Proceedings of the 3rd Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1979.
The Technical and Research Committee on Reclamation

CURRENT REVEGETATION TECHNIQUES AT CRAIGMONT MINE

Paper presented

by:

L. Gavelin

Craigmont Mines Ltd.

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INTRODUCTION AND HISTORICAL BACKGROUND

Reclamation at Craigmont commenced in 1969. Dormant pit waste dumps and completed sections of the tailings toe dam were seeded and fertilized by aerial spraying; the method considered most economical and expedient at that time. A sprinkler irrigation system was installed on the tailings toe dam to maintain optimum moisture conditions during the dry period to sustain plant growth. The continuing reclamation program from 1969 to 1977, as outlined in Appendix I, basically consisted of maintenance of seeded areas as well as new seedings and fertilization as areas became available, including a test plot of hydroseeding on the dump slopes to determine if plant growth could be enhanced in this difficult area. The success of the reclamation program up to this time is best described as marginal, due to (1) the hit and miss nature of aerial spraying; (2) the compaction of the waste dump berms where either the seed was blown away or root development was impossible; and (3) overgrazing by cattle of the new plant life and subsequent loss of seed production. Very reasonable results were obtained on the tailings toe dam under irrigated conditions.

In 1978, a complete review of our program was undertaken and modifications made to hopefully improve and accelerate the results which would be conducive to returning the disturbed land to an economic use. The outcome was an intensified program to provide answers for our final reclamation program prior to our pending closure.

RECLAMATION IN 1978

The 1978 reclamation program consisted of:

1. the use of land-borne equipment to provide a more consistent plant cover.

2. Scarification of the compacted surface to enhance seed germination and plant growth.

3. Fence construction around the pit waste dumps to keep the cattle from grazing the area.

4. The setting up of five large test plots on the tailings impoundment area to test possible economic use and methods of establishing a self-sustaining plant growth.

Comparisons and results of the 1978 reclamation program with respect to past practices will indicate that our re-evaluation and revised procedures have been well founded by the initial results obtained. However, a total assessment will require 2 to 3 years of follow up.

Technical details regarding the tailings impoundment test plots is attached as Appendix II, as well as various seeding application costs relative to work done at Craigmont which is attached as Appendix III.

APPENDIX I

Seed and Fertilizer Mixtures and Application Rates for Reclamation Program to Date

(a) October 1969

Seeding and fertilization of 100 acres of south pit waste dump, 107 acres of north pit waste dumps and 14 acres of tailings dam (bottom 4 benches).

Seed mixture applied aerially at 76.6 pounds per acre

Annual Ryegrass	- 15%
Boreal Fescue	- 20%
Crested Wheatgrass	- 20%
Streambank Wheatgrass	- 8%
Slender Wheatgrass	- 10%
Pubescent Wheatgrass	- 7%
White Clover (double inoculated)	- 8%
Rhizoma Alfalfa	- 12%

Fertilizer 10-30-10 applied at 289 pounds per acre.

(b) April 1970

Re-fertilization of areas seeded in October 1969.

Fertilizer 20-20-10 applied at 200 pounds per acre.

(c) August 1970

Re-seeding and re-fertilization of 14 acres of tailings dam (bottom 4 benches) and 24 acres of south pit waste dumps previously seeded.

Seed mixture - as above applied aerially at 64 pounds per acre.

Fertiliser 10-30-11 applied at 211 pounds per acre.

(d) September 1971

Re-seeding and re-fertilization of 14 acres of tailings dam benches (bottom 4 benches) and re-fertilization of 207 acres of pit waste dumps initially seeded in 1969.

Seed mixture - applied aerially at 36 pounds per acre.

Creeping Red Fescue	- 19%
Annual Ryegrass	- 16%
Crested Wheatgrass	- 32%
White Clover (double inoculated)	- 16%
Rhizoma Alfalfa (double inoculated)	- 16%

Fertilizer 13-16-10 applied at 200 pounds per acre.

(e) September 1972

Seeding and fertilization of 100 acres of north pit waste dumps

Seeding mixture applied aerially at 70 pounds per acre.

Tetraploid Perennial Rye	- 5%
Annual Ryegrass	- 5%
Perennial Ryegrass	- 3%
Creeping Red Fescue	- 15%
Crested Wheatgrass	- 10%
Pubescent Wheatgrass	- 15%
Tall Wheatgrass	- 15%
Intermediate Wheatgrass	- 5%

Sainfoin	- 5%
Trefoil	- 7%
Rhizoma Alfalfa	- 15%

Fertilizer 19-19-19 applied at 200 pounds per acre.

(f) 1976

Based on results of tailings dam soil samples, the 14 acres (bottom 4 benches) were re-seeded, re-fertilized and the remaining 6 acres (the two top benches) of the tailings dam were seeded and fertilized.

Seed mixture applied by broadcasting with a hand cyclone seeder at 80 pounds per acre.

Creeping Red Fescue	- 19%
Annual Ryegrass	— 16%
Crested Wheatgrass	- 33%
White Clover (double inoculated)	- 16%
Rhizoma Alfalfa (double inoculated)	- 16%

Fertilized 19-19-19 at 210 pounds per acre,

(g) 1977

Hydroseeded four test plots totalling 5 acres of pit waste dumps

Seed mixture applied by hydroseeding at 85 pounds per acre.

Fall Rye	- 41%
Nordan Crested Wheatgrass	- 12%
Streambank Wheatgrass	- 12%
Creeping Red Fescue	- 12%
Hard Fescue	- 5.5%

Cicer Milkvetch	- 5.5%
Sweet Clover	- 12%

Fertilizer 12-15-15 applied at 200 pounds per acre.

1977 seeding and fertilizing of the two top benches of the tailings dam:

Seed mixture applied by range drill 50 pounds per acre on one bench and 100 pounds per acre on the other.

Sainfoin	- 20%
Roamer Alfalfa	- 20%
Cicer Milkvetch	- 20%
Crested Wheatgrass	- 15%
Slender Wheatgrass	- 10%
Streambank Wheatgrass	- 5%
Annual Ryegrass	- 10%

Fertilizer 28-16-10 at 300 pounds per acre.

Seeding of test plots on bench of tailings dam:

Plots 1-7 - Seed applied by broadcasting with a hand Cyclone Seeder at 100 pounds per acre.

7 plots each seeded with one of the seeds comprising the above mixture.

Fertilizer 28-16-10 at 300 pounds per acre.

Plot 8 - Seed mixture as above at 100 pounds per acre.

Fertilizer - none.

APPENDIX II

Tailings Impoundment Test Plots

This report details the sequence of work done with the results to-date from the test plots on the west side of the tailings disposal, outlines the work for 1979, and sets out the objectives of the test program.

I. Green Manure Plots - Three, 1-acre plots

These plots will determine which combination of fast growing plants provides a good green manure for improved soil texture and, in conjunction with the barley test plots, will determine the most appropriate method of establishing a permanent crop. The green manure plots were irrigated as required (except for a dry period at the start of the growing season that may have inhibited growth) to provide optimum moisture conditions for the growing season. For the purpose of this report, the green manure plots will be identified as follows:

G1 - Cereal and legume mix - 86% Oats, 14% Austrian Peas.

G2 - Legume mix - 72% Sweet Clover, 28% Red Clover

G3 - Grass and legume mix - 48% Annual Tetraploid Ryegrass, 18% Sweet Clover, 40% Spring Vetch.

The following sequence of work was done to each plot:

- 150 pounds of 20-24-15 fertilizer applied to each G1 and G3
- 175 pounds of 8-20-20 fertilizer applied to G2.
- The ground plowed.
- 150 pounds of 20-24-15 fertilizer applied to each of G1 and G2.
- 175 pounds of 8-20-20 fertilizer applied to G2.

- The ground harrowed twice.
- The Cereal-Legume mix seed at 100 pounds per acre in plot Gl
- The Legume mix seeded at 16 pounds per acre in plot G2.
- The Grass-Legume mix seeded at 45 pounds per acre in plot G3
- The ground compacted.

July (plot Gl only)

- 125 pounds of 21-0-0 fertilizer applied.
- The growth plowed under.
- 425 pounds of 13-16-10 fertilizer applied.
- The ground harrowed.

— The Cereal-Legume mix again seeded at 100 pounds per acre.

September

- The growth on plots Gl, G2, and G3 were plowed under.

October

- The plowed ground harrowed twice.
- Each plot divided in half and seeded at 15 pounds per acre with a permanent seed mix.
- Fall barley seeded at 65 pounds per acre to half of each plot seeded with permanent seed mix.

Observations to Date

1. The Red Clover died out in the Legume mix of plot G2.

2. The most dense growth and sod formation was achieved by the grass and legume mix of plot G3.

3. The strongest individual plant growth was achieved in the Sweet Clover of plots G2 and G3 - averaging ±3-1/2 feet in height.

4. A strong growth of nitrogen fixing bacteria nodules developed on the Legume roots of all three plots.

5. The soil texture has improved from the turning under of the first planting of Oats and Austrian Peas in plot Gl.

6. The Oats and Austrian Pea mix of plot Gl was the only mix that grew quickly enough to allow a second planting in one growing season.

Program for 1979

1. Seeding the remaining half of the plots in the spring of 1979.

2. Apply additional fertilizer if soil samples indicate a lack of nutrients.

3. Supply irrigation in varying amounts to determine what additional moisture is necessary to establish growth.

Objectives for 1979

To determine:

1. Which seeding program will give the best results.

2. If a cover crop is necessary to establish growth.

4. The irrigation requirements to establish permanent growth.

5. The fertilizer requirements necessary to establish growth.

The special permanent seed mix recommended by Bob Donaldson of Buckerfield's consists of 5% Alfalfa, 10% Sainfoin, 5% Cicer Milk-vetch, 25% Crested Wheatgrass, 25% Russian Wild Ryegrass, 25% Streambank Wheatgrass and 5% Troy Kentucky Bluegrass.

lla Barley Plots (Ploughed) Two - 1-acre plots

These plots were established to see if a commercial crop could be grown, to compare growth obtained by irrigation versus natural moisture conditions, and to determine if a cover crop would assist the growth of a permanent grass and legume mix. Irrigation was applied to maintain optimum moisture conditions on the one plot for the growing season.

The following sequence of work was done on each plot:

April

- 150 pounds of 13-16-10 fertilizer applied to each plot.
- The ground plowed.
- 150 pounds of 13-16-10 fertilizer again applied to each plot.
- The ground harrowed twice.
- Craigmont #5 mix seeded on half of each plot at 35 pounds per acre.
- Spring barley seeded in each plot at 75 pounds per acre.
- The ground compacted.

June

- 21-0-0 fertilizer applied at 50 pounds per acre to half of each section in both plots.

September

- Craigmont #5 mix seeded at 30 pounds per acre to the half of the plots not seeded in April with Craigmont #5 mix.

October

- Fall barley seeded at 65 pounds per acre to the half seeded with Craigmont #5 mix in September.

Observations to Date

1. Water is a major factor limiting growth in the dryland plot. The Legumes established fairly well, but the Grasses showed minimal growth.

2. The over-all Barley growth was good but could have used additional fertilizer.

3. The grass and legume mix did establish growth under dryland and irrigated conditions.

4. A stronger grass and legume growth was established with irrigation.

5. The fertilizer application and Barley seeding rate would have to be greatly increased for a commercial crop.

6. The Barley growth did provide protective cover for the seedling growth of the grass and legume mix.

11b. Barley Plots (Harrowed) Six plots totalling 7 acres The purpose of these plots is to determine tillage requirements, optimum time of seeding, and the necessity of irrigation to establish a permanent grass and legume forage crop.

The following sequence of work has been completed on 31/2 acres.

October

- 13-16-10 fertilizer applied at 300 pounds per acre
- The ground harrowed
- Craigmont # 5 mix seeded at 24 pounds per acre.
- Fall barley seeded at 65 pounds per acre.

Program for 1979

1. Fertilize, harrow and seed the remaining 3 1/2 acre test area in spring 1979.

2. Provide irrigation to approximately half of the fall 1978 and spring 1979 "harrowed" Barley plots.

3. Sub-divide the "ploughed" and "harrowed" Barley plots to test the effect on plant growth of varying amounts of fertilizer.

4. Provide irrigation to part of the "ploughed" Barley plot irrigated in 1978.

Test Program Objectives

To determine:

1. Which seeding program will give the best results.

2. The effect of tillage and fertilizer placement.

3. The amount of irrigation required.

4. The fertilizer requirements necessary.

5. If growth can be established and maintained without using "green manures".

6. The effect of the previous year's growth as a mulch.

7. If irrigation is required only for one year to establish permanent growth.

The Craigmont #5 seed mix consists of 5% Hard Fescue, 10% Tall Wheatgrass, 20% Creeping Fescue, 20% Crested Wheatgrass, 20% *Alfalfa* and 25% Sainfoin.

APPENDIX III

1978 RECLAMATION COST COMPARISON FOR VARIOUS SEEDING METHODS

	Helicopter	Aircraft	Dept. of Ag. Heavy Duty Range Drill	Tractor Cyclone Spreader	Tractor Cyclone Spreader & Harrow	Hand Cyclone 1 a/day	Hand Cyclone & Rake
(Seed & Fert.) Application	$19/a	$17/a	$45/a	$12.50/a	$15/a	$60/a	$120/a
Seed Rate & $	100/a $91	100/a $91	20#/a $18	20#/a $18	20#/a $18	40#/a $36	40#/a $ 36
Fert. Rate	300#/a $24	400#/a $32	100#/a $8	100#/a $8	100#/a $8	200#/a $16	200#/a $16
Total $	$134	$140	$71	$38.50	$41	$112	$172
Additional Fert. with Tractor and Cyclone Spreader	-	-	$13/a	$13/a	$13/a	-	-
TOTAL $	$134	$140	$84	$51.50	$54	$112	$172

DISCUSSION RELATED TO LLOYD GAVELIN'S PAPER

Frank Pells, Brenda Mines Ltd. Have you used any reclaim water for irrigation.

ANS. The water used for irrigation on the toe dam was the reclaim water. The water used on the test plots was the cooling water from the compressors.

Question; Have you encountered Knapweed.

ANS. Well the Nicola valley is a major Knapweed infested area of B.C. and we are surrounded with it. It is encroaching on some of the toe dams at the present time. Looking at Knapweed as a cover crop, it certainly does well on disturbed lands.

Harry Quesnel, University of British Columbia. I was wondering what frequency of irrigation you were using and approximately how much water per acre you applied.

ANS. We had six lines on the test plots and we ran them on an eight-hour cycle; however, if I felt that it was not necessary to irrigate we omitted it for a period of time. So in general, I would say that in a 10 to 14—day cycle the total water applied per acre would be about one acre-foot. I would hazard a guess that if you calculated out the moisture requirements for the area it would work out to about three acre-feet.