing, and will continue throughout the life of the project. Syncrude began reclaiming disturbed lands in 1976 with the objective of progressively establishing self-perpetuating plant communities which meet the objectives outlined in the Syncrude Development and Reclamation Plan approved by the Alberta Government.

The post-mining areas, overburden disposal piles, tailings sand dykes, and tailings sand storage areas offer a unique reclamation challenge. Syncrude intends to reclaim these areas to a state usable for forestry, wildlife and recreation. The capability of the land surface will be re-established via placement of a minimum of 70 cm of suitable capping materials using the criteria supplied by the Alberta Soils Advisory Committee. Reclamation materials are being selectively mined using mobile equipment prior to overburden removal and then hauled directly for placement upon reclamation sites. The new land surfaces will be contoured to form gentle slopes and allow good drainage. After disking and fertilizer application, the land will be afforested in order to speed up the rate of plant succession to meet Syncrude's long-term reclamation objectives. The required seedlings are produced by Syncrude in on-site greenhouses using seed collected locally. Native species are being used to improve the rate of success and to ensure that the 'man-made' plant communities blend in with the surrounding vegetation. The final landscape is anticipated to be dominated by a spruce-aspen forest type with jack pine predominantly on the exposed southern and western slopes.