# The Environmental Corner

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## Using Conceptual Site Models To Direct Investigations And Cleanups

In the early 1980's, when the field of environmental consulting was just starting, the United States Congress was busy developing guidance documents to direct how site investigations and cleanup would be conducted. The science was new and there wasn't a lot of data to draw from with respect to how chemicals "behaved" in the subsurface. Everything from our understanding of the fate and transport of chemicals in groundwater to our ability to remediate and contaminated aquifers was in its infancy.

During these early days, site investigations were laid out in great detail. The work plans were thick and full of details on the site history, the sampling approach and rationale, the sampling protocol, the sample analysis methodology and so on. An overriding theme of these earlier investigations included the development of a Conceptual Site Model or CSM. The CSM provided an understanding of the site conditions and process by which contaminants moved from source areas to human and ecological receptors. Over time, the industry matured and before long, everyone was an environmental consultant. Underground tank cleanup funds, paid for with state gasoline taxes, created a pile of money that was vigorously pursued. Environmental consulting was big business and companies of all sizes and background, from large government contractors to small backhoe operators, fancied themselves experts. With this market maturing, the way in which site investigations and remedial actions were being conducted changed and a strict attention to the previous, detailed approach was abandoned. The lengthy, scientific technical reports were replaced with boilerplate reports where the project names seemed to be the only difference from site to site. Scientists and engineers were replaced with technicians and lower rate staff and the industry's work product became a commodity to be shopped for the lowest price.

Fast forward ahead another 20 years and the industry experienced a major change. Regulatory agen-

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*As Seen In...*

**Cleaner & Launderer**

**July 2012**

cies and health officials learned that in addition to having to evaluate the potential effects of hazardous constituents in soil and groundwater, vapors contaminated with organic chemicals like benzene and perchloroethylene, or Perc, also are a health concern. Overnight, the science is back. Since there is a lack of good statistical data regarding the "behavior" and effects of vapors in the subsurface, each site must be evaluated and reported to the regulators in detail. Like during the infancy of the environmental industry, fully developed Conceptual Site Models are being promoted as the best way to conduct site investigations and develop cleanup alternatives, especially if the cleanup alternative includes a risk based closure approach, where contaminants are left in place.

The major phases of developing a CSM include: 1) pre-investigation site evaluation; 2) development of a sampling approach; 3) understanding groundwater plume behavior; 4) understanding vapor behavior; and 5) assessing pre-existing, background conditions. It is important to understand that the CSM is dynamic in that it is supposed to be changed, updated and modified as new information is discovered and learned.

In reality, good consulting engineers inherently think about all of the elements of a CSM already, but most of the time it is done in their head. By laying out the CSM in standardized terms and methodologies, the regulatory agency can better ensure that site investigations and risk-based closures will follow a systematic process from project to project.

The pre-sampling elements include developing and describing the historical land use, the types of chemicals currently or previously used at the site, the likely contaminant source areas, the surrounding land use, the local geologic setting, the potential preferential migration pathways (subsurface utilities), and other special circumstances, such as whether water wells are in the near vicinity of the site.

This pre-sampling work is used to develop the actual sampling plan. Because the sampling plan and site investigation work is ultimately used to assist in determining the remedial alternatives, it is important to consider how people and the environment could be affected by chemicals should they be present at certain levels.

The sampling element includes evaluating the soil, groundwater and vapors that may be present at the site. Such evaluation should consider the sample depths and locations, the sample collection methodology and the sample testing and analysis. When risk based closures are being contemplated, the consultant should consider the collection of both chemical and physical samples. Typically, not enough emphasis is put on the collection of samples to determine the carbon content in soil or the ambient water quality conditions. Such data can be very useful in laying out a case for risk-based closures. Finally, the issue of vapors needs to be addressed. As alluded to, the "behavior" of vapors in the subsurface is not well known. Vapors may migrate and change in concentrations over the course of a year based on large precipitation events, migration along utility corridors and the use of heating and cooling systems inside buildings. Because vapor migration is still not well understood, multiple lines of evidence (LOE) should be evaluated when conducting site investigations.

Another CSM element is the "behavior" of the groundwater plume. The plume behavior includes evaluating and understanding the extent of plume, the aquifer parameters (hydraulic conductivity, gradient and velocity), whether natural degradation is occurring within the plume or along the plume margins (this is where the physical data discussed earlier can come into play), whether there are receptors such as people drinking well water or fish in water bodies, and whether other plumes are present and commingling together.

The vapor element is its own chapter. The agencies are struggling to get a handle on the changes in screening levels between the federal and state governments. Screening levels have been established that suggest if concentrations of chemicals are found in groundwater at a certain location, they will result in vapors of specific concentrations directly above the groundwater location. The science clearly shows that the screening levels extrapolating chemical concentrations in groundwater to chemical concentrations in vapor are not accurate. The use of such screening levels could result in the consultant requesting a neighbor for access and permission to collect indoor air samples in their home or business. While the collection of vapor samples in homes, businesses and schools is necessary in certain situations, there is nothing more uncomfortable than having parents ask tough questions about whether the children are being exposed to harmful chemicals.

Finally, the issue of background

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soil and groundwater quality needs to be incorporated into the CSM. For a site impacted with chlorinated solvents, it is not uncommon for there to be other upgradient sites that have similar groundwater impacts. Often times these plumes blend and commingle together, which can make the remedial alternative or a risk based closure difficult.

Throughout the process of conducting the site investigation and tweaking the CSM, the goal and objective of remediation needs to be kept in mind. In most cases, some sort of risk-based cleanup will be implemented. If that is the case, the exposure pathways need to be addressed. Such exposure pathways include direct contact to contaminated soil, inhalation of vapors and dust, and the ingestion of contaminated groundwater. Often time a risk assessment will need to be conducted that is the collection and analysis of data to characterize the nature and magnitude of risks to humans and the environment posed by one or more chemicals. In developing the risk-based closures, consideration needs to be given to how identified exposures or potential exposures will be eliminated. Exposures can be eliminated by implementing engineering controls such as physical caps and barriers and the installation of sub-slab depressurization systems or increasing the airflow in buildings to eliminate or reduce chemical vapors. Institutional controls such as Environmental Restrictive Covenants (ERCs) are typically included in a risk-based closure. ERCs go with the property title and control the future land use with the intention of minimizing future exposure.

In closing, most sites impacted with chlorinated solvents and other persistent chemicals will be closed with conditions. Conditional closures will typically require some land use restrictions, some engineered controls and long term monitoring. In order to effectively move the site through the investigation and cleanup, minimize overall costs and instill confidence in the regulatory site manager, a Conceptual Site Model should be developed before the site investigation and it should be modified as new information is developed. The CSM should also include an analysis of what risks the contamination poses and a remedial aspect that focuses on a realistic closure scenario.

***With 30 years of experience, Steve Henshaw holds professional geology registrations in numerous states. As President and CEO of EnviroForensics, Henshaw serves as a client and technical manager on projects associated with site characterization, remedial design, remedial implementation and operation, litigation support and insurance coverage matters. He has acted as Project Manager or Client Manager on several hundred projects, involving dry cleaners, manufacturers, landfills, refineries, foundries, metal plating shops, food processors, wood treating facilities, chemical blenders, and transportation facilities. Henshaw has built a leading edge environmental engineering company that specializes in finding the funding to pay for environmental liabilities. By combining responsible party searches with insurance archeology investigations, EnviroForensics has been successful at remediating and closing sites for property owners and small business owners across the country with minimal capital outlay from clients. He is a regular contributing writer for several dry cleaning trade publications on environmental and regulatory issues and remains active with dry cleaning associations by providing insight on changes in law and policy. Visit www.enviroforensics.com or e-mail: shenshaw@enviroforensics.com.***