Plant Uptake of Petroleum Hydrocarbons and Trace Metals and Derivation of Soil-to-Plant Uptake Factors : Advancing the Science of Environmental Risk Assessment

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Environmental Risk Assessment (ERA) is a specialized tool that can be used for management of contaminated sites. Depending on the outcome of the ERA, regulatory closure can be obtained or some form of risk management and/or remediation is required. Not all components of the ERA process are well-characterized, and when there is uncertainty in ERA it is necessary to use conservative assumptions to ensure protection of human and ecological health. These assumptions can add up, causing the findings of the ERA to be somewhat questionable. Therefore, any opportunity to refine the ERA process and make it more accurate should be investigated.

One exposure pathway that oftentimes introduces uncertainty into the ERA process is ingestion of vegetation by humans and ecological receptors. Notably, First Nations and many wildlife species are known to ingest wild plants. However, plant analytical data is generally not collected during environmental site assessments and scientists are left to evaluate exposure to contaminants in plants through the use of soil-to-plant uptake factors (UFs; essentially a ratio of contaminant concentration in plants to contaminant concentration in soil). There are very few soil-to-plant UFs available for petroleum hydrocarbons (PHCs), and those available are generally estimated from such parameters as the octanol/water partition coefficient [K_{ow}]) and not empirical data.

Given the information above, we have completed laboratory studies to: 1) determine the extent to which plants, four species in total, uptake PHCs and trace metals, and 2) establish soil-to-plant UFs and models for specific PHC constituents and metals. Plants were cultivated in PHC- and metals-impacted soil and both growth and health parameters were assessed at various time points. Plant tissues and soil were analyzed for trace metals using Inductively Coupled Plasma (ICP) analysis while PHCs were quantified using two-dimensional gas chromatography time of flight mass spectrometry (GCxGC TOF-MS), a novel laboratory instrument that allows individual PHC constituents to be measured at part-per-billion levels. Findings from these studies will be presented and discussed.

Going forward, this data will allow for more accurate assessments of potential health effects for human and ecological receptors from exposure to contaminants in plants. Furthermore, it will no longer be necessary to collect and analyze vegetation samples to accurately evaluate this exposure pathway as soil samples will suffice. This could lead to cost savings for industries with substantial environmental liability such as Oil & Gas, Mining, and Agriculture. The development of soil-to-plant UFs and models for PHCs and trace metals may also have important applications within the fields of reclamation, phytoremediation, biomonitoring, and others.

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