

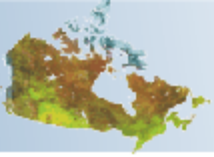
Developing Agricultural Opportunities on Mine Tailings: The Green Mines Green Energy Initiative

Bryan Tisch, Graeme Spiers, Peter Beckett, Alan Lock



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

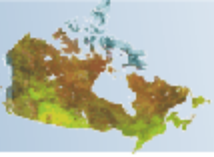




Goal of GMGE

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

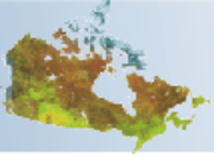




Target Organic Residuals

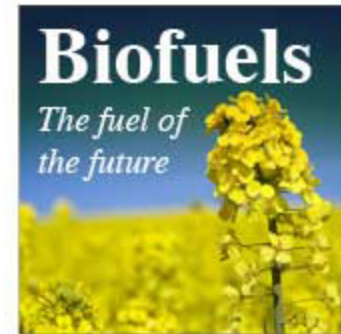
- Source Separated Organic (SSO) compost
- Papermill biosolids
- Leaf and yard waste compost
- Municipal wastewater biosolids





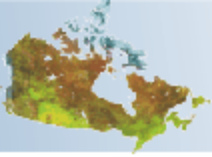
Potential Uses/Species

- 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

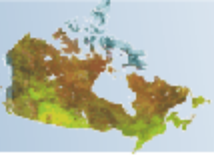
Mining: Xstrata Nickel, Vale Inco, Goldcorp (PGM), BHP-Billiton, Barrick Gold, Highland Valley Copper, Cape Breton Development Corporation

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)



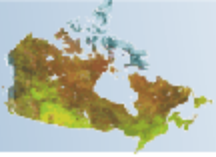


Scope of the Initiative

Four main target areas:

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

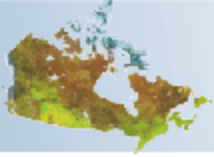




Progress to Date

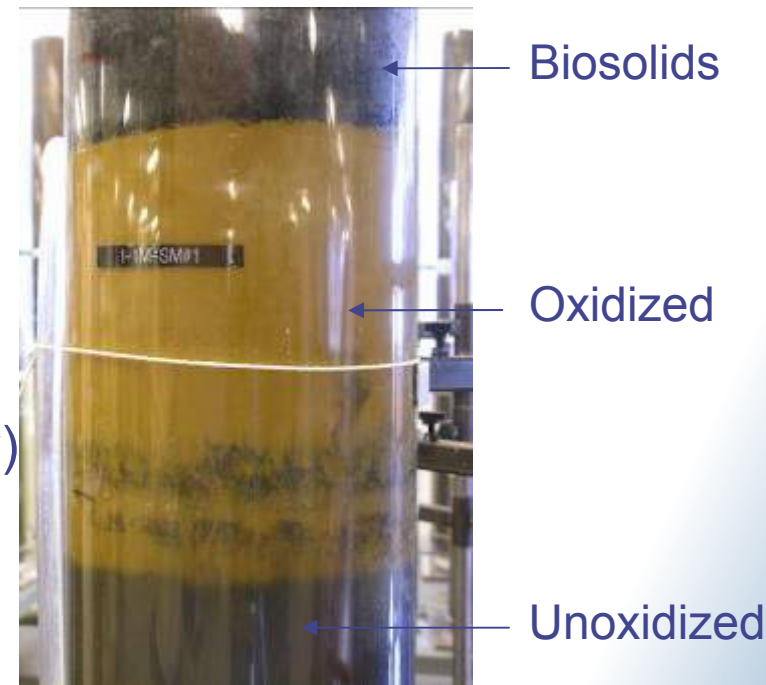
- “Consortium” established (continuing)
- Laboratory studies
 - Leaching columns
 - Effluent treatability
 - Effluent toxicity
 - Growth study
- Field studies
- Communications

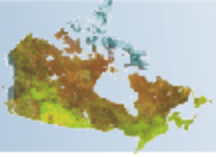




Column Study - Methods

- 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

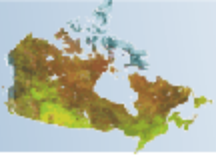




Column Study - Methods

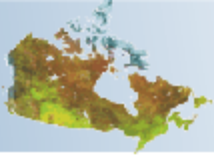
- Filter fabric, silica sand and polyethylene beads added to base of columns
- Unoxidized tailings were slurried and pumped into columns
- Oxidized tailings were dried and homogenized





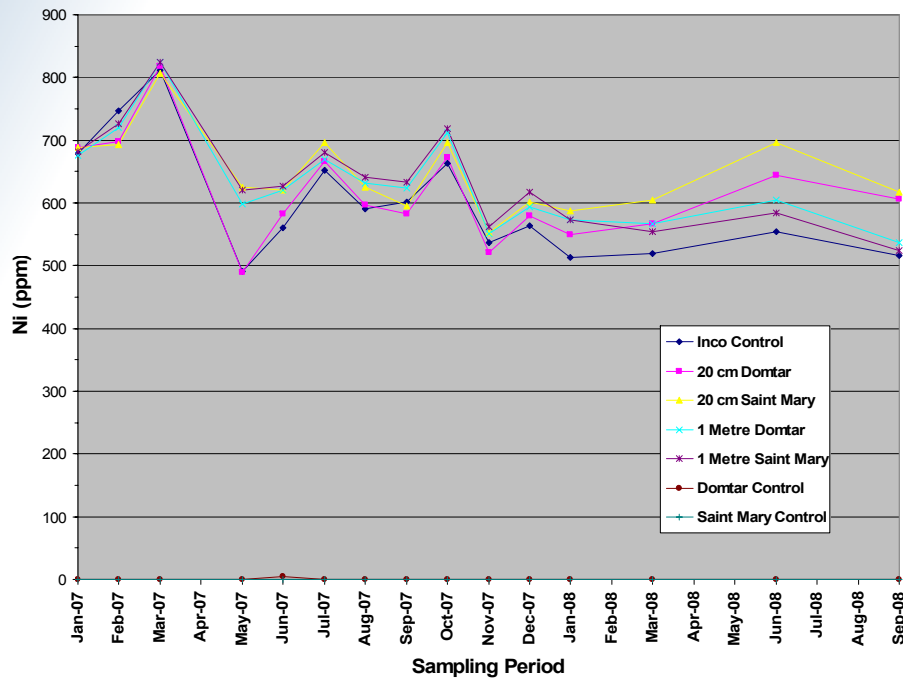
Column Study



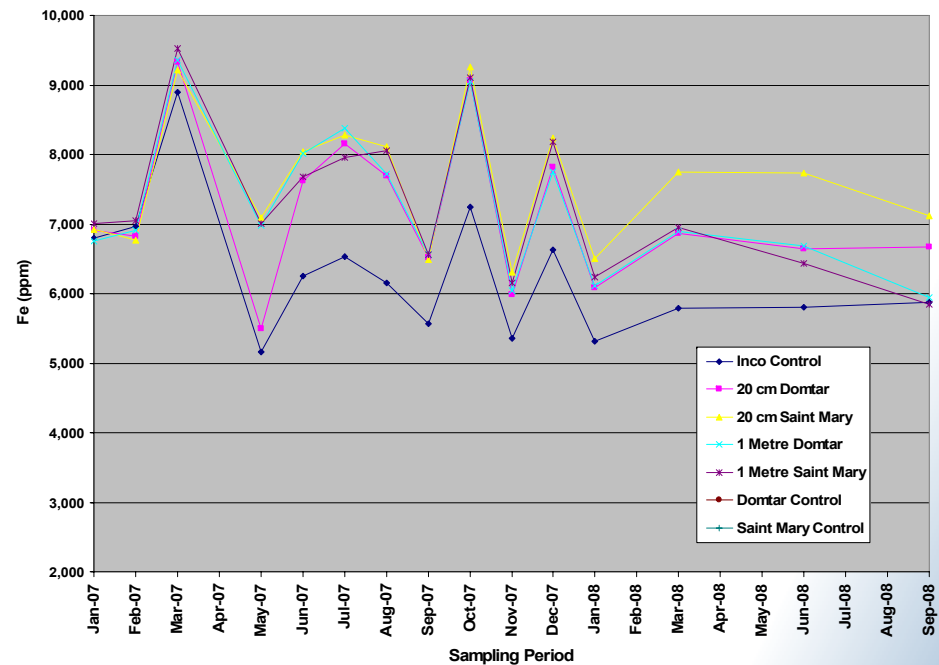


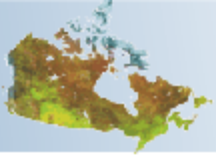
Acidic Cu/Ni Tailings – No Lime

Nickel



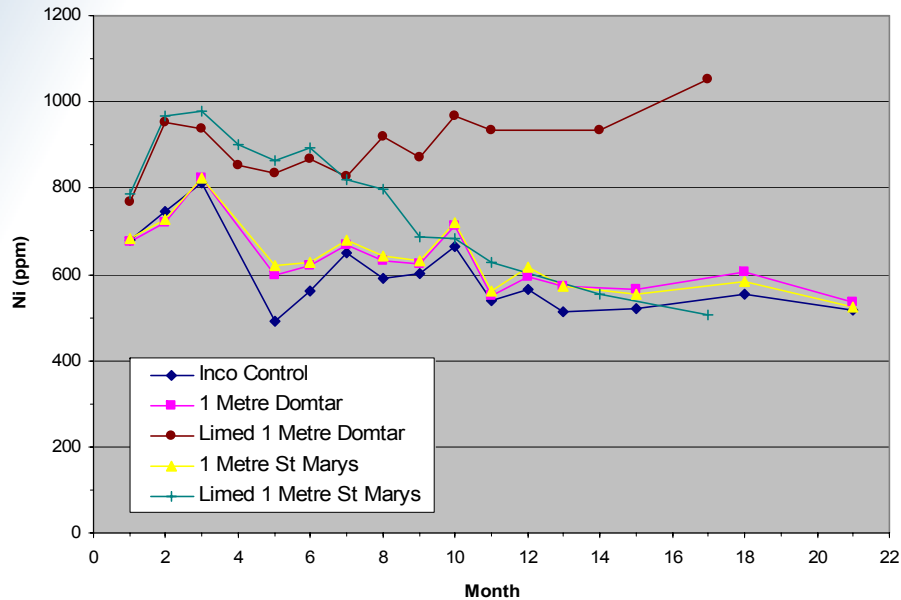
Iron



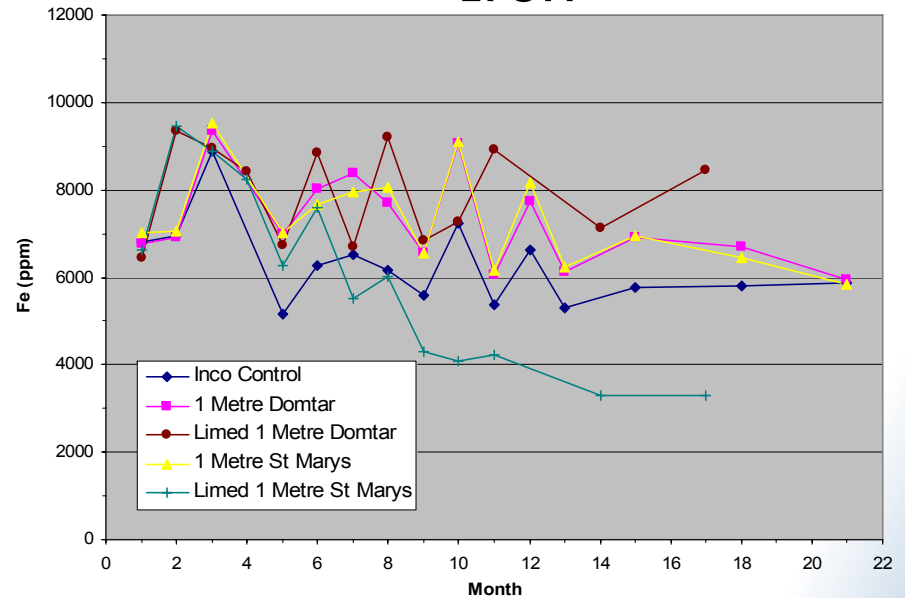


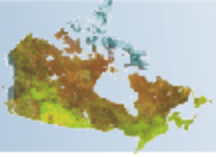
Acidic Cu/Ni Tailings – Limed

Nickel



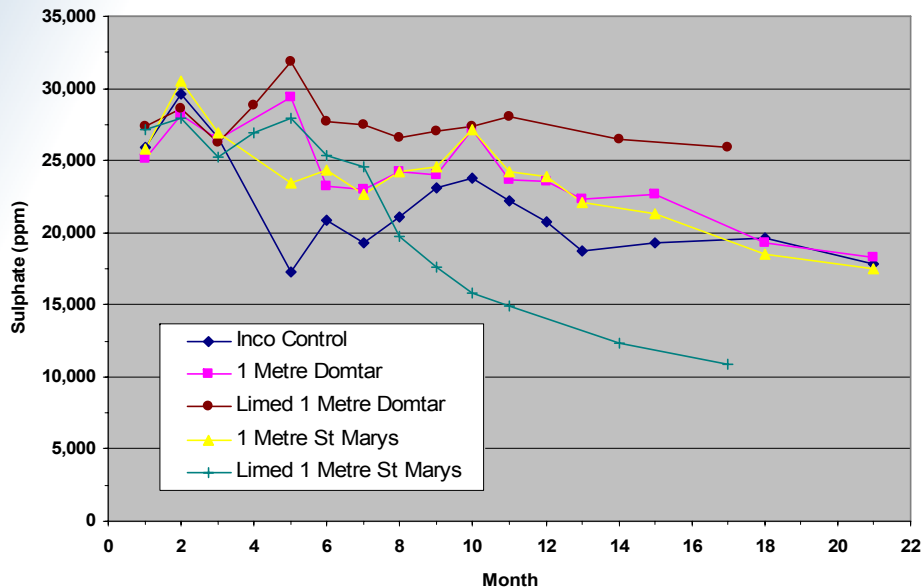
Iron



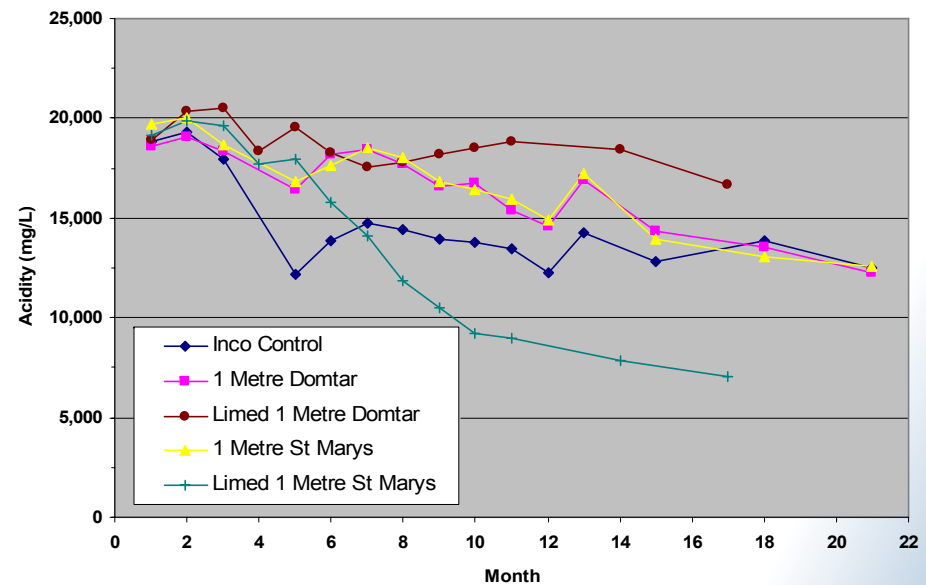


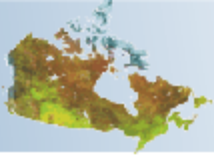
Acidic Cu/Ni Tailings – Limed

Sulphate



Acidity

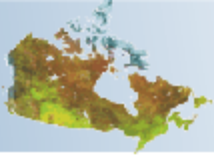




Column Study – Summary of Findings

- 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

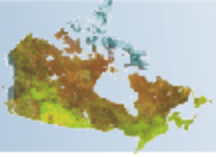




Demonstration Field Plots

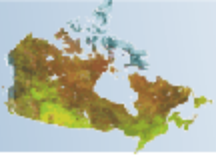
- 1) Vale Inco – Copper Cliff
 - **Papermill Biosolids (St. Marys)**
 - Papermill Biosolids (Domtar)
- 2) Goldcorp (PGM in Timmins)
 - Papermill Biosolids (Abitibi Consolidated)
- 3) Xstrata Nickel - Onaping
 - Compost (Toronto)
- 4) Cape Breton Development Corporation
 - Compost (crab shells + organics)
- 5) Highland Valley Copper
 - Municipal Biosolids (Metro Vancouver)





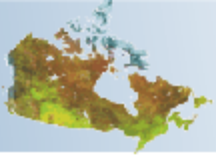
Biosolids Delivery (Winter 2008)





Tilling (May 2008)





Vale Inco - St. Marys Plot

~3,500 m³ delivered and spread

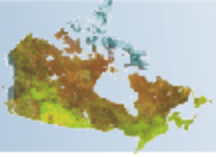


St. Mary's Plot July 10, 2008



Canola August 14th, 2008





Canola: Sept. 29, 2008

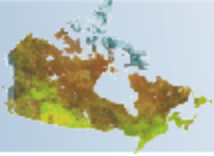


Corn July 29th, 2008



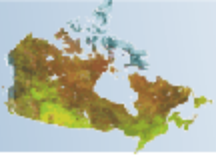
Corn August 14th, 2008





Corn – September 30, 2008

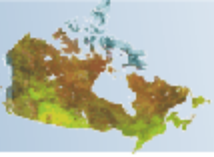




Monitoring

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

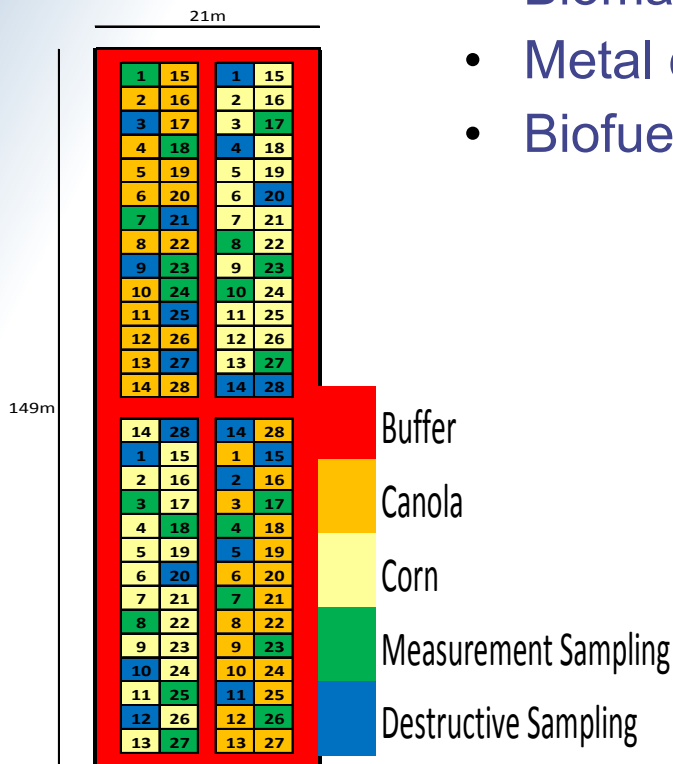


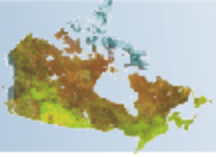


Biomass Sampling

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

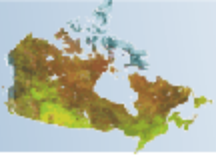
- Biomass yield (relative to agricultural control)
- Metal content
- Biofuel potential (oil/sugars)



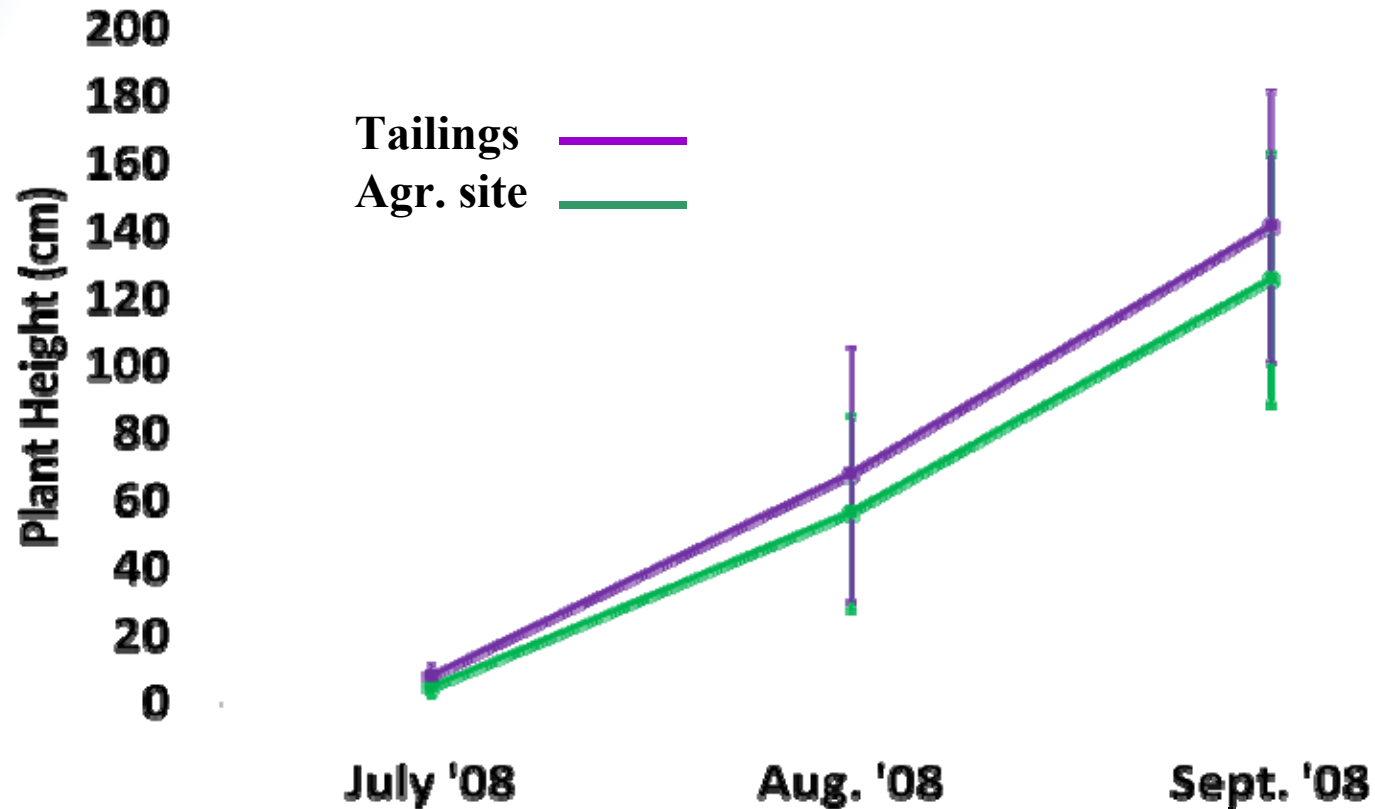


Harvesting (November 2008)



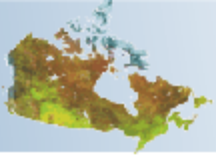


Canola Height

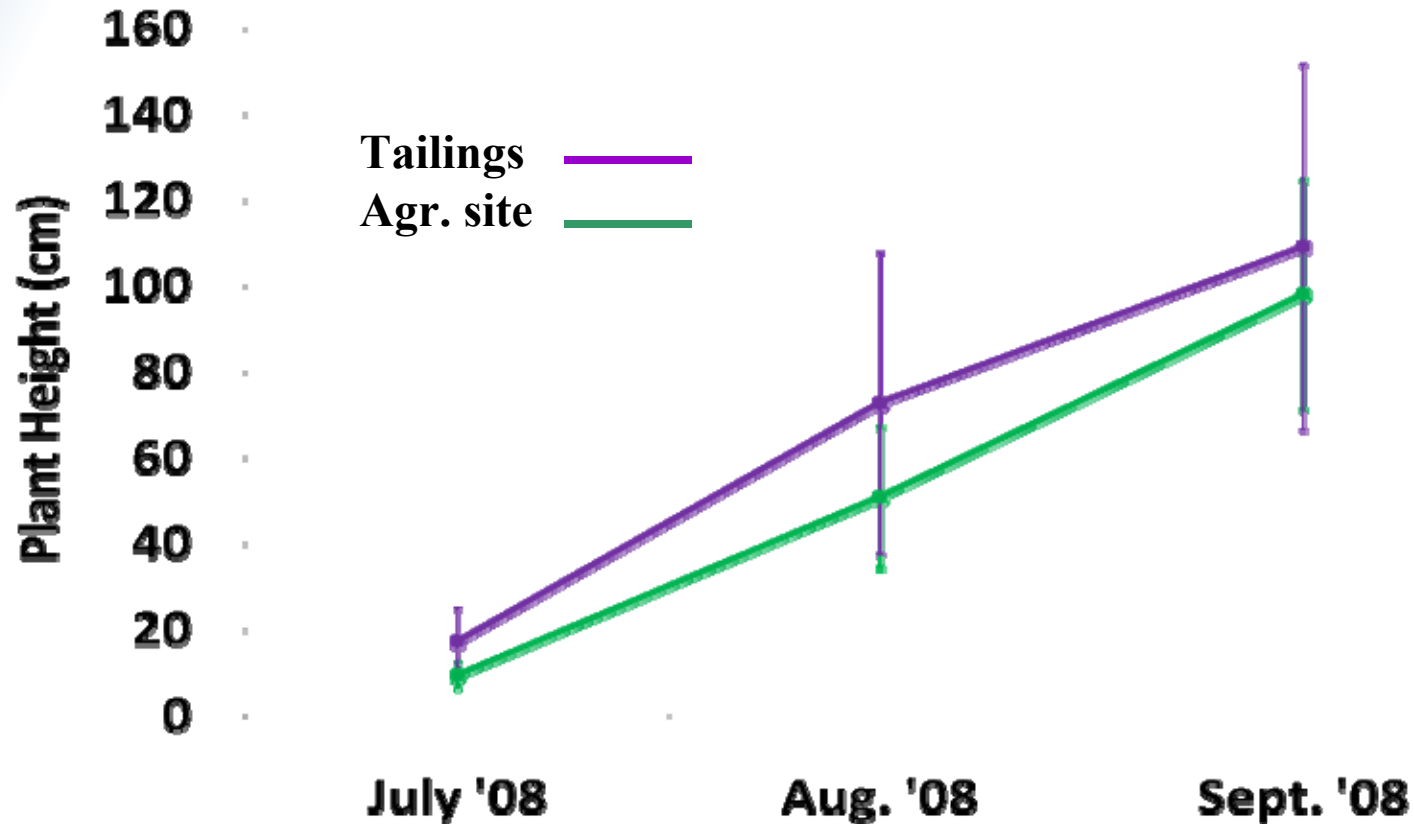


Courtesy: Tamara Posadowski



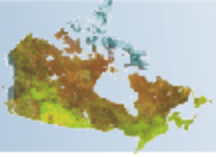


Corn Height

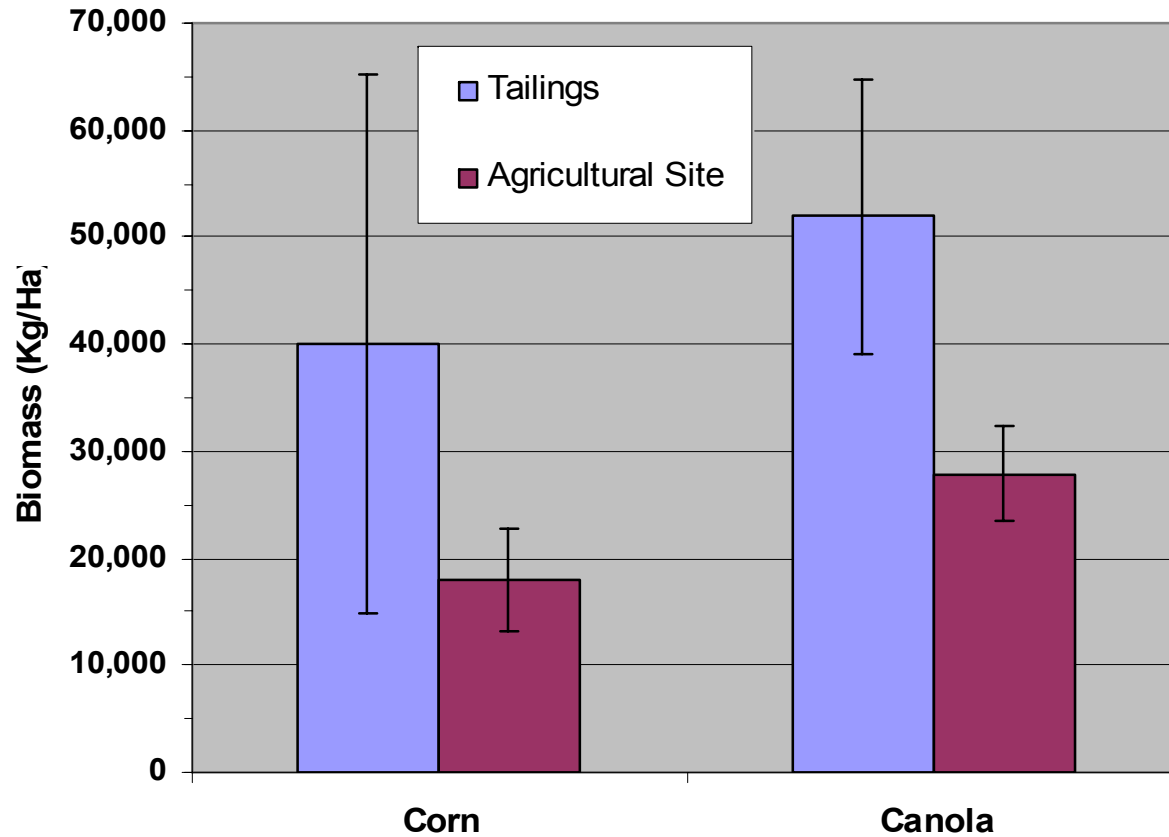


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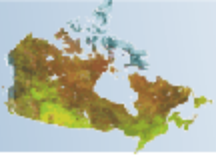


Biomass Yield (Fresh Weight)



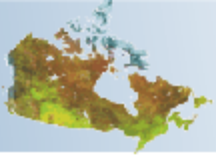
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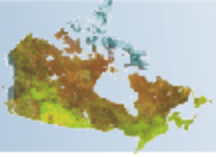
Porcupine Gold Mines - Delnorte





Xstrata Nickel - Strathcona



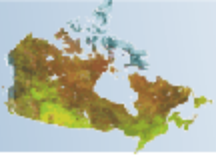


Broughton - CBDC



- Crab shell compost
- Focus on switchgrass
- Solid (pellet) fuel



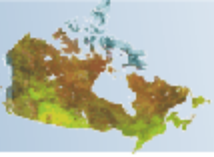


Highland Valley Copper, B.C.



- 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)

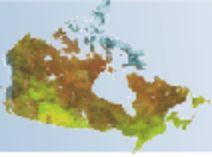




Next Steps

- 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

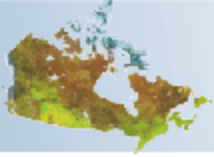




Acknowledgements - People

- Tamara Posadowski, Graduate Student, Laurentian University
- Jennifer Hargreaves, Research Fellow, MIRARCO, Laurentian U.
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- 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



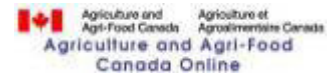


Acknowledgements - Organizations



Natural Resources
Canada

Ressources naturelles
Canada



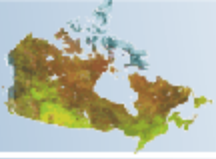
PERM
Productivity
Enhancement & Risk
Management



Natural Resources
Canada

Ressources naturelles
Canada





Now



Questions?

Tailings of the Future??

