CREATING AND DELIVERING BETTER SOLUTIONS
Numerical Assessment of Monitored Attenuation Using Source Depletion as a Variable Loading Factor

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Outline

• Approach & Objective

• Environmental Setting & History

• Modeling

• Source Zone Loading

• Results & Next Steps
Approach & Objective

- A numerical groundwater model was developed for an upstream oil and gas facility in south central Alberta.

- Predict leaching & off-site transport.

- Hydrocarbons from a former underground storage tank.
Approach & Objective

- Determine whether intrusive remedial action was necessary to protect surrounding water resources.

- Site is transected by an ephemeral channel.

- Adjacent intermittent shallow water body.
Environmental Setting & History

• Single gas well facility.
• Phase 1 and Phase 2 ESA.
• Soils and groundwater affected with hydrocarbons.
• Affected area extends off-lease.
Environmental Setting & History
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Soils encountered at the site were stratified and variable.

The upper units were coarser grained material.
Model Domain –
355 m x-direction,
327 m y-direction.

Hydraulic parameters
- Hydraulic Conductivity
- Transmissivity
- Total & Effective Porosity
• Upper model layer was a recharge boundary.

• Ephemeral channel was treated as a recharge area.
Modeling

- Model sensitivity and calibration.

- Model sensitivity analysis was conducted for different values of recharge and hydraulic conditions.

- Sensitivity analysis assessed if changing input parameters will affect the model results and cause model predictions to be invalid.
• Dissolved hydrocarbons, benzene, toluene and ethylbenzene are the target compounds identified by the former assessments.

• Simulation of contaminant transport by use of MT3DMS transport engine.
• MODFLOW model does not simulate vertical transport within the unsaturated zone.

• Loading of hydrocarbons was accomplished with dilution factors used by CCME and AENV Tier 2 Guidelines

\[
t \text{ (year)} = \frac{\ln (M_i/M_0)}{-\lambda}
\]

Where

- \( M_i \): Required mass of chemical to meet AENV criterion
- \( M_0 \): Initial mass of chemical present in soil (above criterion)
- \( \lambda \): Decay constant (1/year)
- \( DF \): Dilution Factor (one through three)
Source Zone Loading
• The loading factor calculated from the source zone was added to the model as a variable source.

• Results were predicted for time frames of 3 years, 5 years and 7 years for benzene, toluene and ethylbenzene.
Benzene
Toluene
Ethylbenzene

Time(day): 995.5

Time(day): 1180.4
Results & Next Steps

• The model predicted that the concentrations for benzene, toluene and ethylbenzene would degrade to values less than their respective guidelines in approximately 7 years, 4 years and 4 years, respectively.

• The estimated range of cleanup is on the order of five to ten years based on the model predictions.
Results & Next Steps

• The model suggests that intrusive remedial actions are not necessary at this site.
• The time frame estimated for the contaminant concentrations to degrade to levels less than guidelines is reasonable.
• Based on model data, the water quality of the adjacent shallow lakes is protected by natural attenuation processes.
• Groundwater monitoring at this site continues to verify the model predictions.
• Questions?
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