

SCEK Project Profile

Project Name:	Adapting Contaminate Sites Approaches for Produced Water Releases to Wetlands
Project Number:	EI-2015-01
Proponent:	Hemmera
SCEK Funding Envelope:	Environmental Impacts
Timeframe:	Phase 1: March 1, 2014 to October 31, 2015

Project objectives

The overall objective is to derive an alternative suite of salt ion numerical soil standards for use within the Contaminated Sites Regulation (CSR) framework that are better focused on a wetland environment as opposed to terrestrial upland soil systems. This would include guidance on the conditions under which these alternative wetland numerical soil standards for salt could be applied, as well as precluding conditions for their use.

The project directly seeks to improve the management regime around an important oil and gas environmental issue by addressing knowledge gaps, developing pragmatic guidance, and communicating the important results and insights to interested parties.

Project description

Accidental releases from oil and gas activities in northeastern BC over the last several decades have resulted in inputs into wetland ecosystems of volumes of saline produced water that are approximately four- to five-fold greater than of petroleum hydrocarbons. Once released, chloride completely dissolves in surface and groundwater and can be readily transported from the initial source area to adjacent areas. An ability to effectively and efficiently address produced water and similar saline water releases is of paramount importance to environmental protection goals.

Environmental quality guidelines and standards such as *British Columbia Approved Water Quality Guidelines* and soil numerical standards contained within the *British Columbia Contaminated Sites Regulation* (CSR) are important tools for regulators, responsible parties and practitioners involved in the assessment and remediation of contaminant releases to the environment. The province of British Columbia adopted in the mid-2000s numerical “soil matrix standards” within the CSR for chloride and sodium. These were developed mostly to assist with the expedited assessment and remediation of road salt storage facilities especially at highways maintenance yards.

Since the adoption of CSR soil numerical standards for sodium and chloride, various contaminated sites responsible parties, their consultants, and western Canadian analytical laboratory service providers have

gained considerable experience in environmental sampling issues, chemical analyses, and interpretations associated with salt contamination. Among the insights gained - especially at Northeast BC oil and gas sites - are the following:

- (i) A large proportion of salt releases enter boreal wetland systems, which can be classified as bogs, fens, marshes, and swamps. The existing CSR salt standards were not derived in consideration of these types of ecosystems.
- (ii) The CSR standards are based on a “saturated paste” soil extraction and analytical method. Such techniques were developed by agronomic researchers to measure the available fraction of nutrients, ions and trace elements to plant roots in agricultural systems with limited moisture content, and are overly complex and potentially inaccurate measures of biological exposures in boreal wetlands.
- (iii) The true effects on wetland mesofauna, plant roots, and other biota is likely to be better correlated with the soil salt solution results than analytical results expressed on a dry soil mass basis for soils (based in turn on saturated paste extract methods) that are almost completely saturated in their native state.
- (iv) The standardized CSR assumptions for back-calculation of soil chloride and sodium concentrations protective of aquatic life based on a groundwater-mediated transport scenario are likely overly conservative for the vast majority of wetland systems.

Overall, the gaps in scientific knowledge and gaps in the regulatory/policy regime for the assessment, risk management, and remediation of saline water releases to boreal wetland ecosystems are an impediment to the timely remediation and reclamation of these sites.

This proposed project is specifically intended to develop a new set of British Columbia Contaminated Sites Regulation (CSR) wetland salt soil matrix standards and application protocols, through the analysis of both existing ecotoxicity data for effects of salt ions on boreal wetland mosses and vascular plants and newly acquired scientific knowledge. These new standards and guidance are intended to be much better suited to assessing and managing the risks of saline water releases to boreal wetland settings.

Project approach

The project methodology is based on four major tasks:

Task 1: Develop guidance on when it would be appropriate to use alternative CSR wetland soil standards for salt, expressed in mg/L.

The proposed alternative CSR standards will be developed specifically for application to saturated soil environments (wetlands) that may have been impacted by produced water releases. Written guidance on when and how to apply soil solution based standards will be based on (i) completion of a critical review of the key assumptions that underlie the derivation approaches for the existing ecological risk based CSR standards versus assumed site characteristics, environmental fate processes, and important ecological receptors for the alternative standards; (ii) extensive discussions with MoE and BC Oil and Gas Commission (OGC) managers regarding similarities or differences in narrative environmental protection goals between terrestrial and wetland salt release sites, the potential for developing better suited approaches for wetlands, and the potential for unintended consequences of alternative approaches such as reduced environmental protection; and (iii) similar extensive discussions with upstream oil and gas environmental managers.

Task 2: Derive alternative CSR *solution-based* wetland salt soil standards based on two major lines of evidence: (i) Interpretation of pre-existing ecotoxicity data collected by Bright during the PTAC/CAPP/AUPRF/PERD *Peatland Salinity Project* (2008 – 2011); and (ii) New scientific data from manipulation field trials in fen-type and marsh-type sites near Fort St. John.

The data exist for the interpretations described in Output 1. New data will be collected to develop the second line of evidence through the following:

- (i) identification of candidate field sites on provincial crown land near Fort St. John, subject to regulatory, First Nations and general public support;
- (ii) further selection of three major field sites, situated in each of a representative bog or poor fen, rich fen, and shrub-dominated marsh environment. Obtain necessary approvals and permitting;
- (iii) establishment of 3 m x 3 m experimental plots at each of the three sites to be dosed with a concentrated NaCl solution to achieve a final surface soil solution electrical conductivity (EC) of 0 (reference site), 0.5, 1, 2, 4, 8, and 16 mS/cm. Triplicate plots at each target salt concentration to be established using a randomized complete block design. Each plot to be sampled and analyzed prior to dosing to establish soil and soil solution chemistry (EC, hardness, pH, major anions and cations, nutrients) and then re-sampled approximately 2 weeks and 2 months after salt application. Vascular plant and bryophyte composition and growth responses to be quantified in parallel with before-after sampling scheme. Soil macroinvertebrates within each plot to be assessed using pitfall traps. It is currently proposed that soil mesofauna will not be assessed pending further input from the project steering committee.
- (iv) evaluation of salt effects on aquatic invertebrates in smaller standing water pools that are not physically connected to adjacent surface water through an open channel, by identifying a suitable site with multiple standing water locations of similar characteristics that are situated approximately cross-gradient to each other and dosing with a concentrated NaCl solution to achieve target water chloride concentrations of 0, 50, 100, 200, 400, 800 and 1600 mg/L.

Task 3: Derive alternative set of wetland soil standards for salt to protect aquatic life based on groundwater-mediated transport assumptions geared for boreal wetland ecosystems (especially in bogs and fens).

The interpretations for Task 3 will rely on the data collected in Task 2 along with several meetings and review with project steering committee members.

Task 4: Develop for consideration by the BC Government for possible incorporation in the CSR, Schedule 5, matrix soil standards for salt, new wetland “Toxicity to soil invertebrates and plants” and “Groundwater flow to surface water used by aquatic life” solution-based matrix soil standards; along with detailed proposed technical guidance or protocol for appropriate use of the above-mentioned new wetland solution-based matrix soil standards for salt.

Project deliverables

The following project deliverables will be provided:

1. *Final report covering:*
 - i. when it would be appropriate to use alternative CSR wetland soil standards for salt;
 - ii. nomination of risk based ecotoxicity thresholds that are relevant to the assessment and remediation of wetland sites;

- iii. a review of boreal wetland hydrology and hydrogeology, enroute to the nomination of appropriate models for predicting salt ion transport, and subsequent modeling of wetland concentrations that would be protective of aquatic life in nearby connected and potentially productive surface water bodies, based on generic site condition assumptions;
- iv. alternative set of wetland soil standards for salt in boreal wetland ecosystems; and
- v. considerations for regulatory changes and industry practices.