Assessment of the Significance of Vapour Emissions During Ex Situ Remediation Activities

PTAC Project # 913351

MERIDIAN ENVIRONMENTAL

Project Objectives

- To assess the overall environmental and human health significance of ex-situ remediation compared to landfill disposal.
- A life-cycle approach was used considering:
  - Emissions from volatile natural gas constituents remaining in soil,
  - Generation of equipment emissions,
  - Generation of process particulate emissions, and
  - Generation and emissions of greenhouse gases.

Approach

- A compartment approach where results are calculated and can be independently evaluated for both scenarios considering particulate generation, criteria air contaminant emissions and ambient air exposure was applied.
- Review of different methods of ex situ treatment (e.g. allu bucket, thermal desorption, chemical reduction/oxidation, biological treatment) with modelling considering allu bucket was conducted.
- Evaluation of available models for predicting emissions, including from remediation activities, landfills, and vehicles
- Evaluation of appropriate model inputs

Ambient Air Exposure

- A review of volatilization models was conducted, the Jury Model implemented by the US EPA to estimate a soil partitioning flux was applied with modification.
- The concentration of petroleum component of toxicological relevant fraction, the soil flux and a calculated diffusion coefficient are used to calculate an air concentration that decreases over time.
- Exposure to nearby residences, or site workers can be estimated from this air concentration and compared against regulatory standards.
- A mass balance approach was used to estimate the potential chemical constituent exposure as a function of time during soil manipulation and handling.
- With the current analytical data, the predicted exposure concentrations are below regulatory standards.

Life-Cycle Approach to Criteria Air Contaminant Generation

- For the ex-situ scenario it was assumed that the carbon in all volatile components released would eventually form carbon dioxide, and this mass was calculated.
- This same carbon mass was assumed to be transferred to the landfill. An new CCME model to predict landfill emissions from biosolids was applied with modification. Based on default inputs used in this model is was assumed that half the carbon mass could degrade to methane, with applied uncertainty factors.
- Ex-situ aeration produces no methane, whereas landfill disposal converts roughly half the degradable carbon to methane. Methane has an estimated 23x greater global warming potential than carbon dioxide.

Equipment Particulate Generation & Criteria Air Contaminants

- Particulate emissions are calculated for fuel combustion, vehicular traffic, and soil handling processes.
- Models for these different processes were reviewed, with an aim to focus on Canadian models where available.
- Estimates of particulates from fuel combustion made using the GHGenius model produced by Natural Resources Canada, traffic particulates using an Environment Canada model and soil handling with models developed by the US EPA.
- Particulate generation is highly dependent on distance to landfill, and soil handling (estimation of allu time). Currently the ex-situ scenario is predicted to have higher localized particulate generation.
- The generation of criteria air contaminants from equipment fuel combustion (CH_4, CO, N_20, NOx, SOx, CO_2) was made using the GHGenius model.

Key Data Gaps

- The lifetime for chemical breakdown of PHC compounds during the landfill methane production phase.
- Uncertainties in some modelling inputs including: fraction of carbon converted to methane, proportion of degradable carbon in soil, equipment fuel consumption rates, default soil silt content and others is being reviewed.
- Emission losses from landfill transport not accounted for.

Conclusions

- The predicted outcomes are scenario dependent and importantly reflect site specific data. Some situations may have low risks for ex-situ exposure and potentially increased emissions from landfill related equipment and methane generation and vice versa.
- A spreadsheet tool that allows for some user input to define soil contamination, distance to landfill, and other site-specific inputs may have high industry utility.