

**HYDROGEOLOGICAL INVESTIGATION OF COAL TAR  
CONTAMINATION AT A FORMER COAL GASIFICATION FACILITY**

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This paper presents the results of an environmental investigation to characterize subsurface contamination and hydrogeologic patterns at a historical coal gas manufacture property in Victoria, B.C.. Appropriate remediation strategies are also discussed.

An archival search was conducted before initiation of field activities to provide documentation of operational practices at the former coal gas facility. This information was used to guide the environmental investigation. Site investigations consisted of surface water and sediment sampling of the harbour, drilling of boreholes and sampling of cuttings, installation of piezometers and groundwater sampling.

The production of manufactured gas from coal produced many waste products including byproduct tars and oils; spent oxide waste containing lime, iron oxides, cyanides and sulphur; and ash. Byproduct tars and oils are immiscible fluids, consequently their groundwater flow patterns are more complex than soluble contaminants. Major stratigraphic zones and groundwater elevations were mapped to enable assessment of likely subsurface contaminant pathways.

Results to date have shown that the coal tar is migrating downslope along the top of an impermeable silt-clay layer toward the harbour. Existing subsurface structures will obviously influence both the presence and migration behaviour of coal tar residues. The complexity of subsurface migration of immiscible fluids rendered the use of borehole information inadequate for the assessment of contaminant pathways. Therefore, a geophysical survey using established techniques was initiated to provide a more continuous description of subsurface conditions and to enable the location of old disposal wells and other historical excavations which may contain waste products.

Analytical protocols to evaluate subsurface contamination by immiscible fluids are not well defined. Two different analytical methods were employed and correlation between the methods was evaluated with respect to the B.C. Provincial Remediation Standards for commercial and industrial land use. The variability of analytical results can largely be attributed to the heterogeneous nature of the subsurface and immiscible and

viscous characteristics of the contaminant. The coal tar tended to be concentrated in high permeability lenses as well as forming discrete globules rather than more uniform subsurface dispersion as would occur with a soluble contaminant. Standard sampling and analytical protocols should be developed for both heavy and light end hydrocarbon contamination.

Following the completion of the geophysical survey, an in-situ bioremediation program is proposed to remove contaminants from the subsurface and reduce contaminant migration to the harbor.

#### POTENTIAL APPLICATIONS OF STABLE ISOTOPES IN STUDIES OF IMMISCIBLE GROUNDWATER CONTAMINANTS

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Isotopes of elements differ in their masses and their abundances are altered (isotope fractionation) by natural mass dependent processes. For example, hydrogen and oxygen isotopes are fractionated in the hydrologic cycle because of the different vapour pressures of isotopic species of water.

The isotopic composition of a sample can be used both as a label for tracing its movement and as a record of geochemical and geophysical conversions.

Applications of stable isotope techniques to the investigation of immiscible contaminants in groundwater have been few. However, when they are considered with a number of closely related studies, many potential uses of stable isotope data become evident.

The isotopic compositions of water and dissolved components have been often used to discern subsurface flowpaths.

Transformations of both immiscible and soluble organic matter have been identified in subsurface systems using stable isotope data. Oxidation of organic matter is evident in the carbon isotope composition of CO<sub>2</sub> or dissolved carbonate. The sulphur isotope composition of dissolved sulphate or product sulphide provides evidence of sulphate reduction during oxidation of organic matter.