

Hydrogeological Assessment Tools

Ian Mitchell, SLR Consulting (Canada) Ltd.

The Science Advisory Board for Contaminated Sites in British Columbia (SABCS) was funded by the BC Ministry of Environment to develop scientific tools that could be used in the identification, assessment and management of contaminated sites in BC. A set of screening-level risk assessment tools was initially proposed by SABCS in October 2004 to address sites where exposure pathways to potential receptors are limited or absent. However, these tools were designed for general use by contaminated sites practitioners and as such, the hydrogeological analyses in the screening-level tools are inherently simple and conservative.

To address a more detailed phase of risk assessment work, the SABCS developed a set of technical guidance documents for a more sophisticated level of hydrogeological analyses (HAT tools). The HAT tools are intended for use by specialists in hydrogeology and address five key topics including the evaluation of: (i) vertical transport in groundwater; (ii) contaminant transport in the unsaturated zone; (iii) light non-aqueous phase liquid mobility (LNAPL); (iv) biodegradation rate for organic contaminants in groundwater; and (v) transport modelling of metals in groundwater. An individual paper for each of these topics was completed under contract by selected consultants. An overview of each topic and a web link to each paper is provided below:

Vertical Transport Assessment Tools

The BC Ministry of Environment has traditionally relied upon a very conservative approach to the evaluation of dissolved contaminant migration based on the use of a simple groundwater pathway model that assumes only horizontal transport to a receptor. The vertical transport assessment tools allow practitioners to consider an expanded model that incorporates either upward or downward flow and the presence of deep confined aquifers. This is accomplished through the use of a stepwise flowchart created for this paper and the identification of a variety of quantitative tools ranging from simple analytical equations for mixing and transport to complex numerical models.

This paper is available for download from the SABCS website at:

<http://www.sabcs.chem.uvic.ca/Vertical%20Transport%20Guidance%20JC.pdf>

Metals Transport Assessment Tools

The Metals Transport Assessment Tools paper describes the three main types of geochemical models that are available to practitioners for the assessment of metals transport in groundwater. Beginning with the simplest methods of analysis, Static Models are presented which utilize computer software codes to assess aqueous speciation, complexation and surface reactions in a groundwater system. In the second type of model known as the Reaction Path Model, software codes that assess the

equilibrium reactions that may occur along an aquifer flowpath are compared and contrasted. Finally, a third type of model, the Coupled Reactive Transport Model is presented. Considered the most complex of the metals transport assessment tools, these software codes are capable of simulating how a geochemical system evolves over time and along a flowpath in three dimensions.

This paper is available for download from the SABCS website at:

<http://www.sabcs.chem.uvic.ca/Metals%20Report.pdf>

LNAPL Mobility Assessment Tools

The LNAPL Assessment Tools paper provides a set of complementary approaches and quantitative tools for the evaluation of LNAPL mobility. The principles of multiphase flow and LNAPL plume stability, and their relationships to aquifer conditions are described. The use of a toolbox approach is encouraged, combining observational methods of evaluation with theoretical methods and laboratory tests. A variety of current methods are discussed including the data requirements and software codes that are available.

This paper is available for download from the SABCS website at:

<http://www.sabcs.chem.uvic.ca/LNAPL%20Guidance%2002-15-06%20rev.pdf>

Biodegradation Rate Assessment Tools

The Biodegradation Rate Assessment Tools paper presents a variety of approaches that can be taken to determine the biodegradation rate constants for the transport of organic compounds in shallow groundwater. This paper identifies methods to differentiate the effects of biodegradation from other attenuation processes and describes the three primary methods used to derive biodegradation rate constants, including laboratory methods, field techniques and numerical modelling. The paper also includes a flow chart to assist in the selection of appropriate tools, and reference tables that summarize the applicability and utility of each method under various field conditions.

This paper is available for download from the SABCS website at:

<http://www.sabcs.chem.uvic.ca/Decay%20Rates%20Report.pdf>

Unsaturated Zone Contaminant Transport Assessment Tools

The Unsaturated Zone Contaminant Transport Assessment Tools paper presents current approaches and methods to evaluate the fate and transport of chemicals in the unsaturated

zone. Fundamental aspects of the soil-water characteristics curve and unsaturated zone hydraulic conductivity are described. A variety of tools ranging from simple, closed-form analytical solutions to complex numerical models are compared to evaluate the leaching of chemicals from contaminant sources and solute transport through the unsaturated zone.

This paper is available for download from the SABCS website at:

<http://www.sabcs.chem.uvic.ca/Rep%200621%20Unsaturated%20Tools%20June%2021.pdf>