OPERATIONAL RECLAMATION EXPERIENCE AT COMINCO'S

BLUEBELL AND PINCHI LAKE MINES

Paper prepared jointly
by:

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INTRODUCTION

Operational reclamation experience at Cominco's lead-zinc and Pinchi Lake mercury properties will be described. The history of mining, ecological setting, land use capability, and the nature and extent of land disturbance will be briefly summarized. The objectives, approach, and method of implementing the reclamation plan including short-term results and costs will be discussed in more detail.

BLUEBELL MINE

Location and History

Bluebell is located within the village of Riondel on the east shore of Kootenay Lake, about 50 kilometres east of Nelson. The property has had a colourful mining history. Over a century ago Indians were reported to have smelted crude musket bullets using ore from the Bluebell outcrop (1). At the turn of the century about 8300 tons of ore were mined and treated in the nearby Pilot Bay mill and smelter. Before 1927 when Cominco acquired the property, about 560,000 tons of ore were mined and shipped to the Trail Smelter by barge and railway (2). During 1952-71 Bluebell produced about 4.8 million tons of ore grading about 5 percent lead and 6 percent zinc (3). Ore was mined by underground methods from sulphide replacements in limestone located under Kootenay Lake.

Ecological Setting and Land Use Capability

Bluebell is situated on Galena Bay at 560 metres elevation. The moderating climatic influence of Kootenay Lake provides more than 150...
frost-free days per year and about 2 centimetres of precipitation per month during the growing season. Total annual precipitation is 90 centimetres (4). The mine is located within the Interior Western Hemlock Zone on a southern exposure (5). The soils have developed on colluvium from the bedrock outcrop and shallow glacial till. Forests are dominated by Douglas fir, white pine, cedar, larch, birch, and cottonwood.

Riondel land has a best physical capability for outdoor recreation and agriculture according to the Canada Land Inventory (6). Deer winter on the south-facing slopes in the area.

Nature and Extent of Land Disturbance

Total land disturbance at Bluebell was 13 acres. About 11 acres were occupied by the industrial site and a small waste rock dump. The remainder consisted of a small tailings spill, an open pit, and a mill site remaining from earlier mining activity. Tailings containing limestone, quartzite, schist, and smaller amounts of sulphides were deposited in Galena Bay.

During 1972-76, equipment was removed from the property, and buildings were levelled to concrete foundations. Mine portals were sealed and the open pit and industrial site were fenced.

Reclamation Plan

Objectives. The objectives of revegetation were to stabilize disturbed land surfaces against erosion, discourage refuse disposal, enhance lakeshore recreation potential, and improve the appearance of the site.

Approach. Plant species and fertilizer programs were selected for the reclamation plan based on the results of a modest field study program carried out during 1976-77. Chemical and physical properties of waste rock and disturbed soils were characterized using conventional soil...
tests. The main plant growth limiting factors were deficiency of organic matter, lack of the essential plant nutrients nitrogen and phosphorus, compaction, and moisture deficiency. Species selection trials showed that grasses such as Timothy, Canada Bluegrass, Orchardgrass, and Redtop established themselves satisfactorily with fall seeding. Spring seeding was necessary for the establishment of legumes such as Alfalfa, Birdsfoot Trefoil, and Alsike Clover. Short-term fertilizer experiments showed that incorporation of the equivalent of 56 kilograms per hectare N, 112 kilograms per hectare P₂O₅ and 56 kilograms per hectare K₂O before seeding, resulted in satisfactory establishment of a grass-legume mixture.

Implementation. Operational reclamation was initiated in November 1977 based on a reclamation plan submitted to the Ministry of Mines and Petroleum Resources.

Site preparation was carried out using a D8 Caterpillar with rippers and a 3 cubic yard Caterpillar 950 Payloader. Waste dumps were resloped to 10° slope angle and graded to blend with the lakeshore terrain. Cemented tailings and, where possible, concrete foundations were buried with a 45 centimetre depth of overburden. Metal objects, timber, and garbage were either removed from the site, burned or buried. The Payloader removed larger rocks exposed in ripping dump surfaces and left a tidy surface appearance. Site preparation was carried out in 7 days (21 man-days).

After resloping, ammonium phosphate fertilizer was broadcast on waste surfaces at 407 kilogrammes per hectare using an "Erocon" air applicator. Fertilizer was incorporated to a 15-30 centimetre depth by backblading with the Cat's brush blade, or by dragging back the teeth of the payloader bucket. Compact surfaces were scarified in two directions before applying the seed mixture. Creeping Red Fescue (40 percent), Canada Bluegrass (27 percent), Timothy (26 percent), and Redtop (7 percent) were surface broadcast at >34 kilograms per hectare.
using Erocon applicator and cyclone spreaders. Seed was incorporated by payloader bucket leaving contour furrows for trapping moisture on the dump surface. Seed and fertilizer were applied in one day (27 man-hours).

In April 1978, Rambler Alfafa (50%) and Birdsfoot Trefoil (50%) were surface broadcast on all areas at 22 kilograms per hectare using cyclone spreaders. Later in June and September 1978, split maintenance fertilizer applications were broadcast at 224 kilograms per hectare in the form of a complete fertilizer (13-16-10). During the initial growing season the grass-legume mixture established and grew satisfactorily on areas having sufficient fines and was dominated by Creeping Red Fescue and Timothy.

About 1800 trees and shrubs were planted in April 1977-78 to screen the open pit and concrete foundations. Bare root 2+0 Douglas Fir, Ponderosa and Lodgepole Pine, and Paper Birch seedlings were supplied by the B.C. Forest Service in Nelson. Arnot Bristly Locust, a spiny acid-tolerant nitrogen fixing shrub, and Black Cottonwood were planted to restrict access to the open pit. A local resident donated 28 four-year old Eastern Maple trees. Trees were planted by hand, using picks.

Costs Reclamation costs since 1972 have totalled 35,000 dollars including 8,000 dollars spent on research and administration and 27,000 dollars spent on planning and implementing operational reclamation (Table 1).

Reclamation planned for 1979 will include application of maintenance fertilizer and additional tree planting. Total costs are projected at 45,000 dollars or 3,500 dollars per acre.

Although future plans for the property are currently undecided, revegetation has made the Bluebell compatible with neighbouring residential areas and has discouraged refuse disposal on the site.
TABLE 1

OPERATIONAL RECLAMATION COSTS AT COMINCO LTD.
BLUEBELL AND PINCHI LAKE OPERATIONS DURING 1978

<table>
<thead>
<tr>
<th>Property</th>
<th>Task</th>
<th>$</th>
<th>$/acre</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>BlueBell</td>
<td>Site Preparation</td>
<td>15,000</td>
<td>1154</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>(Including supervision)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vegetation Establishment and Main-</td>
<td>9,000</td>
<td>692</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>tenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(materials, labour*, travel expenses)</td>
<td>3,000</td>
<td>230</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Administration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(reclamation plan, reporting results)</td>
<td>27,000</td>
<td>2,076</td>
<td>100</td>
</tr>
<tr>
<td>Pinchi Lake</td>
<td>Materials</td>
<td>12,600</td>
<td>166</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>(including transportation)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Administration</td>
<td>8,600</td>
<td>113</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>(Planning, reporting, and analysis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labour*</td>
<td>4,200</td>
<td>55</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Helicopter</td>
<td>2,900</td>
<td>38</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Travel Expenses</td>
<td>2,700</td>
<td>36</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>31,000</td>
<td>408</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: *Cominco labour rates include overhead, vacation/sick leave, and administration levy costs. Bluebell costs were incurred in 1977 and 1978.
PINCHI LAKE OPERATIONS

Location and History

Pinchi Lake Operations is located on the north shore of Pinchi Lake, about 50 kilometres northwest of Fort St. James and 160 kilometres northwest of Prince George. The mine was first operated by Cominco during 1940-44 and produced 53,000 flasks of mercury from 700,000 tons of ore (1 flask=76 pounds). The mine was re-built in 1968 and produced close to 2 1/2 million tons of ore and 176,000 mercury flasks before shutdown in 1975 (7). Cinnabar ore was mined by open pit and underground methods from the Pinchi limestone outcrop and treated in a concentrator and roaster.

Ecological Setting and Land Use Capability

The mine is situated within the Sub-Boreal Spruce Zone at an elevation of 716-814 metres (5). The climate is characterized by cold winters and a short growing season. Annual precipitation averages 46 centimetres with 2.5-5 centimetres per month during the growing season (4). Forests on the Pinchi outcrop are dominated by Lodgepole Pine, Trembling Aspen, and scattered White Spruce, Black Spruce, Douglas Fir, Cottonwood, Birch, and Alder trees. Soil parent materials vary from fine-textured glacio-lacustrine silts near the lakeshore to shallow coarse-textured glacial till and colluvium at higher elevations (8).

The Pinchi Lake area is reported to have moderately high outdoor recreation capability near the lakeshore and is an important winter range for moose (9). Forest capability on the Pinchi outcrop is low.

Nature and Extent of Land Disturbance

The total land disturbance at Pinchi Operations is 200 acres consisting of about 34 acres of open pits and waste rock dumps, a 60 acre tailings
disposal area, and 106 acres of other disturbances such as roads, the industrial site, lagoons, portals, etc. Twenty-five percent of the disturbance consists of tailings, 25% of waste rock, and about 50% of disturbed soils.

During mine shutdown, hazardous chemicals were removed from the property, mine portals were blocked, the West Zone Pit was fenced, the tailings dyke was raised, and a spillway was constructed to control drainage overflow from the tailings pond. A watchman-caretaker currently resides at the site.

Reclamation Plan

Objectives. The objectives of revegetation were to improve plant growth conditions on disturbed mined-land to encourage succession of self-sustaining native and naturalized plant communities. An initial vegetative cover of suitably adapted grasses and legumes were established using commercial fertilizer. This was intended to rapidly stabilize waste surfaces against erosion and improve the appearance of the site.

Approach. The revegetation approach was based on a laboratory growth room and field research studies conducted since 1970, in accordance with the surface work permit. Pertinent results will be briefly summarized.

Disturbed soils and parent materials were revegetated naturally within 2-5 years following disturbance. Natural regeneration was unsatisfactory on waste rock and tailings. Application of the plant nutrients nitrogen and phosphorus as commercial fertilizer was essential for establishment and growth of both native and commercial plant species on waste rock and tailings.

Rambler Alfalfa, Alsike Clover, Canada Bluegrass, Creeping Red Fescue, Timothy, Hard Fescue, and Crested Wheatgrass were established and grew
satisfactorily on waste rock and tailings, and produced seed during seven growing seasons of evaluation. Grasses and legumes were established by broadcast application of seed and fertilizer with no site preparation. Legumes and legume-grass mixtures have provided satisfactory vegetative cover, biomass, and seed production for four growing seasons, since the discontinuation of maintenance fertilizer applications.

During the first few growing seasons, invasion of dense legume-grass cover by native plants was limited by competition. Eventually as cover decreased, invasion of native plants accelerated.

The mercury content of grasses and legumes grown on waste rock and tailings was slightly elevated compared to values reported for the same species grown on normal soils; but was lower than values for vegetation growing in the vicinity of mercury mineralization in B.C. (10, 11).

Implementation. Reclamation at Pinchi has been on-going for a number of years. In 1971, roadcuts, a borrow pit, and portal entrances totalling 15 acres were hydroseeded. Mulch, ammonium nitrate-phosphate fertilizer (24-24-0), and a seed mixture were broadcast at 1120, 233 and 84 kilograms per hectare respectively.

In 1973, the 4-acre West Zone Pit waste dump was revegetated using a pull-type fertilizer applicator and pick-up truck. Before seeding ammonium phosphate, ammonium nitrate and muriate of potash fertilizer were surface broadcast to supply 56 kilograms per hectare N, 112 kilograms per hectare P₂O₅ and 56 kilograms per hectare K₂O. The seed mixture was surface broadcast at 112 kilograms per hectare. Maintenance fertilizer applications of 466 and 233 kilograms per tare applied as 24-24-0 were surface broadcast using hand-operated cyclone spreaders in May 1974 and 1975.

In May 1978, 76 acres consisting of the tailings disposal area, open pits, waste rock dumps, and areas not likely to be disturbed during l
removal of surface structures were revegetated using a Jet Ranger helicopter. Saturated tailings conditions in spring limited access of conventional seeding equipment.

Materials were broadcast on waste surfaces without site preparation. A complete fertilizer (13-16-10) was broadcast on waste rock and tailings at 431 and 862 kilograms per hectare respectively. A Rambler Alfalfa (30%), Alsike Clover (20%), Creeping Red Fescue (25%), Redtop (10%), and Canada Bluegrass (15%) mixture was broadcast at 56 kilograms per hectare.

Fertilizer and seed were applied as follows:

a) at the staging area a 4-man crew loaded 700 pounds of fertilizer or 300 pounds of seed in 30 seconds into two 45-gallon barrels attached to each side of the helicopter.

b) a fifth person lined up the flight path of the helicopter to control material application.

c) application rates were controlled by the helicopter engineer by sliding a metal plate to vary the size of opening on the bottom of each barrel, and by varying altitude and speed. At 200 feet altitude and 25 miles per hour, materials covered a 25-foot wide strip.

d) the total time required to load, fly to the site, apply materials, and return to the staging area varied from 4 1/2 to 5 minutes.

e) the staging area was generally about one half mile from the point of material application.

Twenty-five tons of fertilizer and 2.2 tons of seed were applied by helicopter in 7 hours; 1.6 hours were required to fly the helicopter to and from Prince George.
Seed and fertilizer applications were uneven in some areas. To improve coverage on these areas, cyclone spreaders were used. This will be remedied in the future by using two people to align the helicopter and by using proper cyclone applicators mounted on the helicopters.

By late October 1978, waste rock and tailings were covered with relatively uniform seedling populations. Seedlings did not establish satisfactorily on waste rock left at the natural angle of repose, or where seed and fertilizer applications were uneven. Fertilizer accelerated the regeneration of native conifer and deciduous seedlings on waste rock. On tailings, the invasion of native Nuttall's Alkaligrass was promoted by fertilizer. Establishment of Creeping Red Fescue and Redtop was satisfactory on portions of the tailings pond; but legume establishment was poor and confined to cracks. Relatively poor establishment of legumes on tailings was attributed to a drier than normal summer.

Costs. Reclamation costs since 1970 have totalled 108,000 dollars, including 69,000 dollars spent on research and administration and 39,000 dollars spent on operational reclamation. Reclamation costs during 1978 totalled 31,000 dollars or 408 dollars per acre (see Table 1).

The 1979 reclamation program will include helicopter application of maintenance fertilizer to areas seeded in 1978 and tree planting in selected locations.

Dismantling and removal of tailings and surface structures will begin in 1979. Reclamation of the remaining land disturbance will be carried out when site clean-up is completed.
REFERENCES


DISCUSSION RELATED TO ERIC STATHEFS AND R.T. GARDINERS' PAPER

Neil Duncan, Energy Resources Conservation Board. Why did you leave the concrete foundations at the Bluebell mining site.

ANS. The land use for the area had not been decided, and it was felt by some people that the foundations may possibly be used for future buildings. Also, the cost of hauling materials away would have been quite high.

Kerry Clark, Arcon Associates. I wonder if the vegetation that grows on these sites is suitable as a crop or does it contain metal residue.

ANS. Yes, the vegetation contains metal residue. We have monitored the vegetation annually for nutrient content and metal content and have reported the results to the Ministry of Energy, Mines and Petroleum Resources. In the case of the reclaimed vegetation grown at the Pinchi operations, the metal content is elevated compared to agricultural species grown elsewhere, but is similar in level to native shrubs and trees growing on the Pinchi rock outcrop.

Kerry Clark. Does that mean that it would be unsuitable as a forage crop.

ANS. I don't know, as I am not an expert in the area. All I am saying is that it's similar to the native vegetation growing in the area.