Innovative Solutions Using Risk Assessment Tools as a Map for Site Portfolio Management

FEDERAL CONTAMINATED SITES NATIONAL WORKSHOP
April 14 - 16, 2014
OUTLINE

- History
- Objectives
- Perspective
- Solutions
- Outcome
Perspective

- Global Perspective
- National Perspective
- Risk Assessment as a Management Strategy
- Examples
- Tools
- What a Risk-based Management Approach Can Offer
History

- Portfolio of approximately 700+ sites (Central and Western Canada)
- Global Strategy to Manage Environmental Liability with Risk Assessment (Risk Based Site Asset Management RBSAM introduced in 2011)
- Post-Closing Rights and Obligations (PCRO)
- In 2014, actively operate on 373 Sites (179 PCRO)
Portfolio Management

- Minimize Environmental Liability
- Streamline Efficiencies in Environmental Management
- Brownfield Redevelopment
- Categorization of Sites According to Risk Based Corrective Actions
Overview of One Exposure Pathway

- Common Risk Assessment Strategy
- Vapour Intrusion as a Governing Pathway
- Variables Nationally
- Province Specific Management of Contaminated Sites
Variations in Acceptable Risk Levels for BTEX Across Canada

Risk Levels for Carcinogens
- ILCR = 10E-5
- ILCR = 10E-6

Hazard Quotient for Non-Carcinogens
- HQ = 0.2
- HQ = 0.5
- HQ = 1.0

Provinces:
- AB
- BC
- CCME
- Health Canada
- MB
- ON
- QC
- SK
- Atlantic Provinces
## Variations in Applicable Pathways for Different Media

<table>
<thead>
<tr>
<th>Applicable Pathways</th>
<th>CCME</th>
<th>AB</th>
<th>ON</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOIL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Pathways</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil to Groundwater for Agricultural Use Protection</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil to Groundwater for Aquatic Life Protection</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Soil Direct Contact and Ingestion</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Nutrient &amp; Energy Cycling Check</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-site Migration Check</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Human Health Pathways</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Direct Contact, Ingestion, and Inhalation</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vapour Inhalation</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Food Consumption Check</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-site Migration Check</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potable Water Protection</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Management Check</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturation Limits or Others</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>GROUNDWATER</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Pathways</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact by Soil Organisms</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Groundwater to Surface Water for Aquatic Life Protection</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Groundwater for Agricultural Use Protection</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Human Health Pathways</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vapour Inhalation</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Potable Water Protection</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Management Check</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solubility Limits or Others</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>SOIL VAPOUR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Human Health Pathways</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vapour Inhalation</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Saturation Limits or Others</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Variations in Sub-Slab Attenuation Factors Across Canada

![Chart showing attenuation factors across different locations in Canada]
Differences in Estimated Soil Vapour Screening Levels for VI with $L_T = 100\text{cm}$

### Commercial and Coarse-textured Soil

<table>
<thead>
<tr>
<th>Compound</th>
<th>Alberta *</th>
<th>CCME **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>1.0E+00</td>
<td>1.0E+02</td>
</tr>
<tr>
<td>Toluene</td>
<td>1.0E+02</td>
<td>1.0E+04</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>1.0E+04</td>
<td>1.0E+06</td>
</tr>
<tr>
<td>Xylene Mixture</td>
<td>1.0E+06</td>
<td>1.0E+06</td>
</tr>
</tbody>
</table>

### Residential and Coarse-textured Soil

<table>
<thead>
<tr>
<th>Compound</th>
<th>Alberta *</th>
<th>CCME **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>1.0E+02</td>
<td>1.0E+04</td>
</tr>
<tr>
<td>Toluene</td>
<td>1.0E+04</td>
<td>1.0E+06</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>1.0E+06</td>
<td>1.0E+06</td>
</tr>
<tr>
<td>Xylene Mixture</td>
<td>1.0E+06</td>
<td>1.0E+06</td>
</tr>
</tbody>
</table>

* Calculated based on TG4 table (BC MOE 2010)  
** Calculated based on CCME 2008 approach
# Variations in Soil Parameters within CCME

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Coarse</td>
<td>Fine</td>
<td>Coarse</td>
</tr>
<tr>
<td>Moisture-Filled Porosity (unitless)</td>
<td>$\theta_w$</td>
<td>0.05</td>
<td>0.168</td>
<td>0.119</td>
</tr>
<tr>
<td>Vapour-Filled Porosity (unitless)</td>
<td>$\theta_a$</td>
<td>0.31</td>
<td>0.302</td>
<td>0.241</td>
</tr>
<tr>
<td>Soil Vapour Permeability (cm$^2$)</td>
<td>$K_v$</td>
<td>-</td>
<td>-</td>
<td>$5\times10^{-8}$</td>
</tr>
<tr>
<td>Soil Gas Flow Rate (cm$^3$/s)</td>
<td>$Q_{soil}$</td>
<td>167</td>
<td>83</td>
<td>calculated</td>
</tr>
<tr>
<td>Building Height (cm)</td>
<td>$H_B$</td>
<td>360 for Residential &amp; 300 for Commercial</td>
<td>360 for Residential &amp; 300 for Commercial</td>
<td>488 for Residential &amp; 300 for Commercial</td>
</tr>
<tr>
<td>Air Exchange Rate (1/h)</td>
<td>$ACH$</td>
<td>0.9 for Commercial &amp; 0.5 for Residential</td>
<td>0.9 for Commercial &amp; 0.5 for Residential</td>
<td>2.0 for Commercial &amp; 1.0 for Residential</td>
</tr>
<tr>
<td>Separation Distance from Vapour measurement to Building Foundation (cm)</td>
<td>$L_T$</td>
<td>100</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
Differences in Estimated Depth Specific Soil Quality Screening Levels for VI

Residential and Fine-textured Soil

Residential and Coarse-textured Soil

* Calculated based on CCME 2008 approach
** Reported values for surface soil (CCME 2004/EC 2005)
Strategies for Site Portfolio Management

- Equip Environmental Management with Tools That Can be Used Across Regulatory Boundaries
- A Portfolio Map for Multiple Site Management
- Partnership Across Stakeholders
- Resultant Regulatory Advocacy and Partnership
Toolbox

- Site Sensitivity Assessment
- Risk Assessment
- Off-Site Risk Management
- Multiple CAP
- Regulatory Closure
- Property Sales Agreement
- Closure Reporting
Portfolio Map

Environmental Site Assessment
- Site activities and applicable guidelines (Tier 1 or Tier 2 with consideration of pathway elimination and stratified soil)
- Site Investigation (source removal, lateral/vertical delineation, identification of all APECS and COPCs)

Site Sensitivity Assessment
Identification of Environmental Liability Potential and Data Gaps

On-Site
- Risk Evaluation
- Administrative Controls
- Redevelopment Options

Off-Site
- VI Risk Evaluation
- DUA Assessment
- FAL Monitoring

Endpoints
- Risk Management
- Lease Return
- Regulatory Closure
- Property Sales Agreement
- Federal Transfer to Provincial Lands

Corrective Action Plans
- Remedial Excavation
- Bio-Remediation
- Monitored Natural Attenuation

SELECTIVE APPROACH FOR APPLICABLE GUIDELINES (Examples)

<table>
<thead>
<tr>
<th>Media</th>
<th>AB</th>
<th>MB</th>
<th>SK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>AB</td>
<td>CCME/ON/AB</td>
<td>CCME</td>
</tr>
<tr>
<td>Groundwater</td>
<td>AB</td>
<td>CCME/ON/AB</td>
<td>AB</td>
</tr>
<tr>
<td>Soil vapour</td>
<td>BC</td>
<td>CCME</td>
<td>CCME</td>
</tr>
</tbody>
</table>

TOOLS
- PM Intake (VI)
- SST Intake
- ERA Outline
- VI Screening
- Mann Kendall Analysis
- LNAPL Characterization
- Analytical History
- Multiple CAP
Remedial Options

- In-situ bioremediation
- Targeted risk based excavation
- Brownfield redevelopment management
- Passive risk management systems
- Non-conventional building designs
- Combined land use alternatives
- Administrative controls
Outcomes

- Categorizing remedial programs into levels of risk and remedial methods; result - effective prioritization of sites and coordination with appropriate remedial options
- Multiple corrective plans submitted and approved in a timely manner accommodating the short remediation season in the Prairies
- Tools for project managers to streamline reporting deliverables with prevailing resource limitations in the Prairies
- Acknowledgement of regulatory differences
PCRO Portfolio in 2014 involves over 170 sites currently

Multiple year regulatory closures

In Saskatchewan, estimated cost savings of >$100k on multiple CAP submission (not including value of time savings)

In Manitoba, estimated cost savings of >$100k were reported on the portfolio closures alone in 2013

Overall, recorded >>$100k in cost savings on the active PCRO portfolio
Outcomes (cont’d)

- Portfolio Perspective for Environmental Management Objectives Served to Meet Business Objectives
- This Perspective Served to Develop Tools that Appealed to Regulatory Agencies (Often with Similar Economic/Resource Restrictions)
- Business Objectives Translated into Regulatory Advocacy and Leadership
Lessons Learned

- Initial struggles and frustrations with regulatory subtleties both for Shell and SNC-Lavalin quickly evolved into substantial cost-savings and improved land redevelopment timelines.

- The program is in its last years for the majority of the PCRO sites and will meet the endpoint objectives on a significant percentage of sites.

- Business objectives translated into Regulatory Advocacy and Leadership.
ACKNOWLEDGMENTS

Matthew Lahvis, Ph.D., Team Lead Soil and Groundwater (Shell Projects and Technology US)

Chi Hoang, Ph.D., P.Eng. (SNC-Lavalin)

David Tarnocai, M.Sc., QP_RA, P.Geo. (SNC-Lavalin)
WE CARE embodies SNC-Lavalin’s key corporate values and beliefs. It is the cornerstone of everything we do as a company. Health and safety, employees, the environment, communities and quality: these values all influence the decisions we make every day. And importantly, they guide us in how we serve our clients and therefore affect how we are perceived by our external partners. WE CARE is integral to the way we perform on a daily basis. It is both a responsibility and a source of satisfaction and pride by providing such important standards to all we do.

WE CARE about the health and safety of our employees, of those who work under our care, and of the people our projects serve.

WE CARE about our employees, their personal growth, career development and general well-being.

WE CARE about the communities where we live and work and their sustainable development, and we commit to fulfilling our responsibilities as a global citizen.

WE CARE about the environment and about conducting our business in an environmentally responsible manner.

WE CARE about the quality of our work.