

Salt-Impacted Soil Treatment – A Project and technology Overview

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Englobe

Soils Materials Environment



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Technology Overview

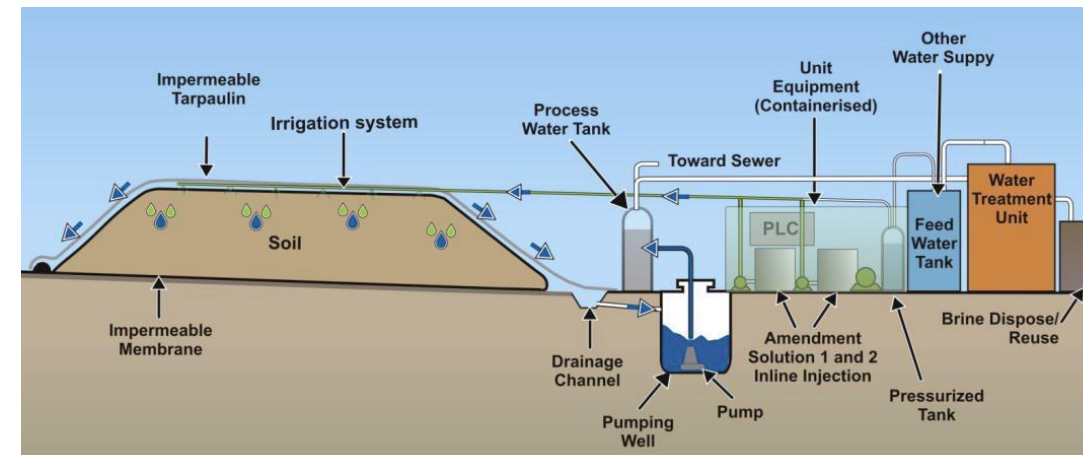
- ◆ The technology has been developed over more than 10 years of R&D efforts.
- ◆ **Engineered soil leaching process** that targets salinity related contaminants (electrical conductivity [EC], sodium adsorption ratio [SAR], chloride).
- ◆ Englobe has developed proprietary methods for:
 - ◆ Characterization protocols to assess treatment potential;
 - ◆ Amendment mixes;
 - ◆ Irrigation strategies.
- ◆ The technology is patented in the USA and patent pending in Canada.
 - ◆ *"Salt-Impacted Soil Treatment Process and System for Remediating a Salt-Impacted Soil".*
WO/2014/059540 .

Technology Overview - Cont'd

- Impacted soil is leached with a solution of various amendment concentration to remove ions:
 - Precipitated;
 - Dissolved ;
 - Adsorbed.
- Reduction of EC, chloride and SAR;
- Process water can be treated with reverse osmosis or disposed of in a deep injection well;
- Treatment duration varies based on pile height and soil type, but is designed to treat one batch per season;
- Volume of water and quantity of amendments are adapted to suit the remediation targets;
- Successful full-scale application in 2018. Two (2) ongoing projects in 2019 in Alberta and NWT.



Pilot Scale Treatment in Leduc. Ab., 2009



Technology Design

2018 Full-Scale Application – The Site

- Large site: ~150,000m³ of salt-impacted soil;
- Upstream/midstream oil:
 - Battery/Satellite
 - Well
- Generated water spills (salt water);
- Large volume of shallow impacted groundwater.



2018 Full-Scale Application– Site-Specific Treatment Targets

- ◆ Overall goal: site remediation;
- ◆ Chloride concentration of 370 mg/kg for underlying soil horizons (under 1.5 m) derived from SST calculation;
- ◆ “Good” rating category for topsoil for EC (2 mS/cm) and SAR (4);
- ◆ “Good” rating category for subsoil (up to 1.5 m in depth) for EC (3 mS/cm) and SAR (4).

2018 Full-Scale Application – Lab-Scale column Trial

Lab trial conducted:

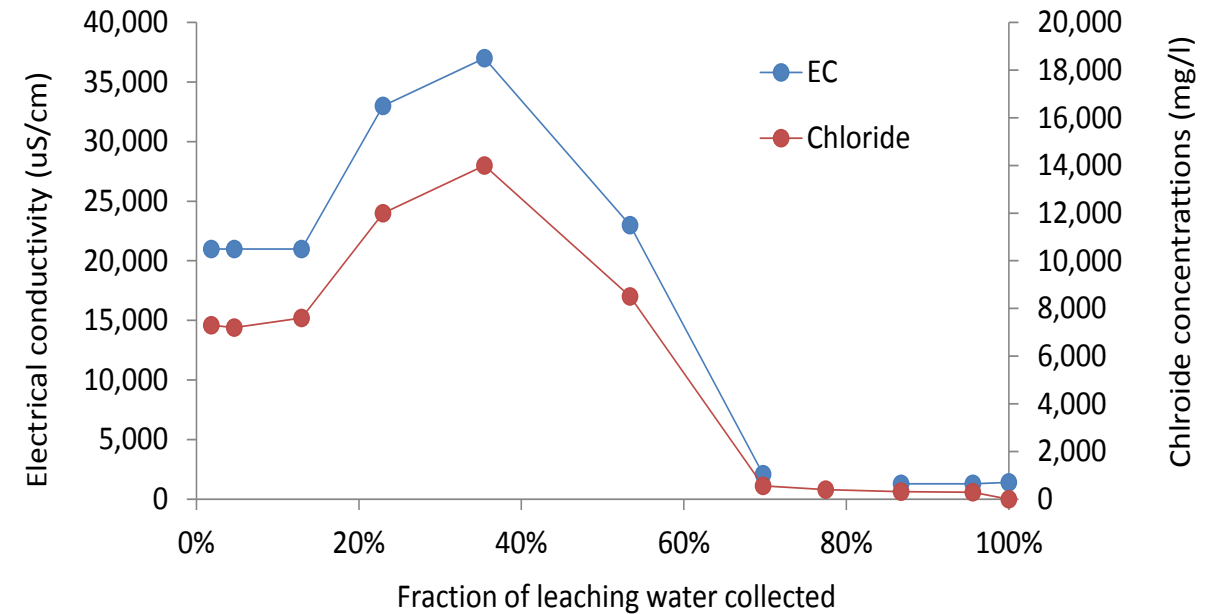
- To confirm reaching treatment objectives;
- To adjust the irrigation strategy.

Initial Soil Results:

- EC: **8.3 mS/cm**;
- SAR: **20**;
- Chloride: **1,400 mg/kg**.

Final Soil Results:

- EC: **0.60 mS/cm (average) 0.54-0.68 (range)**
- SAR: **0.72-2.10 (range)**
- Chloride: **<100 mg/kg (94 % chloride reduction)**



2018 Full-Scale Application – Schedule

- ◆ Installation of reverse osmosisFall 2017;
- ◆ Construction of treatment pad.....June 2018;
- ◆ Mob. of treatment equipment.....July 2018;
- ◆ Start-up of treatment..... Aug. 2018;
- ◆ End of treatment..... Nov. 2018.



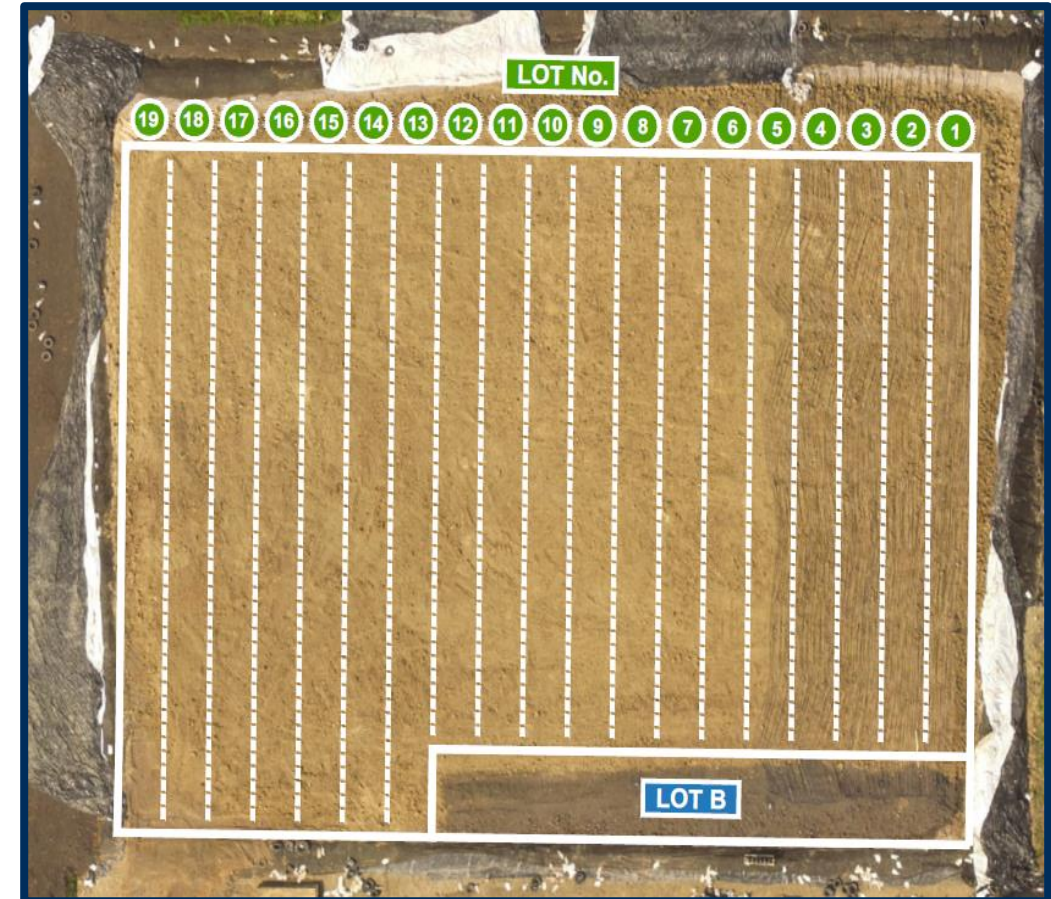
2018 Full-Scale Application – Water Treatment

- Used to treat impacted water from excavations;
- Deionized, clean water used to irrigate impacted soil;
- Clean/concentrate leachate from STF;
- Concentrate from RO was disposed of at a water disposal system adjacent to the site.



2018 Full-Scale Application – Pre-Treatment Results

- ❖ **EC:** 3.3 to 9.3 mS/cm
(average 4.5 dS/m);
- ❖ **SAR:** ranged from 1.6 to 17.7;
- ❖ **Chloride:** 440 to 2,270 mg/kg
(average 804 mg/kg).
- ❖ 32% >75microns = fine soil



2018 Full-Scale Application – Final Results

- ◆ **EC** ranged from 0.4 to 1.9 mS/cm (average of 1.0 mS/cm):
 - ◆ **79 %** reduction for overall EC value, reduction of EC in all samples.
- ◆ **Chloride** ranged from 13 to 287 mg/kg (average of 91 mg/kg):
 - ◆ **89 %** reduction in overall chloride concentration - chloride reduction in all samples.
- ◆ **SAR** ranged from 2.1 to 16.6:
 - ◆ 10 out of 19 lots still showed a SAR value above four (4). The soil was strategically backfilled to account for the residual EC and SAR.

2018 Full-Scale Application – Final Results – Con't

- ◆ Treatment volume: 2,750 m³ soil. All the soil met targets based on the depth it was to be backfilled at.
- ◆ 4,500 m³ of water used for treatment
 - ◆ 2,500 m³ of leaching water treated and recycled for treatment;
 - ◆ 2,000 m³ of impacted GW treated and use for treatment.
- ◆ 2,000 m³ of brine water (heavily impacted) has been disposed of throughout the treatment.
- ◆ Chloride target has been surpassed – process will be optimized in the future – reduction of water used in the process.

2018 Full-Scale Application – Why did it Work?

◆ Large Site:

- ◆ Multi-year treatment justifying investing for the construction of a STF;
- ◆ Space available for the construction of a STF.

◆ Implementation of the Reverse Osmosis:

- ◆ Impacted GW is being treated and reused for treatment;
- ◆ Concentrated leachate from soil treatment is treated, thus reducing water disposal.

◆ Water Disposal System Adjacent to site

◆ Dig and dump option was not a good option:

- ◆ Would require huge volumes of soil to be moved;
- ◆ Shallow impacted groundwater that needed to be managed.

Next Steps



- ◆ 2019 Season at the site – 5,475 m³ of soil are currently being treated. Remaining few weeks of treatment;
- ◆ Possible expansion of the STF in future years over areas of backfilled treated soils;
- ◆ Ongoing development and optimization of process;
- ◆ Further developments to address both hydrocarbons and salt contamination.

Technology Overview – Additional Information

◆ Applicability of the technology

- ◆ The technology can technically be applied to most soil types and levels of contamination;
- ◆ Fully scalable;
- ◆ It provides a sustainable approach for the remediation of salt-impacted sites:
 - ◆ Reduces off-site disposal;
 - ◆ Reduces importation of clean backfill;
 - ◆ Can recover impacted top soil.
- ◆ Treatment volume is only limited by:
 - ◆ The size of the STF;
 - ◆ The duration of the treatment season ($>0^{\circ}\text{C}$ ambient temperature), one batch per year.

Summary



- ◆ First completed full-scale application of the Englobe's technology;
- ◆ Only salt-impacted soil treatment technology commercially available;
- ◆ Provides a viable solution to remediate large salt-impacted sites;
- ◆ Can target high levels of EC, SAR, and chloride contamination even in fine-grain soil.

Thank you!

Questions?

