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Migration of UST Vapors

The contents of this summary are based entirely on two articles published in LUSTLine (Bulletins 27, 28 & 41) by Blayne Hartman, Ph.D. of TEG, Inc. in Solano Beach, CA. [http://www.tegenv.com/articles.htm]

There has been quite a bit of coverage regarding the discovery of leaks in upgraded and new underground storage tank (UST) systems in California during a field-based research project. This project was conducted by the State Water Resources Control Board (SWRCB) as mandated by state law SB 989.

The SWRCB selected a very sensitive tracer-based test (Tracer Tight® test method) that is capable of detecting minute vapor releases as well as unauthorized liquid releases. This field-based research is intended to evaluate the effectiveness of the 1998 UST system upgrade requirements that enhance the existing regulations that require all UST systems be liquid tight.

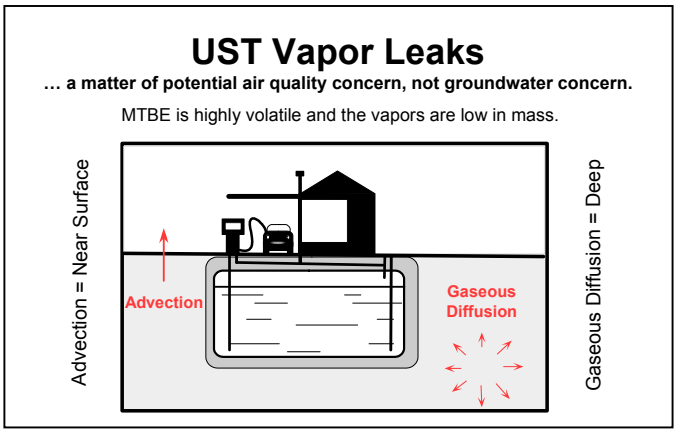
So far, there have been very few suspected liquid leaks but almost one-third of the tests indicate leaking vapors. There are those that are contending that these vapor leaks are evidence of a continuing threat to groundwater resources. Some of those making these allegations point to a 1998 article written by Dr. Blayne Hartman in the periodical publication called LUSTLine entitled, "The Downward Migration of Vapors." However, the dynamics involved with the migration of vapors from USTs cannot be fully appreciated, especially in the context of the SB 989 field-testing results, without reading the first of Dr. Hartman's two articles, "The Upward Migration of Vapors."

In very simplified terms, the migration of vapors below the surface of the ground is controlled by one of two different physical processes; advection or gaseous diffusion. Near the surface (from 3 to 5 feet) advection transport is usually the controlling process that will bring UST vapors to the surface venting to the atmosphere. The movement of vapors by advection is influenced by differences in temperature, pressure and air exchange rates.

When the UST vapor source is located in deeper strata where there are no influences from atmospheric temperature and pressure changes or air exchanges, gaseous diffusion takes over. Under gaseous diffusion, the vapor will radiate out from the vapor (or liquid) source. There is very little likelihood of a vapor (versus liquid) leak emanating from these lower portions of a tank system. Part of this movement of the vapor in deeper strata, from high concentration to areas of lower concentration will result in some downward movement of vapors.

The movement of vapor under gaseous diffusion is highly dependent on soil porosity. During a one-year period, Dr. Hartman estimates that contaminate vapor can move as fast as 25 feet per year. Once the vapors reach groundwater, the movement of the vapors into the groundwater is generally very slow because groundwater movement is so slow.

Hartman contends that in areas with low groundwater flow velocities, the contamination of groundwater by downward vapor transport is not likely to be significant. But, in areas where:
... groundwater flow is in excess of 100 feet per year,
... there are large variations in the water table,
... there is coarse (porous) soil, and/or
... there is a high water recharge from the surface to groundwater,
the gas exchange rates may be higher and cause dispersive



mixing resulting in contamination by gaseous diffusion transport that could be significant. Of course, the significance would depend on the mass of the contaminant in the vapor.

Among today's upgraded tank systems, the tanks are the least likely source of leaks; especially if the tanks are double-walled. Most UST system failures or liquid/vapor leaks are from the pipe plumbing or the fittings on the tops of tanks. In summary, the primary vapor migration process at work on vapors released from UST systems should be advection as the plumbing is generally located from 3 to 5 feet from the surface and in a pea gravel environment. Some may try to make the case that such upward migration will be restricted by pavement and other physical restrictions but the vapors will follow a path of least resistance to a point where they will eventually escape to the atmosphere.

Lost in the discussions about the results of the field-based research project is that the project found all but one of the upgraded UST systems tested complied with the requirement that they be liquid-tight. Roughly two-thirds of the UST systems tested using this very sensitive test were found to have vapor leaks. These leaks were located in the piping and tank fitting which are located within a few feet from the surface. Based on the afore going discussion regarding vapor releases in the subsurface environment, it is very likely that the majority of these vapor leaking UST systems emitted vapors that went directly to the atmosphere via advection influences. The only situation that might offer some groundwater contamination would be a very wet subsurface. Even then, we are talking "vapors" and the contamination would be minimal.