Challenges Facing Phytoremediation in Canada: Strategies for Industry Acceptance

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ENVIRONMENTAL STRATEGIES INC
Remediating the past. Reclaiming our future.

Earthmaster Phytoremediation

We have successfully developed and deployed advanced phytoremediation systems across Canada, and more recently in the United States, for cost effective treatment of soil contaminated with petroleum hydrocarbons (PHCs), polycyclic aromatic hydrocarbons, and salt. Our plant growth promoting rhizobacteria (PGPR) enhanced phytoremediation systems (PEPSystems) create abundant root biomass, stimulate exponential growth of rhizobacteria which facilitate microbial degradation of organic contaminants and partitioning of inorganic contaminants out of the soil into plant foliage. PEPSystems have been successfully deployed on a commercial basis for over 10 years on numerous sites across Canada to remediate PHC and salt contaminants in soil. PEPSystems is a wise remediation choice at contaminated sites where soil volumes are large and landfill disposal is not feasible or desired. Regulators support this sustainable green technology since PEPSystems associated plant growth assimilates carbon (CO_2), has no carbon footprint, and conserves soil by 'cleaning' it. This is opposite to landfill burial which is most commonly used in Western Canada which transfers the associated liability rather than eliminating it. PEPSystems is an effective, low cost, and green bioremediation technology.

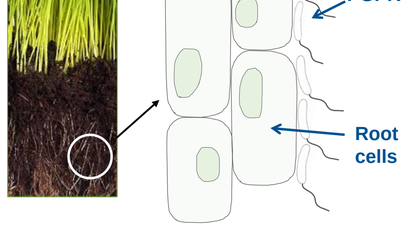
Commercial Applications of PEPSystems

Earthmaster has successfully remediated petroleum hydrocarbon and salt contaminated soil in diverse geographic settings throughout western Canada.

PGPR Selection

PGPR Criteria:

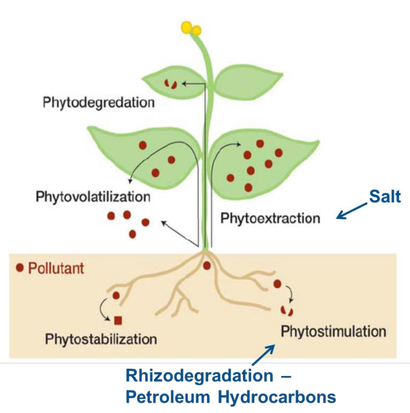
- Naturally occurring soil bacteria
- Geographically relevant
- Not genetically modified
- Biosafety level 1 / non-pathogenic
- High ACC deaminase levels - lowers stress ethylene in plants
- High auxin (IAA) levels – promotes plant growth



Plant Selection

Plant Criteria:

- Rapidly accumulates high biomass
- Extensive rooting system
- Common to geographic area and non-invasive
- Perennial vs. annual
- Wetland or dryland tolerance
- Cost and availability of seed
- Suitable for sowing with seed drill or broadcast spreader
- Treatable with commercial seed treater
- Harvestability (if required)
- Rate of regeneration after harvest
- Salt tolerance (if required)



Research & Development of New PEPSystems Applications

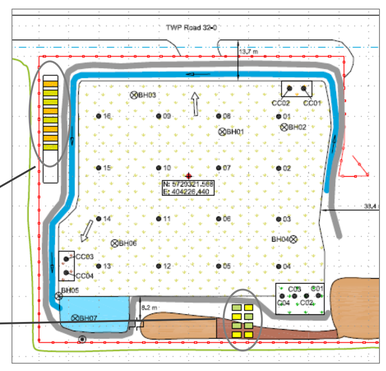
Enhanced Reclamation

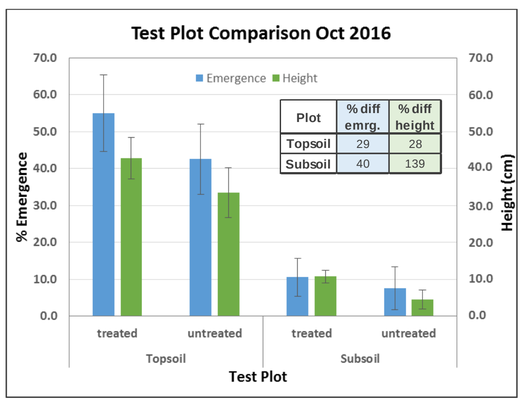
Can PGPR be used to improve efficacy of re-vegetation of marginal and disturbed `clean' soils?

- Clean disturbed soil
- Seed – commercial native grass mix
- +/- PGPR, no fertilizer
- Preliminary experiment

Topsoil test plot: 2 x 3.5 m
+PGPR
-PGPR

Subsoil test plot: 2 x 2 m
+PGPR
-PGPR





Plot	% diff emrg.	% diff height
Topsoil	29	28
Subsoil	40	139

Preliminary results indicate that PGPR treated seed has an advantage for re-vegetation of disturbed areas.

Phytoremediation in Lowland Areas

Can PEPSystems be adapted to treat lowland areas using wetland plant species?

Hydroseeding

Can PGPR treated seed be used in hydroseeding applications?

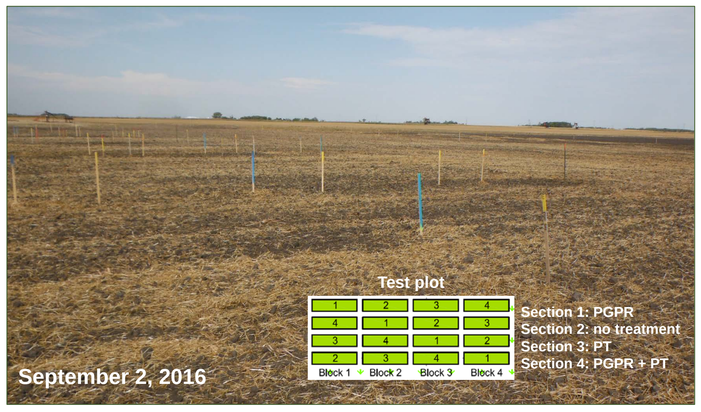
Bioavailable Metals

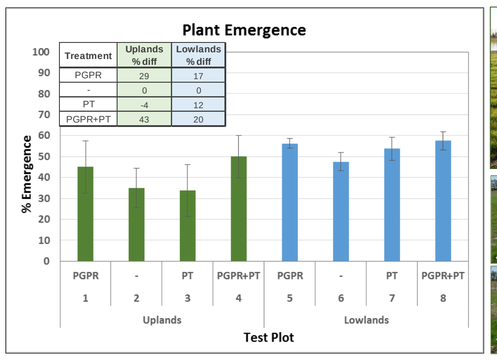
Can PEPSystems be used to accumulate trace metals in plants and remediate contaminated soil?

Complimentary Products to Enhance Remediation

Can PGPR be used with other commercial seed treatments to improve efficacy/speed of salt remediation?

- 500 m³ of produced water: ECe 8 to 18 dS/m; SAR: 13 to 40.
- Flowed into a non-agricultural wet-meadow (upland & lowland).
- Remediation goal: Revegetate and remove salt from the surface soil to allow for sustainable plant growth.





Treatment	Uplands % diff	Lowlands % diff
PGPR	29	17
-	0	0
PT	-4	12
PGPR+PT	43	20

Preliminary results indicated there is no difference between PGPR and PGPR+PT.

Hurdles to Overcome

- Length of time to remediation end points.
- Variability in outcomes associated with being a biological technology that is weather and climate dependent.
- Convincing stakeholders to let natural ecosystem functions have time to remediate contaminated soil vs. instant remediation by offsite landfill disposal.
- Translating lab to field / predictability of remediation times.
- Finding commercial partners for technology enhancement (e.g. urban, agriculture, industrial, forestry, mining, etc.).

Summary

- Earthmaster successfully deploys PEPSystems across Canada and the USA for remediation of salt and hydrocarbon contaminated soil in a variety of geographic locations.
- Earthmaster is working on a number of new applications to make phytoremediation more attractive to clients.
- Low landfill disposal costs in Canada hamper acceptance of effective low cost biological treatments that are relatively more time consuming.

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