EARTHMASTER
environmental strategies

Technical Case Study

The PEPSystems® Advantage For Re-vegetation of Salt Impacted Soil

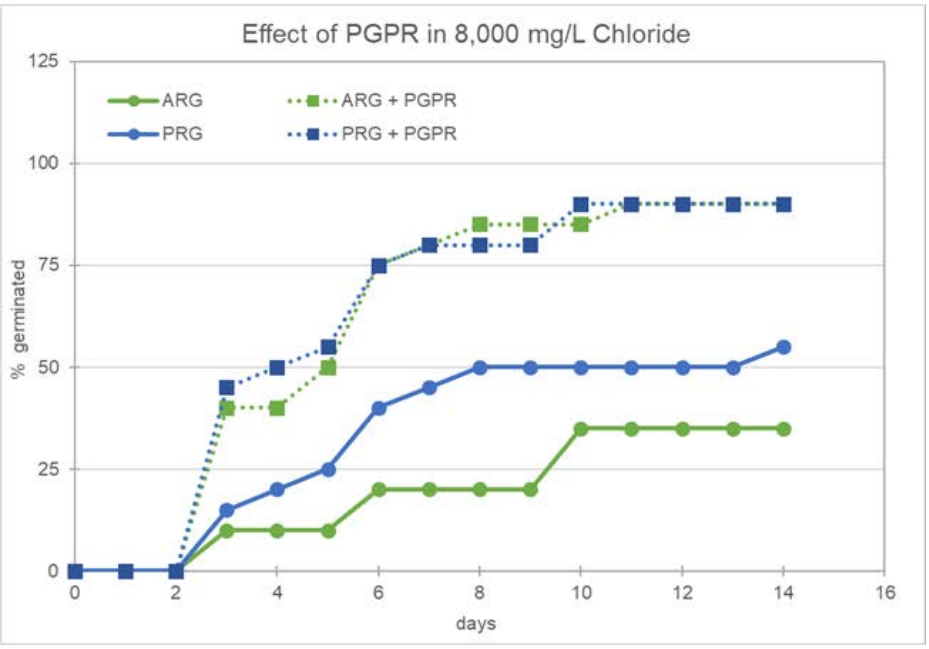
Abstract

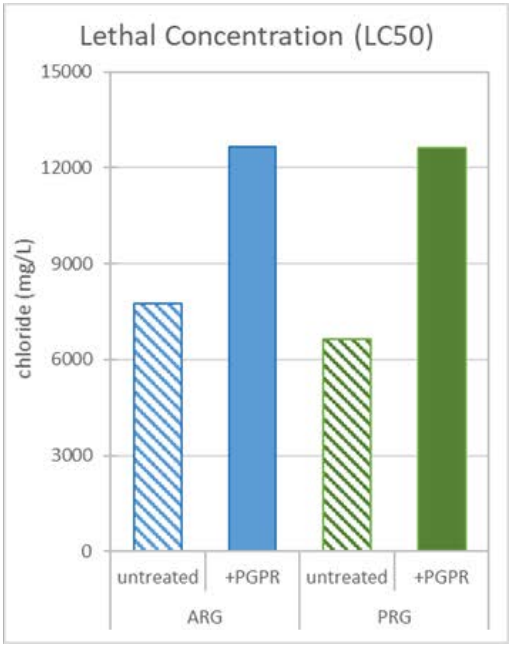
Earthmaster successfully re-vegetated salt impacted soil using a PGPR (plant growth promoting rhizobacteria) enhanced phytoremediation system (PEPSystems®). A poorly vegetated area, approximately 48,000 m² in size, contained soil impacted with produced water (which contained sodium chloride) at an oil and gas production site in southern Saskatchewan, Canada. PEPSystems, used in combination with several species of grass and oats, was deployed following repeated remediation attempt failures using other technologies for over 20 years, including salt leaching and groundwater recovery systems, to reduce salinity impacts. The goal of the PEPSystems technology was to facilitate re-vegetation of the salt impacted site. Over three growing seasons, the bare areas were successfully re-vegetated and a substantial amount of sodium and chloride was removed from the site following harvest of the resulting aboveground plant biomass at the end of each growing season.

PEPSystems® Technologies

PEPSystems is based on multiple complementary techniques that target different aspects of salt and PHC impacted soil remediation. PEPSystems increases plant tolerance to elevated salt levels allowing improved plant growth with commensurate salt uptake into aboveground plant tissue. PEPSystems not only removes PHCs from soil, but results in their metabolism to non-toxic molecules. PEPSystems lowers stress ethylene levels in plants which allows for improved root and shoot growth on impacted soils resulting in efficient and timely re-vegetation of impacted sites. Soil can be treated using PEPSystems both *in situ* and *ex situ*.

Laboratory germination studies using annual and perennial ryegrass seeds treated with PGPR showed that treated seeds had a higher % of the seeds germinate, a faster mean germination time, and the seeds had a better tolerance for increased salinity (shown as an increased LC50 value).





Project Background

The site was located in southern Saskatchewan, approximately 25 km southeast of Weyburn, in a Moist Mixed Grassland Ecoregion. Soil salinity impacts resulted from the release of produced water. Various techniques were attempted to remediate the site plus a groundwater recovery system was installed and used on the site from 1997 to 2002 to aid in recovery of the salts that leached downwards within the soil profile. Laboratory analyses of the soil completed in 2009 showed elevated ECe (up to 45.3 dS/m), chloride (up to 12,000 mg/kg), SAR (≤34.7), and boron (≤23 mg/kg) levels. The client identified phytoremediation as a potential means of re-vegetating the site and reducing salinity levels to avoid having to dispose of the considerable volume of contaminated soil at an offsite landfill.

Remediation Objectives

The remediation objectives were to revegetate the site to at least 70% of the background area plant growth levels and to reduce soil salt levels over time to allow for sustainable plant growth. Note that soils in the area were naturally saline showing ECe levels of 4-8 dS/m.

Solution

Following a detailed evaluation of soil and site conditions and characteristics, a phytoremediation deployment strategy was prepared. Earthmaster amended the surface soil and prepared a suitable seed bed into which PGPR treated seed was sown. Permanent assessment points were established across the treatment area for use in conducting regular soil sampling and vegetation analyses to monitor progress. PEPSystems was deployed in the summer using a combination of *Pseudomonas* bacteria with perennial and annual grasses, and oats. The treatment area soils were managed over three growing seasons to revegetate the area.

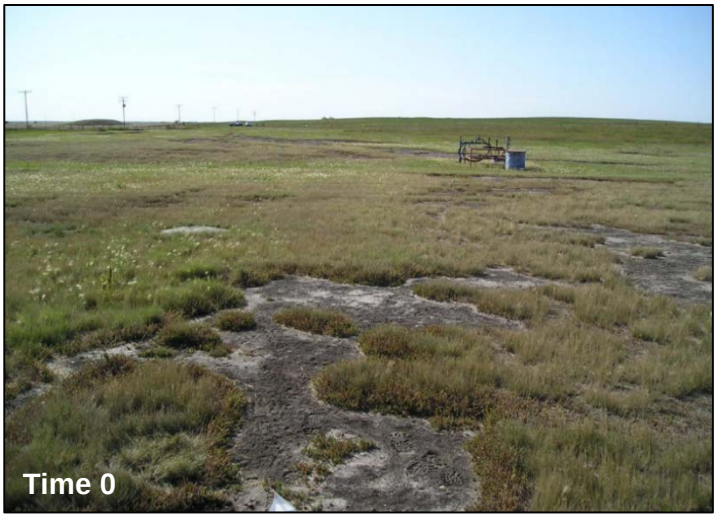
Results

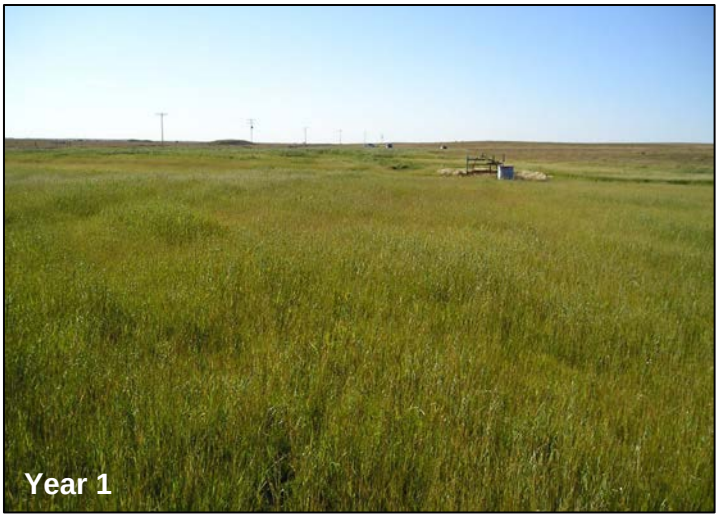
PEPSystems treatment was continued through the year 3 growing season. Excellent plant growth was obtained through all three growing seasons; however, the end of the last growing season experienced severe drought conditions which caused increased evapotranspiration resulting in early season plant senescence. There were a few remaining small areas of poor vegetation growth which were associated with higher sodium, chloride and ECe levels. These areas were generally low lying and would accumulate run-off water following significant rainfall events.

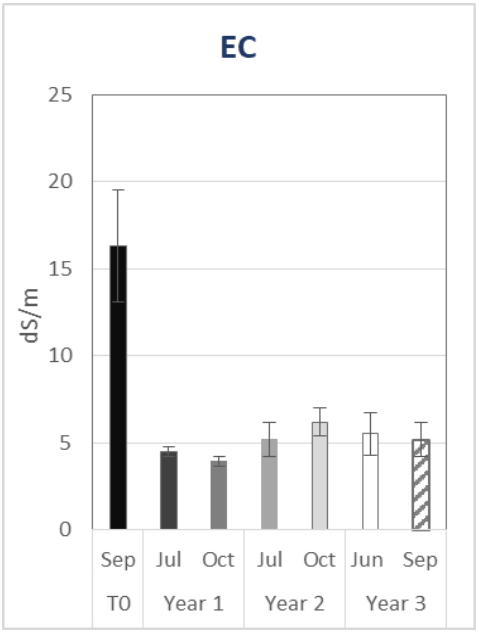
The aboveground plant biomass increased in each successive year (533 g/m² in year 1, 596 g/m² in year 2, and 796 g/m² in year 3) for a total increase of 50% from the start of PEPSystems deployment until the end of growing season 3. The overall salt load at the site decreased due to plant uptake of salts (i.e. sodium chloride). While ECe levels remained relatively constant throughout the three growing seasons, both SAR and boron levels decreased from the levels present in soil samples collected when PEPSystems was deployed.

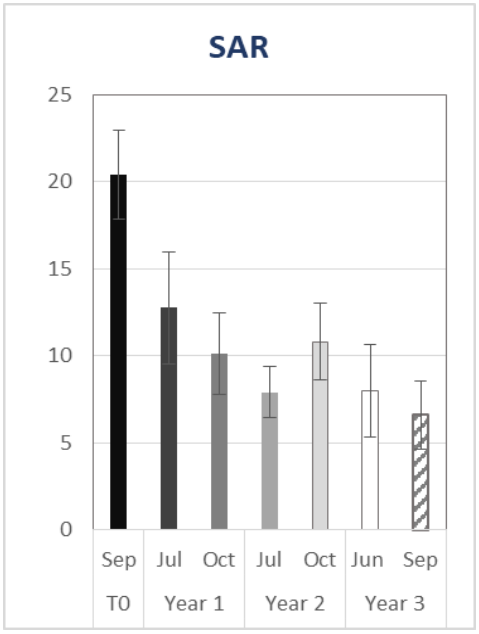
Chloride concentrations increased in the surface soil as PEPSystems treatment continued through to year 3. Chloride ions are extremely mobile in soil enabling them to migrate upwards in the soil profile (reducing the subsurface salt concentration) due to evapotranspiration. Over three growing seasons, despite challenges from

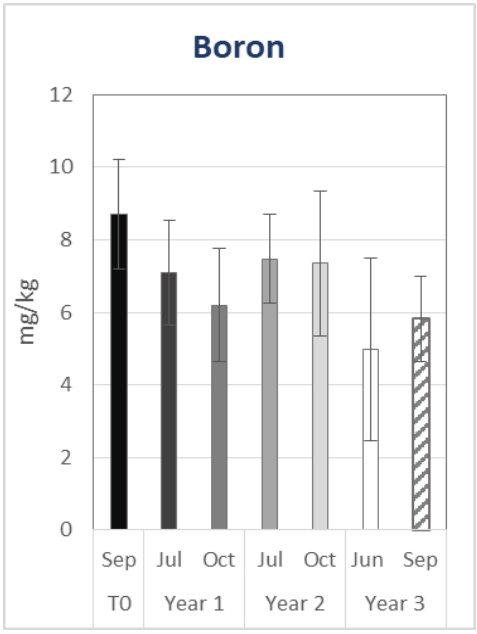
drought, a total of 314 kg of sodium and 1,352 kg of chloride were removed from the site through harvesting of the aboveground plant biomass which had accumulated the salt.











Conclusions

Deployment of PEPSystems led to the successful re-vegetation of a large area of salt impacted soil which initially supported very poor plant growth. Phytoremediation removed substantial amounts of salt while also improving soil physical characteristics that provide for sustainable and enhanced plant growth. While PEPSystems technologies are more time consuming than the only other proven soil salt remediation method for heavier textured soils, (excavation and offsite landfill disposal), PEPSystems offers innovative and effective low cost green solutions to remediating and conserving contaminated soil. This technology is especially suited to remote impacted sites where traditional remediation techniques are not cost effective nor practical

References

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