

In Situ Remediation of Brine Impacted Soils and Groundwater using Hydraulic Fracturing

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An innovative approach is being implemented at a former oil battery site in central Alberta to remediate salt-impacted, clay subsoils using environmentally sustainable and non-disruptive technologies. This approach combines oilfield hydraulic fracturing technology with industrial wastewater treatment technologies. Hydraulic fracturing is an oilfield technology that has been adapted for environmental applications to increase the permeability of fine-grained soils since the early 1990's. Water treatment options using zeolite and flash distillation technologies were investigated to treat saline groundwater. Zeolites are naturally occurring hydrated aluminosilicates that are ideal for ion exchange applications, such as for sodium reduction in co-produced groundwater from coalbed methane operations, for example.

The concept of fracture-emplaced zeolites into low permeability subsoils was investigated because it has enormous potential for mitigating salinity impacts at the field scale.



SOIL FRACTURING EQUIPMENT

The rationale for this approach is to create an *in situ* drainage network similar to that of tile drainage systems, by emplacing zeolites as discrete “drainage layers” via hydraulic fracturing. The zeolite fractures serve as both preferential groundwater flow paths while also providing *in situ* reduction in sodicity by ion exchange. Groundwater is collected from a central recovery well, treated, and re-injected into fractured wells to continue the leaching of salts from impacted soils. The advantage of this conceptual *in situ* approach would be to negate the need for disruptive excavation and topsoil reconstitution as practiced in conventional reclamation methods, and reduce costs. Furthermore, *in situ* treatment of saline impacts can be achieved without interference to ongoing crop planting and harvesting activities.

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POSTER PAPER on:

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Laboratory column testing was performed on different grades of zeolites to investigate their geotechnical and chemical performance with respect to the remediation of salt impacted soils and groundwater. The results of this testing determined that clinoptilolite, a calcium rich zeolite of high cation exchange potential with respect to sodium, was found to have the best properties for drainage and *in situ* reduction of sodicity.

ZEOLITE COLUMN TESTING

Based on these results, a field scale fracturing program was carried out on a 1.6 hectare former oil battery site in November and December of 2005. The site is presently a farmer's field underlain by salt-impacted clay soils and groundwater to a depth of 5 metres. A total of 221 horizontal drainage fractures were emplaced in clay subsoils between depths of 2 to 5 metres at 65 borehole locations.

Selected fractures were mapped using tiltmeter geophysics to confirm the extent of drainage layers placed.

The network of drainage layers emplaced by fracturing was hydraulically connected to a rock-filled dug-out in the former flare pit area. An existing recovery well in the dug-out will be used to recover groundwater which will be treated using flash distillation technology. Treated water will be reinjected into upgradient, fractured wells through subgrade piping to promote the continuous leaching and recovery of salts from subsoils.

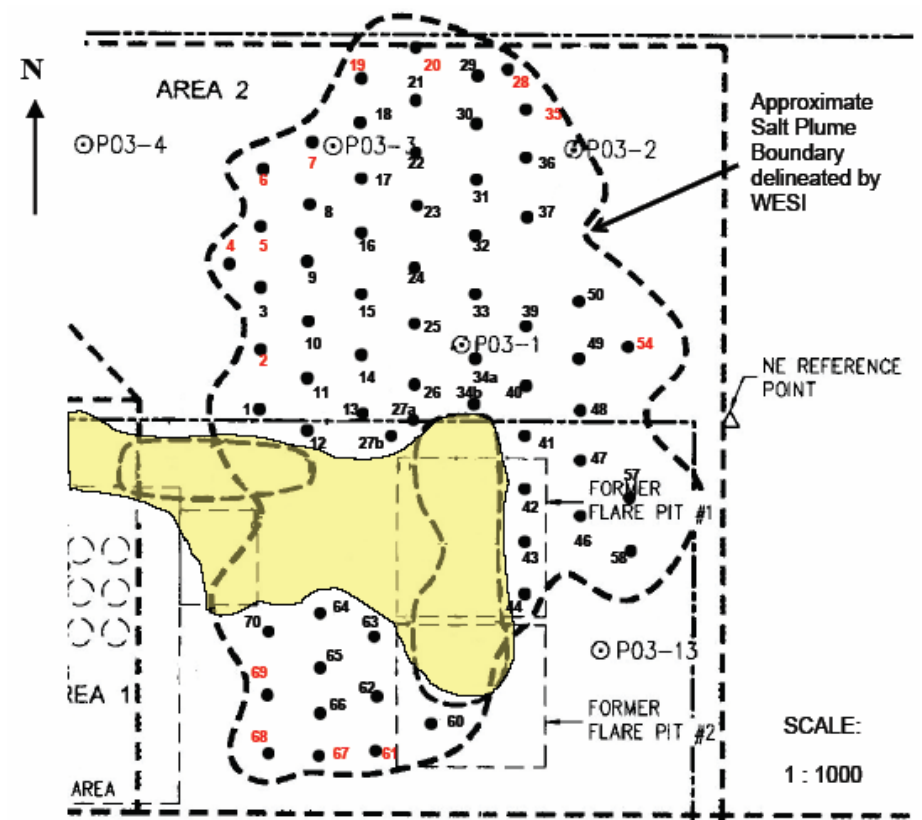


Figure adapted and modified from Wiebe Environmental Services Inc. "Phase II Site Assessment Program" report - Figure 4A, dated February 2004.

LEGEND:

- P03-13 Groundwater Monitoring Well
- 61 Fractured Perimeter Borehole (2 drainage fractures each)
- 11 Fractured Borehole (3 to 5 drainage fractures each)
- Excavated Area

FRACTURE LOCATIONS IN SALT PLUME