Developing Agricultural Opportunities on Mine Tailings: The Green Mines Green Energy Initiative

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15th Annual BC MEND Workshop
The Management of Tailings and Tailings Impoundments
December 3 - 4, 2008
Simon Fraser University, Vancouver, B.C.
Goal of GMGE

➢ To advance mine reclamation through the beneficial use of organic residuals for the sustainable establishment of bioenergy crops and other productive land uses
Target Organic Residuals

- Source Separated Organic (SSO) compost
- Papermill biosolids
- Leaf and yard waste compost
- Municipal wastewater biosolids
Potential Uses/Species

- Ethanol e.g. corn, soybeans
- Biodiesel e.g. canola
- Solid fuel – pellets e.g. switchgrass
- Biogas e.g. corn, canola, switchgrass etc.
- Fibre – switchgrass
- General reclamation – biodiversity, wetlands

Source: http://itsgettinghotinhere.org
Current Participants

**Mining:** Xstrata Nickel, Vale Inco, Goldcorp (PGM), BHP-Billiton, Barrick Gold, Highland Valley Copper, Cape Breton Development Corporation

**Forestry:** Domtar, St. Marys Paper, Abitibi Consolidated

**Government:** Natural Resources Canada, Agriculture Canada, Ont. Ministry of Agriculture Food & Rural Affairs, Ont. Ministry of Environment (observers)

**Academia/Other:** Laurentian University/MIRARCO, Cape Breton University, Alberta Research Council, Sylvis, City of Greater Sudbury, City of Toronto (observers)
Scope of the Initiative

Four main target areas:

- Impact of Organic Residuals on Tailings
- Quantity and Quality of Biomass
- Economic Feasibility
- Communication, Public Education and Technology Transfer
Progress to Date

• “Consortium” established (continuing)

• Laboratory studies
  ➢ Leaching columns
  ➢ Effluent treatability
  ➢ Effluent toxicity
  ➢ Growth study

• Field studies
• Communications
Column Study - Methods

- 10” diam. Lexan columns (duplicate)
- 4 Scenarios
  - Tailings control
  - Control + 20 cm biosolids
  - Control + 100 cm biosolids
  - Tailings/biosolids mix (Au tails only)
  - Biosolids control
- Simulate full tailings profile rather than just near-interface
Column Study - Methods

- Filter fabric, silica sand and polyethylene beads added to base of columns
- Unoxidized tailings were slurried and pumped into columns
- Oxidized tailings were dried and homogenized
Column Study
Acidic Cu/Ni Tailings – No Lime

**Nickel**

**Iron**
Acidic Cu/Ni Tailings – Limed

Nickel

Iron

Inco Control

1 Metre Domtar

Limed 1 Metre Domtar

1 Metre St Marys

Limed 1 Metre St Marys

Ni (ppm)

Fe (ppm)
Acidic Cu/Ni Tailings – Limed

**Sulphate**

![Graph showing sulphate over time for different locations and treatments.]

**Acidity**

![Graph showing acidity over time for different locations and treatments.]

- Inco Control
- 1 Metre Domtar
- Limed 1 Metre Domtar
- 1 Metre St Marys
- Limed 1 Metre St Marys

**Month**

- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16
- 18
- 20
- 22

**Sulphate (ppm)**

- 0
- 5,000
- 10,000
- 15,000
- 20,000
- 25,000
- 30,000
- 35,000

**Acidity (mg/L)**

- 0
- 5,000
- 10,000
- 15,000
- 20,000
- 25,000

**Note:** Graphs depict the changes in sulphate and acidity levels over a period of time for various locations and treatments, with data points showing the measured levels at different months.
Column Study – Summary of Findings

- Sulphate reduction appears to be occurring near the biosolids/tailings interface
- Organic covers appear to increase metal and arsenic leaching from unlimed tailings
- Liming tailings prior to covering can significantly decrease metal leaching, depending on material
- Nutrient management must be considered

➢ Compare results to groundwater monitoring from field trials
Demonstration Field Plots

1) Vale Inco – Copper Cliff
   - Papermill Biosolids (St. Marys)
   - Papermill Biosolids (Domtar)

2) Goldcorp (PGM in Timmins)
   - Papermill Biosolids (Abitibi Consolidated)

3) Xstrata Nickel - Onaping
   - Compost (Toronto)

4) Cape Breton Development Corporation
   - Compost (crab shells + organics)

5) Highland Valley Copper
   - Municipal Biosolids (Metro Vancouver)
Biosolids Delivery (Winter 2008)
Tilling (May 2008)
Vale Inco - St. Marys Plot

~3,500 m³ delivered and spread
Canola: Sept. 29, 2008
Corn – September 30, 2008
Monitoring

- Groundwater
- Weather (temperature, precipitation, solar radiation, and wind speed and direction)
- Temperature and moisture profiles
- Gas flux
Biomass Sampling

Ten randomly sampled 5m x 5m cells for both canola and corn

- Biomass yield (relative to agricultural control)
- Metal content
- Biofuel potential (oil/sugars)
Harvesting (November 2008)
Canola Height

Tailings
Agr. site

Plant Height (cm)

July '08  Aug. '08  Sept. '08

0  20  40  60  80  100  120  140  160  180  200

Courtesy: Tamara Posadowski
Corn Height

- Tailings
- Agr. site

Plant Height (cm)

July '08  Aug. '08  Sept. '08

Courtesy: Tamara Posadowski
Biomass Yield (Fresh Weight)

![Graph showing biomass yield for Corn and Canola in Tailings and Agricultural Site with Courtesy: Tamara Posadowski.]
Porcupine Gold Mines - Delnite

[Images of the Porcupine Gold Mines area, showing different views and landscapes.]
Xstrata Nickel - Strathcona
Broughton - CBDC

- Crab shell compost
- Focus on switchgrass
- Solid (pellet) fuel
Highland Valley Copper, B.C.

- Using sewage biosolids
- Semi arid
- Elevation ~1,268m (Ottawa ~70m)
- 119 mm rain in 2007 – well below normal (237 mm)
- 92 mm over growing season (Ottawa ~455 mm)
Next Steps

- Complete construction of current suite of field plots and implement full monitoring

- Complete 5 year Strategic Plan
  - scope depends on funding available
  - establish Steering/Advisory Committee
  - literature review on utilization of organic residuals for mine reclamation
  - review of availability of organic residuals in Canada and overlap with mining sector
  - communications plan e.g. website
Acknowledgements - People

- Tamara Posadowski, Graduate Student, Laurentian University
- Jennifer Hargreaves, Research Fellow, MIRARCO, Laurentian U.
- John Kwong, Research Scientist, CANMET-MMSL
- Janice Zinck, MWM Program Manager, CANMET-MMSL
- Bernard Vigneault, M&E Program Manager, CANMET-MMSL
- Cheryl Laviolette, Technician, CANMET-MMSL
- Stephanie Marshall, COOP student, Univ. of Ottawa
- Mike Peters, Quentin Smith, Lisa Lanteigne, Vale Inco
- Mike Soenens, Green Zone Farm
- Andre Perrault/Laszlo Gotz, Porcupine Gold Mines
- Joe Fyfe, Xstrata Nickel
- Gerard Shaw, Cape Breton Development Corporation
- Paul MacDougall, Cape Breton University
Acknowledgements - Organizations

PERM
Productivity Enhancement & Risk Management
Questions?

Tailings of the Future??

Now