Effects-Driven Assessment and Management of Complex Operating Sites: Results of Initial Field Investigation

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Background/Objectives. Contaminated sites with complex industrial history and operations require a nuanced approach in their environmental management. This is particularly true when the original products that were used and produced on site are no longer detected, but potential ecological and human health risks remain due to persistent breakdown products. There is little toxicological information and reliable risk assessment approaches for sites where complex mixtures consisting of metabolites and by-products are present. Yet, regulators and industry need to be able to reliably answer the question: Should we be concerned about potential impacts on human and environmental health? To answer this question, a group of academic researchers, industrial partners and the Provincial regulatory agency have partnered to develop an effects driven assessment to estimate the distribution and risk of ill defined contaminants of concern at a 70-year old crop protection chemical blending and packaging facility in Western Canada. In the first stage of the 5 year project, spatial characterization and modeling of the contaminant plume was completed. The 1.7M project is funded through a Natural Sciences and Engineering Research Council of Canada Collaborative Research and Development grant and industry partnerships.

Approach/Activities. Based on initial assessment work completed between 2010 and 2016, and toxicity analysis completed in 2016, 19 boreholes were drilled at the site and 10 monitor wells installed. As evidence of dense non-aqueous phase liquids were identified at the site in the glacio-lacustrine clay and silt soils, the boreholes were extended to 12 m depth. 228 soil samples were collected using incremental sampling methodology (plug based method) and groundwater samples were collected monthly from each monitoring well to characterize water quality parameters and toxicity. Based on the site characterization and 25 years of historic data, a conceptual site model and hydrological model were developed. The 348 (228 soil + 120 water) samples collected are being analysed using the Microtox® assay approach to identify areas and times, where the mixture is most potent. Then Microtox® results will be confirmed by assessing the top 10% toxic samples with the HepG2 liver cell line using a standard serial design method to validate the “toxicity map” for higher vertebrate-based systems.

Results/Lessons Learned. Environmental assessments to date have demonstrated that soil and groundwater on site are impacted by a range of agri-chemicals (pesticides, formulant), petro-chemicals (solvents, formulant, fuel), and metals/metalloids (e.g., arsenic). Some chemicals were identified as exceeding Canadian Council of Ministers of the Environment guidelines (e.g., 2,4-D, MCPA, dicamba, malathion) for soil and groundwater. However, only a small proportion of the constituents in the highly complex mixture were identified. The complex and inconsistent spatial distribution of chemical constituents were further differentiated and the initial draft of the hydrological map completed. The use of the incremental sampling methodology in subsampling the complex soil and contaminant distribution in field conditions at the site will be presented along with the challenges and lessons learned. The conceptual site model further confirms the complex nature of the subsurface conditions and contaminates. In the initial toxicology study completed in 2016, the HepG2 displayed the best combination of sensitivity and selectivity. Groundwater was not acutely toxic to aquatic organisms but was cytotoxic to liver and intestinal cells. In addition, the groundwater likely contains compounds with

potential to impact immune, developmental and endocrine pathways in humans. Future presentations will document the bioassays results with a hydrological map of the site to create an effects driven delineation of the extent and magnitude of mixture present. Our null hypothesis is: H0-a: Detectable bioassay toxicity from whole environmental extracts does not differ across the site. Future presentations will include the results of systemic toxicological analysis, effect- directed adverse outcome analysis, and the site risk assessment.