Validation of Toxicology Test Methods for Assessing Petroleum Hydrocarbon and Brine Spills in Boreal Forest and Taiga Eco-Zone Soils

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The project also included some unique aspects to the toxicological characterization of the contaminated forest soils:

This research project specifically addressed one of CAPP/ERAC's 2006 priorities to "remediate soils that contain salt or hydrocarbons, including development of risk-based closure mechanisms." The primary objectives included:

1. identify and collect suitable forest soils impacted by petroleum hydrocarbons and salts from produced water spills;
2. assess the performance of the new boreal forest species and test systems using the impacted and reference soils; and

3. compare the results generated from the new boreal forest species with standardized Environment Canada soil toxicity species.

All of the project objectives were completed and contributed to the development of a suite of toxicity tests applicable to the assessment of contaminated soils using ecologically-relevant test species:

- Six plant species: Populus tremuloides (trembling aspen), Pinus banksiana (jack pine), Calamagrostis canadensis (bluejoint reedgrass), Picea mariana (black spruce), Picea glauca (white spruce) and Solidago canadensis (goldenrod) (SRC, 2006)
- Three soil invertebrate species: Folsomia nivalis (Collembola), Dendrodrilus rubidus (earthworm), and Oppia nitens (oribatid mite)In general, there was similarity in response between the boreal and EC standard species with two exceptions. Bluejoint reedgrass, a boreal forest plant, was significantly more sensitive than the other plant species tested, regardless of the endpoint assessed and contaminant (e.g., hydrocarbon or salt) evaluated; however, aspen proved to be just as sensitive to bluejoint reedgrass when exposed to the hydrocarbon-impacted soils. The suitability of the boreal forest plants, in addition to these findings, justify the use of a boreal forest plants for the assessment of forest soils.Similar to the

plants, boreal forest species were more sensitive to the contaminants when compared to the EC standard test species. Of the species assessed, the boreal forest earthworm, Dendrodrilus rubidus was the most sensitive species when exposed to the salt-impacted soils, but equally sensitive the EC standard earthworm (Eisenia andrei) for the hydrocarbon-impacted soils. The boreal forest and EC standard (Folsomia candida) collembolan species were equally sensitive to the salt-impacted soils, but Folsomia nivalis was the most sensitive invertebrate for the hydrocarbon-impacted soils. The oribatid mite species, Oppia nitens, was the least sensitive of all soil invertebrates when exposed to the salt-impacted soils, but was as sensitive as F. nivalis to the hydrocarbon-impacted soils. Therefore, these studies also justify the use of boreal forest soil invertebrates for the evaluation of contaminated soils derived from the same eco-zone. Given the varied sensitivity of all the test organisms together, these studies also signify the need to use a suite of test organisms in the assessment of any contaminated soil sample.The project also included some unique aspects to the toxicological characterization of the contaminated forest soils:

1. the use of layered horizons within a test vessel

to mimic natural forest soil conditions; and
2. the use of soil cores as an alternative test system (e.g., plant testing).

The layering of horizons was feasible from the initial collection in the field to the reassembly for testing in the laboratory. The use of distinct horizons is realistic and may help to provide direction on what horizon should be the focus of a study, depending on the source and type of contamination (e.g., surface versus sub-surface contamination). However, the discovery of the presence (or preference) of the test organisms in a particular horizon indicated that a preference for a particular soil type or avoidance of a chemical, might affect the interpretation of a test, or on the other hand, might direct the focus of a test towards a particular horizon (particularly if chemical factors are influential).

The soil core tests were also successful; the majority of plant species germinated and grew within the reference soils cores, but seedling growth was less than that observed for the layered bulk soil tests. However, the soil core tests were fairly good predictors of the level of sensitivity of the various species used in the diluted layered bulk soil tests.

2007 SRC_PHC and Brine Spills in Boreal Forest Soils
2007 SRC_PHC and Brine Spills in Boreal Forest Soils Report
2008 Env Canada_PHC contaminated boreal forest soil

Presentation
2010 Env Canada_Boreal Forest Soil Toxicity Test Methods Presentation
2013 Env Canada_PHC contaminated boreal forest soil Presentation