Field Validations of the F2:F3b Ratio and BOC-adjusted PHC F3 Calculation for Resolving False Detections of Crude Oil and Diesel Petroleum Hydrocarbons in Clean Soils

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The Canada-wide Standard Reference Method for PHCs in Soil, categorizes PHCs into four carbon fractions: F1, F2, F3 and F4. This method extracts PHCs, while also inadvertently extracting natural biogenic organic compounds (BOCs) as well, resulting in false exceedences of F3 PHC soil criteria. BOCs extracted by this method have the following signatures: i) Total carbon range occurs predominantly between C22-C50; ii) Total carbon range is predominantly composed of resolved peaks, rather than unresolved complex mixtures (UCM); and iii) Dominated by odd-numbered n-alkanes. In contrast, PHCs have the following

signatures: i) Different PHC sources can have wide carbon ranges, extending anywhere from C6 to >C34; ii) UCMs are key features of PHC sources, to varying degrees; and iii) PHCs have virtually equal distributions of odd- and even-numbered n-alkanes. The University of Waterloo has developed the F3a:F3b ratio approach, which refers to F3 subfractions C16-C22 (F3a) and C22-C34 (F3b). This approach calculates true PHC concentrations for lighter products, such as diesel fuel and crude oils, which extend into the F3a range. Alberta Environment has recently approved this approach for Tier 2 evaluations. This approach however, cannot be used for heavier petroleum products that do not extend into the F3a range. Therefore, we propose to expand our current F3a:F3b database to include odd versus even n-alkane ratios (Carbon Preference Index) and UCM versus resolved peak ratios. All three parameters would be collectively used to calculate true petrogenic concentrations for the full range of light to heavy, refined and unrefined petroleum sources.

The development of this three-parameter approach would benefit all upstream and downstream industries that work with bioremediation and/or removal of soils contaminated with light and heavy petroleum products. This project is especially relevant to heavier products such as bitumen, asphaltenes, fuel oils, engine oils, etc. This comprehensive approach could be used to better define soil contamination remediation boundary zones, as well as phytoremediated soils. It

could also be used to evaluate true petrogenic concentrations for bioremediation techniques that mix petroleum products with organic materials such as manure and sludge. The resulting benefits pertain to soil bioremediation and excavation cost savings, in addition to eliminating unnecessary disturbances to natural environments.

This project builds on the success of the F3a:F3b approach, by including all light and heavy petroleum products, rather than only the lighter products. This is essential to ensuring that biogenic interference issues can be eliminated for all petroleum products.

The purpose of this study is to determine if field data will validate the F2:F3b ratio, which is based on the results of controlled contamination experiments. This field study is essential to generating confidence that the F2:F3b ratio can be incorporated into the existing CCME CWS PHC document. Another purpose of this study is to demonstrate how the F2:F3b ratio could be adopted as a Tier 1 approach. This would benefit industry by simplifying the process of defining the boundary lines between contaminated sites and surrounding clean soils. Simplification would reduce the time and monetary costs currently associated with contaminated site remediation and risk management evaluations.

Policy Issue

Regulatory Guidelines/Directives/Policies/Criteria

Knowledge Gap

Organics (PHC)

- Natural PHC distribution
- Fate and transport assessment
- Appropriate protection of various exposure pathways,
- CCME guideline assessment

2009 UoW_DRAFT Part 1 Biogenic Petrogenic F3a F3b DRAFT Report
2009 UoW_DRAFT BiogenicPetrogenicF3aF3bDRAFTReport
2012 University of Waterloo_Petroleum Index Presentation
2016 CH2M_ Field Validations of PHC Fractions F2 and F3