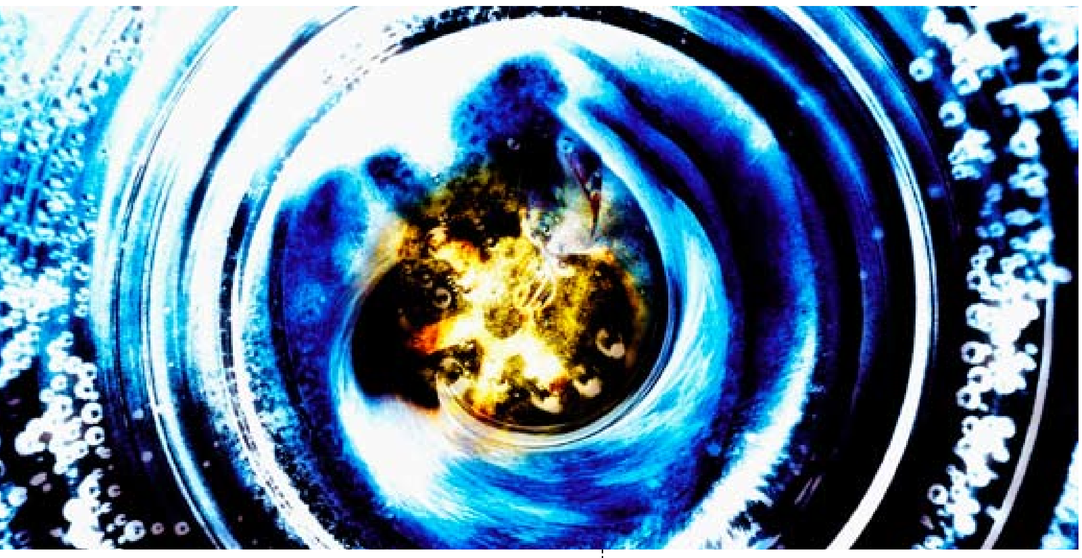
By Camille Atrache

Dealing with subsurface remediation



Subsurface Remediation includes identifying, quantifying and controlling contaminated source(s); considering cleanup levels required for each medium (air, soil, and ground water) to protect human health and the environment; and selecting treatment technologies based on information obtained concerning source(s) and cleanup levels. The challenge is to effectively relate site characterization activities to selecting the most appropriate remediation technologies for contaminated soils and groundwater at hazardous waste sites.

The contaminated subsurface is a system generally consisting of two phases – solid and fluid – and five compartments, namely gas, inorganic mineral solid, organic matter solid, water and oil (Non-Aqueous Phase Liquids (NAPLs)). NAPLs are divided into two classes. LNAPLs are those that are lighter than water such as hydrocarbon fuels (kerosene, diesel, gasoline, etc). DNAPLs are those with densities greater than water such as chlorinated hydro carbons (polychlorinated biphenyls (PCBs), tetrachloroethylene, chlorobenzene, trichloroethylene (TCEs), etc).

Currently, several remediation techniques are being used to restore contaminated groundwater and aquifer material. The pattern of contamination from the release of contaminants into the subsurface environment, such as would occur from an underground leaking storage tank containing NAPLs, is complex.

As contaminants move through the unsaturated zone, a portion is left behind, trapped by capillary forces. If the release contains volatile contaminants, a plume of vapour forms in the soil atmosphere in the vadose zone, i.e., the region extending from the ground surface to the upper surface of the principal water-bearing formation. If the release contains LNAPLs, they may flow by gravity down to the water table and spread laterally. Groundwater moving through subsurface sediments contacts the release and then more water-soluble components are dissolved into the water phase. Therefore, three distinct regions of contaminants are formed in the release. A plume of fumes in the soil atmosphere, a groundwater plume, and the region that contains the oil phase material that serves as the source area for both plumes. If the release contains DNAPLs, these contaminants can penetrate to the bottom of the aquifer, forming pools in depressions.

The pump-and-treat remediation technique

Both hydro geologic information and contaminant information are required for pump-and-treat remediation. Hydro geologic information about groundwater flow includes geological and hydraulic factors as well as groundwater withdrawal factors. The main advantage of the pump-and-treat system is that it could be installed on the property and operated with minimal interference with the operation and use of the property. (The property could possibly be developed without interfering with the pump-and-treat system as well).

This remediation method could be made by the use of either wells (extraction wells, injection wells or a combination of the two) or drains. For low permeability material, drains may be used. If the hydraulic conductivity is sufficiently high to allow flow to wells, then wells are recommended. Injection wells reduce cleanup time required by flushing contaminants to the extraction wells. Injected water can contain nutrients or electron acceptors where bioremediation is used. Injected water could also contain enhanced oil recovery materials for NAPL contaminants.

Pump-and-treat remediation has two parts: 1) pumping system and 2) treatment system.

1) The groundwater pumping system utilizes the principle that groundwater flows in response to hydraulic gradient. A drop in hydraulic pressure is created by the combined effects of elevation, fluid density and gravity. The migration of a plume from its source area often can be prevented by capturing the plume with a purged well. The well must pump hard enough to overcome regional flow in the aquifer. Hydrodynamic control of a contaminated groundwater plume is accomplished by the hydraulic gradient. Along with the pumping system, a physical containment could be used to improve the remediation process. This includes installing barriers to groundwater flow (e.g. slurry walls, sheet pilings, grout curtains, etc.) or diverting uncontaminated surface water away from the contaminated site or contaminated water away from clean areas. Containment also limits the amount of uncontaminated water that requires treatment.
2) Contaminated groundwater and vapours that are withdrawn from aquifer sub surfaces can be treated by various methods, depending on the contaminants. Treatment methods may include one or more of the following:

A) physical processes such as absorption into activated carbons, ion exchange, filtration, air stripping, etc.;
B) chemical process, such as neutralization, coagulation, precipitation etc.

You could also use a combination of both.

In conjunction with the above, biological in-situ treatment of the contaminants is used as well. This is usually accomplished by stimulating indigenous subsurface micro organisms to degrade organic waste constituents.

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