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A Report On Federal & State Programs To Control Leaking Underground Storage Tanks

Where Are the Sites?

The Emerging Context for "USTfields"

by Charlie Bartsch

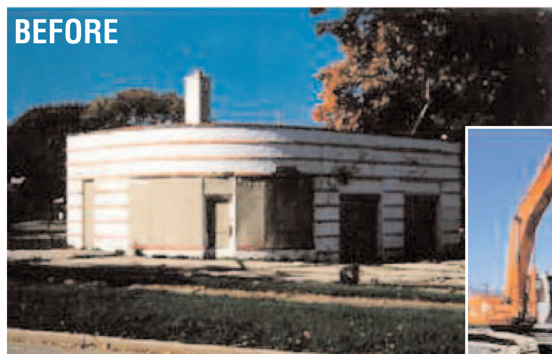
Sherman Perk, a successful independent coffee shop developed on an odd-sized, triangular petroleum brownfield site, is located in the Sherman Park area of one of Milwaukee's most diverse neighborhoods. The building on the site, which was renovated to house the coffee shop, was built in 1939 and operated as a gas station for 50 years. The property sat vacant for 10 years following the closure of the gas station in 1989. It slipped into tax delinquency and was boarded up.

In the mid-1990s, a local community group, Grasslyn Manor, launched the process to register the gas station with the City of Milwaukee's list of Historic Properties. The building was one of the few remaining unaltered examples of a Streamlined Moderne architectural-style gas station in the Midwest, a feature that the group felt could give it a unique commercial advantage.

In the spring of 2000 a new owner, Bob Olin, acquired the property, this time because of its historic value. But the site had serious problems. The City of Milwaukee had ordered the gas station building to be demolished because of the hazard it posed—the structure was seriously deteriorated and the site was contaminated due to fuel leakage over the years. In addition, the site bore a significant financial burden that had discouraged developers from coming forward—the property was nine years' tax delinquent.

But the owner persevered, and in mid-May 2000 he attended a meeting of the Sherman Park Historic Preservation Council to express his interest in reviving the idea of developing a coffee shop at the site. Olin was aided in his effort by a new Wisconsin state law designed to encourage reuse of tax-delinquent, contaminated properties by linking cleanup and reuse to tax foreclosures, assigned tax liens, and a tax forgiveness process. This statute became the tool that facilitated the saving of the gas station, and the coffee shop project was the pilot case under the new law.

■ *continued on page 2*



TANK REMOVAL

Sherman Perk, Milwaukee, Wisconsin

Inside

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Synergy

In the case of Sherman Perk, the parties to the foreclosure included the City of Milwaukee and the Wisconsin Department of Natural Resources (DNR). The city's role was to commence with the tax foreclosure and then place the property in the hands of a developer (in this case, the current owner), who would do what was needed to get the property back into tax-paying status. DNR's role was to oversee the environmental remediation of the property, which it did through the state voluntary cleanup program. After five months of effort, the statute was applied and the petroleum-contaminated Sherman Park site was transferred to Mr. Olin for cleanup and redevelopment.

As a small, community-based developer, Olin faced critical financial hurdles in getting his project underway. He worked with a variety of public agency partners to structure a package of financial incentives that made Sherman Perk a reality. The city and county of Milwaukee provided $30,000 in grants to help cover the costs of site cleanup, including removal of USTs, and the Wisconsin Department of Commerce awarded $100,000 through its Brownfield Revitalization Program to help finance redevelopment.

The grand opening of Sherman Perk took place on August 20, 2001, and the coffee shop has become a thriving neighborhood anchor. In 2003, Sherman Perk's owner paid the greatest tribute possible to the opportunities and process of converting an abandoned petroleum brownfield site—he did it again!

Bob Olin recently opened a second coffee shop at an old gas station site in the historic Kletzsch Park neighborhood in Glendale, Wisconsin (not surprisingly called Kletzsch Perk), and is looking for two more gas station sites for additional outlets.

Petroleum-Contaminated Sites Are Everywhere!

There is an almost uncountable number of abandoned gas stations, not to mention places like idle manufacturing facilities that dealt with oil in some way and dying shopping areas that had oil tanks on site—the list is as long as it is diverse. Thus, the challenge of petroleum-contaminated sites is significant. But this challenge is being met, and communities that are succeeding are doing so because they have defined cleanup and reuse in a new context for these properties. They tend to:

- Approach UST site reuse as an economic development issue with an environmental twist, rather than as only a pollution problem;
- View UST projects as real-estate deals that further community development goals, and in doing so, they turn environmental issues into an approach that creates value, attracts investment, and gathers support;
- Begin cleanup and reuse with the end in mind, using strategies such as risk-based corrective action (RBCA) to guide their efforts; and
- Understand that regulatory processes need to dovetail with development time frames.

Economic Development with an Environmental Twist

If contaminated petroleum sites are viewed as only pollution problems, disconnected from community revitalization goals and economic development strategies, then efforts to reuse these sites will flounder. If, however, localities and their partners view USTfield projects as real-estate deals that further community development goals, then the environmental issues can be structured into an approach that creates value, attracts investment, and gathers support.

This perspective on petroleum site redevelopment also reflects the emerging agenda of EPA, which is increasing the focus of its waste cleanup efforts on a community revitalization and land-use approach. Moreover, the success of this approach will be strengthened if it helps create strong redevelopment partnerships among localities, state agencies, and the private sector.

Most communities have many sites within their boundaries—far more than can be easily or readily addressed. Therefore, the immediate challenge is to prioritize. Anybody can make a list, but if that list is to be effective in leading to the next steps of cleanup and reuse, then it must meet the needs of prospective reusers. And a first key need is a list of likely targets that can meet reusers' needs. An appropriate screening is enormously valuable—prospective reusers are not interested in having the whole phonebook when all they want is five listings.

This inventorying process needs to be conducted in a targeted, focused manner. It can be high-tech, using emerging geographic information systems (GIS) and similar tools. It can also be low-tech, with something as simple as a windshield tour of a community area that officials want to market for new use. To this end, city or county planning and development departments—which likely have prepared and sorted site lists as part of their own economic marketing activities—can be valuable allies in what may naturally evolve into a mutually advantageous effort.

The Legwork

Overall, it is more important to make sites attractive and marketable for

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various types of new uses. This means taking the next step beyond listing and inventorying to analyzing, sorting, and prioritizing—helping to do the first screen to meet the needs of prospective reusers of petroleum-contaminated sites. Local officials and environmental agency staff can take the following critical steps:

- Proactively identify appropriate site reusers by working with contacts in sister agencies to point companies to abandoned gas stations in locations that can meet their demographics but that they might have overlooked.
- Provide a responsive regulatory process that includes a sense of time frames and requirements, as well as giving basic explanations of how liability relief works, identifying who the right points of contact are, and pointing to an ombudsman if one is in place.
- Link users to various financial incentives that can be used to overcome the additional or up-front costs of assessment, cleanup, and site preparation attributable to contamination—many such incentives exist at all levels of government.
- Offer marketing support and outreach—including promoting site reusers as good corporate citizens—which will help them to justify their decision to take on a petroleum-contaminated site.
- Help to make the critical connection with the community, and support public participation and neighborhood outreach efforts pertaining to issues such as type of cleanup, use of institutional controls, and other strategies that can be safely deployed to cut costs while maintaining appropriate health and environmental standards.

Connecting the Dots

"Lists" are enhanced with local capacity to back them up and to carry out the steps noted above. Local governments are ideally situated to foster USTfield activities and promote private-sector investment, and the state needs to be a key player in that process. This partnership can involve a number of activities, and could include:

- assembling sufficient resources to build program capacity and leverage site-specific initiatives, which may mean connecting UST and brownfield efforts where possible to leverage each other's resources
- recognizing that petroleum properties may not fit within traditional land-use approaches and may have to be considered site by site—and may require state help in targeting priority sites for local attention
- considering public uses for petroleum-contaminated properties that complement adjoining private uses, such as post offices, police stations (e.g., Dallas), health clinics (e.g., Tampa), or that can serve as catalysts for related developments
- enhancing local reuse capacity by identifying and educating visible local leadership on UST issues, which could include political leadership from the top as well as a day-to-day champion who can maintain project efforts over time
- integrating UST site activities into broader community development goals, for example, through approaches such as tying them to related economic development activities like small-scale commercial development or infill housing

Moreover, partnerships must go beyond the public sector. Given resource constraints, substantial petroleum site reuse will only be realized when the private sector is engaged as an active partner. The public sector cannot do all of this alone.

Partnerships based on a solid outreach effort are vital to a successful UST effort because they foster communication and the building of cooperation and trust. Depending on the specific project and its location and situation, potential private partners may include bankers, investors, developers, existing private business owners, and lawyers, as well as environmental professionals, private practitioners in several areas (e.g., economic development, engineering, technology services), insurance providers, and even the major oil companies.

Partnership efforts could involve:

- forming good working partnerships with potential redevelopers and reusers of sites, while providing them with basic information and targeted inventories that can prove attractive to them as they go about their business
- enlightening private parties on how to overcome liability and other barriers to successfully redevelop and market tank sites, while explaining key components of the reuse context to them, such as new laws and regulations influencing site reuse, the economic benefits of cleaning and reusing these sites, and various public incentives (e.g., voluntary cleanup program (VCP) releases) and private tools (e.g., environmental insurance) available that can help tie these projects together
- forming good working partnerships with, and providing outreach to, financiers and insurers of USTfields projects by teaching them about new technologies, the value of VCPs, and related elements that can advance their comfort and understanding
- starting to build working relationships with major oil companies

Where are the sites and how are they being reused? More and more examples of how these concepts are coming together in practice can be found. The Sherman Park story at the beginning of this article provides one example. Let's take a glance at examples in Montgomery Park, Maryland and Chevy Place, New York.

Montgomery Park

Today's Montgomery Park in Baltimore, Maryland is yesterday's 26-acre, 1.3-million-square-foot Montgomery Ward catalog distribution center, which was built in 1925. The facility closed in 1985 and remained vacant for 15 years, gradually deteriorating. The structure had the types of contaminants that were common to its era of construction—interior and exterior lead paint, asbestos, petroleum, and PCBs. The site also had six underground storage tanks that had to be removed. The cost of cleanup was approximately $2 million.

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■ **Where Are the Sites** *from page 3*

Montgomery Park, Baltimore, Maryland

The Montgomery Park project incorporated a number of green building concepts. And like many sites incorporating an innovative approach, the developers used a blend of public and private funding sources to pull the project together. In the end, this project converted an 80-year-old historic structure into a state-of-the-art green building. Currently, the eight-story building is 40 percent leased, and 1,800 people work there. The work force is projected to top 4,000 when the building is fully leased.

Chevy Place

The 2.2-acre former Hallman Chevrolet automobile dealership and service garage, now known as Chevy Place, is located in downtown Rochester, New York. This site was redeveloped primarily for residential purposes. Some $10.6 million was invested in Chevy Place for site preparation and construction of 77 new residential townhouses and apartments. Chevy Place also included the construction of a below-grade parking garage, and the renovation of the historically significant Hallman Chevrolet showroom as a restaurant.

From 1930 until 1990, the site was one of the largest new-car dealerships in Rochester. The dealership included a large, multi-bay service and repair garage, as well as a gasoline station. The site was vacant from 1990 until the city purchased the property in 1996. The project, which ultimately would take five years from start to finish, had to overcome several challenges to the city and the developer, including shifting redevelopment plans, historic preservation restrictions, street reconstruction, and funding constraints—and these were in addition to the environmental concerns at the site, which included several abandoned USTs.

Total cleanup project costs, including both phases of remediation, were approximately $750,000. Rochester financed the initial phase of the cleanup with part of its HUD Community Development Block Grant allocation. The developer funded the second phase of the cleanup. In addition, the city assisted the developer with environmental costs via direct reimbursement for certain disposal costs, providing the company with a $2.35 million loan for the redevelopment project, and reducing the purchase price of the property due to the environmental cleanup costs.

But both city and developer agree that the project's benefits outweighed the hassles and were worth the investment. Chevy Place is Rochester's first new downtown apartment complex in 20 years. All 77 units are rented. Chevy Place's most distinguishing architectural feature is its Art Deco showroom, which remains standing due to its historic site designation. The former showroom has been renovated as a 24-hour coffee shop. The apartment complex is located in Rochester's east end cultural and theater district, near the Little Theatre, the Eastman School of Music, the Eastman Theatre, and several restaurants and museums. This project has been a catalyst for additional private development in the area.

Chevy Place, Rochester, New York

BEFORE

AFTER

The Sites Are Out There

In short, local efforts to promote cleanup and reuse of contaminated petroleum sites have come a long way since September 2001, when EPA launched its USTfields pilot initiative to address "abandoned or idle property where redevelopment is hindered by petroleum contamination from abandoned, federally regulated underground storage tanks."

Those first 10 pilot communities played a significant role in shifting local UST activities from an approach that focuses solely on cleaning up environmental problems to an emerging approach that considers petroleum sites from a more comprehensive vantage point—one that also considers real estate and community benefits. Increasingly, when local officials ask, "Where are the sites?" they are seeking responses that include opportunities for economic and community revitalization—with the appropriate environmental twist. ■

Charlie Bartsch is a Senior Policy Analyst at the Northeast-Midwest Institute, where he has carried out considerable research and outreach on brownfields and USTfields. He can be contacted at cbartsch@nemw.org.

A MESSAGE FROM CLIFF ROTHENSTEIN

Director, U.S. EPA Office of Underground Storage Tanks

The Face of Brownfields Is Changing

No longer are brownfields properties just those 10-plus-acre former industrial facilities at the edge of the city. Today's brownfields now include the small, abandoned gas stations that were deserted when traffic patterns changed or as super-sized convenience stores replaced the small corner service station. For years, investors and developers shied away from these properties and the laws prevented us from focusing on petroleum brownfields. The passage of the new Brownfields Law has changed this landscape.

For the first time, we have a law that specifically targets petroleum brownfields, earmarking 25 percent of the annual federal brownfields grant money for identifying, assessing, and cleaning up petroleum-contaminated properties. Before this law, we provided a total of $4.8 million for USTfields pilots. Last year we announced $22.5 million for 102 new petroleum brownfields grants.

On June 15, U.S. EPA announced the second round of brownfields grants, and another $23.1 million was awarded to address more petroleum brownfields properties. In the first year of the new Brownfields Law, we provided 10 times as much funding as was provided in the entire 20 years of the UST program. (See page 32.)

This money can be used to help identify and address low-risk petroleum sites that might otherwise languish for years. Since many of these abandoned properties do not rank as high health or environmental risks, they are often left unaddressed. The new brownfields grants can provide a state with money to remove these relatively low-risk petroleum sites from the state's cleanup backlog. By doing so, we protect our nation's groundwater/drinking water and, at the same time, make now-tainted land attractive for reuse.

I strongly encourage all state UST programs to apply for available brownfields resources and to develop partnerships to foster the identification and assessment of petroleum-contaminated properties. Working together, state and local environmental, economic, and planning agencies can create a comprehensive inventory of abandoned gas stations. With this information in hand, potential hazards can be prioritized and appropriately addressed and, at the same time, we can make it easier for others to consider beneficially reusing stigmatized properties.

With more than 200,000 abandoned gas stations scattered across the country, these properties represent one of the greatest untapped redevelopment reservoirs. To some people, abandoned gas stations may seem too small to worry about or too small to invest in. But I've seen how cleaning up and reusing even a single gas station can make a difference in a small town. For example, Ben and Jerry began their now famous ice cream business in an abandoned gas station in a small town in Vermont. Many communities and businesses are now tapping into this reservoir.

It is up to federal and state regulators to assist communities in understanding the potential risks these properties may present as well as the value of this now-neglected land. And these properties are not just attractive for new retail and commercial uses; there are many examples of former service stations being turned into residential housing, community parks, and for public facilities, such as fire stations and health clinics.

To assist in these efforts, U.S. EPA is working to develop guidelines on how to inventory abandoned gas stations and how to market these properties once they have been identified. As Charlie Bartsch explains in "Where Are the Sites?" we need to develop a better way of identifying these sites and to provide communities with a "how to" guide. We also need to work with communities to integrate these properties into broader community development goals.

Clustering sites can make these properties more appealing to groups interested in investing in communities. In the case of Kansas City, Missouri, an entire city block was rejuvenated with new ethnic restaurants and businesses in just this way.

Whether these sites are reused as new businesses or for public uses, it is important that we work with public agencies, private sector investors, developers, and business leaders to leverage resources for area-wide improvements. By working together to identify these properties, we may be able to benefit communities by protecting their groundwater/drinking water and revitalizing economically stressed areas. Cleaning up and redeveloping these abandoned properties exemplifies how environmental and economic interests can and do work hand in hand. ■

For more information on the Brownfields Grant Program, visit U.S. EPA's Web page at: http://www.epa.gov/oust/rags/pbgrants.htm.

Los Angeles Publishes Guide for Abandoned Gas Station Sites

The City of Los Angeles Brownfields Program has published a 55-page *Guide to Resolving Environmental and Legal Issues at Abandoned and Underutilized Gas Station Sites.* The guide was written to assist public agencies and other stakeholders interested in redeveloping abandoned gas stations in Los Angeles (though readers in other cities could benefit from much of the information as well). The guide describes the various environmental and legal steps and issues involved in locating and acquiring old gas station sites in such chapters as "Gathering Information on a Site" and "Site Status Issues." The publication includes appendices describing federal and state UST programs and resources available to those interested in cleaning up and reusing these sites. The guide can be accessed at *http://www.lacity.org/EAD/labf/Gas%20Station%20Program.htm.* ■

Lead Scavengers: A Leaded Gasoline Legacy?

by Ron Falta and Nimeesha Bulsara

The removal of lead from gasoline is probably one of the most important environmental achievements of the last century. Lead is a well-known poison, and blood levels of lead in children in the United States have dropped by 70 percent since the elimination of lead from gasoline (U.S. EPA, 1996a). While much attention has been justifiably focused on the lead in leaded gasoline, other toxic chemicals were an integral part of the lead antiknock additive package. The halogenated organic chemicals ethylene dibromide (EDB) and 1,2-dichloroethane (1,2-DCA) were added in significant amounts to all leaded automotive gasolines beginning in the 1920s. These compounds served as "lead scavengers," and their purpose was to prevent the formation of solid lead oxide and lead sulfate deposits in the engine combustion chamber (Jacobs, 1980).

Both EDB and 1,2-DCA are probable carcinogens, and they have extremely low maximum contaminant levels (MCLs) of 0.05 micrograms per liter (µg/L) and 5 µg/L, respectively. The MCL for EDB is lower than that for any other organic chemical except dioxin (U.S. EPA, 2001), and EDB is an unusually potent carcinogen (Alexeeff et al., 1990; U.S. EPA, 1997). To make matters worse, EDB and 1,2-DCA have high solubilities in water, and they are mobile and persistent in groundwater (Falta, 2004).

Given these facts, it is surprising that there is relatively little interest in EDB and 1,2-DCA at most LUST sites. The Association for Environmental Health and Sciences (AEHS) conducts periodic surveys of state regulators to document state soil and groundwater cleanup levels for sites contaminated by petroleum hydrocarbons (AEHS, 2004). An analysis of these data by Falta (2004) showed that as of 2003, 34 states did not require testing for EDB or 1,2-DCA in groundwater at sites contaminated by gasoline. Of the remaining 16 states, only eight reported clearly defined limits for these compounds, and in several cases, these regulations have been implemented only in the last few years.

Similarly, a review of the literature on gasoline contamination and remediation reveals only a handful of references that discuss EDB and 1,2-DCA contamination from leaded gasoline (Bruell and Hoag, 1984; Hall and Mumford, 1987; Pignatello and Cohen, 1990; Ellis, 2003; Landmeyer et al., 2003). This small number of references should be contrasted with the hundreds of papers and reports on BTEX and MtBE contamination and remediation.

Composition of Leaded Antiknock Mixes

The antiknock properties of lead in gasoline were discovered by Midgley and Boyd (1922). They found that the addition of only a few grams of tetraethyl lead per gallon of gasoline would eliminate engine knock in test engines. Shortly after this initial discovery, they found that the lead also caused engine fouling due to the formation of solid lead deposits. However, it was soon discovered that compounds containing bromine, or a mixture of bromine and chlorine, could eliminate this fouling problem by forming volatile lead halides (Boyd, 1950).

By the late 1920s and early 1930s, EDB and 1,2-DCA were firmly established as the lead scavengers in the lead antiknock mixtures (Table 1). Lead scavengers are always added to antiknock mixtures in molecular proportion to the lead itself to insure complete reaction with the lead. Over time, the proportions of EDB and 1,2-DCA in antiknock packages varied, but the automotive mixture was standardized in 1942 at a ratio of 0.5 moles of EDB and one mole of 1,2-DCA per mole of lead (Hirschler et al., 1957; Jacobs, 1980; Lane, 1980; Pignatello and Cohen, 1990; Thomas et al., 1997). Aviation gasoline, used in piston engine propeller planes, uses only EDB, in the proportion of one mole of EDB per mole of lead (Jacobs, 1980; Lane, 1980).

Given the lead content of a gasoline, the concentrations of EDB and 1,2-DCA in the gasoline can be computed using the molar ratios and molecular weights. Falta (2004) calculated U.S. national average gasoline lead, EDB, and 1,2-DCA levels for the period from 1949 to 1988. Until the U.S. EPA-mandated reduction began in 1974, average lead levels in gasoline were about 0.6 g/L to 0.7 g/L. These correspond to EDB concentrations of

Table 1 Historical Lead Scavenger Ratios in Lead Antiknock Additive Packages (from Jacobs, 1980)

YEAR	MOLAR RATIO OF EDB TO LEAD	MOLAR RATIO OF 1,2-DCA TO LEAD
1926–1928	1.5	0.1
1928–1929	1.15	0.1
1929–present *(standard aviation mix)*	1.0	0.0
1930–1933	0.85	0.3
1933–1934	0.75	0.4
1934–1942	0.70	0.45
1942-present *(standard automotive mix)*	0.50	1.0

0.27 g/L to 0.32 g/L, and 1,2-DCA concentrations of 0.29 g/L to 0.34 g/L. These levels dropped sharply after 1974. Lead was essentially eliminated from automotive gasoline by 1988. Leaded gasoline continues to be used for aviation and for off road uses such as racing, but these uses currently account for a minute fraction of overall gasoline consumption in the U.S.

Table 2
Comparison of Lead Scavenger Properties with Benzene

PROPERTY	ETHYLENE DIBROMIDE	1,2-DICHLOROETHANE	BENZENE
Molecular Weight	187.86[a] g/mol	98.96[b] g/mol	78.11[b] g/mol
Aqueous Solubility	4,321[a] mg/L	8,520[b] mg/L	1,750[b] mg/L
Vapor Pressure	1.47[a] kPa	8.10[b]kPa	8.00[b] kPa
Octanol-Water Partition Coeff., (dimensionless)	58[a]	30[b]	130[b]
Henry's Constant (dimensionless)	0.029[a]	0.050[b]	0.220[b]
Average Concentration In Leaded Gasoline	0.29[c] g/L	0.31[c] g/L	13.0[d] g/L
Gasoline-Water Partition Coefficient (dimensionless)	152[e]	84[c]	350[f]
Maximum Groundwater Concentration near a Leaded Gasoline Release	1,900 µg/L	3,700 µg/L	37,100 µg/L

[a]Montgomery, 1997; [b]Bedient et al., 1999; [c]Falta, 2004; [d]API, 2002; [e]Pignatello and Cohen, 1990; [f]Cline et al., 1991

Dissolution and Transport

The effective solubility of a gasoline component in water is determined primarily by its aqueous solubility and by its concentration in the gasoline. EDB and 1,2-DCA have solubilities of several grams per liter in their pure form (Table 2). As discussed earlier, they were also present in significant concentrations in leaded gasoline, so it would be expected that leaded gasoline spills could result in high groundwater concentrations of EDB and 1,2-DCA.

The maximum (equilibrium) groundwater concentration of a gasoline component near residual or free-product gasoline (LNAPL) can be calculated using the gasoline-water partition coefficient, K_p. This partition coefficient is defined as the ratio of the concentration of the chemical in the gasoline (C_o) to the concentration of the chemical in water (C_w):

$$K_p = \frac{C_o}{C_w}$$

The partition coefficient can be measured experimentally, or it can be estimated from the chemical properties of the component and the bulk gasoline. Dividing the concentrations of EDB and 1,2-DCA in gasoline by their K_p values gives the expected groundwater concentrations of these compounds near residual or free-product leaded gasoline (Table 2). Comparing these concentrations to the MCLs, it is clear that EDB and 1, 2-DCA could pose a threat to groundwater that is similar to that posed by benzene (Falta, 2004).

The chemical properties of EDB and 1,2-DCA (Table 2) favor transport in groundwater. These chemicals are both volatile, but their high solubilities in water result in very low Henry's constants. Chemicals with low Henry's constants preferentially partition into the water phase instead of the gas phase. For this reason, once these chemicals dissolve in water, they would not have a tendency to volatilize into soil gas, and movement of EDB or 1,2-DCA vapors in the vadose zone would be greatly reduced by partitioning into soil water.

EDB and 1,2-DCA also have very low octanol-water partition coefficients (Table 2). The octanol-water partition coefficient is related to a chemical's tendency to adsorb to aquifer materials. These low values indicate that EDB and 1,2-DCA do not adsorb strongly. Both EDB and 1,2-DCA are expected to be more mobile than benzene, and 1,2-DCA has a mobility in groundwater that is similar to that of MtBE (Falta, 2004).

Degradation

EDB was used as a pesticide from 1948 until 1983, when that use was banned. As a result, laboratory and field studies have been conducted to document EDB degradation in soils and groundwater. (See, for example, Pignatello and Cohen, 1990.) Many of these studies have found fairly rapid aerobic and anaerobic degradation of EDB in the subsurface, but low levels of EDB (above the MCL) have been found to persist for decades after EDB releases (Pignatello and Cohen, 1990; Steinberg et al., 1987). Falta (2004) describes several large EDB groundwater plumes at the Massachusetts Military Reservation where EDB does not appear to be degrading significantly (see also U.S. EPA, 2000a, b).

1,2-DCA is a common industrial feedstock and solvent, and groundwater plumes of this chemical have been widely documented (Fetter, 1999; Ravi et al., 1998; Cox et al., 1998). The degradation of 1,2-DCA in groundwater appears to occur under both aerobic and anaerobic conditions (Cox et al., 1998; Cox and Major, 2000), but decay half lives can be long compared to BTEX compounds (Bedient et al., 1999).

While studies have focused on EDB and 1,2-DCA degradation from past agricultural or industrial uses, we are not aware of any studies on EDB or 1,2-DCA degradation for cases involving leaded gasoline releases. It is likely that the aerobic and anaerobic degradation of BTEX compounds at a LUST site could have important effects on the degradation of EDB and 1,2-DCA, possibly enhancing the reductive dehalogenation process. This may be an important area for future research.

Cancer Risks and Detection Limits

U.S. EPA classifies EDB and 1,2-DCA as probable carcinogens. The low MCLs for these compounds are based on their potential for causing cancer in humans. The lifetime risk of cancer due to consumption of contaminated

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■ **Lead Scavengers** *from page 7*

drinking water is estimated using a slope factor, ρ_f, in an exponential model that approaches 100 percent risk at high doses:

$$Risk = 1 - \exp(-\rho_f * C_w * q_w / m)$$

where C_w is the concentration in water (mg/L), q_w is the daily water intake (L/d), and m is the body mass (kg). The cancer risk slope factor has units of risk (proportion of exposed population with tumors) per mg of contaminant per kg of body mass per day (U.S. EPA, 1992b). At low risk levels, this equation gives a linear relationship between risk and dose equivalent to

$$Risk = \rho_f * C_w * q_w / m$$

Slope factors for benzene (a known carcinogen), EDB, and 1,2-DCA are given in Table 3. The slope factor can be used to calculate specific risks associated with different drinking water concentrations. This is typically done using the risk equation with a daily water intake of 2 L and a body mass of 70 kg. The drinking water unit risks in Table 3 are computed this way, and when multiplied by the drinking water concentration in µg/L, they give the lifetime cancer risk. U.S. EPA recommends that the slope-factor model only be used for risks that are less than or equal to 1 in 100 because slope at higher exposures may differ from that at lower exposures (U.S. EPA, 1992a).

Table 3 U.S. EPA values for Cancer Risk Assessment from Contaminated Drinking Water

Chemical	Cancer Risk Slope Factor proportion of exposed population with tumors per (mg/kg) per day	Drinking Water Unit Risk proportion of exposed population with tumors per µg/L
Benzene[a]	1.5×10^{-2} to 5.5×10^{-2}	4.4×10^{-7} to 1.6×10^{-6}
1,2-DCA[b]	9.1×10^{-2}	2.6×10^{-6}
EDB[c]	85	2.5×10^{-3}

[a]U.S. EPA (2003); [b]U.S. EPA (1991); [c]U.S. EPA (1997)

The lifetime excess cancer risks associated with different drinking water concentrations are plotted in Figure 1. The potential cancer risk from water contaminated by EDB is much higher than the risk posed by benzene at a given concentration, while risk from 1,2-DCA contamination is similar to that of benzene. The upper endpoints of these curves correspond to the maximum expected groundwater concentrations near a leaded gasoline spill from Table 2. Note that the risk from EDB is calculated to exceed 0.01 (dashed line), so this upper part of the risk curve should be viewed with caution. Nonetheless, it is apparent that dissolved EDB could pose a cancer risk that greatly exceeds the cancer risk from benzene at sites where leaded gasoline was released, considering that groundwater concentrations of EDB could easily exceed 100 µg/L.

It is helpful to put these cancer risks in perspective by considering typical analytical methods used at LUST sites. U.S. EPA Methods 8021B and 8260B are commonly used to measure BTEX concentrations, and they can both be calibrated for EDB and 1,2-DCA if these chemicals are included on the target analyte list (Ellis, 2003; U.S. EPA, 1996b, c). With these analytical methods, detection limits for EDB range from about 3 µg/L for Method 8260B to about 8 µg/L for Method 8021. From Figure 1, a concentration of 5 µg/L EDB corresponds to a cancer risk just over 0.01 or 1 in 100. This risk is equivalent to that posed by benzene at 7,700 µg/L to 28,200 µg/L. In other words, if Method 8021 or 8260B is used to quantify EDB at a LUST site, the cancer risk posed by EDB at the detection limit is comparable to that posed by benzene near its effective solubility limit from gasoline.

EDB concentrations in groundwater can be quantified at much lower levels using U.S. EPA Method 8011 (U.S. EPA, 1992b). This is a microextraction technique using hexane with GC analysis with an electron-capture detector. This method can achieve detection limits as low as 0.01 µg/L.

Field Data from UST Sites

South Carolina is one of the few states in the country that has routinely required testing for EDB at sites where leaded gasoline could have been released. Testing groundwater at active UST sites for EDB began in the early 1990s, and current South Carolina Department of Health and Environmental Control (SCDHEC) procedures specify analytical Method 8011 with a detection limit of 0.02 µg/L (SCDHEC, 2001). We have been working closely with the SCDHEC Bureau of Land and Waste Management Underground Storage

FIGURE 1. *Calculated lifetime excess cancer risks due to consumption of contaminated drinking water. The upper endpoints of each curve correspond to maximum expected groundwater concentrations near a leaded gasoline spill (Table 2).*

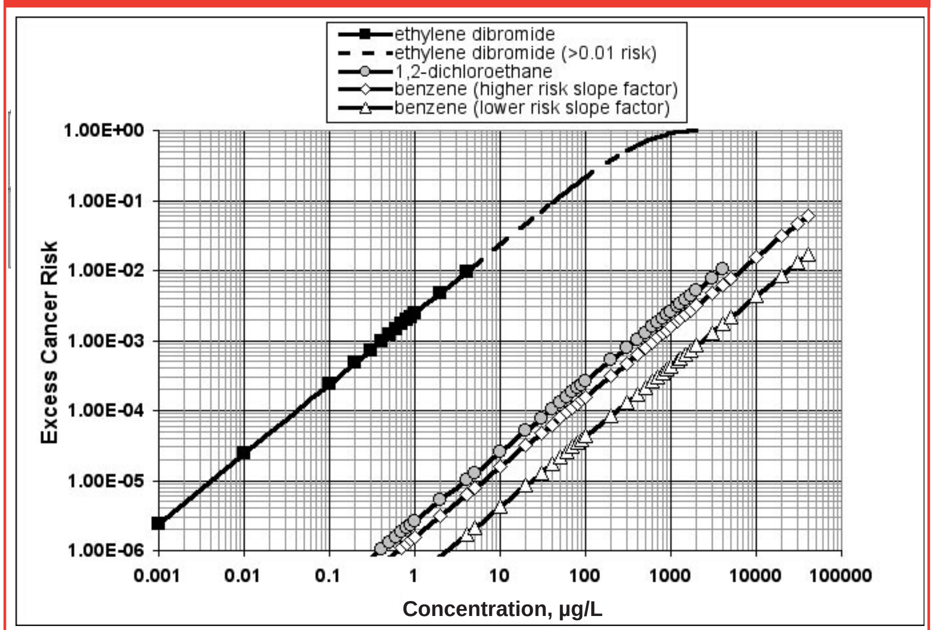
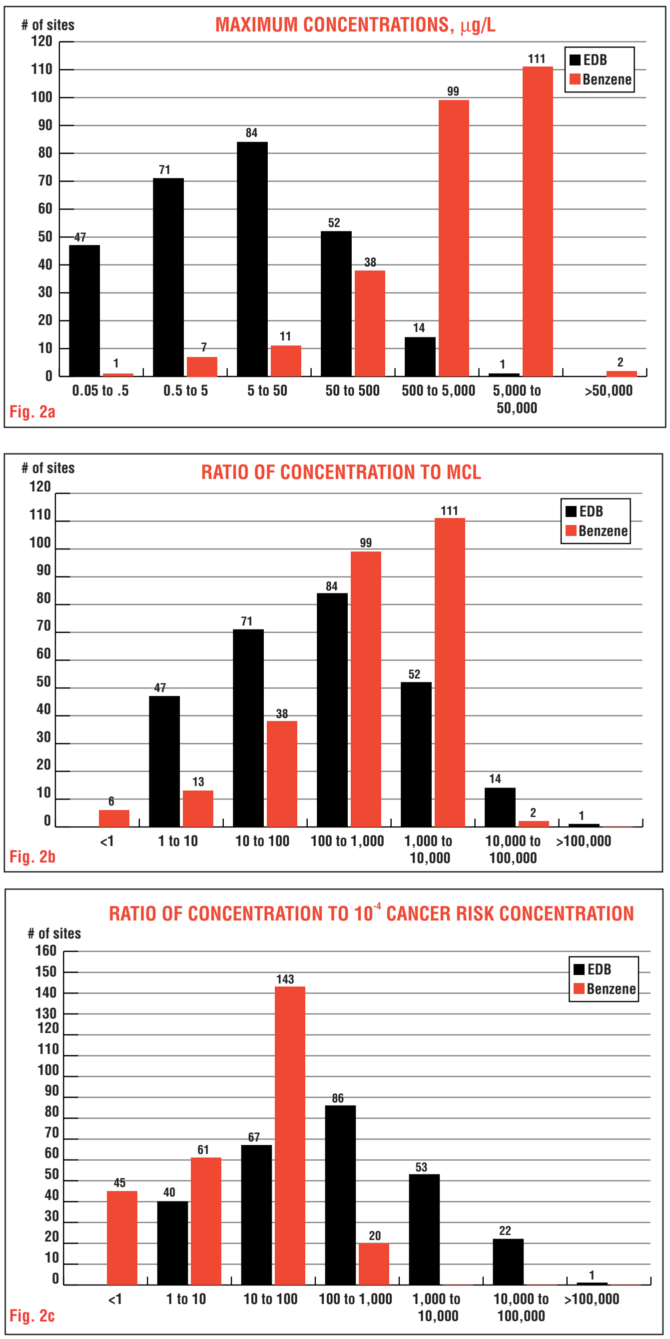


FIGURE 2. ***Maximum groundwater concentrations of EDB and benzene at South Carolina UST sites where EDB has been detected above the MCL: (a) maximum concentrations; (b) maximum concentrations divided by MCLs; (c) maximum concentrations divided by 10-4 cancer risk concentrations.***



Tank Program over the past several months in an effort to quantify the magnitude of the lead-scavenger problem.

According to the SCDHEC database, there are 7,158 sites in the state where petroleum product releases have been reported. Approximately 1,280 of these have been tested for EDB, and EDB has been detected in the groundwater above the MCL at 316 of these sites. It is important to note that the gasoline release history at most UST sites is unknown. In many cases, the tanks at sites with reported releases would have contained both leaded and unleaded gasoline over time, and the relative amounts of leaded and unleaded gasoline spilled are unknown.

Figure 2a demonstrates a comparison of maximum EDB and benzene groundwater concentrations at sites where EDB was detected above the MCL. The total number of sites in this graph (i.e., 269) is slightly lower than the overall number of EDB sites (i.e., 316) due to difficulties in verifying the maximum benzene concentration values reported for some sites. EDB concentrations range from the MCL of 0.05 µg/L up to a maximum of several thousand µg/L. Significantly, more than half of the EDB maximum concentrations are above 5 µg/L, and about one-quarter are above 50 µg/L. As would be expected for gasoline spills, maximum benzene concentrations are higher, with typical maximum values in the 500 µg/L to 50,000 µg/L range. The upper part of this range (20,000 µg/L to 50,000 µg/L) usually indicates that there is residual or free-product gasoline nearby.

The maximum EDB and benzene groundwater concentrations have been divided by their MCLs in Figure 2b. Because of EDB's very low MCL, the ratio of EDB concentration to its MCL is similar to that for benzene, even though the actual concentrations of benzene at these sites are much higher. Both chemicals are found to exceed their MCLs by factors of 1,000 or more at many sites. Therefore, from a regulatory perspective, the impact of EDB at these sites may be comparable to that of benzene, assuming a similar mobility and persistence.

The maximum EDB and benzene groundwater concentrations are divided by their 10^{-4} lifetime excess cancer risk drinking water concentrations in Figure 2c. From Table 3 and Figure 1, the 10^{-4} lifetime cancer risk occurs at a drinking water concentration of 0.04 µg/L for EDB, and at a concentration of 63 µg/L to 230 µg/L for benzene. The larger concentration value was used for benzene in Figure 2c, because it also falls into the published U.S. EPA concentration range (100 µg/L to 1000 µg/L) corresponding to a 10^{-4} cancer risk (U.S. EPA, 2003).

EDB appears to pose a larger cancer risk than benzene at most of these sites. Sixty percent of the maximum EDB concentrations exceed the 10^{-4} cancer risk concentration by a factor of 100 or more, compared to only 7 percent of the maximum benzene concentrations. About 30 percent of the EDB concentrations exceed the 10^{-4} cancer risk concentration by a factor of 1,000 or more, while none of the benzene concentrations pose a cancer risk this high.

Using these measured groundwater concentrations, it is apparent that the dominant drinking water cancer risk may come from EDB rather than from benzene at sites where leaded gasoline was released. Of course there is little risk unless the contaminated water is consumed, so the length and persistence of EDB plumes will be a critical variable in any site risk assessment.

Unanswered Questions

At this stage there are more questions than answers about the magnitude of the lead-scavenger problem. It is certain that there have been tens of thousands of releases of leaded gasoline in the United States, but the typical size and nature of EDB and 1,2-DCA

■ *continued on page 10*

■ Lead Scavengers *from page 9*

groundwater plumes is unknown. Many old LUST sites have never been analyzed for EDB or 1,2-DCA, so it is not known to what extent these compounds are still present in the groundwater at these sites. There is little or no published information on the breakdown of these contaminants under the biogeochemical conditions that would occur in and downgradient of gasoline spills, so it is difficult to predict their long-term behavior.

We believe that a significant new research effort focusing on EDB and 1,2-DCA contamination at UST sites is justified. ■

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■ *continued on page 23*

EPA/ASTSWMO Form Team to Delve Into EDB and 1,2-DCA in Groundwater

Many state drinking water programs are finding ethylene dibromide (EDB) and 1,2-dichloroethane (1,2-DCA) compounds in their water supplies. Both compounds were added to leaded gasoline as lead scavengers until the late 1980s, when leaded gasoline was phased out. Both compounds have also had other uses—EDB was widely used as an agricultural fumigant until it was banned in 1983, and 1,2-DCA is still used as an industrial solvent. Both of these compounds have federal maximum contaminant levels (MCLs) in drinking water—0.05 ppb for EDB and 5.0 ppb for 1,2-DCA.

Given the discussion that has recently occurred regarding the current and historic use of EDB and 1,2-DCA, the Association of State and Territorial Waste Management Officials (ASTSWMO) and U.S. EPA have a formed a team to explore the use and occurrence of these compounds and their potential impacts at LUST sites.

Although these compounds have not been used as gasoline additives for more than a decade, as information in the article "Lead Scavengers: A Leaded Gasoline Legacy?" suggests, the possibility exists that these compounds may persist in the environment and affect drinking water supplies. Since these compounds have had other uses, especially EDB as an agricultural fumigant, the source of lead scavengers in the environment is unclear.

To determine what problems, if any, these lead scavengers pose to public health and the environment, the team will take the following steps:

- **Develop an understanding of the potential problem as it exists today.**
  - Compile existing background information—toxicological data, historical usage information, and occurrence in drinking water supplies
  - Evaluate selected state databases and case files for information on sampling, monitoring, and remediation at LUST sites
  - Conduct a study on the effectiveness and cost of treatment and remediation technology
- **Assess whether or not there are any gaps in our current knowledge. If so, develop and implement appropriate measures to fill the gaps.**
  - Identify next steps. Evaluate the results of the previous two steps. ■

For more information on this effort, contact Hal White, U.S. EPA Office of Underground Storage Tanks, at white.hal@epa.gov ***or (703) 603-7177. A copy of the team's full mission statement is available on the OUST Web site at:* http://www.epa.gov/oust/pbscavms.pdf.**

On-Site, On-Line Calculators and Training for Subsurface Contaminant-Transport Site Assessment

by Jim Weaver

EPA has developed a suite of on-line calculators called "OnSite" for assessing transport of environmental contaminants in the subsurface. The purpose of these calculators is to provide methods and data for common calculations used in assessing impacts from subsurface contamination by petroleum hydrocarbons and oxygenated additives. The calculators each contain background information and a guide to their formulas and data. The calculators are available on the Internet at *http://www.epa.gov/ athens/onsite.* They are divided into four categories, Model Input Parameter Estimates, Simple Transport Models, Unit Conversions, and Scientific Demos, which include the following information:

Model Input Parameter Estimates

- Hydraulic gradient (horizontal)
- Vertical gradient
- Moisture content in a sample
- Retardation factor
- Henry's constants
- Estimated longitudinal dispersivity
- Diffusion coefficients in air and water
- Darcy's law
- Seepage velocity
- Effective solubility from fuels
- Multiphase mass distribution

Some of the parameter-estimation calculators are designed to make simple calculations more convenient, while others are designed to make less well-known calculations more commonly available. Even for experienced analysts, the availability of prepackaged calculations is viewed as a convenience. Beyond obvious labor savings, "convenience" facilitates correct application of the principles and ultimately more scientifically sound decision making. Web-site usage statistics show that even the simple calculators are used frequently.

A somewhat different class of calculation is represented by the effective solubility calculator, which determines concentrations of chemicals in equilibrium with various fuels. In contrast to the retardation factor, the formula itself is much less well-known, and the required input data are not commonly available. In this case, the calculator provides a resource to the community as the ability to calculate this quantity is not expected to be widespread.

The gradient is an example of the formula calculators. Determining the direction of groundwater flow is fundamental in assessing potential receptors. Figure 1 shows results for a site with four wells that was sampled over six sampling rounds. These data, which were confined to a small area of the station property, did not adequately allow determination of the groundwater flow direction. Figure 1 shows indicated flow directions which ranged from 90 to 270 degrees—essentially east to west. The easterly directions occurred with the lowest magnitude of gradients and thus are the least certain.

Simple Transport Models

- Plume diving
- Steady plume length
- One-dimensional transport from a pulse, continuing, or fuel source
- "Domenico" models: steady state centerline, unsteady
- Uncertainty in transport calculations
- Vapor intrusion calculations with the Johnson-Ettinger model

In this section, simple transport models are provided for several scenarios. Research conducted at some contaminated sites showed that plumes were pushed downward, rather than diluted. Development and testing of assessment methodologies provided software for predicting this behavior. Providing an on-line calculator (plume diving) placed this technology directly into the hands of the leaking underground storage tank community.

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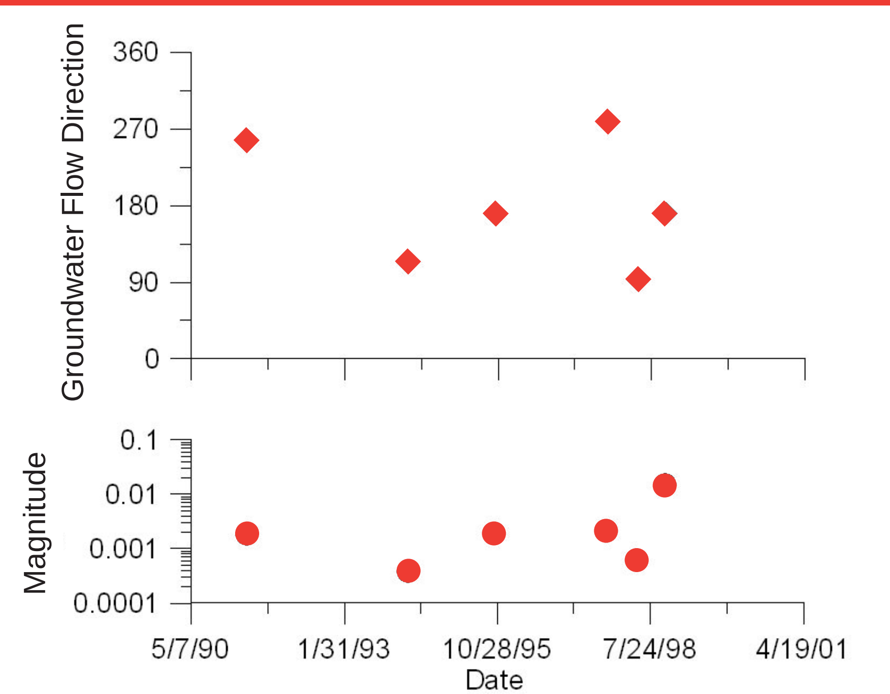
FIGURE 1. ***Groundwater flow magnitude and direction from a site with four wells sampled over six sampling rounds.***



■ On-Line, On-Site Calculators

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Other calculators address contaminant transport. One of the newest models addresses uncertainty in transport models. Given that model inputs are uncertain, the impact on a groundwater receptor can be determined and a guide to worst-case parameter sets can be provided.

As an example, the plume-diving calculator was applied to the BTEX and MtBE plume at East Patchogue, New York. To apply the calculator, the water table was fitted to observed data, and the amount of plume diving was simulated by estimating the recharge along the plume and other aquifer properties. Figure 2 shows the fitted water table ("A"), the estimated top of the plume ("B"), and MtBE, benzene, and xylene plumes. Wells must be screened to depths below the line "B" for the plumes to be sampled at an appropriate depth.

FIGURE 2. ***Vertical cross section through the xylene (a), benzene (b,c) and MtBE (d,e) plumes at East Patchogue, New York. The flow, from left to right, is influenced by recharge, which causes the plume ("B") to be pushed below the water table ("A").***

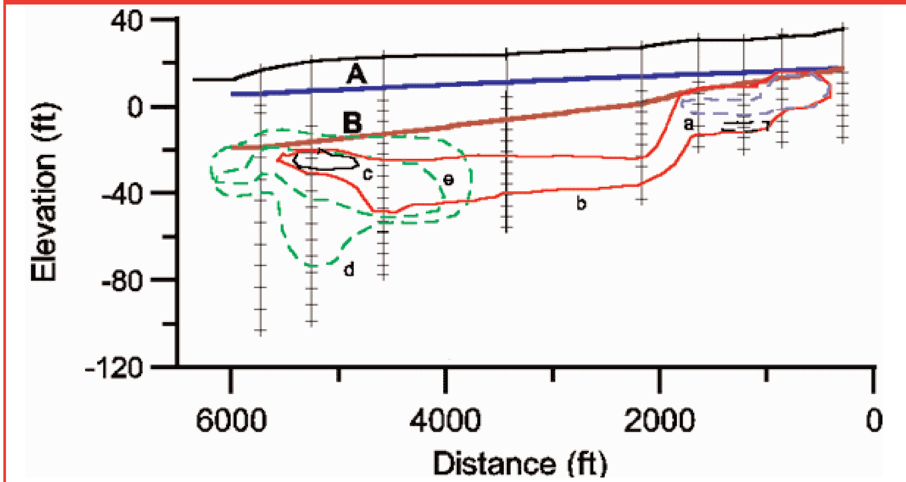
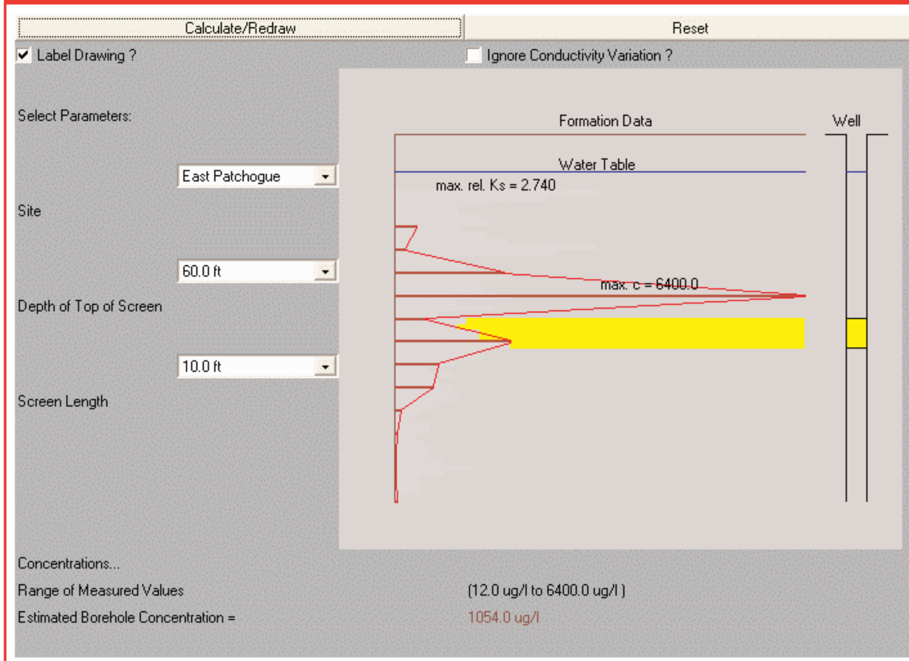


Figure 3. Borehole-concentration averaging. Concentration data from a multilevel sampler are plotted with depth (red line) along with a representation of the well screened at a user-supplied depth.



Unit Conversions

- Flow rates
- Hydraulic conductivity
- Half lives/rate constants
- Henry's law constants
- Dates/sequential times
- Latitude-longitude to distance
- Degrees C to Fahrenheit

Some unit conversions are fairly unique to this field and misunderstanding of the several common unit sets may cause problems for site assessment. Henry's law coefficients are often given either as a dimensionless constant or in units of pressure divided by solubility. The numerical magnitude of these constants differs greatly. Similarly, a large group of practitioners use units of centimeters per second for hydraulic conductivity, while others understand values better in other unit sets such as feet or meters per day.

Scientific Demos

- Darcy flow in a laboratory column
- Unsteady mass balance
- Flow in a one-dimensional aquifer
- Borehole-concentration averaging

These calculators were developed as aids to a modeling course that has been taught to state regulators and consultants since 1997. Averaging in boreholes is illustrated in Figure 3, where concentration data from a multilevel sampler are plotted with depth (red line) along with a representation of the well screened at a user-supplied depth. The calculator shows how the position and length of the screen influence the apparent concentration, which can differ significantly from the highest concentration in the formation.

Beginning this year, the course, "Modeling Subsurface Transport of Petroleum Hydrocarbons," can be found at *http://www.epa.gov/athens/learn2model.* Ideas for new calculators are developed from suggestions from users and in response to requests for information. These have come from state agencies, U.S. EPA regional and program offices, and the private sector. Contact Jim Weaver at *weaver.jim@epa.gov* to discuss these concepts or suggest new ideas. ■

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This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for publication.

Tracking Troubling Vapor Releases in New Hampshire

by Gary Lynn

New Hampshire regulations require routine groundwater monitoring whenever groundwater quality standards are exceeded. Because of this requirement, the state has gained a considerable database of groundwater quality information at operating gas stations where releases have been identified. About four years ago, the Department of Environmental Services (DES) started to observe a trend at many operating gas station sites in which the concentration of MtBE was increasing and all other contaminants were stable or decreasing. DES concluded that an ongoing release of MtBE was occurring at these sites and impeding site remediation and closure. To help troubleshoot this problem, we began to track all of these ongoing release sites. We also began to investigate whether other states have observed and addressed this issue. (Also see LUSTLine *#46, March 2004, "Enhanced Leak Detection in California—What We've Learned," by Randy Golding.)*

Putting the Facts Together

Our review of existing studies and fieldwork turned up several very interesting investigations:

■ **Santa Clara Valley Water District** A pilot study was commissioned to determine whether there were undetected releases of MtBE present at 1998 upgrade-compliant gas stations. The Water District study (July 22, 1999) found MtBE contamination of groundwater at 13 of the 27 sites that were investigated. MtBE was the only petroleum constituent found in five of the 13 contaminated sites. The Water District attempted to statistically correlate the presence of contamination with the various types of UST system components present at each site. The analysis concluded that there was a statistically significant association between the occurrence of MtBE contamination and the presence of a vacuum-assist Stage II vapor-recovery system. DES believes this study is significant because the only plausible link between vacuum-assist Stage II equipment and MtBE groundwater contamination is the existence of vapor releases. (*http://www.scvwd.dst.ca.us/Water/Technical_Information/Technical_Reports/_Reports/USTMtBEStudyFinal.pdf.*)

■ **University of California at Davis and Tracer Research** A joint report on an UST System Field-Based Research Project was submitted on May 31, 2002, to the California State Water Resources Control Board. (*http://www.swrcb.ca.gov/cwphome/ust/leak_prevention/fbr/docs/FBR_Final_Report.pdf.*) The study evaluated the occurrence and environmental significance of very small releases from 1998 upgrade-compliant UST systems. The researchers tested 182 UST systems by inoculating the systems with tracers and then collecting subsurface vapor samples and analyzing them for the presence of the tracers.

Detectable levels of tracers were found at 61 percent of the tested systems. All but one of the tracer detections were judged to have been associated with a vapor-phase release. In addition, the study noted that none of the releases observed would likely have been detected by leak-detection systems that meet current performance standards of 0.1 gallons/hour. This study strongly indicates that vapor releases commonly occur but are infrequently detected by routine measures.

The study also draws a distinction between balance and vacuum-assist Stage II vapor recovery systems. Both types of systems are found to produce positive tank pressures during deliveries. According to the study, the assist system "is more likely to lead to pressurization of the UST ullage space for longer periods because of the tendency to return a larger volume of air to the tank than the volume of liquid product withdrawn." In fact, a number of Stage II vacuum-assist systems specify air-return to liquid-removal ratios of 1.0 to 1.2.

The study found a similar percentage of vapor-release detections for balance and assist Stage II systems, but the average detected concentration of tracer was approximately 2.6 times higher for the assist systems. The detection percentage should be approximately the same for balance and assist systems because there is little difference in the below-grade components of the two systems; however, the leak rate for the vacuum-assist system would be greater because of the greater operating pressure within the system.

■ **Vermont** Over the last two years, the Vermont UST program has been routinely assessing the presence, source, and significance of vapor releases at operating UST facilities with ongoing remedial groundwater monitoring. The methodology utilizes a hand-held, direct-read vapor measuring instrument, typically a photo-ionization detector (PID), to measure vapor concentrations in the vicinity of readily accessible tank-top fittings. Measurements are usually conducted as part of a routine UST compliance inspection.

The vapor-concentration readings can help pinpoint potential vapor-release source locations. Volatile organic compound (VOC) concentrations ranging from 2.0 to 200 parts per million (ppm) have been measured in the vicinity of tank-top features under normal operating conditions. Under pressurized (delivery event) conditions, VOC emissions concentrations show a significant increase. Based on this information, the Vermont UST program has determined that the primary vapor-release sources from operating USTs are vent lines, ancillary risers, caps, in-tank monitor wiring fittings, and Stage I vapor-recovery poppets. In general, any tank-top component that could allow the emission of

■ continued on page 14

■ **Tracking Vapor Releases in NH**
from page 13

VOCs under primary-tank pressurization is considered a potential source of hydrocarbon vapors that could contribute to groundwater contamination.

■ **New Hampshire** MtBE concentrations found in reformulated gasoline (RFG) are typically 9 to 11.5 percent in New Hampshire. The MtBE concentration in gasoline vapors is even higher because the vapor composition emanating from a mixture of chemicals like gasoline is dependent on the mole fraction of each component in the liquid phase and the pure-phase vapor pressure of each component. MtBE has a pure-phase vapor pressure that is much higher than other key constituents of concern (e.g., BTEX compounds).

The combination of high MtBE vapor pressure and high MtBE content in RFG results in a vapor-phase composition that is significantly enriched in MtBE. There is a good discussion of this phenomenon and calculation of the anticipated concentration of MtBE in an article by Blayne Hartman in *LUSTLine* #30, "The Great Escape."

DES also found a Finnish analysis that compared the composition of regular gasoline and vapors in equilibrium with the gasoline that indicated a nearly three-fold increase in the concentration of MtBE in the vapor phase compared with the liquid phase. *(http://www.uku.fi/vaitokset/2002/isbn951-802-491-X.pdf.)* The take-home message from these data is that the composition of a vapor release of MtBE-based reformulated gasoline will include a very substantial MtBE component.

Vapor Releases and Tank Pressurization

Based on the information we reviewed, we decided that vapor releases could potentially explain the data trends that were being observed at our LUST monitoring sites. We decided that further investigation was necessary to evaluate vapor releases from active USTs and set out to explore the effects of tank pressurization on vapor-phase releases.

A working hypothesis was developed postulating that a combination of the physical properties of MtBE, the operating pressures found in Stage II tank systems, and leaks in tank tops and tank-top fittings was creating the elevated MtBE levels in groundwater at our monitored LUST sites. We conducted an investigation to evaluate this hypothesis and establish the relationship between vapor releases, UST system operating pressures, and MtBE groundwater contamination.

To conduct this investigation, DES installed pressure-monitoring equipment and a data logger on five operating UST systems. The pressure was then monitored continuously and recorded in each of the UST systems for approximately one week. The UST systems monitored included a balance and four vacuum-assist Stage II installations. DES confirmed a number of the results and conclusions found in the California field-based study, including the following:

- The monitored UST systems routinely showed positive operating pressures ranging from just above atmospheric to three inches of water column (the pressure-relief setting of the tank vent).
- The vacuum-assist tank systems in two of the four systems monitored showed significantly higher pressure levels than the balance system. The other two vacuum-assist systems had relatively low operating pressures and additional follow up is required to determine whether the vacuum-assist systems were fully operational or operating at very low air-to-liquid ratios. The low level of pressure (except during deliveries) in the UST with a Stage II balance system was expected because balance systems use the slight positive pressure generated by adding fuel to a car's gas tank and a low-level vacuum in the UST system to recover vapors created during car fueling.
- The two Stage II vacuum-assist systems that showed positive pressures showed daily cycles (accumulated pressure during the day because of fueling activities and lost pressure at night, presumably because of vapor releases). Both of these systems had six-figure MtBE contamination in groundwater.
- All observed delivery events resulted in strong pressure oscillations.

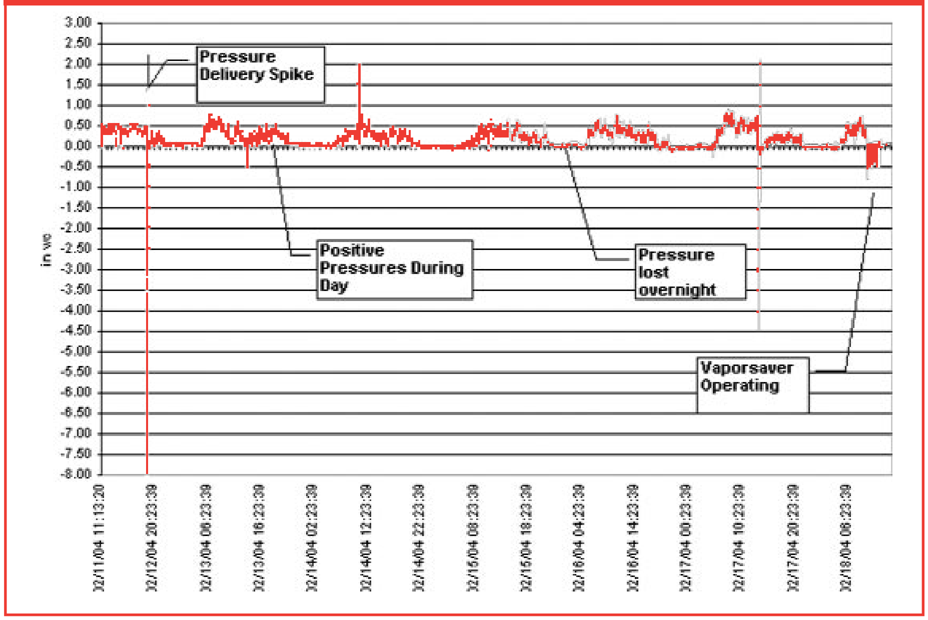
Figure 1 is an example of a vacuum-assist system pressure chart that was generated during the research. The data indicate that the pressure gradients that are integral to the operation of this Stage II vacuum-assist system, in combination with the significant vapor-phase concentration of MtBE, are a plausible explanation for the MtBE contamination observed in groundwater for this LUST site. Note: Each tank-system pressure profile is different. The other vacuum-assist system with a known MtBE release exhibited much larger daily pressure cycles (ranging from atmospheric to 3.5 inches of water column), possibly because the tank system was tighter.

The Vapor Release/ Groundwater-Contamination Connection

We decided that it was important to go beyond showing that vapor releases were a plausible explanation for what was being observed. We decided to closely study one of our ongoing release sites to see whether manipulating the pressure in the UST system would affect the MtBE concentration in the groundwater outside the UST system. We chose to investigate an existing operating gas station site with a well-established, increasing MtBE concentration trend. Pressure-monitoring information showed that the vacuum-assist system was causing positive tank pressures. Daily pressure cycles seemed to indicate that the system lost pressure overnight due to leakage. Note: A review of multiple pressure-decay tests conducted at the facility revealed that the facility lost an average of 0.4 inches of water column of pressure in just 10 minutes (each test passed, but typical tests passed by just 0.1 inches of water column).

The enhanced Tracer Tight testing method was used on the tank system to evaluate its tightness. A different tracer was added to each grade of gasoline and the release of tracer was evaluated by sampling soil

FIGURE 1. ***Vapor Release Research, New Hampshire***
UST pressure (in inches of water column) vs. time



vapor adjacent to the storage system and testing it for the presence of hydrocarbons and the tracer compounds. Concentrations of tracer indicated that the super gas tank had the most significant release, and the regular tank also showed a release, although almost an order of magnitude less than the super tank. We compared the characteristics of the release with the criteria used to evaluate the vapor-versus-liquid releases in the California field-based research study. The release exhibited the characteristics of a vapor release (i.e., relatively low ratio of total volatile hydrocarbons compared to tracer).

DES next evaluated the leakage rate of the tracer after manipulating tank-system pressures. For the purpose of the research being conducted, DES elected to utilize a commercially available system designed to continuously maintain the pressure inside storage systems at or slightly below atmospheric pressure. The technology, supplied by OPW, and known as a Vaporsaver, uses membrane separation technology to concentrate and condense gasoline vapors in the storage tank, essentially filtering the gasoline out of the air in the tank. The gasoline-free air is exhausted to the atmosphere, thus controlling the tank pressure, while liquid gasoline is returned to the tank. The vapor processor is automatically controlled by a pressure sensor to create an average net negative pressure in the tank. No repairs or other changes in the UST equipment or operations were made; all of the changes observed in tracer releases from the storage system were the direct result of controlling tank-system pressures.

The tracer test was repeated with a different tracer after the Vaporsaver system was installed. There was a significant reduction in the tracer concentrations observed in soil gas in the vicinity of the tank system. The reduction in tracer levels was observed at nearly every sample point. It should be noted that the Vaporsaver minimized but did not eliminate the development of positive pressures during tank delivery (it kept up with normal operations but not the spike in pressures that occurs during a delivery) and that there were periods of system downtime caused by a combination of belt and electrical problems. As a result, DES did not observe a total elimination of the release of tracer; however, a significant reduction in tracer and total volatile hydrocarbons in the vicinity of the USTs was observed.

DES is evaluating the long-term reliability of the Vaporsaver technology. DES believes that eliminating the pressure in tank ullage spaces will eliminate the driving force for vapor releases and minimize gasoline vapor leakage rates—based on the immediate impact in soil-gas contaminant levels surrounding the tank system observed at our test site after the pressure was controlled.

Groundwater at the experiment site is being monitored to determine whether the changes in tank-system operating pressures will also reduce the high levels of MtBE groundwater contamination observed in nearby wells. As can be seen in Table 1, dramatic reductions in MtBE concentrations were observed in samples taken approximately two months after the Vaporsaver unit reduced UST system operating pressures (February 18, 2004 was the date of system start-up). All overburden wells near the USTs had significant MtBE concentration reductions; the only wells near the tank system that did not see reductions were the two deep wells that are screened in bedrock. DES believes these wells will respond more slowly than the overburden wells.

Table 1 **Groundwater trends in wells adjacent to the tank installation**

Monitoring Well Number	Concentration of MtBE in ppb (11/13/03)	Concentration of MtBE in ppb (1/27/04)	Concentration of MtBE in ppb (3/24/04)	Concentration of MtBE in ppb 2 months after start-up (4/21/04)
JB-13/MW	45,300	12,000	18,400	714 (96% reduction)
JB-14/MW	160,000	176,000	159,000	4,320 (97% reduction)
JB-16/MW	471,000	277,000	276,000	91,400 (66% reduction)

The concentrations of MtBE detected in wells JB-13/MW and JB-14/MW were the lowest detected in those wells since they were installed in 1998. It should be noted that these reductions were achieved during a time period when the Vaporsaver unit was not operating full time due to operational difficulties that have since been resolved. DES believes that the data establish an extremely strong relationship between tank-system operating pressures, vapor releases, and groundwater contamination, since MtBE groundwater

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contamination reductions occurred solely because of the reduction in tank-system pressure.

Follow-Up Analysis of Ongoing Release Sites

Upon review of the data generated by this research project, we decided that it would be valuable to review our list of ongoing release sites (based on upward trends in groundwater contamination by one or more of the contaminants) versus the type of Stage II system present at the facility. We compared the distribution of Stage II systems for all of our LUST sites at operating gas stations with the distribution of systems believed to be ongoing release sites. DES requested that the consultant collect a sample of the vapors from the influent of the SVE system when the PID readings spike after a gasoline delivery. MtBE was detected at 415,000 µg/m^3 in the sample. The next highest concentration detected was nearly an order of magnitude lower (toluene at 52,700 µg/m^3).

The consultant is slated to return to the site for the next gasoline delivery to develop an accurate estimate of the mass released via the potential vapor leak during gasoline delivery. Although the fast response time seems inconsistent with a delivery-induced liquid release, DES intends to evaluate this possibility by conducting an in-depth inspection and evaluation of the tank system. We hope to identify the cause of the release and learn more about the potential for vapor releases during deliveries. Although the mass released is likely to be small, DES notes that it was sufficient to threaten nearby private drinking water wells and forced the state fund to pay for the installation of the SVE system.

Table 2 New Hampshire LUST sites vs. ongoing release sites

Stage II system	% of active LUST sites	% of ongoing release sites
Exempt	47% / 253 sites	14% / 12 sites
Balance	11% / 61 sites	9% / 8 sites
Vacuum Assist	42% / 225 sites	77% / 79 sites

As shown in Table 2, gas stations that are exempt from Stage II system requirements are significantly less likely to experience ongoing releases, and the vacuum-assist system sites are much more likely to do so. This is strong evidence that vapor releases are responsible for the increasing concentrations of MtBE observed in groundwater at ongoing release sites. DES believes that this is because vacuum-assist systems are more likely to have higher average tank-system pressures, based on our observations at two of the four systems evaluated and an understanding of vacuum-assist system operation.

Although our analysis of available data indicates that most of the exempt systems do not exhibit increasing MtBE groundwater contamination trends, DES does not believe that the Stage II-exempt systems are immune from vapor releases. We have a Stage II-exempt-tank system that is surrounded by a soil vacuum extraction (SVE) system with an extraction point located in the tank-system backfill. The consultant has observed spikes in PID readings at the SVE system immediately following gasoline deliveries.

These data indicate that there are at least small, episodic releases of vapors from any system that is not vapor tight, since all observed systems had tank-system pressure spikes during gasoline deliveries. It should be noted that these spikes are brief in duration (approximately 5 to 15 minutes) and thus do not constitute a release of the same volume of vapors as when a system is continuously operating under positive pressures. The much lower mass that is released results in much lower concentrations of MtBE in groundwater, making DES reviewers less likely to associate these spikes with ongoing releases.

The Pressure of It All

Based on a review of existing studies and DES data, it appears that vapor releases are common at operating gas stations. Additionally, DES data indicate that this class of release poses a groundwater contamination threat when MtBE is present in significant concentrations in the gasoline. The environmental significance of these releases depends on a number of factors, including the size of the release, gasoline composition, site-specific geology, hydrogeology (e.g., depth to groundwater, groundwater flow velocity), and the presence of sensitive receptors. New Hampshire is particularly vulnerable with its high water table, its heavy use of groundwater, and the relatively high concentration of MtBE in gasoline supplied to much of the state.

The potential for releases is dependent on tank-system installation practices and other factors; however, the vapor release rate is highly dependent on tank-system operating pressures. Vapor releases should be evaluated as a source of ongoing releases at all active gas stations with Stage II systems, especially vacuum-assist Stage II systems, and tank pressurization should be minimized to the extent practicable. Minimization of tank pressures will reduce vapor release rates.

None of the releases at ongoing release sites were detected using conventional leak-detection equipment and technology. In fact, at most of the sites where DES requested the identification and elimination of observed leaks, the source of the release was not identified using the traditional leak-detection methods, such as pressure decay and line-leak detection testing. This strongly suggests that the existing leak-detection methods do not detect vapor releases and that the allowable leak rates specified in the UST rules are larger than the releases that are typically present. The data strongly indicate that significant MtBE plumes can result from these undetected releases and that better leak-detection methods are required to prevent MtBE contamination of groundwater.

Although it appears that New Hampshire's recent legislative MtBE ban could address much of the vapor release problem, as a state, we must deal with our current situation because the ban will not take effect unless U.S. EPA approves of the state's efforts to opt out of reformulated gasoline. Additional research

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Tank-nically Speaking

by Marcel Moreau and Ken Wilcox

Marcel Moreau is a nationally recognized petroleum storage specialist whose column, Tank-nically Speaking, is a regular feature of LUSTLine. *In this issue Ken Wilcox, President of KWA, Inc., specialists in third-party testing of leak detection equipment, is Marcel's co-author. As always, we welcome your comments and questions. If there are technical issues you would like Marcel to discuss, let him know at* marcel.moreau@juno.com

The Limits of Leak Detection

Once Upon a Time…

…In the Land of Leaks, the King had had enough. He had gotten used to leaky faucets that ran continuously no matter how tight he turned the faucet handle, leaky bathtubs that drained out long before he was ready to end his soak, and a leaky fishbowl that kept his goldfish anxious that his servants would not arrive to refill the water before it drained out of the fishbowl. The King had accepted as a fact of life that his roof would always leak onto his crown when he sat on the royal throne, that the royal limousine would always be plagued with flat tires, and that the royal soup bowl would forever dribble onto its saucer.

"Thank heavens for secondary containment," he sighed in the midst of a state dinner, thankful that the rich red tomato soup leaking from his bowl into his saucer would remain there rather than flow into his royal lap.

The situation had not always been so, but all memory of a leak-free time had long ago faded into the dustbins of antiquity. The royal records showed that the King's great-grandfather had terminated all maintenance in the kingdom to save money and keep more gold in his coffers. But the old King's mandate had acquired a life of its own. People had just gotten used to the results of poor maintenance and had come to believe it was the only way things could be.

The Last Drip

But on this day, the King had had enough. He was wearing his favorite white silk shirt and drinking a blueberry smoothie. He had forgotten to don the royal bib that was standard attire in the kingdom. As he put down his goblet, he spotted a chain of purple drops dripping down the front of his shirt. He had had a long rainy day, dodging drips throughout the castle, enduring the drops on his head through the interminable council meeting, slogging though the soggy courtyard in his leaky rubbers, and his patience was short. The blueberry medallions decorating the front of his shirt simply put him over the edge.

"Call the Minister of Science and Technology," he roared.

The Minister arrived at a run and out of breath.

"I've had enough," said the King. "From this day forward, I declare that there shall be no more leaks in my kingdom."

The Minister of Science and Technology knew better than to argue with the King when he was in this mood, so he bowed and said, "Yes, your majesty," and shuffled off on his mission to eliminate leaks.

Is a Drip a Leak?

A few months later, the King asked his Minister of Science and Technology for a progress report. He had noted just that morning that although many things had improved and the royal goldfish were considerably more relaxed, his bathroom faucet still exhibited a drip.

"Well, your majesty, we have made remarkable progress. I believe your order to eliminate leaks has been accomplished," beamed the Minister of Science and Technology.

"But," said the King, raising an eyebrow, "why does my royal faucet still drip?"

"Oh," said the Minister, somewhat befuddled. "As your highness has noted, that is not a leak, that is a drip."

The King began to fume, thinking his minister was playing word games with him. "What do you mean it is only a drip, and therefore not a leak? I ordered all leaks to be eliminated, and that includes drips!"

"Yes, your majesty," sighed the Minister of Science and Technology, and he dispatched a royal plumber to see to the King's faucet.

Is a Weep a Leak?

By the next week, the King was pleased to note that the drip in the royal sink had stopped. However, he noted that the rim of the spout was showing a little rust staining. The Minister of Science and Technology came to investigate. He donned a glove, smeared a little yellowish paste on his index finder and touched the tip of the faucet spout. The paste turned bright red.

"What's that?" asked the King.

"Water-finding paste," said the Minister. "The change in color indicates that there is water on the tip of the spout.

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I believe this indicates that water is still weeping out of this faucet."

"What?" blurted the King. "I said I want no more leaks!"

"That's right," said the Minister. "We have eliminated leaks and drips, but I didn't know you wanted to eliminate weeps as well."

"Well, I do," bellowed the King. "See that you do it."

What Exactly Is a Leak?

The Minister of Science and Technology wept. His engineers had found it relatively simple, though somewhat expensive, to eliminate leaks. They had groaned somewhat when he had asked them to eliminate drips, but they had risen to the challenge and found ways to do it. He was sure that getting them to eliminate weeps was going to take some serious coddling and cajoling on his part.

With some trepidation, he convened all of the kingdom's ministers to see what solutions they might come up with. "…So we need to eliminate weeps as well as leaks and drips," he said to the assembled group. As anticipated, a chorus of groans arose from the engineering staff.

"When is this going to stop?" demanded the Minister of Standards. "Every time we jump over the bar, the King raises it. We can't keep jumping higher forever!"

"The King has spoken," said the Minister of Science and Technology. "We must eliminate leaks."

"But what is the King's definition of a leak?" asked the Minister of Communication.

"Aye," said the Minister of Science and Technology, "there's the rub."

Back in The Land of LUSTs…

Our frustrated king has unwittingly created a dilemma for his ministers. The king wants no leaks. The ministers, however, need boundaries, limits, and a concrete definition of what is to be achieved. For engineers to even begin to consider a problem such as building a bridge, they must know the span of the chasm to be crossed, the weight and number of vehicles to be transported across the bridge, the nature of the geologic materials that will support the bridge, and the properties of the materials that will be used to construct the bridge.

To achieve any engineering goal, or arguably, nearly any goal, we need to have parameters. We must have a clear definition of the goal so that we know what we're up against and know when we've reached it. Indeed, defining the goal is often one of the thornier issues that must be resolved before progress toward meeting that goal is possible.

In Days of Yore

The history of UST leak detection in the United States provides a concrete example of the need to carefully define goals. Leak-detection vendors in the 1980s made many outlandish claims about the accuracy of their equipment. They could do this because at the time there was only the following simplistic goal that had been promulgated by the fire code: You must be able to detect leaks of 0.05 gallons per hour, taking into account temperature changes in the product during the test.

There was no standard way of determining the accuracy of vendors' claims, and many vendors "proved" the accuracy of their equipment at trade show venues by demonstrating how they could measure remarkably small leaks in small plexiglass tanks holding a few gallons of colored water. That the demonstration bore little resemblance to the reality of trying to accurately measure similarly small leaks in the dynamic environment of a 10,000 gallon underground gasoline storage tank was not even recognized, let alone given any consideration.

U.S. EPA's "Edison Study," conducted in the mid 1980s, brought a rude awakening to most leak-detection vendors; the results showed that most claims of tightness-test accuracy were not much more than wishful thinking. The problem of a fuzzy goal was remedied somewhat when the federal tank regulations went into effect in December 1988. The rules specified not only a detection leak rate, but also a probability of detection, a probability of false alarm, and a list of factors influencing tightness-test results that had to be considered when conducting a tightness test. The regulations further resulted in the publication of protocols to use to evaluate whether leak-detection equipment could in fact meet the specifications of the regulations.

With the problem more completely defined, it became a relatively simple task to engineer equipment that would conform to the goals described. Through the 1990s, hundreds of leak-detection methods were developed and evaluated against the standards set in the federal rules.

That Was Then, This Is Now

But now we are in a new century. The leak-detection standards established some 16 years ago are still the law of the land. Back then, we measured PC processing speeds in megahertz and memory capacity in megabytes. Today we are talking gigahertz and gigabytes—speeds and capacities a thousand times faster and bigger. Now we are exploring nanotechnologies that build structures on the scale of molecules.

Despite substantial technical progress in a multitude of engineering disciplines in the last decade and a half, our routine standard for leak detection is still 0.2 gallons per hour, or 4.8 gallons per day, 144 gallons per month, 1,752 gallons per year. The presence of MtBE in our gasoline has taught us that this standard is woefully inadequate to prevent contamination. In addition, our existing standard primarily addresses liquid releases, while studies show that vapor releases may be much more common and in some circumstances more significant than liquid releases in terms of the mass of gasoline released to the environment. (See "Tracking Troubling Vapor Releases..." on page 13.)

Déjà Vu All Over Again

But change is in the wind. Some states, notably California, have tightened or are contemplating tightening the leak-detection standard established 16 years ago in the federal rules. Unfortunately, we are also seeing a repetition of the wild and wooly 1980s, because the new leak-detection standard has, to date, been incompletely defined.

California, for example, has specified a detectable leak rate of 0.005 gallons per hour at a probability of detection of 95 percent and a probability of false alarm of 5 percent. But additional parameters, such as the pressure at which the leak is to be defined or even something as basic as whether the leak rate in question relates to a leak of liquid or vapor, have not been specified. In addition, the technologies being developed today are a far cry from the technologies contemplated when the leak-detection evaluation protocols were being written some 15 years ago.

There is oftentimes only a poor fit between the old protocol's procedures and the new equipment's design. The result is a free-for-all among vendors, all choosing to define their leaks and evaluate their technologies in the way that best demonstrates the capabilities of each particular device.

Should There Be a Limit to Leak Detection?

"Let me tell you how we define a leak," said the Minister of Petroleum. "We estimate that our current technology can find leaks of 2.4 gallons per day. A few of our methods can find leaks of 0.120 gallons per day. Any leak rate less than this we ignore because we cannot reliably measure it. However, a vendor came to me recently and showed me a method he says can find leaks of a gallon per year."

"A gallon per year is remarkable," interrupted the Minster of Standards, "but if you are looking for leaks that are that small, you will definitely be increasing your rate of false alarms and you'll be failing a lot of systems that are tight."

"Yes," said the Minister of Petroleum. "One of the problems this vendor has had is that everything he tests fails the test. But the leaks, if they are there, are so small that no one can find them to fix them. It's driving the storage system owners and installers crazy."

"So," said the Minister of Reason, "while I suppose the King would consider a loss from a storage system of a gallon a year a leak, I find myself compelled to question whether we really need to find leaks of a gallon a year or less."

We have lost sight of the goal. Today, we are seeing technologies with the ability to detect phenomenally small leak rates. But the existence of these technologies begs a broader question: Are we really gaining anything in terms of protecting human health and the environment from petroleum releases?

Is "because we can" a sufficient rationalization for setting a leak-detection standard of a gallon a year or a molecule a century? Is this really the best place to spend our time and money? Can leak detection be carried too far?

Does Size Matter?

"We need some basic facts," mused the Minister of Reason. "We need to answer the question, 'How small a leak is relevant?' The answer will be different for different situations, but we first need to answer this question if we are going to have an intelligent discussion about what size leak is significant."

"Yes," said the Minister of Standards, "that is the fundamental question that must be answered. To answer it, we need some basic research. For example, we need to know what happens when gasoline leaks into the ground. And if we are going to put any new constituents in the gasoline, we need to figure out what that is going to do to the characteristics of the gasoline that is released. Then we need to figure out what size leak is acceptable in different geologic and cultural environments while still protecting human health and the environment and let that be our standard."

As our ministers note, a difficulty with using a "no-adverse-effect leak rate"—the leak rate that is so small that no measurable harm to human health or the environment is likely to result—as a leak-detection standard is that this leak rate will vary not only with gasoline constituents, but also with the geologic environment into which the gasoline is released and the proximity of the receptor to the release. But developing, implementing, and regulating site-specific acceptable leak rates does not seem like a very workable scenario.

From a practical standpoint, it would be more realistic to develop an acceptable leak-rate number that would be protective in 95 or 99 percent of situations from a national perspective. Individual jurisdictions could impose stricter standards in more sensitive areas.

So what might the no-adverse-effect leak rate be? We don't pretend to know, but it seems to us that it would be worthwhile to determine such a value. Our current leak-detection standard of 0.2 gph was established not because it was empirically determined to be protective of human health and the environment, but because of the technological limitations of the leak-detection equipment available at the time.

Now that the old technological limits can be superseded, we suspect it is time to tighten the regulatory standard. The question of how much to tighten the regulatory standard should be answered by sound science that documents what it takes to protect human health and the environment from petroleum releases from storage systems.

A Draft Definition

"OK," sighed the Minister of Science and Technology, "if we were to try to set a limit on the size leak we are looking for, how would we define it?"

"As simply as possible," said the Minister of Standards emphatically. "I would suggest something like this: A leak-detection method must be able to detect a loss of some yet-to-be-determined quantity X, with the units mass/time, from any portion of the storage system, with a probability of detection of at least 99 percent and a probability of false alarm of no less than 1 percent. The mass-release rate is to be measured under normal operating conditions for the system."

We would add to the minister's definition that if secondary containment is used, both walls of the storage system must be monitored. We would support the minister's and our definition with the following rationale:

- Defining the leak rate as a mass rather than a volume eliminates the need to distinguish between liquid and vapor leaks. What matters is the mass of contaminant released to the environment per unit of time, not whether the release occurs in liquid or vapor form.
- The probability of detection is set at 99 percent because most existing vendors have chosen this standard for their equipment, even though the current regulatory minimum standard is 95 percent. If vendors believe that 99 percent is a more acceptable number to their customers, then why have the regulations settle for less?

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■ **Limits of Leak Detection** *from page 19*

- The leak rate would be defined at the operating condition of the storage system to take into account the widely varying pressures in different storage-system components (e.g., bottom of tank, top of tank, pressurized piping).
- While I still believe that secondary containment holds the most promise for very sensitive leak detection, we have learned that, in some cases, secondary containment is part of the problem rather than the solution. (See "Pipes and Sumps—As I See Them" below.) Monitoring both walls of secondary-containment systems will help to ensure that these systems achieve their promise of fully containing petroleum releases from storage systems.

The Bottom-Line Leak

We sense that the existing leak-detection standard of 0.2 gph is too permissive. But if we are going to tighten up leak detection then we need to have a rational standard for the size of leak to be detected and some clearly drawn parameters to describe the acceptable leak rate.

Our king's vision of a no-leak kingdom is unachievable because our modern-day ability to measure impossibly small quantities leads to a scenario where all things are declared to be leaking. The ministers' approach of determining the size leak that it makes sense to detect, carefully defining this leak, and then letting the engineers do their work to find ways of reliably detecting this leak seems an eminently more practical solution to the problem. ■

What do you think?

Pipes and Sumps—As I See Them

Thoughts from a Florida UST Inspector

by Ernest M. Roggelin

Because of space constraints and because it will be more helpful if you view the photos for this article in color, we have chosen to make all 65 of the photos Ernest provided to illustrate this article available to our readers on the NEIWPCC Web site at: *www. neiwpcc.org/lustline/sumpandpipingphotos.htm.*

Since the mid-1990s there has been an increased level of interest, or perhaps just more active reporting and sharing of information, among state and federal UST inspectors regarding the deterioration of storage tank system components, specifically nonmetallic underground piping and containment sumps.

Nonmetallic piping includes two types: rigid (thermoset) and flexible (thermoplastic). How do you tell these types or brands of pipe apart? First, get to know the contractors in your area—visit their shops, ask questions, and get your "hands on" experience. Second, the Internet is a wonderful tool, and most manufacturers offer a wealth of detailed information for the curious (go to www.pei.org *for links to most manufacturers' Web sites). The sumps of concern are located at the tank top (piping sumps), beneath dispensers (dispenser sumps), and where piping goes from an abovegrade to a below-grade location (transition sumps).*

So let's have a look at pipes and sumps. The photographs used to illustrate this article come from a variety of governmental agencies throughout the United States.

First the Piping

■ **Thermoset Piping**

Thermoset or rigid fiberglass-reinforced plastic (FRP) piping has been around for at least as long as I have been inspecting tank facilities. Typically, someone has to "do" something foolish or deliberate (e.g., step on it, drill through it, score it, impact it), improperly install it, or have it be subjected to ground movement (i.e., shearing) to create a problem. I have not observed any deterioration of thermoset materials from exposure to petroleum products.

■ **Thermoplastic Piping**

Thermoplastic piping, especially the polyurethane and early polyethylene flexible compositions, have been subjected to intense scrutiny over the past several years. Following the introduction of polyurethane-based piping in the early 1990s, Florida began seeing microbial growth and degradation in the outer jacket of some single-walled piping within three to five years of installation. (See Figure 1.) Manufacturers typically replaced the affected sections and often the entire run at a given station with the latest version of the pipe. There was no mandatory recall of the initial pipe. Replacement was apparently based on the individual behavior or response of the pipe.

FIGURE 1. *Black mold growth; degradation of single-walled pipe's external cover*

Fast-forward five to seven years, or approximately 10 years from installation, and we've found that an increasing number of thermoplastic piping systems at Florida facilities have been experiencing a variety of pipe-deterioration conditions. In retrospect, most of the initial product lines manufactured had a 10-year warranty. A warranty refers to the expected lifetime of any given product. This is not to say the pipe has to reach the end of its warranty period to experience problems, although time may be a unifying factor. So, should we be surprised at the events?

Signs of Concern

What are inspectors seeing during the course of their site visits?

- Exterior and interior color change in the pipe
- Mold growth on the outside of the pipe
- Softening or jelling of the pipe
- "Blowout," a term used to describe the rupture of the outer jacket of the primary pipe
- Cold growth or lengthening of the pipe, including backing off fittings, and movement of equipment out of position (see Figures 2 and 4)
- Brittle interior core and cracking of the carrier portion, cracking of the secondary wall, and loss of internal integrity of the pipe (see Figure 3)
- Loss of communication within the interstice of a coaxial pipe
- "Alligatoring" or rippling of the outer layer
- Fitting failure

Causes?

Initially, manufacturers' response to the piping problems was to direct the blame to the installation contractors. However, contractors are all required to be manufacturer trained in piping installation, so this logic is somewhat circular. As states began sharing information about a widening pool of incidents at various types of facilities, this rationale became implausible. I would be remiss if I did not attribute some level of responsibility for the problems to "contractor error," as problems do occur because of deviation from standard practices.

Next in line for blame were the facility owners. Manufacturers insisted that the exteriors of their products were not designed to be in contact with petroleum for an extended time period (e.g., beyond 72 hours). They implied that the initial designs assumed pristine, well-maintained piping runs that were not subject to long-term exposure to petroleum products. Failure to maintain these conditions was obviously a failure in piping maintenance on the part of owners, though the requirement that these products be maintained in such a pristine environment is not stated on any manufacturers' sales literature that I have seen.

FIGURE 2. *Growing pipe meets fitting*

FIGURE 3. *Split of secondary pipe; apparent failure of primary layer underneath*

Exposure of the exterior of the pipe to petroleum can occur within an interstitial space of a coaxial pipe, within a secondary or tertiary "chase" pipe, or from environmental exposure due to soil and/or groundwater contamination at a facility. Given that in the real world exposure of the piping exterior to petroleum will occur, how is an owner to return the piping to "pristine" condition?

There are two areas of concern associated with post-exposure cleaning. First, the separate-component primary and secondary pipes do not all have the smooth bore typical of thermoset fiberglass pipe. Thermoplastics typically have what I call a corrugated chase that has the potential to retain liquids within the separate cells of the corrugation. Second, with the coaxial style of pipe, there is a question of how to flush the interstice of product once exposure has occurred. Furthermore, how can the cleanliness of the interstice for either type of pipe ever be verified?

Standards?

"Hey, there are compatibility standards in the regulations," you say. Sure, Florida has a number of them, including UL 971 from Underwriters Laboratories (UL).

One of my duties is to represent the Florida Department of Environmental Protection (DEP) on the UL's 971 Standard Technical Panel. The panel is composed of representatives from manufacturing, industry, interested parties, and regulatory authorities that meet and by consensus develop new and revised standards capable of evaluating a specified product. The regulatory authority input has been a recent change to the panel's makeup.

One point of discovery that became evident during the technical panel's evaluation process for the UL 971 standard was that the existing standard focused on the testing of the primary carrier portions of the pipe—the exterior of the pipe was ignored. The new standard under development at present will evaluate the entire pipe—both inner and outer walls.

Now the Containment Sumps

So what about containment sumps? States have different requirements...

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■ **Pipes and Sumps** *from page 21*

let alone the federal rule. Florida has specific language requiring dispenser sumps or at least a method of sub-dispenser containment; but the typical piping sump is not a requirement. The facility just has to have a method of providing access to the piping interstice for monitoring. Granted, most new facilities have some form of sump, but many existing facilities have earthen or gravel "pits" beneath a traffic lid—pits that serve as excellent conduits to groundwater.

What do inspectors see when they look into a containment sump? There are facilities with discrete sumps and facilities with factory-mated units. By factory-mated, I mean those sumps that are heat-welded to the tank shell and those where a mating collar is an integral part of the tank shell. The factory-mated units can be made of thermoset or thermoplastic materials. Again, the thermoset types are most likely to suffer from impact damage or contractor error. They do not appear to deteriorate from contact with petroleum or to deform from external ground or water-table pressures.

Signs of Concern

Thermoplastic sumps have exhibited the following types of problems:

- Rippling, collapse, or inward movement of walls from external pressure. (See Figure 4.)
- Distortion of the floor from apparent "long-term" exposure to petroleum.
- Groundwater upwelling pressures or lack of backfill support causing some of the floor distortion on the discrete models. The floor distortion for the factory-mated type is more of a concern since it is typically the tank's secondary containment that is undergoing this deformation.
- Sump penetration boot failures. (See Figure 4.)

Discrete sumps have their share of contractor errors, especially by electrical contractors, who are not typically concerned with maintaining the liquid-tightness of sumps. These errors are all readily visible to the experienced and patient inspector during the installation oversight process. Thermoset sumps require foreknowledge by the inspector of the correct angle of penetration of piping through the sump walls and the use of appropriate penetration fittings.

FIGURE 4. *Ripple in sump wall; torn boots; shift in pipe position within secondary pipe*

Thermoplastic sumps, especially older thin-walled models, can deform in response to soil movement and/or shallow groundwater levels. As mentioned, bulging of the walls is a readily noticeable event, along with cracking of structural features. In addition, there is the reaction of the "plastic" to long-term exposure to petroleum, whether it is free product, petroleum contact water, or vapor.

Manufacturers have failed to provide sufficient guidance on "how" these structures can be cleaned after exposure. Complicating the issue is the designation of most of these sub-grade structures as confined-space entry points. An additional concern from the facility owner perspective is the waste disposal cost of flushing a secondary-containment unit with water or an emulsifying agent. When thermoplastic sumps are damaged, there does not appear to be a manufacturer's recommendation on how to repair them.

Solutions?

In Florida, DEP and Local Program (county-level) inspectors are out in the field routinely performing annual, follow-up, installation, closure, discharge, and quality-control inspections. A heck of a lot of inspections! For example, my local program has performed 814 inspections since July 1, 2003. On a statewide level, more than 25,000 inspections are performed annually!

What is the incentive for a facility to maintain its system in "full compliance"? Protecting a significant investment? Avoiding the potential to receive a regulatory penalty? Even in light of problems with long-term exposure of sumps and piping to petroleum, the regulatory focus has not increased in this area. Granted, inspectors in Florida are tasked to specifically note the type and condition of piping at a given facility, but this item typically remains a "minor" infraction. The bulk of the responsibility rests with the facility owner/ operator, some of whom contract out the monthly release detection monitoring to third parties.

In summary, there are problems with certain components of UST systems. Inspectors, owners, their consultants, and contractors can and must frequently evaluate the condition of their systems, maintain the equipment properly, and act in a timely and responsible manner upon the discovery of problems. Many facility owners mistakenly believe that secondary containment is the cure for all their petroleum storage ills. What they do not recognize is that, in some cases, secondary containment is part of the problem, not the solution. ■

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From Our Readers

It's Time to Get Heated Up About Heating Oil Tanks

Cliff Rothenstein's article in the March 2004 *LUSTLine* celebrates the successes of the 20 years in which the UST program has been in existence. He says we worked effectively to ensure that all UST systems in use today meet federal standards. But…he is speaking of federally regulated USTs, and there are a huge number of petroleum-storing USTs that are not federally regulated. These heating oil tanks are often bare steel and have been in the ground for years, some for decades, without testing or upgrade. Who knows how many of them are leaking? Does anyone even know how many heating oil tanks there are?

The states are left to decide for themselves what degree of regulation they will impose on these tanks, without any federal guidance, standardization, or funding. And the states are on their own in having to to overcome huge pressure from those who support doing nothing more than the minimum required by the feds. The decision to exempt heating oil tanks from federal regulation 20 years ago was no doubt based on politics and economics, but can we continue to ignore this big elephant in the room?

While heating oil tanks were not federally regulated for the first 20 years, hasn't the time come for this huge chunk of the tank universe to be addressed? Isn't this an important enough issue? Shouldn't the environmental impact of leaving aged and aging heating oil tanks in the ground for the next 20 years without federal regulation be viewed as simply unacceptable?

There has been considerable federal interest in cleaning up brownfield sites. Petroleum cleanup costs are now eligible for federal funding at these sites. Doesn't it follow that there should be equal federal interest in regulation of the heating oil tanks that have contributed to the petroleum contamination for the purpose of release prevention? The same political and economic disincentives in play 20 years ago are probably still there, but if we, the UST regulatory community, don't consider heating up this environmental issue, who will?

Paula-Jean Therrien
Principal Environmental Scientist
RIDEM/UST Management Program/LUST

"Finishing Strong" Resonates in Germany

[Edited to improve clarity.]

I am head of the Industrial Environmental Protection section in the Umweltamt, Düsseldorf, Germany. In my section we are responsible for the fueling sites in Düsseldorf. As a frequent reader of *LUSTLine,* I love the very informative and in many cases also entertaining way you [Robert Renkes] and all the other authors share their experience about USTs. Although we have in many ways a different regulation and compliance system for USTs in Germany, I found it very interesting to read your article, "Finishing Strong," in *LUSTLine* #46.

We have quite the same experiences and observations with our updated UST systems and fueling facilities—especially your description of the "modern" tank owner, which illustrated the exact same findings that we made. We found out that in many cases the site owners are more interested in registering and controlling the temperature of the refrigerators in the convenience stores (in Germany up to three times a day !!) than to register the "little red light"on their leak detector.

In a site inspection campaign we conducted in 2002, we found out that at six of 70 stations this little red light was glowing without evoking any reaction from the site owner. Some of the owners (mostly the newcomers) did not even know what the installation was for or where exactly it was located!! One owner did not realize that he had tanks on his site!!

Yours,
Holger Stürmer

Wander LUST

by Pat Ellis

A roving column by reporter Patricia Ellis, a hydrologist with the Delaware Department of Natural Resources and Environmental Control (DNREC), Tank Management Branch. Pat welcomes your comments and suggestions and can be reached at Patricia.Ellis@state.de.us.

Trading Shoes

Risk-Communication Strategies

A few years ago, a state environmental agency held a series of public meetings in an area where a number of LUST sites had been impacted nearby domestic wells. (The state shall remain nameless to protect the guilty.) Some of these meetings had hundreds of people in attendance. From the descriptions in the news articles, some of the meetings got a little bit ugly. At one of the public meetings attended by more than 500 people, the state official was booed when he tried to curtail heated comments from the audience. He commented, "This is my meeting. We don't have to be here." In response to this, a woman screamed from the crowd, "Yes, you do. You work for us." That's something to keep in mind—always.

Picture the scene: You are the state's environmental project manager, and you are meeting with the residents whose drinking water wells have been impacted by a gasoline plume. They have been drinking and bathing in contaminated groundwater for heaven only knows how long. Worse, their kids have been exposed to this contamination. They want answers, and they want them now. They want to know who is responsible, and they want it cleaned up—immediately. They don't want to be told repeatedly, "The investigation is ongoing." So they wait. They wonder. They worry. Can they shower, brush their teeth, and cook with the water? The experts say, "It's a minor risk." Will they ever be able to sell their houses? Appraisers say not without clean water. Is there any connection between their physical ailments and the contamination? Experts say that there's almost no way to tell.

Would you want to hear vague answers? You deal with these issues on a daily basis, but this is something new and scary for the impacted parties. As regulators, the best thing you can do is make sure that all parties are included in the information loop as soon as possible. And, when you are planning how you want to get these people in the information loop, one of the most important things that you can do is to put yourself in their shoes.

Imagine that you are "Trading Shoes." If this were your family with the contaminated well, what questions would you be asking? Imagine yourself to be Uncle Joe or Aunt Mary, who haven't had all of the environmental training that you've had. You need to explain everything to them in terms they can understand.

At a single meeting you may find yourself in the position of communicating potential risks simultaneously to residents who (a) haven't been exposed to contaminants in their water, (b) have been exposed at levels below state or federal standards, (c) have been exposed to contaminants above established "safe" levels, and/or (d) have been exposed to contaminants for which "safe" levels have not yet been established. Each of these scenarios would pose a unique risk-communication challenge. Couple this with the fact that, if you are the impacted party, no amount of contamination is acceptable in your water, whether or not it is "safe."

So before you face the crowd that has gathered at the local school or town hall, carefully plan what needs to be said and how it should be said. You probably don't want to find yourself crawling away licking your wounds, looking forward to the heyday the press will make of the meeting, anticipating the angry calls that you will field for days or weeks to come, and knowing that your relationship with the public has gotten off to a rocky start and will probably remain that way.

Strategic Planning

Before you have your first interactions with the public, gather a team together and develop a communication strategy. How are you going to communicate with the public? There are lots of possibilities—big public meetings, small group sessions, one-on-one, press releases or news conferences, neighborhood newsletters, open-house meetings. There is a place for each of these types of communication at some time during the process.

The public wants and needs to be kept informed. They want to be included in the decision-making process; they want their concerns to be listened to and acted upon. Keep in mind, however, that the information you may want to present to them may not be the information they want to hear.

With your team, hone your take-home message. It needs to be clear, concise, and consistent, and if you want your message to get across, the public needs to believe that you are trustworthy and credible.

Dr. Vincent Covello of the Center for Risk Communication in New York City states that there are four factors that affect the public's perception of trust and credibility:

- Showing that you are caring and that you sincerely empathize with their problems
- Showing that you are dedicated and committed to addressing their problems
- Conveying your honesty and openness
- Assuring all concerned that the problem is being dealt with by people with competence and expertise

If you can't show these traits in meeting with the public, then maybe someone else needs to be doing the interacting.

How Do You Establish Trust and Credibility?

Trust and credibility won't happen with a "trust me, I'm with the government" attitude. That trust has got to be earned. Let's flesh out the factors listed above with some pointers.

■ **Caring and Empathy** – Let people know that you care—both verbally and nonverbally. Watch your body language. Make eye contact. Say you care! Be prepared to listen to people, not just talk at them. Let people vent, but keep it under control. Let them know that they will all have a chance to express their concerns, but that melees aren't allowed.

■ **Dedication and Commitment** – Be open and accessible. Know what you're doing—people can tell who knows and who doesn't. Follow up on issues that you promise to follow up on. Allow enough time to talk to those who want to talk to you.

■ **Honesty and Openness** – Be proactive in your communication. If you make a mistake, admit it. Avoid technical jargon and acronyms! The public doesn't know the alphabet soup of acronyms that we use every day. Don't hide behind a podium. Stand out in front of it, close to the audience. Again, it's the body language. Arms crossed in front of the chest give the message that you are closed to what they are saying. Always tell the truth. If you don't know the answer to a question, say so, say you'll research it and get back to them.

■ **Competence and Expertise** – Let people know your credentials and experience. Be able to cite similar cases. Use clear and concise language. Speak to the level of education or expertise in the audience, without talking down to them. Above all, be prepared.

Outrage, Power Ball, and People

According to Dr. Peter Sandman of Rutgers University, "The public pays little attention to hazard; the experts pay absolutely no attention to outrage." The public can get worked up about what the experts might see as a relatively minor risk (e.g., that one-in-a-million increase in the possibility of getting cancer). These are the same people who buy a Power Ball ticket with a one-in-a-million chance of winning several million dollars. They don't want to be that one-in-a-million person who gets the cancer from the water they are drinking.

The "experts" can't understand how everyone can get so lathered up about what for them is encountered in their normal working day. The experts know the science and the risks. They know how long each step in the project might take. It takes time to conduct investigations and develop remediation plans. You know that, but they don't. For the public, it's the uncertainty that increases anxiety, so the more informed you can keep them, the easier it will be to get past the outrage and anger and deliver a message that can be heard.

Risk information often comes from people who are professionally inclined (possibly even trained) to ignore feelings. How do people respond when their feelings are ignored? They yell louder, cry louder, listen less! That stiffens the experts, which further provokes the audience. Acknowledging people's feelings in advance can reduce the chances of conflict between the cold bureaucrat and the hysterical citizen.

Planning Your Public Outreach

Once you have your planning group together, decide on the type of outreach event that would be most effective for the situation. How wide a group needs the information? Decide on the key messages that you need/want to convey. Key messages should be stated clearly and concisely. Some guidance suggests that each key message should be no longer than twelve words. Have supporting information to back up the key messages.

During the course of your presentation, repeat the message several times to be sure that it sinks in. Anticipate the difficult questions that the audience might ask and decide how you want to answer them. Practice in front of an audience beforehand. This is probably not the time to assign the task to someone with no public-speaking experience. It can be an ugly sight to have your main speaker get that deer-in-the-headlights look when he or she stands up to speak before a restless or angry crowd.

In situations where hostility may develop, emotions peak, and fear or worry bubble up, communicating with the public takes special skills. Communicating in a manner that is clear, concise, and positive enhances the opportunity for the message to come across clearly. Environmental communication requires a two-way, interactive dialogue between regulatory agency staff and affected stakeholders—communication in which stakeholder concerns, opinions, and reactions regarding programs, sites, projects, or issues are addressed.

As Hard as You Try...

It is not always possible to please everyone. In one of my current projects, 14 domestic wells have been impacted in a neighborhood of about 100 homes. After listing all the pros and cons of replacing wells with deep, double-cased wells versus extending a nearby public water

■ *continued on page 26*

■ **Risk Communication** *from page 25*

main, the DNREC made the decision to extend the public water line. Residences with impacted wells and nearby wells that are threatened will be tied to the water line at no expense to the residents except the quarterly water bills.

Due to the layout of the neighborhood, the water line will also extend past houses with wells that are not threatened. These people will be allowed to connect to the line voluntarily, but they will have to pay for the connection from the water main to their houses. We have been dealing with people who are upset that they will now have a water bill when they hadn't before, people who wish that we would consider them threatened so they can be connected for free, and people in other areas of the neighborhood whose wells are not threatened, and to which the water line won't be extended, who feel that we are not treating the entire neighborhood as a unit. There actually are a number of people who are grateful that they will soon be getting rid of the carbon filters that are removing the gasoline from their water and getting supplied with water that is tested regularly by the water utility.

No matter which choice we made to try to solve the water contamination problem in this neighborhood, some people would be unhappy. Much of the recent interaction with the public for this project has been one-on-one, in person, or on the phone. Since the project is in a resort area, about half of the residents are seasonal; many of the others are retirees on fixed incomes. Mailed newsletters have also provided information to the residents.

By not holding large meetings, we have taken away the opportunity for rabble-rousers to grandstand, and people in the neighborhood have seen that we are willing to listen to their concerns. The seasonal residents have been kept in the loop on progress even though they may live several states away. Public outreach has been extensive and time-consuming, and we've hit a few rough spots, but in general things have moved relatively smoothly.

We've learned that you can never please all of the people all of the time, and that there are some people that you can never please. But the residents know that we will try to keep them informed about what is going on, listen to their concerns, and explain anything that they don't understand.

Be Prepared

We have tried to follow the suggestions in the literature on risk communication. There is a wealth of guidance available in the literature on developing risk-communication strategies. If I can offer one key suggestion, it is that you should develop a general strategy for risk communication *before* you need it. When the need arises, assemble your planning team and customize your approach.

> ***Stop and think about what kinds of questions you would be asking if it were your well that was impacted and your family was drinking the water.***

Provide as much information as you can as soon as you can. Have someone present information at meetings who can do so without using a lot of technical jargon and acronyms. Analogies can help explain concentrations—a part per million is equal to one drop of gasoline in a full-size car's tankful of gas. You may understand groundwater hydrology and the engineering of remedial systems, but the average homeowner doesn't.

Have someone available from Public Health who can explain potential health risks. A good explanation of the kinds of safety factors that are built into developing maximum contaminant levels (MCLs) can go a long way toward easing someone's fears. In addition to the regulatory agency, the responsible party and his or her consultant should also be available to make presentations or answer questions.

Be able to present a timeline for what is going to happen next. Public meetings are good, but you can also send out periodic community newsletters to provide updates on the progress of investigations or remediation. Provide the phone number and name of the person who will be available to answer questions and respond quickly to all requests for information.

You Would Cry Too if It Happened to You

Stop and think about what kinds of questions *you* would be asking if it were *your* well that was impacted and *your* family was drinking the water. Those of us in the DNREC got to experience this frustration first-hand. There was a case (not ours) where low, but rising, contamination levels of bis (2-chloroethyl) ether, or BCEE, forced the closure of four public wells supplying about 5,000 customers (approximately 13,000 residents).

BCEE, considered a probable carcinogen, is normally found only near chemical plants or chemical waste sites. Federal drinking water rules do not require routine testing for it because it is rarely found in groundwater. The chemical was detected in monitoring wells as part of a monitoring program in place because of four nearby Superfund sites.

In what became a protracted and complicated failure-to-communicate situation—which I will spare you—it finally occurred to someone that our own building, which was also adjacent to the same Superfund sites, also received its water from the contaminated well field. We hadn't been invited to the earlier public meetings for impacted residents.

We soon found ourselves sitting there in the audience listening to the explanations about our exposure to this chemical, and many of us were not the least bit shy about asking some fairly pointed questions. Why did it take so long to notice that the containment pumping had decreased? Why hasn't BCEE always been on the analyte list for the Superfund wells since it had been detected early on in the studies? Who was asleep at the wheel? Why the heck did it take so long for U.S. EPA and our own agency to notify public health officials and the water company? Why wasn't a lower action level set when public wells were in the area?

Public health officials said that they were unsure how long customers had been drinking contaminated water. We'll never know because monitoring wasn't being done. What was the maximum level to which we were exposed? The fact sheet developed by Public Health states that the "possible human carcinogen" classification is based on sufficient evidence of carcinogenicity in animals and a lack of adequate human study data. Ingestion of BCEE has been shown to cause liver cancer (hepatomas) in mice. What are the possible health effects if I also have some other health issues or exposure to other contaminants? I'm not a mouse, so what do those numbers mean to me? At no time in the meeting did I hear any reason or apology for the oversights and delays that were involved in the project.

None of us regulators like to have one of our projects come back to bite us on the you-know-what, so we try to manage them all so that they will stand up to technical, legal, and public scrutiny. On those occasions when that fails, get the information out quickly, fully, and truthfully, and put yourself in the other guy's shoes when it comes to planning that outreach. While I did not attend the original meeting for the public, I felt that there was much room for improvement in the way that our in-house information meeting was conducted. ■

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Mandatory Training for UST Operators

Observations from the Oregon Front Line

by Ben Thomas

An ambitious deadline. A new series of requirements. A constant barrage of reminders. A limited number of service providers. Confused tank owners. Thousands of tanks at stake. Is it the 1998 upgrade deadline? Not exactly, but close.

On March 1, 2004, Oregon became the first state to have set a regulatory deadline for training UST operators. By that date, every owner of fuel-dispensing UST systems in Oregon must have designated a person as the official "operator" and have proven that the operator received formal training on all of Oregon's UST rules. They had nine months to do it. No problem.

Oregon met the challenge in a unique way that didn't require a significant resource burden on the Department of Environmental Quality (DEQ). In fact there was virtually no burden; the department relied on private enterprise to deliver the whole thing. First, DEQ created guidance to qualify training vendors. Then it created guidance for would-be instructors to follow. Then it invited the instructors to post their contact information and training dates on the state's Web site. Then the DEQ broadcast letters statewide alerting operators that training options were now available. Later the agency would audit classes to make sure the trainers were doing the right thing.

As a listed vendor, I personally trained more than 25 percent of all Oregon operators from June 2003 to April 2004. That's more than 500 people in 30 classes in nine months. Students had to take my eight-hour class on UST regulations, including lessons in administrative rules, financial responsibility, enforcement, leak detection, spill and overfill prevention, corrosion protection, suspected releases, and other applicable codes. Eight hours bought them a full-day lecture, a reference guide, two quizzes, multiple classroom exercises, and a certificate of completion.

Welcome Ladies and Gentlemen

When a large number of people are forced to take a class in a topic many of them have been working in for years, you learn some interesting things. Some thought they knew enough to get by. Some didn't know where to begin. Some simply didn't want to burn up eight hours in a classroom. One day last summer at a class, an older gentleman crossed his arms and said loudly, "I've been pumping gas for 45 years and I'll be damned if I'm gonna sit here and let some pissant kid tell me how to pump gas." Needless to say, he needed some convincing on the value of the day that lay ahead.

Provided below are my personal observations of the great Oregon UST operator training experiment. It's nothing scientific, but it is based on talking to hundreds of operators, fielding more than a thousand questions, chatting with area service providers, and reading several hundred class quizzes and feedback forms. Because it is the only training summary of its kind to date, I thought the readers might find these

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■ **Mandatory Training** *from page 27*

reflections useful if they decide to bring a comprehensive training package to other states.

■ **The need to upgrade the operator** Nearly everyone I talked to had an automatic tank gauge, a number of operators knew it did a test, but on average they didn't know much more. Items like keeping the tank full enough to get a valid test, 12 months of record history, responding to invalid tests, proving third-party certification, and periodic maintenance and calibration seemed like novel topics of discussions.

■ **Tanks 101: C+** I found the average attendee had a fundamental grasp on tank system basics. They knew they had certain alarm capabilities. They knew they had a tank "computer" that did something or other. They generally knew whether they had steel or fiberglass systems. What they didn't know was how to organize all these UST rules into one manageable bundle. One student commented, "I wish this class had been available years ago."

■ **What did they know?** Virtually everyone with pressurized line had line leak detectors (or so they claimed). A decent number of operators knew they needed an annual line tightness test and line leak detector function test, but I wasn't so sure these tests were widely done each and every year. Many with double-walled pipes didn't know about the importance of keeping containment sumps clean and free of liquid. When I asked what certain alarms meant, I was met with plenty of blank stares.

■ **Old news to some** A few large companies already had progressive recordkeeping and training programs in place. For example, ConocoPhillips in particular has an excellent record-tracking system to which all of its dealers must adhere. These students tended to understand the more in-depth requirements and asked more complex compliance questions during class.

■ **A pleasant surprise** When surveyed, the majority of students found the class relevant and useful. That surprised me, given that nearly everyone who took the class did so against their will. For a population of students who have a grasp on tank-system basics, that tells me there is still much to learn and much that can be learned (especially when taking a class is required).

■ **Side effects** I haven't been able to quantify it, but I think I created a lot of work for service providers doing testing and maintenance in the Northwest. The main grumble I heard at the end of the day was, "Boy, am I due for a checkup." One thing I really encourage operators to do is to set up an annual "tank physical" so their systems can be given a top-to-bottom inspection on a routine basis.

■ **Any value in it?** Operators overwhelmingly felt that the eight-hour course better prepared them for a compliance inspection. I spoke with a few operators who were inspected shortly after the class. They all told me they passed with flying colors. They told me they now understood the equipment, what the inspectors wanted, and how to get into compliance, based on what they were doing wrong when they first came to class.

■ **Did they learn anything?** I gave all students a 10-question multiple-choice quiz on basic UST rules before each class. The average score coming into the class cold was 50 percent. I gave the same quiz at the end of the day. The average score jumped up to 90 percent. That tells me that people were paying attention and showed improvement on their comprehension of basic UST rules.

Ready for Inspection

DEQ inspectors have told me they have seen a noticeable increase in preparedness for compliance inspections. That might be an obvious conclusion, since the owner must now, by law, designate an operator to handle UST matters, but the inspectors are thrilled nonetheless. The more ready an operator is, the quicker the compliance inspection and, hopefully, the fewer the violations to follow up on.

So now that the deadline has passed, what's the compliance rate for training? Not bad. DEQ estimates that more than 80 percent of the UST systems in Oregon now have designated, trained operators. Officials say it might be more like 90 percent because they are still receiving verifications around the state. That's impressive given the state didn't enforce the requirement but rather encouraged people to get trained using the state's normal outreach channels.

And what about the cranky old fellow who didn't want me telling him what to do? Over the course of the day, a slow transformation occurred. He eventually quit glaring at me, uncrossed his arms, picked up his pen, and started taking notes. Soon he was asking questions. By the end of the day he was smiling and joking. As he was leaving, he approached me and agreed, almost seemingly against his better judgment, that the course has been worth his while. He said he had to get back to the station to make himself a recordkeeping binder for the next inspection. ■

Ben Thomas ran the Alaska UST leak-prevention program from 1995 to 2002. He now has a consulting and training business in Washington State. For more information on the Oregon program, go to www.bentanks.com/oregon.htm, *or e-mail Ben at* mail@bentanks.com.

New Regulations Change UST Operation in California

In California, new regulations were recently adopted that will change the way UST systems are operated. The regulations, mandated by California's legislature, will require UST owners, operators, installers, service technicians, and inspectors to meet minimum industry-established training criteria. Additionally, a new "red tag" enforcement tool has been adopted to help address significant violations and recalcitrant owners.

Training and Certification

California has required manufacturer training and state licensing of UST installation contractors and service technicians for several years. New regulations enhance this program by requiring an additional certification exam for these individuals. The certification exams are developed and administered by the International Code Council (ICC), a non-profit organization with vast experience in developing codes (e.g., fire, building, electrical) and testing individuals for their knowledge of those codes. ICC followed recognized test-development procedures and worked closely with a group of industry experts to create the certification exams.

Beginning January 1, 2005, every UST facility must have a "Designated UST Operator" who is certified by passing the ICC "California UST System Operator" exam. Service technicians have until July 1, 2005 to obtain certification.

The Designated UST Operator must conduct monthly visual inspections of the UST facility and provide on-the-job training annually to all other facility employees. The regulations were designed to minimize the impact on UST owners by requiring only one individual to be certified, while the remainder of facility employees are required only to attend a simple on-the-job training provided annually by the certified individual.

Any individual can serve as a Designated UST Operator as long as he or she possesses a current ICC California UST System Operator certificate. Because there is no regulation specifying who can serve as a Designated UST Operator, UST owners have several options available to satisfy the requirement. Owners may:

- choose to become their own Designated UST Operator,
- have one individual serve as the Designated UST Operator for several facilities, or
- contract out with a service company that will provide a certified individual to serve as a Designated UST Operator.

This requirement places a minimal burden on UST owners yet ensures that each UST facility will be inspected monthly by an individual with knowledge of UST laws and management practices.

For more information on California's new UST training and certification requirements, visit the California State Water Resources Control Board's UST Program Web site at *http://www.swrcb.ca.gov/ust/training/new_trng_reqmts.html.*

Red-Tag Regulations

On June 13, 2004, California adopted regulations allowing inspectors to prohibit fuel delivery by affixing a red tag to the fill pipe of any UST system system found to have one or more "significant violations." The term "significant violation" means the failure of a person to comply with any requirement of Chapter 6.7 of the Health and Safety Code or any regulation adopted pursuant to Chapter 6.7 that involves any of the following:

- Violation(s) that cause or threaten to cause a liquid release
- Violation(s) that impair an UST system's ability to detect a liquid leak or contain a liquid release
- Chronic or recalcitrant violators

If the significant violation poses an imminent threat to human health, safety, or the environment, the inspector may affix the red tag immediately upon discovery of the violation. If the significant violation does not pose such a threat, the inspector must first notify the owner or operator, giving the owner or operator seven days to correct the violation before a red tag may be affixed to the fill pipe.

After the owner or operator of a red-tagged UST system corrects the violation and notifies the inspector, the inspector must re-inspect the UST system within five days to determine whether it continues to be in significant violation. If the inspector determines that the significant violation has been corrected, the red tag must be removed immediately.

If fuel is delivered to a red-tagged UST system, California state law allows enforcement action to be taken against the UST owner, the UST operator, and/or the person who delivered the fuel. State law also prohibits tampering with a red tag. In addition, state law prohibits the removal of a red tag by an owner or operator unless the violation has been corrected and the regulatory agency has given written authorization to the owner or operator for removal.

Civil penalties of up to $5,000 per day for violation of the above red-tag requirement may be assessed by the regulatory agencies. For more information, contact Leslie J. Alford at 916-341-5810 or email her at *alfordl@swrcb.ca.gov.* ■

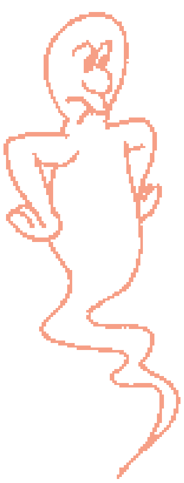
Sugar? Cream? MtBE?

It's Time to Close the Gap Between Water Supply and UST Programs

by Kara Sergeant

I don't drink coffee on a regular basis, but I do know that the last thing you want in your coffee is a splash of MtBE. Yet this is exactly what was occurring at a Dunkin' Donuts operated in conjunction with a Mobil gasoline station in Rutland, Massachusetts. The discovery of 2,200 ppb MtBE in the facility's well in February opened the eyes of environmental regulators and industry to the potential for other such cases of public drinking water contamination. Officials do not know how long the well has been contaminated.

The well was identified during a larger investigation of food service establishments located near hazardous waste facilities to make sure the establishments have the necessary permits. State officials discovered that the Dunkin' Donuts had been operating at the gas station for two years without having obtained a water supply permit from the state.



The facility is classified as a transient non-community (TNC) public water supply, because its well provides water to more than 25 people at least 60 days a year. Other examples of TNCs include restaurants, motels, and rest stops. TNCs are required to meet federal and state regulations, which in Massachusetts include enforcing a 100-foot protective radius around the well and sending monitoring reports to the state.

The 2,200 ppb MtBE level exceeds the state's guideline level of 70 ppb. The facility owner also did not maintain a protective zone around the well. The Dunkin' Donuts was immediately shut down, and local private wells were tested for contamination. One home adjacent to the station had trace amounts of MtBE.

The facility owner hired a licensed site professional to perform preliminary tests on the site, including a soil-gas survey, borings, monitoring wells, and tank-tightness tests, including spill bucket and dispensers checks. Although MtBE was detected, the source was not located. All USTs tested tight, and there was no apparent upgradient source. The state is waiting for the consultant to submit the findings of the site assessments, at which time the state will propose Immediate Response Action plans (the next step required by DEP). Dunkin' Donuts, based in Randolph, Massachusetts, has cooperated fully with the state's investigation.

It is important to realize that this is a water supply issue. In most cases a business may operate a food establishment in conjunction with a gas station even if it has onsite wells, but it must be registered with the appropriate state authorities so that public health can be adequately protected.

The good news is that some states are working to improve communication between the UST/LUST and drinking water programs. The New England Interstate Water Pollution Control Commission (NEIWPCC) held a meeting with New England and New York state and federal program staff in May to discuss ways to improve the partnerships between the programs in an effort to better protect drinking water supplies.

The Dunkin' Donuts case was one of the issues that came up at the meeting. As a result, several states are attempting to identify food establishments located in conjunction with gasoline stations. One idea states had was for UST inspectors to note on their inspection form if a food service, such as a convenience store or coffee service, is present on the site and to pass this information along to their drinking water counterparts. Inspectors could even go so far as to ask operators if they know if they're hooked up to the municipal system or whether they have an onsite well. Also, industry representatives should determine the source of drinking water at their sites and check with their state drinking water program to see what regulations apply. ■

Kara Sergeant is an Environmental Analyst with the New England Interstate Water Pollution Control Commission, which publishes LUSTLine. *She can be reached at* ksergeant@neiwpcc.org.

■ Tracking Vapor Releases in NH

from page 16

might lead to information on measures that can be taken—apart from national or state policy decisions on fuel content—to mitigate vapor releases. For example, research on Stage II systems should be encouraged and information made available that compares the amount of pressurization caused by the various Stage II systems. Stage II system designs should be evaluated to determine whether equipment changes can be made that would allow a reduction in air-to-liquid ratios and increase onboard refueling vapor-recovery (ORVR) compatibility with Stage II systems. Finally, new methods of vapor-release detection should be developed and implemented.■

Gary Lynn is the Petroleum Remediation Section Manager of the State of New Hampshire. He can be contacted at glynn@des.state.nh.us.

Field Notes

from Robert N. Renkes, Executive Vice President, Petroleum Equipment Institute

MAKING A LIST—CHECKING IT TWICE

The new and upgraded underground storage tank systems currently in the ground are made up of a complex collection of mechanical and electronic devices that can fail under certain circumstances. Although tank system failures are uncommon, almost all can be prevented or quickly detected as long as the systems are properly operated and continuously maintained.

The Petroleum Equipment Institute's (PEI's) Board of Directors believes regular, periodic equipment inspections will save UST owners/operators a considerable amount of money over time by (a) preventing leaks and spills; (b) discovering small problems before they become large ones; (c) promoting good operation and maintenance practices; (d) extending the overall life of UST systems; and (e) avoiding fines, penalties, and enforcement action.

PEI recognizes that inspection checklists designed to organize and identify proper UST system operations and maintenance procedures are not available to all tank owners and has initiated a project to draft such a document. The association has begun the process of collecting inspection and maintenance checklists from state UST regulators, equipment manufacturers, and tank owners.

Once a representative sample has been received, PEI's Tank Installation Committee will publish a recommended checklist that will be available to anyone that might benefit from it, such as tank owners, regulators, and UST service companies. PEI envisions that the list will include recommended frequencies for inspecting and/or testing the following equipment: tanks, piping, tank and line leak-detection systems, monitoring wells, dispenser sumps, vent lines, spill buckets, cathodic protection, and flex connectors.

PEI hopes to make its checklist available in October. If you have a checklist that you are willing to share with the PEI Tank Installation Committee, please mail it to Bob Renkes, P.O. Box 2380, Tulsa, Oklahoma 74101 or e-mail it to *rrenkes@pei.org*. If you are interested in receiving the PEI Checklist when it becomes available in October, contact Bob Renkes at the address above. ■

EPA Grants Awarded to Petroleum Brownfields Sites

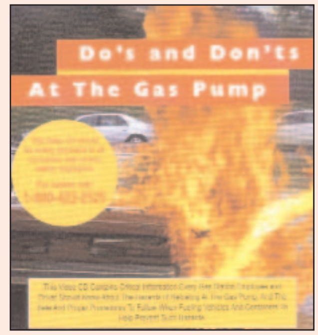
Of the $75 million in Brownfields grants announced on June 15, $23.1 million, or 25 percent, will be used to address petroleum brownfields. These grants were awarded to 111 entities and include 88 assessment grants, 22 cleanup grants, and six revolving loan fund grants. The $23.1 million for petroleum Brownfields grants will demonstrate that petroleum-contaminated properties, such as abandoned gas stations, can be successfully and profitably cleaned up and reused.

A number of state UST programs applied for available Brownfields funds for petroleum sites this year. The four state UST programs to receive petroleum assessment grants are: the Michigan Department of Environmental Quality ($200,000), the Missouri Department of Natural Resources ($200,000), the South Carolina Department of Health and Environmental Control ($25,000), and the Utah Department of Environmental Quality ($200,000). For more information see, *http://www.epa.gov/brownfields/archive/pilot_arch.htm.* ■

Hear Ye, Hear Ye, L.U.S.T.LINE's Online!

...and the photos are in color too. Go to *www.neiwpcc.org/lustline.htm*. The LUSTLine Index is online too—just click on "LUSTLine Index".

New CD on Refueling Safety Available



OPW and the North American Nozzles Manufacturers have initiated a refueling awareness program to inform and educate the public about the hazards of refueling vehicles. The program is a cooperative effort among OPW, Husky, Catlow, Emco Wheaton, and other nozzle manufacturers in the United States.

Changes to fuel-dispensing products initiated by this group include:

- New Hose Warning Tags for every hose point to warn of the hazards of refueling
- Permanent warnings printed on the nozzle covers
- Prepay-style nozzles per NFPA 30A and the Uniform Fire Code
- Flowlock nozzles
- *Do's and Don'ts At The Gas Pump* – video in CD-mpeg format

The free video has essential information for customers as well as service station employees. It can be copied or downloaded from the OPW Web site at www.opw-fc.com and can be viewed on most computers with CD readers. For more information, call 1-800-422-2525. ■

L.U.S.T.LINE

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