New England Interstate Water Pollution Control Commission 01852-1124
116 John Street
Lowell, Massachusetts
www.neiwpcc.org/lustline.htm

Bulletin 51
December
2005

L.U.S.T.LINE

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

Tanks in the Wake...

A Postmortem of Katrina, Rita, Wilma

by Ellen Frye

When disaster strikes. When devastation rules and lives are tossed and lost to the ravages of wind and water. When your world's gone topsy-turvy and you cast about to recapture...something. When a container of 6,000 tons of frozen chicken parts is washed from ship to shore, destroying everything in its path until it rests in a residential neighborhood and sits...in the heat...for weeks...before it is cleared away. When flies feast on all manner of rot and darken the sky at the slightest disturbance. When water and wastewater systems sit choked, interrupted, and indifferent. When oils, metals, industrial compounds, petrochemicals, pesticides, and other glop coat the landscape. When moonlight is the sole relief in the blackness of night. When cars are on top of houses, and refrigerators are perched in trees, and Dr. Seuss is nowhere to be found. When surreal is real...what can we say about USTs?

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First Impressions

We have all seen the pictures of the devastation wrought by Hurricanes Katrina, Rita, and Wilma on the Gulf Coast states. In the hardest-hit areas, few aboveground structures survived the 20- to 30-foot storm surge and the 140-mile-an-hour winds. Convenience stores, pump-island canopies, and fuel dispensers were no exception.

"It was like a bomb hit the area…mainly from the water surge," says John Cernero, U.S. EPA Region 6 UST/LUST program manager, who assisted the Louisiana Department of Environmental Quality (LDEQ) inspectors and a team of inspectors from U.S. EPA regional offices in conducting inspections to determine UST system damage and operability. "Some former UST facilities were nothing but mud flats. Some were just twisted rubble. So much rusted immediately because of the salt water."

"There was much more than I could have anticipated," sighs David Bernstein, U.S. EPA Region 2, who headed up the EPA inspection team. "Did you know that fiberglass sump covers float, unless they are bolted down? Do you know how hard it is to conduct an inspection when a facility is under a foot of mud?" He recalls the smell of putrefying convenience store food, and the exposed sumps acting as booby traps for unsuspecting inspectors. "It's hard to tell if some owners will come back since some areas are not repopulated yet," he says. "Some, I suspect, will not return."

Photo courtesy of David Bernstein

Mud, mud everywhere, and not a sump…

A huge pile of debris was deposited at the dispenser islands of this store.

So I guess we can say that if we didn't already have a sufficient appreciation for the power of water, most people, including tank owners, operators, and regulators, do now. I guess we could say that the lion's share of gasoline sloshing around the post-Hurricane Katrina/Rita floodwaters in the New Orleans area probably came from flooded automobiles and not so much from USTs. At some UST facilities in the affected areas, the tanks stayed put, while everything aboveground was swept away.

Like so many other things aboveground, ASTs did not fare so well. Large field-erected and shop-fabricated ASTs can be quite vulnerable under certain storm conditions. Some of the large aboveground crude oil tanks and petroleum barge terminals in the affected areas along the Gulf Coast had significant releases. (On September 15, the Natural Resources Defense Council reported that nearly six million gallons of oil were pouring out of seven pipelines and coastal storage tanks ruptured by Hurricane Katrina.)

So how did the fuel systems and associated structures fare, especially in the zone near the coast? As Charles Harp, Tanks Section Environmental Manager for the Florida Department of Environmental Protection's (FLDEP's) Northwest District (the Panhandle), points out, we need to keep in mind that there are three types

L.U.S.T.Line

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LUSTLine is a product of the New England Interstate Water Pollution Control Commission (NEIWPCC). It is produced through a cooperative agreement (#T-830380-01) between NEIWPCC and the U.S. Environmental Protection Agency.

LUSTLine is issued as a communication service for the Subtitle I RCRA Hazardous & Solid Waste Amendments rule promulgation process.

LUSTLine is produced to promote information exchange on UST/LUST issues. The opinions and information stated herein are those of the authors and do not necessarily reflect the opinions of NEIWPCC.

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NEIWPCC was established by an Act of Congress in 1947 and remains the oldest agency in the Northeast United States concerned with coordination of the multimedia environmental activities of the states of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

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LUSTLine is printed on Recycled Paper

of hurricane-damage scenarios: rainfall flooding, storm surges—flooding with enormous wind and water energy—and wind. Depending on where they were located, UST facilities ran the gamut. Harp has the many storms that pummeled the Panhandle etched firmly in his memory.

USTs in Mississippi?

According to Kevin Henderson, Mississippi Department of Environmental Quality (MDEQ), and as also described by inspectors in Louisiana, most convenience stores and canopies in coastal areas subject to storm surges were wiped out. "Some had nothing to mark the place where they'd been except the store's foundation slab and the pump island," says Henderson. "Canopies were reduced to twisted steel columns and jumbled aluminum panels. Only a few fueling dispensers were left standing. The destruction was complete."


Quick Mart, Biloxi. Store after the storm. Only one tank could be accessed here due to the sand/debris covering the parking lot.

Henderson reports that although there were some big releases from ASTs, by and large the USTs survived intact, even though the external pressures they were subjected to from the storm surge exceeded their design pressure. "As long as the fill and tank gauge caps were tight, little water got into the tanks and the fuel seems to have stayed put."

With all the rain and flooding, UST inspection teams in Mississippi and Louisiana were not reporting instances where underground tanks floated out. Apparently, tanks were adequately anchored and stayed in place despite the likelihood that they were fairly empty due to a high demand for fuel.


Here we've got proper anchoring and resultant shearing…and lots of beer!

Many of the shear valves did not properly shear. A number of piping systems were damaged and left open to the environment as a result of inadequate shear valve anchoring. This failure of shear valves to shear was a common finding in Louisiana as well. (See "Did the Shear Valves Shear?" on page 7.)

"Many dispenser cabinets that were poorly anchored were knocked down," says Henderson. "The four bolts that typically anchor the cabinets are not nearly enough to properly anchor them. Although nothing would have saved many of the dispensers, it is apparent that they were too easily knocked down. High winds brought down some dispensers with apparent ease.

"Vent lines should be all metal or otherwise anchored at the transition from aboveground to underground. Only at those facilities where the vent lines were broken at or near the surface was there any real problem with water intrusion into the tanks. If vent lines are nonmentallic underground and then transition to metal aboveground, they have a tendency to break off right at or just below ground level when they are in the soil. If they are in concrete, this is usually not a problem."

With regard to tank-top fittings, Henderson says that as long as there was a "decent" cap and it had a gasket on it, the tanks generally did not take on any water. It seems as though the hydraulic pressure of the water on top of the tanks acted to seal the caps tightly. "We have seen very little water in any of the submerged tanks where the vent lines were standing and they had decent caps on the tank risers," says Henderson. "A few tanks lost their caps entirely, presumably because they were not 'decent' caps to begin with…or someone removed them.

"A number of tank beds were apparently scoured out, at least partially, although we know of only three or four where evidence of this can been seen at the surface," says Henderson. "I don't know what can be done about this other than to require paved coverings (maybe even sheet pilings of the tank excavation walls or some kind of vault in very vulnerable locations)."

Kevin Henderson photographically documented his inspections. All of the photographs in this article, except for two, were taken by him. He has graciously provided us with a PowerPoint® presentation that can be viewed on NEIWPCC's website at *www.neiwpcc.org.*

USTs in Louisiana

While many coastal tank facilities in Louisiana suffered damage similar to that in Mississippi, the New Orleans area experienced additional problems as a result of prolonged flooding. Recognizing that an enormous amount of work would be needed to get systems back in operation

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"Typical" debris field in the parking lot of the store made inspection of the tank system difficult.

This fill port of a "regular unleaded" tank was uncovered, and the tank was found to be full of water when gauged by MDEQ personnel.

■ **Tanks in the Wake** *from page 3*

(e.g., tightness testing and replacing lines and electrical systems) and that the speedy return of UST facilities to normal operation was crucial to the recovery effort, the LDEQ issued two documents, a portion of an Emergency Declaration pertaining to USTs and a *Plan for Evaluating Underground Storage Tank Sites Impacted by Hurricane Katrina* (*www.deq.state.la.us*).

The Emergency Declaration "suspends provisions contained in the UST regulations that owners/operators may not have been able to comply with due to the storm and its subsequent flooding. It also provides for continuing coverage by the Motor Fuels Underground Storage Tank Trust Fund, with no additional deductibles that might have attached to a claim for reimbursement should the owner/operator not have been able to comply with the regulations due to storm conditions. "

The sites flooded by the hurricane had to be evaluated to determine the response actions necessary to place UST facilities back into service and protect human health and the environment. The UST evaluation plan contains "the expedited process that tank owners/operators must follow before bringing an UST system back on line. The process describes the steps owners and operators must take to bring the UST safely on line without having to wait until precision tank and line tightness tests can be performed."

LDEQ inspectors initially surveyed affected UST areas for obvious signs of releases (e.g., sheens). With the overwhelming need to get UST facilities back into operation, help was needed. The U.S. EPA UST inspection team was charged with determining operability. "These were not 'compliance' inspections," explains John Cernero. "They were conducted to determine whether an UST system could be placed back into operation without further testing (e.g., line/tank tightness testing) on a temporary basis. If the UST could be placed in operation, the owner/operator was required to at least conduct inventory control." The team completed more than 900 facility evaluations.

"We developed an inspection routine to determine the degree of damage caused by Hurricane Katrina to the affected parishes as it related to environmental and operational concerns," explains David Bernstein.

"For example, water in an UST would be considered an environmental concern, due to questions as to how the water got into the tank and the proper disposal of water after it was removed from the tank. An operational concern might be the condition of an ATG system damaged by water at a flooded facility. While a nonoperational ATG might not be an immediate environmental concern, it will have to be repaired/replaced at some point for the facility to meet release-detection requirements.

"Basically, the inspectors performed all the physical aspects of a UST inspection, allowing for LDEQ follow-up work, in most cases, to be completed by a request for documents," says Bernstein. "The facilities were checked for whether shear valves operated correctly, condition of release-detection equipment, levels of water and/or product in tanks and groundwater monitoring wells, cathodic-protection equipment such as rectifiers, damaged vent lines, damaged sumps, spill buckets, electrical wiring, tank floatation, free product, dispensers, and general overall damage to the facility."

Water in All the Wrong Places!

I asked David Bernstein, who spent a month in Louisiana conducting these inspections, and Scott Hoskins, U.S. EPA Region 4, who may still be racking up time in Louisiana for all I know, what they thought were the biggest tank problems. What stood out most in their minds (besides shear valve issues) was that, due to flooding, storm surges, and high lev-

Cap gone from tank fill allowing four-inch riser to become filled with sand and debris during storm surge. This tank was found to be completely full of water with nine inches of sand/debris in the bottom.

els of rain, many tanks were found to contain water, with water levels ranging from a few inches to completely full. The water had entered the tanks through vent pipes and loose or missing fill caps and bung holes.

LDEQ will have the job of tracking the disposal of this contaminated water by requesting copies of manifest documents that detail where the pumped water was disposed of after removal. Because of the large amount of contaminated water that must be disposed of, at high cost to the owner, follow-up to ensure proper disposal is essential for preventing adverse impacts to the environment.

The sheer volume of UST system equipment destroyed by the hurricane and ensuing floodwaters also struck Bernstein and Hoskins—hundreds of dispensers, ATG systems, impressed current rectifiers, and other electronic equipment. "A great deal of follow-up work will be needed to make sure that these systems are properly replaced," says Bernstein. "On at least two occasions, I witnessed a facility owner attempting to put a product dispenser back into service although it had been completely underwater."

"Many owners have told me that they didn't realize that they would have to do tank-tightness tests," remarks Hoskins. The *Plan for Evaluating Underground Storage Tank Sites Impacted by Hurricane Katrina* specifically states that a flooded system that is determined to be suitable for receiving product may be put back into service, but that it should have an integrity test performed as soon as contractors and services become available to perform the testing and no later than six months after product was first placed into the tank after flooding.

Where's the Fuel When You Need It?

Further east, in Florida, where hurricanes are no stranger, people in parts of the state are still smarting from September 2004's Hurricane Ivan, when water surges were powerful enough to move four multi-million-gallon ASTs off their foundations and devastate support buildings. (Yes, Virginia, gigantic aboveground bulk-storage tanks move, particularly if they don't have enough ballast.) During Hurricane Ivan, the state had a significant loss in bulk-storage capacity for fuel distribution—tank farms were lost and docks couldn't receive fuel. In 2005, after Hurricane Dennis in Florida, and shortly after Rita and Katrina, about one-third of the nation's refinery capacity was out of service.

As Marshall Mott-Smith, Administrator of FLDEP's Storage Tank Program explains, oil companies must perform a ballast balancing act, trying to keep fuel in the bulk-storage tanks and at the same time keep the fuel supply moving out to where it needs to be. As Mott-Smith reminds us, all USTs get their fuel from ASTs. Because of what happened during Ivan, this year's storms have fueled concerns about fuel supplies—an issue before, during, and after storm-related evacuations in any coastal area. Images of streams of vehicles creeping along on major evacuation routes in Texas, Louisiana, Mississippi, and Florida during Katrina and Rita attest to the seriousness of this issue.

In many of the hardest-hit areas of the Gulf Coast, U.S. EPA waived certain requirements in order to facilitate the transport and distribution of fuel needed to get the economy and infrastructure up and running. Emergency gasoline stations were permitted for 30 days, for example, without having to worry about issues such as vapor recovery from the pumps. Skid tanks, tank trucks, and even trucks holding 55-gallon drums of fuel were permitted (or not) on an emergency basis.

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This tanker was set up as a temporary fueling station for emergency vehicles during the fuel crisis that followed the storm.

■ Tanks in the Wake *from page 5*

Charles Harp and Marshall Mott-Smith can rattle off the names of hurricanes and associated damage like devoted scholars. They report that, generally, during Ivan, Wilma, Jean, and Francis, USTs suffered canopy and dispenser damage but had few problems with shear valves or floating tanks or water in tanks (just in sumps), because most of the damage was wind related. But fuel availability was the most serious issue, whether it was because ASTs and USTs were empty due to peak demand, because the fuel supply network was disrupted, or because gasoline was stored in tanks but there was no electricity available to operate the fuel pumps.

The Florida Legislature is proposing a new law that will require tank owners and operators to have emergency electric power backup, such as generators or electric pumps powered by portable generators. “Our department is purchasing 30 portable electric fuel pumps that can be powered by 12-volt car batteries,” says Mott-Smith. “Although they are designed for use on aboveground tanks, we have had them adapted for use on underground tanks. Flow rates are 10 to 12 gallons per minute, and we have acquired in-line meters for quantifying the fuel dispensed. The pumps will be used for Dade, Broward, and Palm Beach County government fleet management or other essential government services operations that have underground tanks, but no electric power to run their fuel dispensers”

The ASTs at this Munroe Barge Terminal in Biloxi floated off their footings. A release of 482,000 gallons of fuel occurred, but no evidence of this fuel was ever seen (presumed “lost” out to sea). The three tanks that floated up against the larger tanks are 75,000-gallon gasoline tanks.

This older installation was completely demolished.

When It’s All Said and Done…

According to a November 29, 2005 press release from the National Oceanic and Atmospheric Administration: “The 2005 Atlantic hurricane season was the busiest on record and extends the active hurricane cycle that began in 1995—a trend likely to continue for years to come. The season included 26 named storms, including 13 hurricanes [14 now with Epsilon] in which seven were major (Category 3 or higher).”

On that happy note, let’s just say we should improve what we can improve and accept that which we cannot change, such as natural forces that will have their way come hell or high water. If shear valves are working properly, then damage to an UST system will be that much less. If caps are on tight, then water might not enter the tank itself. If tanks have anchor straps and ballast, then they probably won’t float. The issues are bigger than our little old storage tanks. We’ve just got to do the best we can. In the next issue of *LUSTLine*, David Bernstein will provide additional information on the results of U.S. EPA’s 900-plus inspections and tips they discovered about performing inspections in a topsy-turvy world. ■

A boat in the wrong place.

Photo courtesy of David Bernstein

Did the Shear Valves *Shear?*

by Marcel Moreau

Kevin Henderson of the Mississippi Department of Environmental Quality had the job of assessing the damage caused by Hurricane Katrina to some of Mississippi's hardest-hit fueling facilities. He took the photographs in this article (and many others) to document the damage. I spoke with Kevin to find out what he observed regarding the condition of UST system dispenser shear valves. The following discussion reflects observations made by investigators in areas of Louisiana.

M. *Your pictures show that most dispensers were knocked over by forces of wind and water. Did the shear valves shear?*

K. We found many instances where the shear valves (a.k.a. crash valves, impact valves, or fire valves) did not shear off, and some instances where the valve mechanism did not close or only partially closed, even when dispensers had been swept clean away. In a number of cases where the shear valves did not separate, the flex connectors beneath the shear valves were stretched and pulled out of the ground because the shear valves' connection to the dispenser island did not hold. (See Figure 1.)

FIGURE 1. *This trio of shear valves did not function as designed. The valve body did not separate at the shear joint because the valves, along with their anchoring bar, were pulled up and out of the dispenser island.*

M. *What do you think happened to cause the shear valves not to separate?*

K. A shear valve is designed to operate when shear forces (forces acting perpendicular to the axis of the valve) affect the top part of the valve above the shear joint relative to the bottom part of the valve below the shear joint. (See Figure 2.) Shear forces are the kinds of forces involved when a vehicle rams into a dispenser. The wind and maybe water forces that tipped over these dispensers caused more of a tensional (stretching) force to be exerted on the shear valves as the dispenser cabinets tipped over. As a result, rather than the shear joints separating, they held and the piping was uprooted from the ground.

M. *Were the shear joints properly anchored?*

K. By and large they were solidly anchored, but again, they were anchored to resist shear forces. The tensional forces they experienced caused some of them to slide up and out of the clamps that were supposed to hold them in place. In some cases, the steel anchor bar to which the shear valves were attached failed to hold and was torn out of the dispenser island. (See Figure 1.) This is what generally occurred when multiple shear valves were attached to a single anchor bar that ran the length of the dispenser island opening. In cases where there were single shear valves anchored to individual anchor bars running across the short axis of the dispenser island opening, the anchoring mechanism seemed to hold better. (See Figure 2.)

Photos courtesy of Kevin Henderson

FIGURE 2. *This pair of shear valves functioned as designed. The valve mechanisms closed completely and the bottom part of the valves remains solidly anchored to the dispenser island. The top part of the valves, along with the entire dispenser, has been blown away.*

M. *If another storm of Katrina's intensity were to threaten Mississippi in the future, do you have any recommendations for what UST system owners might do to prepare for the worst?*

K. I'd suggest tripping all the shear valves by hand as a good precautionary measure to take as you are shutting down the station. There's nothing short of removing a dispenser to high ground that would save it from a storm of this magnitude, but if you could find a qualified technician in time, you might consider disconnecting the unions that connect the dispenser to the underground piping. That way, the dispenser could get blown away without disturbing the underground piping, which might simplify the job of returning to business afterwards. Of course, with a storm of this magnitude, it's going to be a long time before anything returns to normal anyway. ■

The Case of the Buckled Steel Tanks on Mississippi Highway 90

by Kevin Henderson

It was a Kangaroo convenience store owned by The Pantry, Inc., located on the north side of Highway 90, which runs parallel to the Gulf Coast in Biloxi, Mississippi—practically on the beach. The facility had three 12,000-gallon sti-P3® tanks, which were installed in 1994. The tanks were buried approximately six feet deep, anchored with deadmen, and paved over with an eight-inch-thick reinforced-concrete pad. The store building was completely destroyed by the 30-foot storm surge of Hurricane Katrina. The dispenser cabinets were recovered from the storm rubble as far away as a quarter mile from the store. The concrete pad over the tanks was slightly sunken and buckled, apparently due to scouring of the backfill materials underneath the pad during the storm surge. Strangely, the tank vent lines were left standing, although they were leaning so that the tops of the vents were approximately 10 feet above ground level.

A few days after the storm passed, the owner observed fuel seeping up between the cracks in the concrete pad of the store parking lot and flowing onto Highway 90. Observing the site conditions, we surmised that the regular tank must have somehow rolled or rotated—the tank risers were out of alignment with the manway openings in the concrete pad. Since the tank was steel we didn't believe it was buckled; we thought the tank risers could have been broken out of the nylon bushings at the top of the tank, serving as the source of the fuel we were seeing at the surface.

When we stuck the tanks, we observed the following:

- The diesel tank had about 50 inches of fuel in it with 10 inches of water.
- The premium tank was completely full of water/fuel (mostly water).
- We couldn't get a gauging stick in any of the regular tank risers (lending credence to our belief that the tank risers were broken out of the tank-top bungs).

The store was shut down at midnight on the day before the storm made landfall in the early morning hours of August 29, 2005. The owner reported that the following inventory was in the tanks at the time the store was closed: regular – 5,650 gallons; premium – 4,000 gallons; diesel – 3,760 gallons. A delivery of 3,000 gallons was made to the regular tank on the day the store was closed down.

The regular tank was the last to be removed and with great difficulty, as water infiltration could not be stopped for quite some time and the tank had approximately 18 inches of sand in it. The end-cap weld seams—the entry points for the persistent water infiltration—were busted open along the top quadrant of each end of the tank. (See photo below.) Once the end caps of the regualar and premium tanks were removed, it could be seen that the tank manufacturer had installed a vertical brace in the center of each tank. These vertical braces probably prevented the tanks from being buckled much worse than they were.

The regular tank buckled and its end caps ruptured.

After responding to the fuel seepage, the owner made the decision to permanently close the tanks. Due to several logistical concerns, the tank removal did not begin until October 19, 2005. The premium tank, which was in the middle, was removed first. The tank was buckled along its entire length and one of the end caps was buckled. Although the tank was badly buckled, there were no breaches in the wall and no fuel was lost. The diesel tank was removed next and was not damaged.

So What Happened?

What caused these three tanks to behave so differently given that they were all exposed to the same 30-foot storm surge? While an engineering analysis has not been conducted, consider the following scenario: The 30-foot storm surge rapidly inundated the tanks and tank vent lines. The 30-foot water column exerted a force of around 15 psi at the top of the tanks. Was the weight of the water, combined with the six-foot burial depth, enough to buckle the tanks? Apparently not since the diesel tank was unaffected and was perfectly cylindrical.

But what caused the premium and regular tanks to buckle? Since the tank vent lines were submerged, water would have entered the tanks. However, the period of submergence was apparently not great enough to fill the tanks with water. Reports indicate that the storm surge came inland and then receded within two to four hours. It could be that enough water entered the tanks to quickly bring down the temperature of the fuel that was in the tanks. As the fuel cooled, there was a rapid decrease in volume (due to shrinkage). The decrease in fuel volume caused a vacuum to be applied to the tank interior since the vent lines were submerged. The flame arrestors installed on the vent lines apparently did not allow enough water to enter the tanks to compensate for the rapid fuel shrinkage. This vacuum, combined with the weight of the water/backfill on top of the tanks, is apparently what caused the tank buckling. So why did the three tanks behave differently?

The diesel tank likely didn't buckle because no appreciable vacuum was applied to the tank and the temperature of the fuel was probably cool to begin with. The fuel would have been at or near ground temperature as no recent deliveries had been made to the diesel tank. The premium tank may have buckled because a vacuum was applied to it. Gasoline undergoes relatively high shrinkage when it cools, and the premium tank received a delivery not long before the store was shut down.

The regular tank buckled severely and ruptured because a sizable great vacuum was generated within this tank. The store had a high throughput volume of regular gasoline immediately prior to the storm since everyone was filling up his or her vehicle in preparation for evacuation. A delivery was made to the regular tank on the afternoon before the storm hit. It is likely that this fuel was quite warm relative to the seawater that rapidly entered the tank when the storm surge occurred.

So My Working Theory Goes Like This...

The regular tank suffered severe buckling and ruptured, while the premium only buckled somewhat and the diesel did not buckle at all due to the difference in vacuum that was generated as a result of fuel shrinkage.

It is also possible that enough of the backfill material surrounding the regular and premium tanks was scoured out during the storm to allow the buckling to occur. Since the structural strength of USTs is largely dependent on the support of the backfill, any loss of backfill around these tanks could have allowed the buckling. However, no evidence of backfill scouring immediately around the tanks was observed, although it would probably have been difficult to discern since it is likely that any scour would have been refilled as the storm surge receded.

In all likelihood, it was probably a combination of all these things that ultimately led to the demise of these tanks. Hey, what do you think? ■

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Two Washington State USTfields Pilots Receive Phoenix Awards

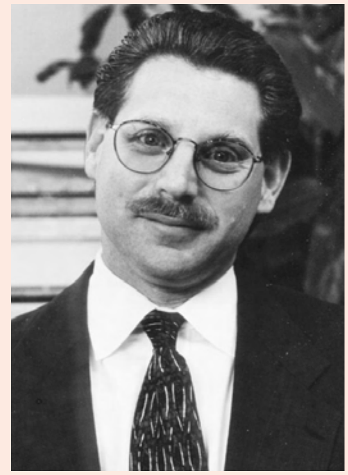
The following Washington USTfields Pilot projects were among the 2005 Phoenix Award winners at the Brownfields Conference in Denver in November:

■ **SEATTLE** – USTfields Pilot funds were used to clean up 100 cubic yards of petroleum-contaminated soil at the former Daley's Dump Truck Service site in a rundown and underserved section of Seattle. This helped prepare the site for its reincarnation as the location of the Dakota, an appealing and much-needed 178-unit affordable, housing development. The development provides not only housing but also jobs and economic benefits for an area of Seattle in need of both.

■ **ROSALIA** – This Community Impact–UST award winner is a shining example of how the cleanup and reuse of an old gas station can revitalize a rural area. Rosalia is a town of about 600 people whose leaders and citizens were determined to clean up an abandoned gas station dating back to 1923 and restore the station building. Funding from the Washington Department of Ecology, Whitman County, U.S. EPA, and private donors enabled the town to remove petroleum contamination at the site, work with the State Historical Preservation Office to restore the old station, and create habitat for native species. Rosalia now has an attractive regional visitor's center that provides information about Rosalia and rural Whitman County and serves as the interpretive center for visitors drawn to the nearby Steptoe Battlefield, a state park listed on the National Register of Historic Places. The center helps draw tourism dollars to rural southeastern Washington. ■

A MESSAGE FROM CLIFF ROTHENSTEIN

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



A Summer To Remember

I'll remember the summer of 2005 for a long time; it gave our country some significant tank-related events that will keep EPA and state tank programs quite busy for the coming months and years. On one front, EPA and states have much work ahead to implement the new underground storage tanks legislation. And on another, EPA and states are supporting the Gulf Coast states as they deal with UST facilities that were in the paths of Hurricanes Katrina and Rita.

New UST Legislation

Over the last few years, Congress considered various pieces of UST legislation. But it was not until summer 2005 that Congress agreed on legislation and sent it to the President. Consequently, on August 8, 2005, President Bush signed the Energy Policy Act of 2005. Title XV of this act created the Underground Storage Tank Compliance Act of 2005, which sets forth amendments to Subtitle I of the Resource Conservation and Recovery Act—the original legislation that created the underground storage tanks program.

This new law significantly affects federal and state tank programs and will require major changes to our programs. Additionally, gas station owners and operators, as well as other nonmarketers who own USTs, will be affected by the changes EPA and states make to their tank programs.

We've always known that preventing releases is an essential part of our program. And now with this legislation's focus on prevention, we will have more tools to make changes to the tank program that will lead to fewer releases from UST systems and help us to better protect America's environment.

Specifically, the new law expands eligible uses of the Leaking Underground Storage Tank Trust Fund, extends the Trust Fund tax through 2011, and mandates new measures to be taken, such as:

- Inspecting tanks every three years
- Developing operator-training requirements
- Prohibiting fuel deliveries at noncompliant UST facilities
- Requiring secondary containment for new and replaced tanks and piping, or financial responsibility for tank installers and manufacturers
- Cleaning up releases that contain oxygenated fuel additives

Some of the requirements must be in place as soon as August 2006, with other requirements effective in subsequent years. EPA has already reached out to the Environmental Council of States, the Association of State and Territorial Solid Waste Management Officials Tanks Subcommittee, and others, and has developed work groups with broad state, regional, and tribal participation.

All of us will face enormous challenges to implement the new provisions of the law. Fortunately, the tank program's history has proven that together we can succeed when we take on new challenges. And I believe that together and in spite of tight deadlines and limited budgets, we will turn our challenges into new opportunities to ensure that our nation's land and water are safe from UST system releases.

Katrina and Rita Are Not Merely Names

Hurricane Katrina devastated America's Gulf Coast in August by obliterating entire communities; damaging thousands of homes, some beyond repair; flooding rural, suburban, and urban areas; and taking the lives of more than 1,000 people. Weeks later, Hurricane Rita rushed ashore, further complicating cleanup and delaying citizens' return to their homes. With the floodwaters receding and initial devastation assessed, state tank programs are now focusing on damage to UST facilities.

I applaud the extraordinary efforts of state and EPA regional tank program staff who are helping in so many ways—assessing the damage, inspecting affected UST facilities, evaluating risks from petroleum contamination, and readying the Gulf Coast's UST facilities to return to use. Additionally, I am grateful to those states with hurricane and flood experience that have graciously shared their knowledge in dealing with UST facilities impacted by severe winds, storm surges, and flood damage. I thank all of you and sincerely appreciate your personal dedication and professional accomplishments in dealing with the aftermath of the devastation from these hurricanes.

The Strength of Our Partnership

States, tribes, local governments, and industry—along with EPA—have so far done a great job of protecting America's environment from UST system releases. And I am certain that our strong partnership will enable us to succeed in conquering the challenges of summer 2005. ■

Okay, Who's on First?

The UST and LUST Aspects of the Energy Policy Act

by Ellen Frye

Title XV of the Energy Policy Act of 2005 created the Underground Storage Tank Compliance Act (USTCA), under Subtitle B, amending Subtitle I of the Resource Conservation and Recovery Act (RCRA)—the original legislation that created the underground storage tanks program. Although Subtitle B does not touch the technical requirements of Subtitle I, it does substantially change the UST program for both U.S. EPA and the states. And the deadlines? Put on your running shoes and FLY. The clock started as of August 8, 2005, when the Act was signed into law. And the funding? Not bad! Will the states ever see it? Don't know.

While many of the provisions of the Act sharpen the fangs of the nation's UST program, some of the provisions are giving state programs unadulterated angst. For example, besides some painfully tight deadlines and an uncertain funding prognosis, the Act seems to suggest that once the new funding regime does kick in, states that do not comply with the UST/LUST requirements ***completely*** *will receive* ***no*** *funding. Yikes! So let's review the essence of USTCA.*

Mandatory UST System Inspections

Section 1523 of USTCA establishes a tiered inspection approach that requires states to conduct on-site inspections of all regulated USTs at three-year intervals. U.S. EPA will need to provide states with guidance that establishes "minimum credible" inspection criteria. For states with inspection backlogs, an initial two-year period is provided to conduct on-site inspections for all facilities not inspected since December 22, 1998. States with resource problems may petition U.S. EPA for an additional year to complete the first three-year cycle. U.S. EPA is also required to conduct a four-year study of compliance assurance programs that could serve as alternatives to the required inspection program.

In a November 2005 memo to the states and EPA regions from EPA OUST Director Cliff Rothenstein, UST programs were urged to focus their inspections on facilities that had USTs in place on or before December 22, 1998 and that have not been inspected since that date. The memo explains: "For inspections conducted in the period from August 8, 2005 to the date of the publication of our guidance, we will consider any on-site inspection as meeting the inspection requirements as long as the inspection is:

- conducted by a state, local (when contracted or delegated by a state), EPA, or certified third-party inspector; and
- sufficient to determine compliance with federal UST requirements in Subtitle I or state requirements that are part of a state UST program EPA has approved under the state program approval procedures."

Operator Training

Section 1524 gives U.S. EPA two years to develop operator-training guidelines, which are to be the basis of state training programs. The guidelines must be specific to three classes of operator personnel responsibilities:

- Employees having primary responsibility for on-site operation and maintenance of UST systems,
- Employees having daily on-site responsibility for the operation and maintenance of UST systems, and
- Daily on-site employees having primary responsibility for addressing emergencies presented by a spill or release from an UST system.

The guidelines must also take into account such considerations as:

- Existing state training programs
- Training programs already being employed by tank owners/operators
- The high turnover rate of tank operators and other personnel
- Improvements in UST equipment technology
- The nature of the business that has an UST
- Training needs for the different classes of operators

States may receive up to $200,000 to develop and implement the requirements. States will enforce compliance with the requirements.

Delivery Prohibition

Section 1527 establishes a prohibition on deliveries, two years following enactment, to tanks that are determined to be ineligible, as defined in guidance developed by EPA, one year following enactment, and in consultation with the states and other parties. A special category of rural- and remote-area tanks is eligible for exemption from the delivery prohibition under certain circumstances. Although earlier versions of the bill included a delivery prohibition roster or tamper-proof tag, this section does **not**. There are provisions for enforcement of the delivery prohibition. U.S. EPA has one year to issue regulations or guidelines to implement this section. Enforcement of the delivery prohibition will begin in two years.

Compliance Reports/Strategies

Section 1526 requires states to report all out-of-compliance USTs owned or operated by the federal, state, and local governments. Also required is an annual public record of regulated USTs that must include the number, sources, and causes of releases; the number of equipment failures; and the record of compliance within the state. States may need to establish active websites for public access.

Section 1529 requires EPA to develop a strategy for UST compliance and LUST cleanup on tribal lands and to submit a report to Congress detailing implementation progress.

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■ **Energy Policy Act** *from page 11*

Secondary Containment versus Installer/ Manufacturer Financial Responsibility

Section 1530 provides additional measures to protect groundwater resources from petroleum releases. States must require one of the following:

- Secondary containment of newly installed underground tanks and piping within 1,000 feet of an existing community water system, to include the motor fuel dispenser system (i.e., dispenser pans) under specified conditions.
- Certain forms of financial responsibility for manufacturers or installers to provide for the possible costs of corrective action, and also a form of installer certification. Manufacturers' financial responsibility does not affect the liability of owners/operators.

EPA must issue guidance or regulations and states must have requirements in place within 18 months.

Federal Facility Issues

Section 1528 establishes an extensive management regime for all USTs owned or operated by the departments and agencies of the federal government, requiring that they comply with all federal, state, interstate, and local requirements, and explicitly waives federal sovereign immunity from such requirements. The only exception is a specific Presidential waiver in the paramount interests of the United States. There is also a federal reporting requirement somewhat more extensive than that required of state governments under Section 1526.

And, of Course, the Resources

The Act dramatically expands the use of funds previously reserved for cleaning up leaking underground fuel tanks, in order to meet new requirements to both prevent and remediate tank leaks. Trust Fund monies will also be able to be used for compliance activities, as the focus will shift over the next few years from cleanup to prevention. Congress authorized $605,000,000 annually. The appropriations, which would come from five pots of money, cover a number of different activities. (See Table 1.) When or whether Congress will actually appropriate the funding is the huge unknown.

Section 1522 amends Subtitle I of RCRA to require statutory distribution of 80 percent of LUST appropriations to states. States may use these funds to conduct corrective actions, administer state assurance funds, or carry out enforcement. Allocation of funds to states will require a cooperative agreement with EPA. EPA may not distribute these funds for certain purposes to any state that has diverted funds from a state fund or state assurance program for uses not related to USTs after the date of enactment.

The allocation process may be adjusted, but only after consultation with state LUST programs and taking into consideration specified criteria. A provision allows separate withdrawal of approval for any state fund or assurance program for cause without withdrawing approval of the state UST program. Also, there is a description of the process for cost recovery, which requires extensive analysis of the owner/operator's ability to pay. The Act expands the permissible uses of LUST Trust Fund monies to include inspection, enforcement for release prevention, operator training, delivery prohibition, and federal/tribal tanks.

Section 1525 provides authority for remediating oxygenated fuel contamination using a specially allocated LUST fund appropriation. It authorizes up to $1 billion for oxygenated fuels cleanup for fiscal years 2005-2009. This is an additional authority to that already provided to EPA and states to undertake corrective action for UST releases. To qualify, an oxygenated fuel release must be from a UST.

Section 1531 authorizes appropriation levels between the years 2005 and 2009 that would permit appropriations of up to $50,000,000 per year for UST management, and a total of $555,000,000 annually from LUST funds for the tasks authorized in the Subtitle from this source. At this point, this new funding will not be appropriated for 2005 or 2006. We won't know what Congress intends to spend in 2007 until next summer.

TABLE 1 Authorized USTCA Appropriations (New Subtitle I, Section 9014)

■ **Remediation –** Covers administration, enforcement, cleanup. Funding source: Section 9014(2)(A)	**$200,000,000**
■ **Oxygenated Fuel Remediation –** Determine eligible uses of LUST funds and oversee cleanup of eligible sites. Funding source: Section 9014(2)(b)	**$200,000,000**
■ **Inspections –** Develop cooperative agreement guidelines and determine sites to be inspected. ■ **Additional Measure to Protect Groundwater –** Monitor and enforce compliance with secondary containment or financial responsibility regulations. Funding source: Section 9014(2)(c)	**$100,000,000**
■ **Operator Training –** Develop guidelines on training for UST operators. ■ **Delivery Prohibition –** Develop enforcement guidance. ■ **Compliance Enforcement –** Conducting inspections, issuing orders, bringing action. Funding source: Section 9014(2)(d)	**$55,000,000**
■ **General Implementation –** Covers implementation of Subtitle I not covered by LUST Trust funding. Funding source: Section 9014(1)	**$50,000,000**
Total Potential Funding	**$605,000,000**

Miles to Go...

Meeting USTCA's new requirements and deadlines depends on swift action on the part of both U.S. EPA and the states. The EPA Office of Underground Storage Tanks is on the case and is working with the states through the Association of State and Territorial Solid Waste Management Officials to begin the implementation process. Fourteen work groups have been formed, composed of representatives from state and EPA regional and headquarters UST/LUST programs. Go team! ■

Wander LUST

by Patricia Ellis

A roving column by reporter Patricia Ellis, a hydrologist with the Delaware Department of Natural Resources and Environmental Control, Tank Management Branch. Pat served as a member of U.S. EPA's Blue Ribbon Panel on MtBE. She welcomes your comments and suggestions and can be reached at *Patricia.Ellis@state.de.us.*

LUST and Fuel Harmony

Ethanol and Motor Fuels Aspects of the Energy Policy Act of 2005

To the disappointment of many of us in state tanks programs, the Energy Policy Act of 2005, signed by President Bush on August 8, does not ban MtBE, nor does it clarify U.S. EPA or state authority to ban MtBE or other fuel additives. To the disappointment of many petroleum refiners and marketers, the Act does not provide MtBE or renewable-fuel product-liability waivers, nor does it provide transition assistance to MtBE manufacturers to convert MtBE-production facilities into other uses. So let's see what the Act does do regarding the composition of gasoline. Let's consider the aspects of the Act that those of us in federal and state LUST regulatory programs will need to be concerned with when there is a release from a fuel storage tank.

Air Quality-Related Provisions

In Title XV, Subtitle A of the Energy Policy Act, Congress eliminated the 2 percent by weight oxygen content requirement for federal reformulated gasoline (RFG). This provision takes effect 270 days after signing of the Act, unless a state already has a waiver, in which case the provision took effect the day the Act was signed. (As far as I know, no states have been granted waivers from the oxygenate requirement if they are required to use RFG. California, New York, and Connecticut all had their requests for a waiver from the oxygenate mandate turned down earlier this year.)

However, while lifting the requirement for use of oxygenates in RFG, the Act requires that the total pool of gasoline sold in the United States contain increasing volumes of renewables (e.g., ethanol), a volume that starts in 2006 at 4 billion gallons and grows to 7.5 billion gallons by the year 2012. In 2004, approximately 3.5 billion gallons of ethanol were being used in gasoline.

Each gallon of cellulosic biomass is considered equivalent to 2.5 gallons of renewable fuel for purposes of the renewable fuel standard. Increasing amounts of cellulosic biomass ethanol must be used after 2013. The Act provides incentives and loans for construction of facilities that can produce cellulosic biomass fuels and for research on cellulosic biomass fuels.

The Act allows for any area within the ozone transport region to opt into the RFG program, whether or not the area is an ozone nonattainment area. A governor would need to petition U.S. EPA. The agency would need to act on the petition within 180 days, and the program would be put in place as soon as practicable, but not later than two years after the date of the approval.

The Act calls for the maintenance of toxics air pollutant emission reductions resulting from RFG. To do this, EPA is required to establish standards for air toxics reductions for each refinery and importer based on historical average annual emissions from calendar years 2001 and 2002. This provision is designed to eliminate backsliding on gains made in toxics reductions by the RFG program when the oxygen mandate is eliminated.

Health Effects of Substitutes

The Act requires U.S. EPA to conduct a study of public health and environmental (multimedia) impacts of the increased use of MtBE substitutes such as EtBE, TAME, DIPE, TBA, ethanol, isooctane, and alkylates. It would be nice to have health data for these chemicals, but it's beyond my understanding why anyone would want to substitute any of the other ethers for MtBE, when most of them have taste and odor characteristics similar to those of MtBE. If they ended up in your drinking water, you probably wouldn't be happy, and their chemical properties would make them nearly as difficult to remediate as MtBE.

From the information made available to the states, we don't even have good public health data available for MtBE. Where is the EPA

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draft risk assessment that promotes MtBE from a likely animal carcinogen and possible human carcinogen to a "likely" human carcinogen? Evidently this document was written more than a year ago and has been circulating around EPA since then. Rumor has it that the document has been shelved. Possibly, it may return from hyperspace when the winds shift at some point in the future.

According to a news release by the Environmental Working Group (*http://www.ewg.org/issues/mtbe/20050711/ index.php*), the U.S. EPA Office of Research and Development's National Center for Environmental Assessment has already approved the risk assessment. When internal review is completed, it still has to go through the external review process. This document was requested during the congressional hearings on the energy bill, but I don't believe it was provided to Congress.

EPA is required to publish a study within four years analyzing changes in air emissions resulting from the implementation of the provisions in the Act, and must develop a fuels model that reflects the effects of gasoline characteristics on emissions from vehicles in the calendar year 2007.

The study must also estimate the impact of blending increasing amounts of ethanol into gasoline on total evaporative emissions. Evidently the study need not include potential permeation effects of ethanol through elastomeric materials (rubber and plastic parts) that make up the fuel and fuel vapor systems of a motor vehicle, despite the fact that permeation may make a significant contribution to emissions from vehicles.

Permeation may also contribute to releases from UST systems. Are those of us in the tank program convinced that every tank currently storing gasoline can safely store gasoline that contains ethanol? Will every owner and operator know whether all plastic and rubber parts in his or her system are compatible with ethanol? What about the older fiberglass tanks? What about scaling on the inside of steel tanks from ethanol use?

The New England Interstate Water Pollution Control Commission and Northeast States for Coordinated Air Use Management published a three-volume report in 2001 entitled the *Health, Environmental, and Economic Impacts of Adding Ethanol to Gasoline in the Northeast States*, which addresses these and other important concerns about increased usage of ethanol in gasoline. Any other potential changes to the composition of fuels need to be addressed in a similar manner—before, not after—the fact. (The report is available at *http://www.nescaum.org/resources/ reports/ethanol/index.html.)*

Fuel System Harmonization Study

U.S. EPA and the Department of Energy (DOE) are required to conduct a study of federal, state, and local requirements concerning motor vehicle fuels. The Fuel System Requirements Harmonization Study will contain recommendations for legislative and administrative actions for motor vehicle fuels to improve air quality, reduce cost, and increase supply liquidity.

The study will assess the effects of a variety of fuel requirements on supply, quality, and price; the effects on achievement of air-quality standards and goals, and related environmental and public health protection standards and goals; the effects on domestic refiners, the fuel distribution system, and industry investment in new capacity; the effects on emissions from vehicles, refiners, and fuel haulers; the feasibility of providing incentives to promote cleaner-burning fuels; and the extent to which air-quality impacts and fuel prices can be projected to result from Tier II vehicle and fuel standards. The study and recommendations are to be submitted to Congress by June 1, 2008.

The legislation requires EPA and DOE to consult with governors, automakers, state and local air pollution regulatory agencies, public health experts, fuel producers and distributors, and the public.

Wait a minute! Have we forgotten about water-quality issues again, as we did when the Clean Air Act Amendments required the use of oxygenates in RFG, thereby launching the MtBE problem? If we're going to be messing around with fuel composition again, could we also involve some water-quality people in the discussion so we don't have another MtBE debacle? The group that EPA and DOE consults with should also include individuals who are knowledgeable about how potential new gasoline components will behave in the environment. Or will it be, as Yogi Bera said, *déjà vu* all over again?

Additional fuel harmonization legislation has been bandied about in the House and Senate but hasn't taken off. The bottom line is that discussion over fuel content may well not be over.

Boutique Fuels

Subtitle C of Title XV addresses boutique fuels. The Act requires the EPA Administrator, in consultation with the Secretary of Energy, to determine the total number of fuels approved as of September 1, 2004, in all state implementation plans. The list was required to be published in the *Federal Register* by November 6, 2005.

There are currently 18 different base blends of gasoline with 45 different fuels. The most recent map of "U.S. Gasoline Requirements," updated by K.W. Gardner of ExxonMobil in June 2004, indicates that 17 different gasoline "varieties" are in use in the United States. They include:

- RFG – North
- RFG – South
- Oxygenated fuels
- CA CBG
- RFG/CA CBG
- AZ/CBG
- Oxy fuels/7.8 RVP
- Oxy fuels/7.0 RVP
- Conventional gasoline
- RFG with ethanol
- NV CBG
- 7.2 RVP
- 7.0 RVP
- 7.8 RVP MTBE –no increase
- 7.8 RVP
- 7.0 RVP 30 ppm S
- 300 ppm S

Multiply these by three different octane ratings, by summer and winter variations, by low- and high-altitude variation, by northern and southern blends, and you've got a real mess! Several of these blends are used only in a small area of the country, or, if used in several areas, the areas of usage are noncontiguous!

The Act limits the number of boutique fuels that states and localities can require. EPA is not allowed to approve a state implementation plan that will increase the total number of boutique fuels beyond the number approved by September 1, 2004. If a previously approved fuel is dropped from the list, another fuel can take its place. States or regions can adopt a fuel standard that is already in place elsewhere.

EPA and DOE are required to conduct a joint study that focuses on determining how to develop a federal fuels system that maximizes motor fuel fungibility and supply, addresses air-quality requirements, and reduces fuel price volatility. The study must include recommendations to Congress for legislative changes necessary to implement such a system. Results of the study must be presented to Congress not later than 12 months after the date of enactment of the Act.

What will RFG look like if new legislation passes and the Federal Fuels List contains only one variety of RFG? Will it contain an ether, such as MtBE or ethanol, or will it be like California Cleaner-Burning Gasoline (CA CBG)? This would depend on how RFG is specified on the list. Would RFG be defined by an allowable "recipe" or by a performance standard?

What will conventional gasoline look like if only one version is allowed? Somehow, a tremendous amount of ethanol needs to be incorporated into the fuel mixture within the next few years. In which gasoline variety will it be included? With the high vapor pressure of ethanol, there probably wouldn't be large amounts of it specified for the RVP-controlled gasolines.

Rather than dictating specific ingredients and recipes for motor fuels, the federal government should limit its role to setting environmental end goals for fuels. One of the recommendations of the U.S. EPA Blue Ribbon Panel was that any changes in gasoline composition should be designed so as not to result in an increase in MtBE use in conventional gasoline areas. One benefit of establishing performance standards for gasoline rather than dictating a recipe would be added flexibility for gasoline production and distribution.

What About the Lawsuits?

How many MtBE producers or gasoline refiners plan to stop adding it to gasoline because the Energy Policy Act does not provide a safe harbor against lawsuits? I don't think that we have an answer to that yet.

We in the tank program need to be aware of what is in our fuel supply, so we can research issues that may have an effect on tank systems, and so we know whether anything needs to be done differently during investigations and cleanups. How long was MtBE used in our gasoline before the states started to catch on?

Earlier drafts of the energy bill included statements to the effect that MtBE stinks, tastes bad, and contaminates water supplies—therefore let's ban it! Yet the signed version of the bill simply states that claims and legal actions filed after the date of enactment related to allegations involving actual or threatened contamination of MtBE may be removed to the appropriate United States district court.

This leaves the many lawsuits filed by the State of New Hampshire against a multitude of petroleum companies last year as the only suits that will definitely continue in state courts. It is generally thought that state courts tend to be more generous with damage awards.

What About Groundwater Cleanup?

Does the Act provide any type of funding for dealing with impacted water supplies? On one of my projects, I'm in the final stages of extending an existing water main into a neighborhood where numerous domestic wells were impacted by a gasoline release. The source of the release is a gas station that is eligible for reimbursement under our state program.

The cost of extending the line is more than $500,000. Close to $250,000 was spent providing carbon filters and sampling domestic wells during the initial release investigation, and until the water line extension could be completed. About $400,000 has been spent on investigating the 1,600-foot-long plume, which extends at least 75 feet into the unconfined aquifer, and some additional plume delineation is still needed. I've approved a corrective-action plan for one area of the plume, and the consultant is working on plans for other areas. The eventual cleanup cost is unknown.

Our state reimbursement program has a *total* of $1 million that we can reimburse in one year, for *all* the sites that are still eligible for reimbursement. Where does this site fall in the money "promised" by Congress? (See article on page 11.) There's no recalcitrant responsible party (RP), no poverty-stricken RP. We have an RP, but the site is eligible for reimbursement under our state program.

Can any of the money go toward supplementing state reimbursement programs to cover the extra expense required for oxygenated fuel releases? In most states, tank owners/operators use either insurance or a state fund as their mechanism for financial responsibility. I'm sure that many state funds have been hard hit by increased investigation and cleanup costs because of MtBE releases.

The Act does indicate that the oxygenated fuels funding requires that the release of oxygenated fuel must be from an UST. Did the Act provide any funding to help deal with sites with MtBE impacts, but for which a source has not been identified (yet), or may never be identified? If any of this funding is ever eventually appropriated, there needs to be flexibility in how it can be spent.

Additional funding will certainly be welcome…no, actually, it will be essential, if Congress expects these requirements to be met. The funding that Congress has authorized for appropriation must actually be appropriated.

We in the tank program need to be aware of what is in our fuel supply, so we can research issues that may have an effect on tank systems, and so we know whether anything

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The Case for Multicomponent Analysis of Gasoline

by James Weaver

As we all know, leaking underground storage tank problems begin with a release from a storage system and a fuel. The fuel contains chemicals that can be delivered to groundwater and soil gas. Since humans aren't particularly good detectors of low levels of specific chemicals in food, water, or air, we can easily expose ourselves to unknown hazards. In the case of a leaking underground storage tank, there is the potential that we could be exposed to many of the chemicals composing the fuel.

The importance of evaluating gasoline composition then comes from its obvious role as a source of contamination to aquifers and soil gas. I can think of six specific reasons for the study of gasoline from a LUST perspective:

- Without an evaluation of all components of gasoline, we cannot be sure we are adequately protecting against harmful substances.
- Detailed characterization of gasolines provides a means to predict the types of potential impacts that may occur. The need to predict results follows from the very nature of LUSTs: releases occur unseen and undetected for years in many cases. It is clearly impossible to go back in time and measure the composition of a leaked fuel, but knowledge of composition is needed to model or estimate the risks associated with a release.
- The loading of all components of a gasoline to an aquifer can impact remedial technologies, because it's not just BTEX and MtBE that enter a treatment system.
- Biodegradation is generally acknowledged to be electron-acceptor limited. Thus, the pool of electron acceptors is available only for a finite mass of contaminants at most sites. The loading of all chemicals in a gasoline contributes to usage of electron acceptors and needs to be considered.
- As shifts are made away from MtBE and toward ethanol in gasoline, other changes in gasoline composition will occur. This might result in differing levels of various other contaminants in soil gas or groundwater. Knowledge of shifts in composition can give decision-makers the ability to predict potential impacts.
- Multicomponent analysis may be useful for distinguishing among different gasolines as part of an environmental forensics investigation. (See *LUSTLine* #49, "Environmental Forensics: Chemical Fingerprinting Gasoline and Diesel Fuel at LUST Sites.")

To serve these ends, the U.S. EPA Office of Research and Development (ORD) has been studying gasoline composition by organizing volunteer samplers from around the United States and generating detailed hydrocarbon analyses of around 300 chemicals, and by reviewing industry data collected by Northrop Grumman Mission Systems in Bartlesville, Oklahoma. What factors have we learned influence fuel composition? The short answer is that regulatory requirements, octane needs, vapor pressure, and performance requirements are the major drivers.

Regulation, Benzene, Oxygenates, and the Clean Air Act

Federal and state regulations have a major impact on gasoline composition, particularly on benzene and oxygenate content. The Clean Air Act Amendments of 1990 (40 CFR Part 80) mandated changes in gasoline composition to improve air quality. The amendments required that reformulated gasoline (RFG) be sold in major metropolitan areas and others with the worst summertime ozone levels. (This requirement will now be eliminated by May 2006 due to the passage of the Energy Policy Act of 2005.) The amendments also prevented conventional gasoline sold in the rest of the country from becoming more polluting than it was in 1990.

The RFG requirements for benzene and oxygen content can be achieved on a per-gallon or average basis. These have slightly different standards. Those that were in force since 1995 are shown in Table 1. If the requirement is met on a per-gallon basis, the oxygen content must be greater than 2.0 percent by weight and benzene must be less than 1.0 percent by volume. Where the requirement is met, on average, a gallon of gasoline could contain up to 1.3 percent benzene by volume and as little as 1.5 percent oxygen by weight, while still meeting the average standards of greater than 2.1 percent by weight oxygen and less than 0.95 percent by volume of benzene. (See Table 1.)

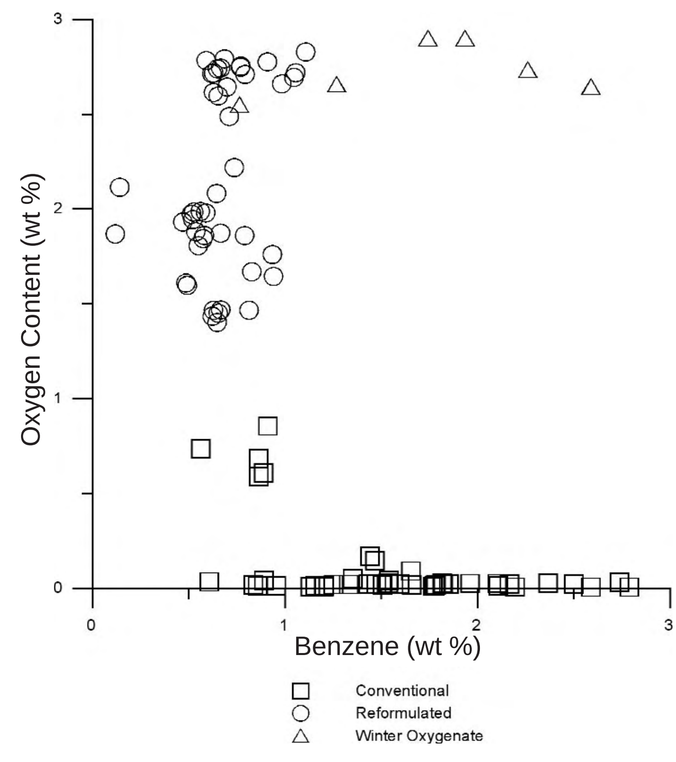
The Clean Air Act contains an anti-dumping provision to prevent compounds (e.g., benzene) limited in one area from moving to areas where they are not limited. The anti-dumping provision of the Clean Air Act is complicated, as it is based on the fuels that were produced or imported in 1990. Producers or importers determine a baseline derived from their 1990 production/importation. If they were not in business in 1990 or if they meet other requirements, their baseline is set to the baseline for "complex model" emissions. Under this standard, the average benzene concentration is 1.60 percent by volume. In areas using conventional gasoline, the benzene content may vary due to various refiner/importer baselines. Recent EPA surveys (John Weihrauch, U.S. EPA, Office of Transportation and Air Quality, 2005, personal communication) indicate benzene levels as high at 5 percent, by volume, in some samples, although most samples are below that level.

The winter oxygenate program is implemented by the states to control

TABLE 1 Clean Air Act standards for reformulated gasoline (40 CFR, Part 80.)

COMPONENT	PER GALLON	AVERAGE BASIS STANDARD	AVERAGE BASIS PER-GALLON LIMITS
Oxygen	>2.0% wt	>2.1% wt	>1.5% wt
Benzene	<1.0% vol	<0.95% vol	<1.30% vol

FIGURE 1. *The relationship between oxygen and benzene content in samples from the US EPA gasoline study (Weaver et al., 2005)*



carbon monoxide pollution—an oxygenate is added to gasoline to cause the fuel to burn cleaner. Under this program, there is not a requirement to reduce benzene as there is for reformulated gasoline. Thus, we find fuels with oxygenates and high benzene concentrations.

Many of the greatest differences among gasolines are driven by regulatory requirements for benzene, oxygenates, and ethers. Figure 1 is a scatter plot of oxygen content from all oxygenates versus benzene content. Samples of RFG (circles) had benzene contents of less than 1 percent by weight, as is required. Most conventional gasolines had low oxygen and benzene contents—between 0.5 and 2.75 percent. Some conventional gasolines had oxygen contents between 0.5 and 1.0 percent. These were all premium gasolines from Georgia, and the oxygen (MtBE) in the gasoline was likely used just for octane enhancement.

MtBE and/or other oxygenate bans are now in place in about 20 states. Several of these states were included in our study (New York, Colorado, California, Illinois) and we found that oxygenate requirements were being met through the use of ethanol.

Octane

When crude oils are distilled in the first stage of refining, gasoline is one of the products. Because crude oil does not produce sufficient amounts of straight-run gasoline and the octane rating of this gasoline is too low for modern automobiles, additional processes are used to produce more gasoline and higher octane ratings. These processes include catalytic cracking, reformulating, isomerization, and alkylation. Our gasoline composition study has found that major component differences between premium and regular gasolines are usually related to increases in toluene, oxygenates, and alkylation products in premium fuels.

Alkylation is used to produce branched alkanes called isoparaffins that boost the octane rating of gasoline. Ironically, octane, being a straight-chain organic, lowers the octane rating, while its highly branched isomers boost octane. These isomers are 2,2,4-trimethylpentane, 2,2,3-trimethylpentane, and 2,3,4-trimethlypentane.

Since the octane number is also boosted by oxygenates, they are often used for this purpose, even in the absence of an oxygenate requirement. We found this to be the case in gasoline from Georgia and other southeastern states. Observations like this showed that regular and premium and conventional and reformulated gasolines could be reliably differentiated by their composition (Weaver et al., 2005).

However, forensic differentiation among fuels may be limited by such factors as the changing composition of fuel delivered to tanks, releases of premium and regular from the same station, the supplying of differently branded gas stations by the same refiners, and trading of gasoline among suppliers.

Historical Analysis

Our current data represent contemporary gasolines, but fuel from prior releases is likely to have had a different composition. To address this, we are using industry data that date back to the 1930s. The Northrop-Grumman Mission is the successor to prior organizations that collected these data, and is the current source for the data. The data collected in their surveys has varied over the years, but it now contains results for benzene and the oxygenates. From these we will be able to see the changes that have occurred in gasoline for about 170 locations in the United States.

Figure 2 shows benzene concentrations measured over four years for Atlanta. Earlier data show generally higher benzene concentrations than in later years. Both winter and summer data show roughly the same concentrations. MtBE data for the same time period (Figure 3) show higher MtBE concentrations in Atlanta premium gasoline than in mid-grade and regular, and sometimes higher MtBE concentrations in winter than in summer. When filled in with prior years, these data will form the basis of estimates of composition over the past 30 years.

Environmental Impacts

Figure 4 shows the estimated water solubilitiesof the most prevalent com-

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■ **Multicomponent Analysis of Gasoline** *from page 17*

pounds found in a conventional gasoline, and it is also plotted for a reformulated gasoline and a reformulated/MtBE-ban gasoline. The concentrations of each component differs among the samples, but the largest differences occur for the ethers and alcohols.

Figure 4 also shows that all of these compounds have predicted solubilities above 0.1 mg/L. These are theoretical effective solubilities, so they represent the maximum concentrations that might occur. These constitute the additional loading to the aquifer beyond that of BTEX and oxygenates, which could impact biodegradation of BTEX and other components and ex-situ treatment systems such as carbon filtration units. These impacts occur because of the limited capacity associated with each of these processes.

FIGURE 2. *Plot of "Bartlesville" benzene data for the years 1990/1991, 1994/1995, 1998/1999 and 2001/2002.*

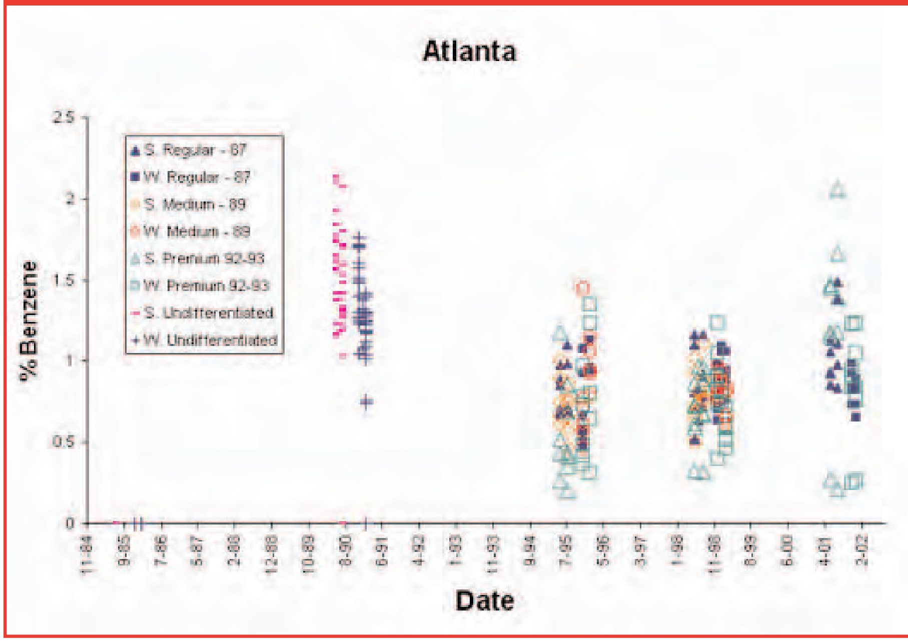
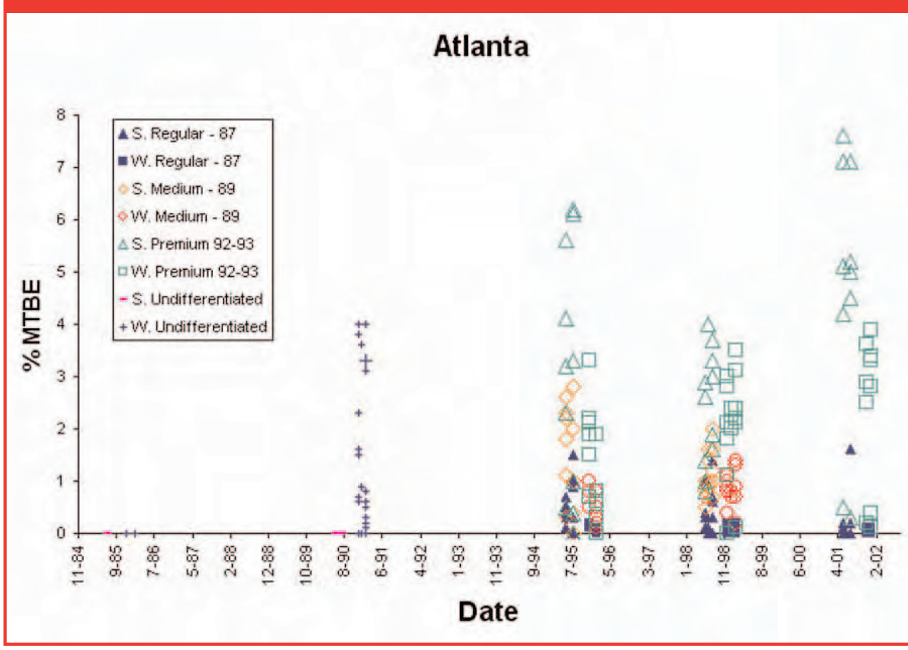


FIGURE 3. *Plot of "Bartlesville" MtBE data for the years 1990/1991, 1994/1995, 1998/1999 and 2001/2002.*



De Minimis Concentrations

There is a small detail evident from the MtBE concentrations shown on Figure 4: The estimated MtBE concentrations in water for reformulated gasoline in an MtBE-ban state are above 10 mg/L. In conventional gasoline, concentrations are above 50 mg/L, while in reformulated gasoline they are above 1,000 mg/L. This shows that small amounts of MtBE in gasoline can still dissolve in water.

If the de minimis concentration is 0.5 percent (wt), there would be roughly 743 grams of MtBE per gallon of gasoline (compared with 11% (wt) MtBE in gasoline with 18,670 grams per gallon). Thus, although there is a reduction of MtBE content by a factor of 25, there is still enough MtBE in the gasoline to equilibrate with water on the order of 10 mg/L.

Contaminant plumes associated with three premium gasolines are shown in Figure 5. These plumes were generated with U.S. EPA's Hydrocarbon Spill Screening Model, which includes simulation of the flow of the gasoline and its emplacement in the aquifer, followed by aquifer transport (Weaver et al., 1994, EPA/600/R-94/039a.). The simulations differ only by MtBE content in the source gasoline.

The most notable fact about these results is that the extent and area of the plumes is only slightly less for the MtBE-ban RFG of New York compared to the Georgia premium with MtBE for octane enhancement (4.89%) and Virginia RFG with MtBE (13.13%). This follows from the basic principles of contaminant transport: the advective term of the equation doesn't depend on the concentration.

So, either a high-groundwater velocity will generate similar-sized plumes in any of these cases, or a low-groundwater velocity will not spread the MtBE much in any case. The concentrations, however, are much less for the low-MtBE gasoline. Thus, the impact may be below a reasonable level, given the standards set for groundwater.

Additives

Our work still has not addressed the third major category of compounds

FIGURE 4. *Comparison of estimated water solubilities of regular low-elevation gasolines. Includes most prevalent compounds in conventional gasoline plus ethanol.*

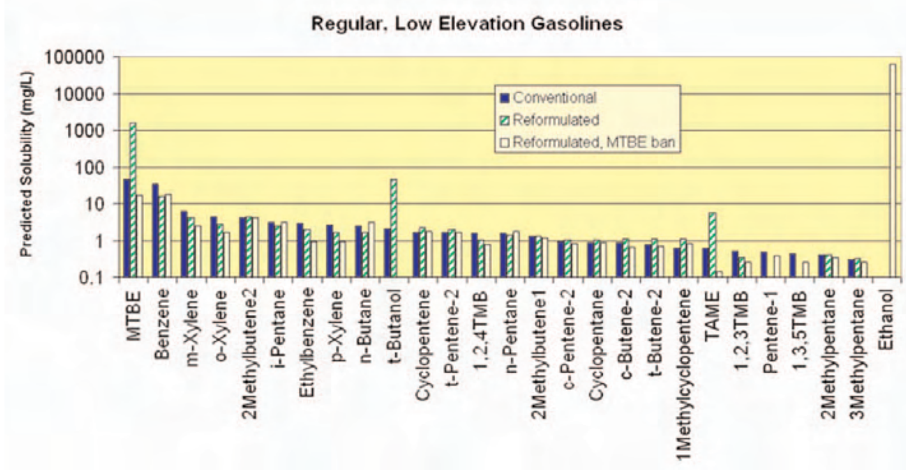
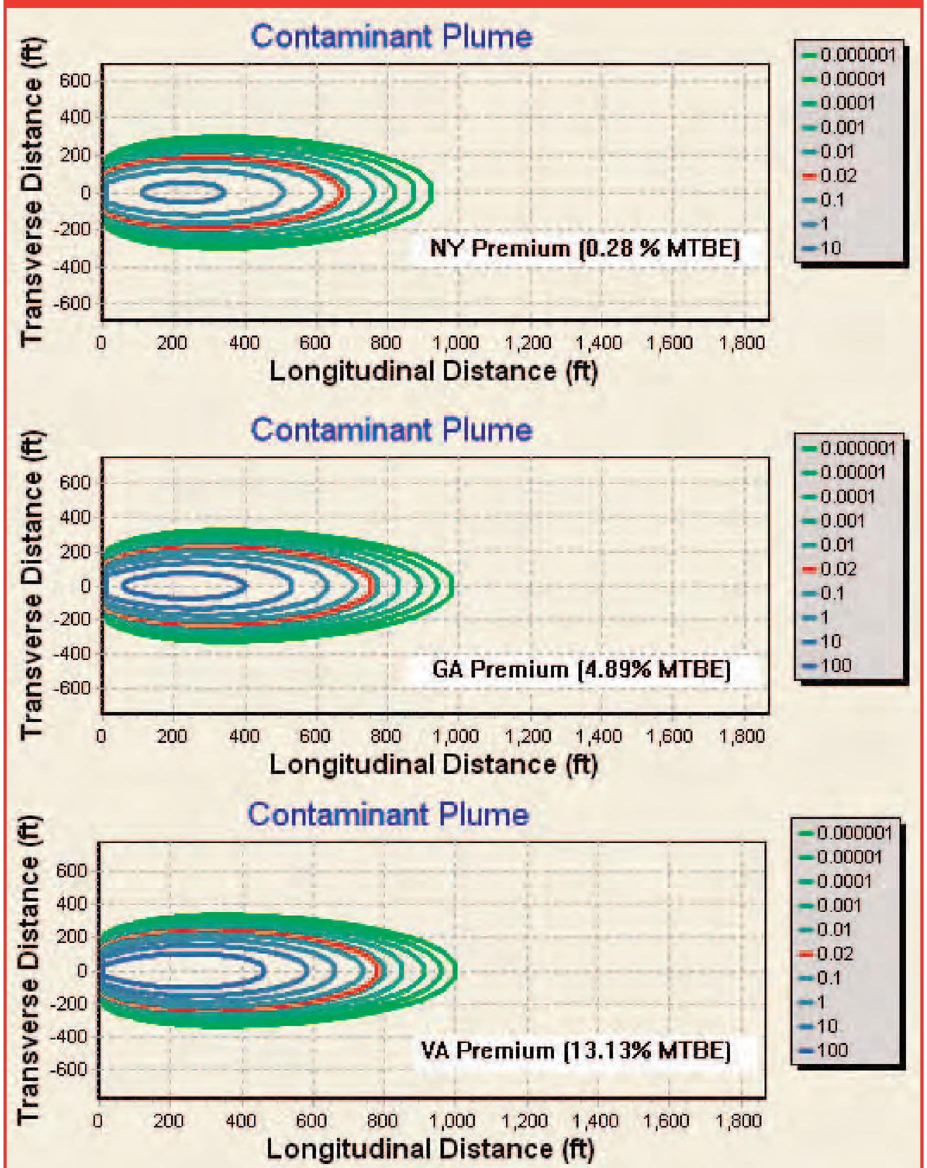


FIGURE 5. *Contaminant plumes generated from premium gasolines with 0.28% (NY) MtBE, 4.89% (GA) MtBE and 13.13% (VA) MtBE, respectively.*



in gasoline—additives. These compounds are added for a variety of purposes and are largely proprietary. One of our next steps in evaluating gasoline is to use publicly identified additives in simulation models to evaluate the potential impact of these compounds.

What's on Our Radar Screen?

Tracking the composition of gasoline reveals many aspects of LUST problems and can benefit the program by providing an understanding of one main driver of the problems: What compounds are we concerned with at a given site? From time to time, "new" problems emerge for the tanks program, and sometimes these new problems aren't so new, but a product of incomplete treatment of our old problems. In the mid-1990s, was MtBE a new problem (when it had been approved for use since 1979), or was it simply not on our radar screen? Are lead scavengers a new problem, or are they the result of the lack of consideration of the composition of older gasolines? What's next? ■

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Jim gratefully acknowledges the volunteers who collected samples for the ORD gasoline composition study (see the listing in http://www.epa.gov/athens/publications/downloadable.html*) and Lourdes Prieto and JoAnn Action of EPA.*

Disclaimer

Although this work was reviewed by U.S. EPA and approved for presentation, it may not necessarily reflect official agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

[Editor's note: The online version of LUSTLine #51 *at* www.neiwpcc.org *contains color versions of the figures in this article.]*

■ **LUST and Fuel Harmony**
from page 15

needs to be done differently during investigations and cleanups. How long was MtBE used in our gasoline before the states started to catch on?

MtBE was first used in gasoline in parts of the United States in 1979. Garrett, Moreau, and Lowry raised the alarm in 1986 ("MTBE as a Ground Water Contaminant," 1986, *Proceedings of Petroleum Hydrocarbons and Organic Chemicals in Ground Water Conference*, NWWA-API, November 1986). Most states didn't even start looking at MtBE as a chemical of concern until about 10 years after that, if not longer, and even then they didn't necessarily know how or where to look for it.

We're trying to play catch-up now with lead scavengers—and leaded gasoline is long gone. Just once, it would be nice to be on the leading edge, helping to prevent a problem, rather than dealing with one after it has happened. ■

Ford and VeraSun to Cooperate on E-85 Infrastructure Promotion

Ford Motor Company and VeraSun Energy Corporation recently announced the formation of a new partnership designed to expand the fueling infrastructure to support flexible-fuel vehicles capable of running on E-85. According to Ford, only about 500 fueling stations in the United States currently offer E-85. The company said its new initiative with VeraSun should increase the number of stations that support flexible-fuel vehicles capable of running on E-85, particularly in the Midwest, where ethanol availability is growing. Specifically, the effort will serve to convert fuel pumps to VeraSun's branded E-85 (VE85) in existing fueling facilities. The companies will also launch a consumer-awareness campaign to promote the benefits and use of E-85. ■

ORD Publishes Report on MtBE Remediation at LUST Sites

U.S. EPA's Office of Research and Development (ORD) has published Monitored Natural Attenuation of MtBE as a Risk Management Option at Leaking Underground Storage Tank Sites (EPA/600/R-04/179). The 88-page report is intended for UST technical staff in state agencies. It reviews the current state of knowledge on the transport and fate of MtBE in groundwater, emphasizing the natural processes that can be used to manage the risk associated with MtBE in groundwater or that contribute to natural attenuation of MtBE as a remedy. It provides recommendations on the site-characterization data that are necessary to manage risk or to evaluate monitored natural attenuation (MNA) of MtBE, and it illustrates procedures that can be used to work up data to evaluate risk or assess MNA at a specific site. The report is available at *http://www.epa.gov/ada/download/reports/600R04179.pdf*. A limited number of hard copies are available through the ORD Library by e-mail at *ill.ada@epa.gov* or by phone at (580) 435-8505.

On a related subject, an article entitled "Anaerobic Biodegradation of MtBE at a Gasoline Spill Site" recently appeared in Ground Water Monitoring and Remediation [25(3):103-115]. (Most of the information in this article is discussed in the ORD study.) The article describes an MtBE plume at a retail gasoline station in New Jersey where long-term monitoring data indicated that the concentration of MtBE was slowly declining over time in the wells that were within the footprint of the plume. The ratio of TBA to MtBE increased with distance from the source area, and the ratio of TBA to MtBE in individual monitoring wells in the plume increased over time. As concentrations of MtBE declined in the microcosms, concentration of TBA increased. The decrease in concentrations of MtBE in the microcosms could be accounted for by an increase in the concentration of TBA. ■

List of Known Insurance Providers for USTs Updated

UST recently revised its publication, *List of Known Insurance Providers for Underground Storage Tanks* (EPA/510/B-05/003, September 2005). This booklet provides UST owners and operators with a list of insurance providers that may be able to help them comply with financial responsibility requirements by providing a suitable insurance mechanism. The revised version is available through the OUST website at *http://www.epa. gov/oust/pubs/inslist.htm*. ■

Oil Company to Pay $10.7 Million for UST Violations

A major oil company with 62 stations in San Diego County will spend $10.7 million on fines and equipment upgrades under a settlement of UST violations. The settlement covers approximately 2,200 violations of UST requirements, hazardous waste laws, and an unfair business practice statute. Under the agreement, the stations are required to provide tamper-resistant underground sensors and improve maintenance and management practices to prevent a repeat of the violations. ■

Breaking Up Isn't Hard to Do

A View of NAPL Using Electrical Resistivity Imaging

by Todd Halihan, John Billiard, and Stuart McDonald

Characterizing a site affected by fugitive fuel products from spills, leaks from tanks and lines, or an accidental release (e.g., sudden flooding in New Orleans) is a prerequisite to any cleanup project. Assessing the lateral and vertical extent of sources and the associated environmental impact is the first step in knowing how to address these issues and to develop an appropriate project schedule and budget. On most nonaqueous-phase-liquid (NAPL-) -affected sites, drilling programs are the usual first step in most cleanup programs, closely followed by a best-judgment interpolation between discrete sampling data from soil borings and wells to create a site-conceptual model.

This industry standard methodology has most often led to the creation of inaccurate site-conceptual models that guide planning for marginally successful remedial work to remove the NAPL. Frequently, more time and money are required for remediation than originally predicted, leaving frustrated stakeholders in the wake of the investigation and cleanup efforts.

This article examines some fundamental problems that plague the characterization and cleanup processes, and presents some case studies of an improved electrical resistivity imaging (ERI) geophysics approach that yielded innovative views of the subsurface at several difficult sites. Further, these case studies illuminate a relatively new conceptual model for consideration when characterizing and remediating sites.

Specifically, when using ERI geophysics followed by drilling to support the results of the image, NAPL sources in these cases are confirmed to exist as "blobs," not as continuous layers or "plumes" as currently believed by many in the environmental industry. Finding the full extent of NAPL blobs using only conventional drilling techniques is like trying to round up quiet cattle in a dark field, where the end result is that most often some will get away. ERI geophysics can help find the NAPL blobs and often finds the related dissolved-phase impacts, making cleanup strategies more predictable and more reliable.

What's the Problem?

The problem with finding the blobs stems from the fact that a real-world site rarely, if ever, resembles the conceptual model of the idealized site. In the idealized model, NAPL migrates into both the unsaturated and saturated zones as a cohesive mass, ultimately ending up on top of the groundwater table as a layer (Walther et al., 1986). Ultimately, the NAPL begins to dissolve into groundwater and migrate based on groundwater gradient. Simple cartoons that illustrate the idealized conceptual model are generated to indicate how the world works (Schwartz and Zhang, 2003). We call this the "world we would like" conceptual model.

These cartoons are not consistent with the "real world," but unfortunately they are commonly used to form the conceptual model, guiding the decisions that precede the cleanup process. The use of a more sophisticated real-world, site-conceptual model has not been practical until recently when ERI geophysics provided a tool that allows one to effectively "see" into the subsurface in a cost-effective and meaningful way.

The real-world, site-conceptual model is complex and was previously difficult to impossible to derive. To make matters worse, the NAPL source itself is a cocktail of hundreds of compounds that can vary between refinery locations and seasons of the year. NAPL can change over time while stored in tanks and will undergo changes once it makes its way into the environment.

The "World We Have" Model

When NAPL enters the subsurface, it starts migrating in three dimensions as a NAPL source, a dissolved phase in the groundwater, and a vapor in the unsaturated portions of the subsurface. NAPL changes character with time and migrates under various retardation and degradation mechanisms. After some period of time, NAPL sources end up as discrete blobs that are difficult to find using conventional characterization techniques. We call this the "world we have" conceptual model.

The fact that NAPL is observed and migrates as blobs is seen in pore-scale experiments, where NAPL in groundwater disperses as it migrates (Conrad et al., 1992). Similarly, on the basin-wide scale, oil fields are not continuous, but occur in distinct patches in a region. This knowledge, plus the data that the new techniques our collective research have developed, is showing us that the world we get is definitely not continuous (Halihan et al., 2005a).

Research and technical practice demonstrate every day that the "world we would like" conceptual model is a failed paradigm and that we collectively need a new "recipe" in the cookbook for environmental cleanups. Abandoning idealized conceptual models and embracing the "world we have" conceptual model makes sense because we get closer to understanding the scope of the true problem, which is the only way an appropriate and cost-effective solution can be developed.

In the idealized "world we would like" paradigm, a project typically starts with drilling and other conventional techniques in an attempt to find and track the NAPL. This site-characterization work is conducted by effectively "drilling blind," and it likely results in undetected NAPL blobs between borings that act as ongoing sources during and after active remediation. In the

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■ **NAPL Using Imaging**
from page 21

"world we have" paradigm, the site-conceptual model must have field data that locates the blobs, before drilling starts. Therefore, follow-up confirmation drilling is more focused and effective and can provide a predictable and successful exit to a cleanup project.

How About Using Underground "Photography" First?

ERI geophysics is a potentially attractive way to assist in characterizing NAPL-affected sites and is analogous to taking a digital electrical "picture" of the subsurface. Punching holes with direct-push or auger drilling is time consuming and provides a limited one-dimensional sample of the subsurface at a single point in time. Assuming wells are installed, maintained, and monitored properly, the question of what is between adjacent well or boring locations always remains. Most sites that we have examined have wells that are improperly placed, screened in the wrong location, and/or not in good communication with the groundwater system.

ERI geophysics can produce two- or three-dimensional images (pictures) of the subsurface that provide a more complete understanding of the distribution of NAPL and related contamination. Three-dimensional images can most easily be generated on typical sites by coalescing a set of two-dimensional datasets. The reliability standard to be applied to any geophysical technique, including ERI geophysics, is that the resulting images must be sufficiently accurate so that they have a direct correlation to the subsurface—the images should be "drillable." Without data of this quality, the cost of geophysical techniques does not justify their use in many cases.

ERI geophysics has several qualities that make it attractive for shallow-site investigations (i.e., less than 500 ft). It works in a wide range of natural aquifer materials, gives accurate measurements with relative ease, and produces draft images on-site within an hour of completing an ERI geophysical survey. A rapid and accurate result while on-site is very attractive, as investigations can be tailored in real time.

Proprietary research developed at Oklahoma State University (OSU) in concert with its commercial partner Aestus, Inc., now allows for very accurate pictures of the subsurface that assist in guiding subsequent drilling investigations or remediation. In most cases, high-resolution ERI geophysics (commercially available as GeoTrax Survey™ via Aestus, Inc.) can be deployed quickly from the surface only, and can provide images at depths within the typical site needs.

The Research Behind the Magic

Much of the initial ERI geophysics research was done through collaborative efforts between OSU, the Oklahoma Corporation Commission, Petroleum Storage Tank Division (PSTD), and Aestus, Inc. On one of the PSTD sites, OSU developed a technique to use ERI geophysics in direct-push boreholes so the site could be monitored very accurately over a period of time (Halihan et al., 2005b). The site had relatively simple geology and had not yet been remediated at the start of the project.

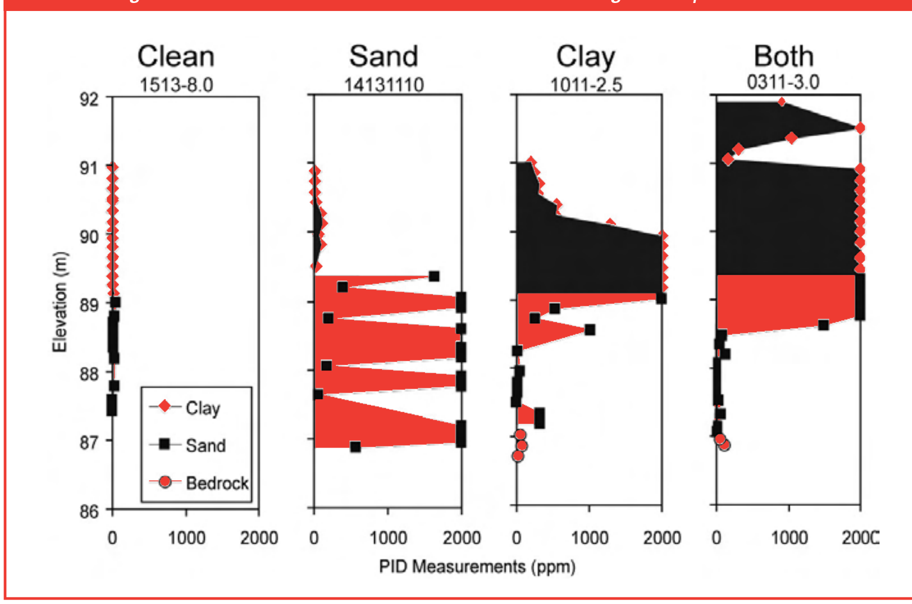
The results initially appeared problematic relative to the "world we would like" site-conceptual model that the team used going into the project. Although the site had a relatively simple geology with clay overlying a sand aquifer, no continuous NAPL plume was apparent in the ERI images.

Instead, separate blobs of NAPLs that correlated with slight variations in the elevation of the clay/sand interface were found. There was no continuous NAPL plume at the groundwater interface, as expected using the "world we would like" conceptual model. After checking the cables, instruments, methodologies, and interpretations, OSU conducted an intensive direct-push coring program to confirm the ERI images. The results of the confirmation-drilling program were completely inconsistent with the conceptual model of a continuous NAPL plume.

The site was sampled using the direct-push method, and some cores indicated high concentrations of NAPL in both the sand and the clay (Figure 1). Other cores indicated high concentrations of NAPL in just the clay, and in other areas, just the sand. In addition, some soil cores were completely clean within a few feet of highly contaminated areas.

In other words, moving the boring location by only a few feet in certain locations resulted in data that supported a completely different

FIGURE 1. *PID readings of NAPL in dual-tube direct-push cores sampled within 60 feet of each other at a site in Enid, OK. Cores were located using ERI images. Note that each core provides a different conceptual model for the site, but the cores are close enough to one another to be considered from a single sample location.*



conceptual model of the site (Figure 1). Therefore, depending on how lucky (or unlucky) the consultant/driller was, the site-conceptual model and hence cleanup strategy would change drastically. In addition, these data clearly did not support the "world we would like" conceptual model with NAPL in a layer on top of the groundwater table.

When compared, the ERI geophysical image/data matched the drilled core data (Figure 2). It was clear the site-conceptual model needed to change from the "world we would like" to the "world we have" paradigm.

After remediation began at the site, additional ERI geophysical datasets confirmed the blob configuration (Figure 3). The subsequent ERI geophysical data indicated the site was getting dirtier in some areas, not cleaner. The ERI images suggested that previously unmapped hydrocarbons were entering the site from an area that was not originally characterized. The "world we would like" site-conceptual model of a continuous NAPL plume prevented the original investigators from looking past clean location boundaries, since these edges would have been outside the area of a continuous NAPL plume.

Since the work performed at the Enid, Oklahoma site, numerous other sites have been characterized using this improved method for ERI geophysics with similar results. That is, the original site-conceptual model has changed from one that envisioned a continuous NAPL plume, to one with discontinuous NAPL blobs.

Most of the sites characterized by ERI geophysics have been subsequently characterized using drilling techniques. In all cases where confirmation data are available, the ERI images were proven to be correct and the site-conceptual models have improved to include the discontinuous NAPL blob concept.

What You Don't Know Will Hurt You

On many of the sites where improved ERI geophysics has been used and the results confirmed via drilling, NAPL blobs have been discovered in areas thought to be clean or at least devoid of ongoing NAPL

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FIGURE 2. *Three-dimensional ERI geophysics of a site in Enid, OK prior to site remediation in December 2002. Over 50,000 field data points were collected to generate this image. Image is positioned looking from the southwest towards the northeast. The northwest corner has no data since no cable was located in this position. Fifteen subsurface cables with 27 electrodes each were used to obtain the dataset. The isoshells in red represent the volume of the subsurface that has resistivity above 46 ohm-meters. This is estimated to correspond to the location of free product on the site. The image was produced using data from OSU in EarthVision in conjunction with Aestus, Inc. and Hazlett-Kincaid, Inc.*

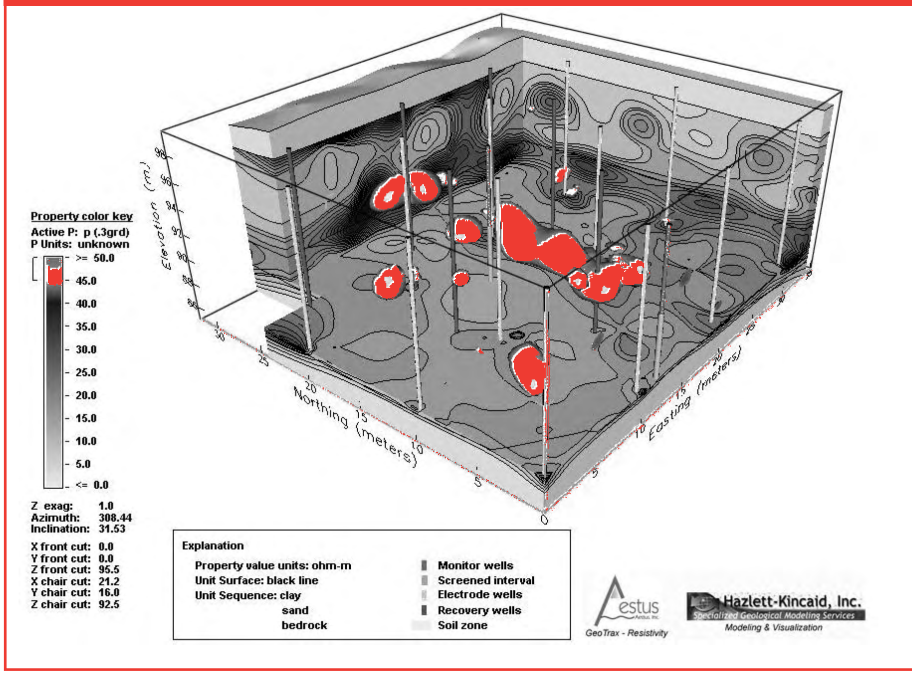
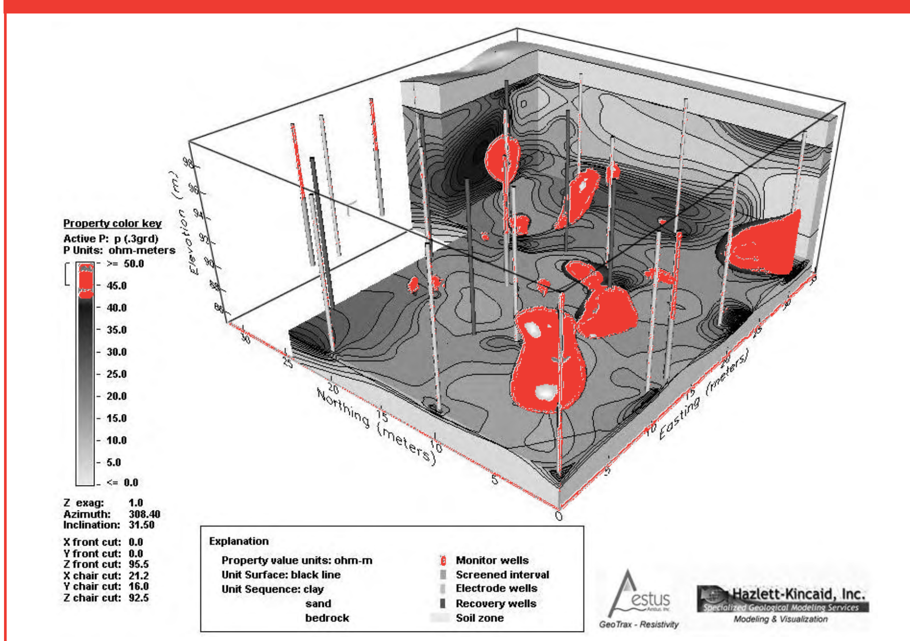


FIGURE 3. *Three-dimensional ERI geophysics of a site in Enid, OK during site remediation in August 2003. Image is positioned looking from the southwest towards the northeast. The northwest corner has no data since no cables were operational in this position. Thirteen subsurface cables with 27 electrodes each were used to obtain the dataset. The isoshells in red represent the volume of the subsurface that has resistivity above 46 ohm-meters. This is estimated to correspond to the location of free product on the site. Note the new orientation of resistive "blobs" that has occurred since remediation began. No significant "blobs" remain within the area enclosed by the remediation wells. The image was produced using data from OSU in EarthVision in conjunction with Aestus, Inc. and Hazlett-Kincaid, Inc.*



■ **NAPL Using Imaging**
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sources. The following case studies illustrate why what you don't know will hurt your schedule and your budget, at the very least.

■ Golden, Oklahoma

This was a LUST site where characterization was conducted several times via drilling and direct-push (92 monitoring wells were installed in a five-acre area), and three separate remediation technologies were subsequently deployed. Remediation consisted of standard NAPL removal via pneumatic pumps, soil-vapor extraction, and finally the use of an innovative soil-surfactant flush to achieve predefined cleanup levels. Characterization and remediation were conducted over a 10-year period. About $1.2 million had been expended over that period at this rural site.

ERI geophysics was deployed at the tail end of this project to evaluate the effectiveness of the cleanup technologies. NAPL blobs were detected outside of the delineated plume at the site (Halihan et al., 2005a). Staff from the U.S. EPA Ground Water and Ecosystems Restoration Research (GWERD) laboratory in Ada, Oklahoma used the image produced by ERI geophysics and conducted their own drilling program to confirm the ERI image results. EPA advanced seven soil borings within a 50-foot distance along the ERI geophysics survey line in the area of the NAPL blobs (Figure 4). Soil samples were collected about every 6 or 12 inches along the soil core and analyzed for total petroleum hydrocarbon (TPH).

EPA's TPH confirmation data indicated a semi-quantitative correlation between TPH concentration and ERI resistivity values. The ERI geophysics data as well as the borings also confirmed that NAPL blobs existed between the site-remediation wells. Additionally, the highest TPH value ever measured at this site was detected using the ERI geophysics image after all of the characterization and remediation work had already occurred. This ERI geophysics field work was completed in less than one week.

■ Hobart, Oklahoma

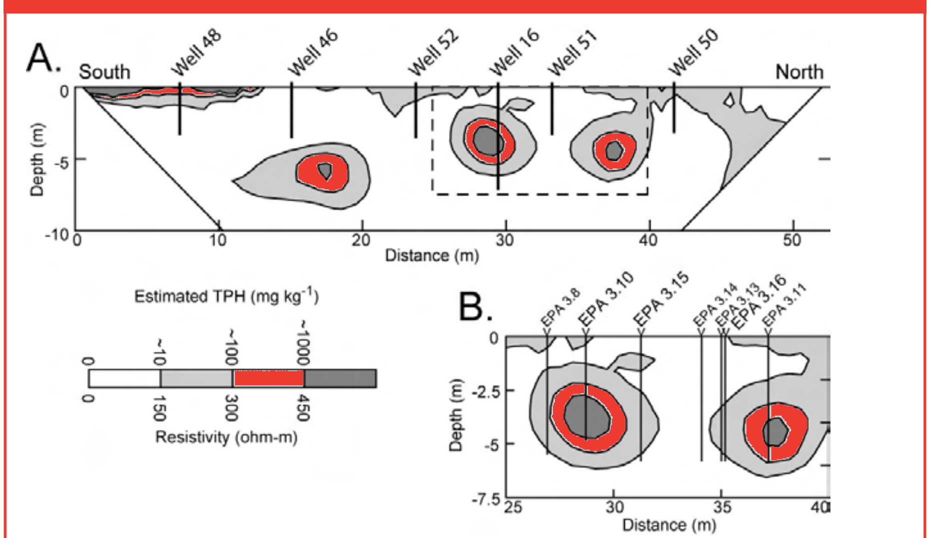
This site had a significant gasoline vapor intrusion into a nearby State Department of Human Services building, creating health concerns for employees. There were no obvious source sites nearby (e.g., a gas station). A consultant had already characterized the site and had not discovered NAPL sources but did discover high levels of VOCs in the vadose zone. Although a shallow soil-vapor-extraction trench was installed next to the building, the vapor intrusion into the building was not fully mitigated.

ERI geophysics was used to survey the area around the building (Figures 5 and 6). The images suggested that the NAPL sources were slightly deeper than what had previously been the deepest soil-boring depth (i.e., greater than 12 feet).

The previous characterization had been conducted using direct-push, which encountered refusal from a hard layer at about 12-feet deep. A larger auger-type rig was brought to the site and advanced soil borings to confirm the ERI geophysics image results. In every case where ERI images indicated the likely presence of a NAPL blob, NAPL was discovered in the soil boring. At the conclusion of the ERI geophysics work, a three-dimensional ERI image was created using a resistivity value roughly equivalent to NAPL locations at this site (Figure 6).

Note that the NAPL blobs were all discovered slightly below the 12-foot depth where the hard layer was encountered by the direct-push rig. Also, some of the NAPL blobs were deeper than the current water table. As a result of this work, the Oklahoma Corporation Commission, PSTD is now considering alternative methods of source removal.

FIGURE 4. *Electrical image EI-2-NS from Golden, OK site (modified from Halihan et al., 2005a). A) Vertical lines in image indicate the location of monitoring and remediation wells. Dotted line indicates area of inset. B) Vertical lines indicate the location of EPA soil borings used to sample high resistivity anomalies. Notes: Estimated TPH values are an approximation, and resistive surface anomalies correspond to soil variability, not hydrocarbon contamination.*



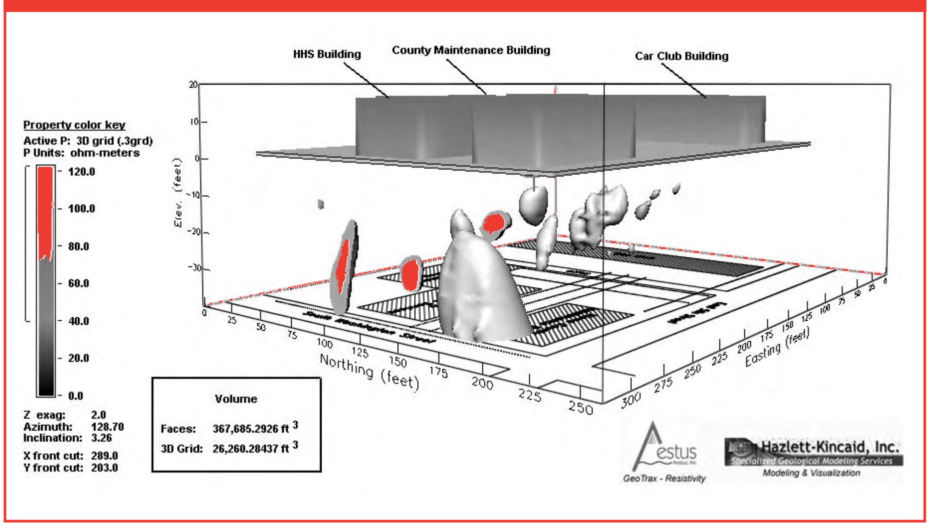
Designing Better Ways to Characterize NAPL Sites

The bottom line is that the LUST cleanup industry needs better tools and a new "recipe" for characterizing NAPL-impacted sites. Because drilling alone does not allow NAPL sites to be characterized without significant unknowns, these unknowns often manifest themselves as future liabilities for project stakeholders.

The use of improved characterization techniques/paradigms will lead to more accurate site-conceptual models. Such models will ultimately yield more realistic and reliable results during the remediation and monitoring phases of these projects. Stakeholders will better understand the extent (or lack of extent) of environmental impacts being addressed and will ultimately become less frustrated. Site remediation will become more predictable, reducing surprises

FIGURE 5. *Two-dimensional ERI geophysics of site in Hobart, OK during site characterization. Dotted lines indicate the location of ERI geophysical data lines. Fifty-six electrodes were used to obtain the dataset along each line. The isoshells in red represent the approximate location of free product.*

FIGURE 6. *Three dimensional ERI geophysics of site in Hobart, OK during site characterization. Image is positioned looking from the northeast towards the southwest. The isoshells in red represent the approximate volume of the subsurface that has free product on the site. Note the color scale of this figure is slightly different from Figure 5 to show detail in each view.*



and years of monitoring the unknown.

ERI geophysics has the potential to be integrated throughout various phases of the site-cleanup process. As a first step, ERI geophysics can be used to direct the drilling for improved site characterization. During remediation, ERI geophysics can be used to track the progress of remediation efforts. When NAPL removal is believed to be complete, ERI geophysics can be used to confirm that the site is devoid of NAPL blobs. Although this article is focused on NAPL blobs, it should be noted that many case studies exist where ERI geophysics has been successfully used to semi-quantitatively locate and track NAPL-related dissolved-phase contamination in groundwater.

Future Directions

In order to better manage the risks and uncertainties that surround LUST and other environmental site investigations, we believe geophysical techniques will play a significant role. More and more evidence supports the assertion that our current understanding of contaminant behavior in the earth's subsurface is not very good, largely because our view of the world to date has been derived predominately from borings and monitoring wells.

The consequences of this poor understanding are far reaching—it costs more money to characterize a site and more time to remediate a site. The impacts may even affect a project stakeholder's company balance sheets via environmental liability reporting. It is critical that we have a good understanding of these sites and a sound site-conceptual model from the outset. We are confident that high-resolution geophysical approaches, tied to confirmation borings, will become the new standard in site characterization, as stakeholders demand more certainty and less risk from their site-remediation investments.

ERI and other techniques will evolve toward full three-dimensional site characterization methods. The characterization process will require that data be collected and visualized in three dimensions or four dimensions (i.e., three-dimensional data tracked over time) so stakeholders of all backgrounds can understand the problems and the potential solutions.

Computing and software improvements will drive this technology forward—a process that has already occurred in the medical field as CAT scans, MRIs, and X-rays have become the first ingredients in that industry's new "recipe" for dealing with "unknown subsurface problems" before operating on a patient.

Historically, the progression of ideas has always evolved from doubt to argument to acceptance and finally to a state of obviousness. What is originally controversial becomes obvious and other ways of approaching environmental problems become quaint or "old school." We should always remember that young technologies need to be introduced to the world with a little care, and that those that become proven will help us foster the health of the environment. ■

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Michigan's Noninvasive UST Assessment ODYSSEY

by Dan Yordanich

Since 1999, I've had the task of coordinating the litigation and the development and implementation of an enforcement initiative for the largest and most important case to date involving Michigan's underground storage tank regulations. The case involved a noninvasive assessment methodology based on predicting the leak-free life of a storage tank that could be used to determine whether an UST was suitable to be upgraded by installing a cathodic-protection system.

As I sit here pondering the task of writing this article, I have to wonder whether other states have experienced similar problems with these noninvasive assessments. This story is about our odyssey of litigating and enforcing this case and the results of our findings. For many of you, I suppose, our findings will come as no surprise. This is the Michigan story. Draw your own conclusions.

The Alternative-Methods Route

On December 22, 1988, when the federal 40 CFR Part 280, Underground Storage Tank; Technical Requirements, became effective, many states followed suit either by adopting the provisions of the rules or by adopting the provisions of the rules with state-specific amendments. In response to the threat posed by a very large population of existing bare-steel storage systems, the rules required the mandatory upgrade of these USTs by no later than December 22, 1998.

To meet the requirements of the rules, USTs could be upgraded by internal lining, cathodic protection, or a combination of both. For bare-steel USTs being upgraded with cathodic protection, the integrity of the tank had to be established by using one of four methods:

- The tank is internally inspected and found to be structurally sound and free of corrosion holes;
- The tank is less than 10 years old and can be monitored for leaks using a monthly monitoring method (not inventory control) after the application of cathodic protection;
- The tank is less than 10 years old and is assessed for corrosion holes by undergoing a tightness test before and three to six months after the installation of cathodic protection; or
- Some other method if approved by the implementing agency.

This story involves the development, use, and approval of a method of assessment allowed by the fourth option.

U.S. EPA recognized that alternative assessment methodologies had been developed by the cathodic-protection industry and chose to not include them at the time the rules were adopted because an industry-wide consensus code had not been established. To be competitive with the internal-lining industry, the cathodic-protection industry set about to develop a consensus code.

In January 1995, an industry-wide consensus code for alternative methodologies was established and published as the American Society for Testing and Materials (ASTM) Designation: ES 40-94 *Emergency Standard Practice for Alternative Procedure for the Assessment of Buried Steel Tanks Prior to the Addition of Cathodic Protection.*

This emergency standard indentified three alternative methodologies for the assessment of buried steel tanks:

- a noninvasive method using a statistical evaluation of site data to predict corrosion failure (i.e., perforation)
- an invasive method using predictive analytical models in conjunction with video camera inspection
- a method using robotic devices equipped for ultrasonic inspection.

This story is about the first of these methods.

It is important to note that ASTM ES 40-94 required that prior to evaluating the suitability of tanks for upgrading with cathodic protection, tanks had to be tightness tested by an approved method to establish that they were not leaking. According to the emergency standard, tanks 10 years old or older found to be leak-free with a probability of corrosion failure of less than 0.05 could be upgraded by cathodic protection.

The Michigan Department of Environmental Quality (MDEQ) was fortunate to have had a senior-level engineer serve on ASTM's Subcommittee E50.01 on Storage Tanks who provided valuable insight regarding these alternative assessment methodologies, and who recommended that MDEQ not adopt this ASTM emergency standard.

Even though EPA recommended the use of the methodologies identified in ASTM ES 40-94, MDEQ did not adopt this standard because it believed that the Michigan UST rules provided adequate authority to the agency to approve or reject alternative methodologies. MDEQ was not convinced that the standard provided adequate justification for accepting only the methods described in the standard, and most importantly, adopting the standard would limit the agency's ability to provide a thorough technical review of the alternative methodologies being proposed. MDEQ chose to review and approve alternative methods on a case-by-case basis.

Corrosion Processes

Before I proceed, let me interject a brief description of the corrosion process, which can proceed in two distinct ways that have important consequences on the useful life of a buried structure. The first of these two processes is *pitting corrosion*, which occurs when anomalies exist in backfill in direct contact with the buried structure or on the surface of the structure. Pitting corrosion is the result of a high rate of corrosion concentrated on a small portion of the surface area of the structure and is not uniform.

The second process is *uniform corrosion*, which occurs when there are no anomalies in the backfill of the buried structure or on the surface of the structure and corrosion occurs uniformly over the structure's surface. Uniform corrosion occurs as the result of a very low rate of corrosion. In general, buried structures are more likely to be subjected to pitting corrosion than uniform corrosion.

EPA's *Causes of Release from UST Systems* (EPA, 1987) study concluded that about 50 percent of the corrosion holes in tanks were plugged and did not leak, and that approximately 7 percent of USTs 12 to 15 years of age were leaking. The study also concluded that as many as 7 percent of existing USTs were corroded through but not leaking. This may be because corrosion-induced "rust plugs," backfill, and interior sludge seal the holes (Figure 1). In addition, information obtained by EPA from industry experts indicated that cathodic protection can cause these "rust plugs" to loosen, triggering a release soon after cathodic protection is applied to the UST.

FIGURE 2. *Internal corrosion so severe the tank could not be repaired for lining. The assessment of this tank predicted uniform corrosion.*

Approving Alternative Methods

So, with MDEQ's decision to review and approve alternative methods on a case-by-case basis, an international company that represents a coalition of cathodic-protection companies specializing in analyzing corrosion problems and designing and implementing programs to stop corrosion on all types of structures enters the picture. The company sought Michigan's approval to use a noninvasive technology to assess USTs to determine their suitability for cathodic-protection upgrade.

The company indicated that it had worked closely with a well-known statistician to develop a noninvasive assessment methodology that was (interestingly enough) similar to the noninvasive assessment method specified in ASTM ES 40-94. This methodology used a proprietary statistical analysis model composed of many probability measures that incorporate site-specific information to predict the expected leak-free life and present and future probabilities of corrosion failure for the UST being investigated.

The method determined, among other things, the conditional probability of corrosion failure given pitting corrosion (CPL), the probability of localized corrosion (an "unconditional" probability of pitting corrosion), and the expected leak-free life of the tank if pitting corrosion exists. The company's recommendation for cathodic-protection upgrade was to be based on these determinations.

In reviewing the proposed noninvasive assessment method, MDEQ recognized that it had merit as an assessment tool; however, the agency also recognized that the method did not allow for the assessment of all conditions, such as tank-wall thickness, internal corrosion[1] (Figure 2), or structural defects that could lead to tank failure, or the need to install striker plates (Figure 3). MDEQ concluded that the method should not be approved without added conditions.

One of the most important conditions MDEQ placed on the use of this methodology was that should the noninvasive assessment of site-specific information result in a tank having a CPL in excess of 0.05, the tank would need to pass an internal

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1 The procedure for noninvasive assessment described in ASTM ES 40-94 did require the determination of the presence and extent of internal corrosion, but only immediately below the fill riser.

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inspection to ensure its structural integrity prior to upgrade. MDEQ did not approve the use of the "unconditional" probability of localized corrosion. MDEQ reasoned that if the tanks had no perforations or leaks when the CPL was determined to be high (>0.05), then one would conclude that the "unconditional" probability of localized corrosion was very small, and therefore assume that uniform corrosion was taking place. MDEQ did not want to make this assumption.

In July 1995, MDEQ issued *conditional* approval of this noninvasive methodology. In its approval, MDEQ did not make any reference to the ASTM ES 40-94 standard or any other standard, since the approval was based exclusively on the company's proposal.

It is noteworthy that upon notification of MDEQ's conditional approval of the noninvasive assessment method, the company did not request clarification, reconsideration, or modification of the terminology used or the conditions imposed by MDEQ.

The Beginning of the End

While the company was not required to submit noninvasive assessment reports directly to MDEQ, we acquired several reports from owners as part of our regulatory function. Upon review of these reports, it became clear that the company was recommending cathodic-protection upgrades of tanks that had failed the CPL and was basing its recommendation on the "unconditional" probability of pitting corrosion, a part of the procedure that Michigan had specifically NOT approved.

Late in 1997, MDEQ notified the cathodic-protection company that its conclusions and recommendations were in direct contradiction with the conditions on our approval of the methodology. Negotiations between the company and MDEQ intensified as the company tried to convince us that we did not understand the terms or the statistical process used in its method and requested that we approve the full assessment methodology.

MDEQ claimed all along that we fully understood the terminology and statistical process used and that we intentionally sought to limit the process so that it was, we believed, no less protective of human health and the environment than Michigan's UST regulations required.

FIGURE 3. *The noninvasive assessment methodology did not address the need to provide striker plates in USTs to prevent holes being formed under the drop tubes. For this heavily pitted tank, the noninvasive assessment predicted uniform corrosion.*

Meanwhile, it appears the company altered its reporting format in a manner that made it difficult for us to determine the statistical probability basis for the recommendation that an UST was suitable for upgrade. Based on these reports, USTs continued to be upgraded.

During the period of negotiations, MDEQ received at least three reports of tank failure at facilities where the USTs were assessed and recommended for cathodic-protection upgrade, based on the use of this noninvasive assessment methodology. The tanks at two of these facilities were found to be severely pitted and perforated (Figure 4). The UST at the third facility had a split weld seam; however, there was no determination as to whether the weld seam failed as a result of corrosion or some other structural deficiency.

Once extensive negotiations had failed to yield an agreement and MDEQ recognized that numerous existing USTs could present an unacceptable risk to public health and the environment, MDEQ issued a January 2000 final decision to reaffirm its original conditional approval and deny the company's request for approval to use the full methodology.

Litigation and Due Process

Once MDEQ issued its final decision, the company appealed. In November 2000, Michigan's circuit court issued an order affirming MDEQ's decision. The order was appealed through Michigan's judicial system until, in August 2001, the Michigan Supreme Court denied the company's application for leave to appeal.

Late in 2001, the company voluntarily provided MDEQ with records for over 400 facilities in Michigan for review to determine whether the violations and the potential risks to public health, safety, welfare, and the environment were of substance rather than form. After reviewing these records, MDEQ determined that USTs in use at approximately 253 facilities had been assessed and upgraded with cathodic protection contrary to MDEQ's conditional approval of the method.

As a result of this review, in July 2002, we provided notice to the owners of these facilities informing them of our findings and advising them of the corrective actions they needed to undertake to bring the affected UST systems into compliance. While MDEQ did not establish a deadline for compliance, a one-year deadline was conveyed verbally to owners, industry representatives, and the court.

In light of the courts' findings and the realization that they would be facing potential enforcement

FIGURE 4. *Perforation in end cap.*

[Editor's note: To view more MDEQ photographs of various causes of tank failure, visit the NEIWPCC website at www.neiwpcc.org.*]*

actions, such as red-tagging to prohibit delivery of product to substandard USTs, the owners of affected USTs filed suit against the cathodic-protection company and MDEQ in July 2002. The suit sought to establish a class action against the company and prevent MDEQ from taking enforcement actions.

In September 2002, the court denied the motion to prevent MDEQ from taking enforcement actions and ordered the parties in litigation to establish a schedule that would allow the affected owners to perform the corrective actions required to return their USTs to compliance. In November 2002, the court granted the motion to certify the class of affected owners.

One of the primary concerns of the affected class and the court was that MDEQ would take actions against the affected parties without giving adequate notice and the opportunity to show compliance. MDEQ was concerned about due process because of the potential that the enforcement actions could result in many separate instances of litigation.

With these concerns in mind, MDEQ outlined for the court the administrative process it would follow in taking action against an owner of a facility with noncompliant USTs. The process entailed a series of three notices, whereby the owner was given deadlines for bringing USTs into compliance and an opportunity to prove, by the submittal of substantiating documentation, that the USTs were in compliance. In July 2003, MDEQ initiated the first step in this administrative enforcement process.

In October 2003, the court granted and approved a settlement between the tank owners/operators and the company. By this settlement, the owners/operators agreed to fully and forever release and discharge the company from any and all claims and causes of action of every kind, nature, and description which they, collectively and individually, may have had, or may now have, or possibly could have against the company in return for payment from the company.

Finally, in December 2003, the court granted MDEQ's motion to have the affected class's claim against MDEQ in the original suit dismissed. With this dismissal, MDEQ was free to fully implement the administrative enforcement process outlined for the court.

Process Results and Findings

The initiative that was undertaken to enforce the upgrade requirements of Michigan's UST rules began with the identification of 253 facilities and includes information about 260 facilities. This amounts to approximately 900 USTs that MDEQ determined were assessed and upgraded with the installation of cathodic protection in a manner contrary to MDEQ's conditional approval of the noninvasive assessment methodology. The data described here were obtained by MDEQ as a result of internal inspections or observations made during excavation of these USTs at the time of closure.

Since the beginning of the initiative, MDEQ has achieved a 97 percent facility compliance rate with the internal inspection and permanent closure requirements. The remaining 3 percent of noncompliant facilities have been abandoned or are otherwise not currently in use, and the USTs were red-tagged to prohibit product delivery.

Of the approximately 900 tanks involved, a total of 340 USTs were excavated. Of those, MDEQ staff conducted 172 external inspections to determine the type of corrosion process that was taking place. Based on these inspections, pitting corrosion was determined to be the operative corrosion process on 79 percent of the USTs, and uniform corrosion was the operative corrosion process on the remaining 21 percent.

Of the facilities where pitting corrosion was observed to be the operative process on one or more of the USTs, MDEQ determined that at 72 percent of these facilities the site conditions did not justify the company's assumption that uniform corrosion was the operative corrosion process.

To date, a total of 509 USTs have been inspected internally to determine structural integrity—visual inspection and gauging ultrasonic thickness of the tank shell in accordance with the requirements of National Leak Prevention Association, Standard 631 (NLPA 631) entitled *Entry, Cleaning, Internal Inspection, Repair and Lining of Underground Storage Tanks* – with Appendix MI (1991). It should be noted that because of the obvious limitations of internal inspections, the corrosion process that is operative on the outside surface of an UST and the degree to which that process is occurring cannot be determined with complete certainty or accuracy.

Of the USTs inspected internally, approximately 8 percent failed the internal inspection due to pitting corrosion or perforations, and less than 1 percent failed due to uniform corrosion. Nearly 5 percent of the USTs failed the structural integrity requirements of NLPA 631, because the UST was more than 2 percent out of round, had a split weld seam, or

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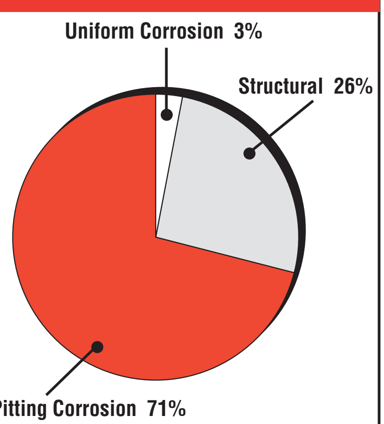
had dents or flat spots exceeding the criteria for tank repair.

Of the 252 facilities (out of the total of 260) where corrective actions were performed to remove or internally inspect USTs, 19 percent were found to have one or more perforated USTs. Of the 681 USTs that were externally or internally inspected, 10 percent were found to be perforated due to pitting corrosion.

It is important to note that the main objective of an internal inspection is to assess the structural integrity of an UST, and not just whether or not the UST has perforations. In examining the causes and frequency of tank failure, we determined that 94 out of 681 USTs that were visually or internally inspected failed because of a structural deficiency. Of these USTs, 71 percent failed due to pitting compared to a 3 percent failure rate due to uniform corrosion. UST failure due to other structural deficiencies, such as the tank being out of round, occurred in 26 percent of the failed USTs.

THE RATES FOR CAUSES OF UST FAILURE



Other Findings

It should come as no surprise to the seasoned tank regulator that as a result of our close scrutiny of this population of facilities and USTs, MDEQ found other deficiencies that were affecting the operation and maintenance of the UST systems and our ability to regulate them.

During inspections of excavated USTs, we found that damage to the asphaltic or dielectric coating on the outer surface of an UST that occurred during installation could cause preferential corrosion to occur where the bare metal was exposed to the corrosion processes.

Of facilities performing corrective actions, 33 percent reported confirmed releases. MDEQ was unable to determine the exact number of releases that were attributable to the improper assessment of the UST's suitability for cathodic-protection upgrade or to historic releases from other USTs at the facility, piping, or overfills. However, a review of MDEQ records from prior to this initiative showed that there were a number of facilities that reported releases within six months, or shortly thereafter, following cathodic-protection upgrades that MDEQ believes are attributable to the dissolution of "rust plugs."

During our initiative, nearly 8 percent of the USTs inspected internally failed due to pitting corrosion or perforations; however, when we reviewed tank-tightness testing, leak detection, and monthly monitoring records, there was no evidence that the USTs were leaking at rates detectable by the release-detection methodology being used. This finding coincides with concerns expressed by EPA in the preamble to the federal rules that as many as 7 percent of existing USTs are corroded through but not leaking because "rust plugs," backfill, or interior sludge seal the hole.

We also found that the vast majority of the owners/operators were not performing the required three-year cathodic-protection system testing or inspecting their impressed-current cathodic-protection systems every 60 days, as required by state and federal regulations. In addition, many owners/operators had performed repairs to their facilities or other UST system components that severed buried cables or otherwise caused damage to the impressed-current cathodic-protection systems, rendering the systems incapable of providing adequate cathodic protection to the USTs.

MDEQ also questioned the accuracy of some information on the construction of USTs reported on registration forms. This tended to be the case where UST ownership changed numerous times, and the subsequent owners apparently did not verify tank construction prior to purchase. Nearly 8 percent of the USTs targeted during this initiative that were reported to be cathodically protected steel were either fiberglass, steel with fiberglass coating (composite tank), or sti-P3® tanks. Unfortunately, several sti-P3 tanks that appeared to be in good condition were excavated.

In instances of discovery or claim of an sti-P3 tank, MDEQ required further cathodic-protection testing or documentation to prove the UST was adequately protected by the sacrificial anode at the time of installation of the impressed-current cathodic-protection system. If a sti-P3 tank was found to be inadequatley protected, an internal inspection was required by MDEQ.

The problem of accurately reporting information on UST registration forms only highlighted the need for owners to verify tank construction prior to purchasing facilities and the complications implementing agencies encounter that hinder effective implementation of the UST program.

How Many More Out There?

The continued use of noninvasive assessment methodologies to predict the suitability of USTs for cathodic-protection upgrade is unlikely with the passing of U.S. EPA's 1998 deadline for upgrading bare-steel USTs of a certain age. However, these methodologies could be used to evaluate bare-steel USTs in other countries, bare-steel USTs not regulated by federal and state UST rules, as well as other buried metal structures, such as pipelines.

I will let you draw your own conclusions regarding the effectiveness of noninvasive assessment methodologies to predict UST failure due to corrosion as the sole means of assessing the suitability of an UST for cathodic-protection upgrade. Regulators should consider our findings, together with the means by which they regulate their UST programs, when evaluating whether or not there exists a population of USTs whose cathodic-protection upgrade, based on the use of noninvasive assessment methodologies, is suspect and should be subjected to further scrutiny. ■

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Tanks Down East

by W. David McCaskill

David McCaskill is an Environmental Engineer with the Maine Department of Environmental Protection. "Tanks Down East" is a regular feature of LUSTLine. *David can be reached at* David.Mccaskill@maine.gov. *As always, we welcome your comments.*

SHIPSHAPE FROM STEM TO STERN

Maine's Comprehensive Annual Third-Party UST Inspection Program

Penobscot Bay is a stunning place, studded with spruce-trimmed granite islands, the exposed tops of drowned mountains left over when the glaciers completed sculpting their masterpiece some 13,000 years ago. Plying these cold, bold waters are elegant two- and three-masted schooners that look more organic than mechanic. In this real-life Earth Sea, all creatures and crafts must be well built and well maintained to withstand the rigors of winter, wind, and wave. Here in Maine, we have a tradition of making sure that all things—200-year-old farmhouses, 125-year-old schooners, or 15-year-old USTs—are shipshape from stem to stern.

In this installment of "Tanks Down East," we'll take a look at how Maine's annual third-party inspection program has fared the rigors of ensuring that our UST systems are performing their dual duties of providing for our energy needs and protecting precious groundwater resources.

Our Inspection Law

Annual UST inspections have been required in Maine since 1991, but the inspection results were not required to be reported to the Department of Environmental Protection (DEP). In 1995, we started sending out letters to our petroleum-containment captains (owners/operators) to remind them of their sacred inspection duties. But a study conducted in 2000 found that only 25 percent of our UST systems were being inspected, and of the facilities inspected, 35 percent had deficiencies that remained unfixed year after year. (See *LUSTLine* #38, "There Ought to Be a Law!")

In 2000, our inspection law was amended to require *all* UST owners to submit annual UST inspection results to DEP on or before July 1, 2003, and on or before July 1 annually thereafter. In Maine, we regulate all underground petroleum tanks, including those used to heat homes, schools, and businesses. So this inspection requirement touches a bunch of different folks besides your typical gas station operator. The inspections are paid for by the owner/operator and cost between $250 and $500, depending on the number of tanks at the facility and the kind of equipment on the site.

The Inspection Report

Failure to submit a passing inspection report can result in the ultimate penalty—a shutdown order. The inspection must be performed by a certified inspector or tank installer. The inspection report form, which was developed by our crack DEP UST staff, summarizes all the required annual inspection criteria in Maine's UST rules. The goal of the new law is to ensure that the inspections are undertaken and that any deficiencies discovered are corrected.

The items to be inspected include the oft-repeated litany of the practiced UST regulator—leak detection, corrosion protection, and spill- and overfill-prevention equipment. But in Maine, the inspection consists of seeing not only that these components are present, but that they are, in fact, in good condition, installed properly, and operating correctly.

The inspection includes a functional test of all significant components—interstitial space probes, gauge sticks, inventory control records, cathodic-protection readings, spill buckets and their often-broken lids, and the proper operations of those fickle flapper valves and their evil equivalent, the ball-float valve!

Prior to the change in the annual inspection requirement, the reporting forms were vague, to say the least. Following the implementation of our new inspection form, it was still apparent that some inspectors were simply identifying the type of UST equipment at a facility and not necessarily removing each item and inspecting it for proper operation. During the first season of the new inspection requirement, DEP identified a number of facilities where electronic sensors and overfill-prevention devices were inoperable and apparently had been for some time. In other cases, there was no access to this equipment provided during the initial tank installation and therefore no way to properly inspect the equipment.

So we've continued to improve upon our inspection form. That's why it is now eight pages long and has a 22-page handbook to go with it. (Go to *http://www.maine.gov/dep/ rwm/ ust/annualinspects.htm* to see what's on the form.)

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■ **Maine's Third-Party UST Inspection Program** *from page 31*

A New Tank-Inspector Class

With our new inspection program we had to create a whole new class of licensed technician—the certified tank inspector. We already had about 85 certified installers who were automatically qualified to be tank inspectors, but the industry had concerns that there would not be enough certified tank installers to perform all these inspections. (To become a certified tank installer, you must apprentice under an installer at four UST installations and take an initial and final written test.)

Since few new tanks were being installed in Maine, it was difficult to attract people to the business. However, many tank and pump companies had pump technicians who were factory trained to work on various kinds of UST equipment and who could potentially fill the inspector gap. Before the inspector program, our UST rules allowed only certified tank installers and manufacturer-certified persons to perform the annual equipment inspections.

The manufacturer-certified persons were not under the jurisdiction of our tank installer board. This created a somewhat unlevel playing field in that certified installers could be fined or disciplined for improper behavior, but manufacturer-certified persons had no one to put them to the lash!

There were a few existing companies that were using their manufacturer-certified personnel to perform inspections, but they were limited in what they could work on. For example, to test the cathodic-protection readings you had to hire a certified tank installer or NACE-c ertified cathodic-protection tester (of which there are very few).

To deal with all of these issues, we developed the certified tank-inspector class. To become a certified tank inspector you must pass a very comprehensive test. Certified tank inspectors must still be manufacturer certified to work on manufacturer-certified equipment and must be NACE certified for cathodic-protection testing if they choose to test that portion of an UST facility. Currently there are about 27 certified tank inspectors. So between this new group of tank inspectors and our 85 installers, we now have about 112 certified tank inspectors out there.

Getting Ready

We knew that such a new and comprehensive program would have some growing pains. So we decided to commit resources upfront to provide several statewide training venues for inspectors and installers and send mailings to facilities owners. As part of our preparation, we convened a work group with installers to help us develop and critique our inspection report form. In 2002, we set out on a statewide voyage to train the installers and inspectors and to get even more input.

How's It Going?

In 2004, of the 3,180 registered UST facilities in Maine, 2,276 submitted a passing inspection report, 205 submitted only a failed report (i.e., they didn't get the problems fixed in time), and 699 didn't submit any report. After invoking the whole suite of our usual regulatory torture tools—follow-up letters, phone calls, and compliance inspections—we had a "shutdown" list with just six facilities located in sensitive groundwater areas.

The shutdown orders gave facility owners 30 days to come into compliance with the inspection law (i.e., fix their UST systems so that they would pass) or they would have to shut down their pumps. All six got their systems shipshape prior to the 30-day compliance deadline.

Based on our preliminary results for this year, the number of owners/operators that are not sending in inspection reports has been, roughly, cut in half. It's getting better, and we are planning to use the same strategy for this round of nonconformers. After a few more years, using a combination of hand-holding and wrist-slapping, we'll hopefully reduce the number of brigands to a minimum.

Checks and Balances

So, at least once a year, all the things you wish the owners/operators would pay attention to are examined by a knowledgeable person. At least once a year, product and/or water in sumps is pumped out, the probe is put back in place where it can do its job (not hanging a foot above the bottom of the sump!), and the leak-detection console alarm is reset. We also gain all this data for trend analyses on equipment failure and the effectiveness of our inspection form and our rules, so we can tweak, as needed.

Suspicious-minded regulators may wonder what will keep unscrupulous inspectors from passing their favorite customers year after year. We have several checks on such behavior. Our inspectors are certified by the Maine Board of Underground Tank Installers, so there is an incentive to "do the right thing." Otherwise, if they are caught they will be referred to a disciplinary board where they can be fined or lose their licenses. There are several ways to be caught. Our staff perform between 400 and 500 compliance inspections a year where we field truth the inspection data.

Competition also serves as a check on the program. In the yearly mad dash to get their tanks inspected, some owners wait until late in the inspection season and find that their usual inspector is booked. So they hire another inspector, who may see things in a different light.

For example, there have been flaps over the flapper valve among inspectors. The flapper valve is an overfill-prevention device that sits down in the drop tube of the tank and is set to reduce flow at 95 percent of the tank volume. It shuts off flow all together at 98 percent. The difference between 95 percent flow reduction and 98 percent shut-off gives the driver room to drain the delivery hose.

During an inspection, the inspector is required to pull out the flapper-valve assembly to check that it is operating properly and set at the correct height. There have been cases where a facility's regular inspector has passed the same flapper valve year after year, but then a new, hired-at-the-last-minute inspector finds the valve set higher than the required 95 percent (allowing more product to be squeezed into the tank and increasing the risk of an overfill). (See *LUSTLine* #49, "Small Spills Count.")

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Field Notes

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

PEI Introduces Online Owner/Operator Training; Revises UST Installation Document

Online Owner/Operator Training

Online training designed to assist owners and operators in understanding and operating their underground petroleum storage systems is now available through the Petroleum Equipment Institute (PEI).

The training, provided through the PEI Learning Center at *www.pei.org/learn*, currently includes courses that teach owners and operators:

- The main features of their Veeder-Root TLS-350 automatic tank gauges, including inventory, leak detection and important alarms
- The fundamentals of how their pressurized pumping and dispensing systems work, and what needs to be done to detect leaks in these systems
- The basic principles of operation, potential pitfalls, and operation and maintenance procedures associated with spill-containment and overfill-prevention equipment.

The courses are designed with the audience in mind. Students view short video lessons (each about two minutes long) that depict authentic characters in real-world scenarios who learn from a peer. A friendly technician, an experienced brother-in-law, or a knowledgeable pump and tank contractor explains what students need to know to operate their storage systems knowledgeably, safely, and within the requirements of the federal regulations. While a video window provides a story line and audio information, an accompanying graphics window provides pictures, graphics, animation, and summary notes that further explain and illustrate the course content.

The lessons are followed by multiple-choice quizzes that reinforce the information that has just been presented. At the end of the course, students may download or print course materials for future reference. After completing a final exam, students may print a certificate of course completion. Courses cost $79 and take about an hour to complete. Any computer with a high-speed Internet connection and sound capabilities can be used to access the courses 24/7.

Course content has been carefully researched and reviewed by a panel of equipment manufacturers, installers, distributors, service companies, tank owners, and state and federal regulators. While specifically targeted for UST operators and owners, the courses are ideal for newly hired UST regulators, service technicians, and sales or customer service personnel who need to understand the fundamentals of UST operation and maintenance.

State UST regulators are encouraged to provide a link to the PEI Learning Center on their websites so anyone seeking UST information can easily find the training they need.

These courses represent the first offerings in PEI's online UST university. Future courses being considered include fueling safety, dispenser inspection and maintenance, and cathodic protection of tanks and piping. If you would like to recommend topics for future course development, contact Bob Renkes at PEI: (918) 494-9696.

RP100 – 2005

The 2005 edition of PEI's *Recommended Practices for Installation of Underground Liquid Storage Systems* (PEI/RP100) is now available. This edition supersedes the previous recommended practices of the same name that were published in 2000. PEI revises RP100 when warranted to ensure that users of its documents receive the latest guidance on the proper methods and techniques for installing UST systems.

PEI's Tank Installation Committee reviewed 118 suggestions submitted by various individuals and groups to revise the previous edition of PEI/RP100. Over 50 percent of these comments were accepted in some manner by the committee. Significant changes in the 2005 edition include:

- A recommendation to install monitored containment sumps around submersible pumps and beneath dispensers
- A recommendation against the use of ball-float valves for overfill prevention
- An expanded discussion of piping testing requirements during and after installation
- A requirement that UST owners establish an inspection, maintenance, and testing schedule for their storage system equipment.

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Revitalizing Contaminated Sites: WE'VE COME A LONG WAY, BABY!

by Edward H. Chu

Over the past three decades, we have seen an evolution in the way our country approaches the assessment and cleanup of contaminated sites. As we've come to realize the extent and magnitude of our environmental problems, we've (appropriately) focused our attention squarely on addressing the immediate threats to our health and well-being. During the formative years, we struggled to better understand the threats and figure out how best to address them. Our more mature land cleanup programs now reflect hard-wrought experience in assessing and cleaning up contaminated sites, whether from hazardous wastes or petroleum and petroleum-related products.

With this maturity comes wisdom. For example, we now better understand the social and economic context that contaminated sites have in their respective communities, and the potential that these sites have to improve the well-being of people in those communities. We also understand that land is a valuable and finite resource and that ignoring previously developed, and sometimes contaminated, land has profound impacts on our quality of life.

In short, we understand the importance of reusing sites with real or perceived contamination once they've been assessed and cleaned up. Communities, too, are seeing the opportunities to reclaim sites following cleanup, and some developers and others with an interest in the land are increasingly eager to meet their needs.

In keeping with this movement, those of at U.S. EPA have a very simple vision and goal for our cleanup programs—to restore and return all contaminated (and potentially contaminated) properties to America's communities so that they can reuse the land for beneficial and productive purposes. In creating this new vision for our cleanup programs, we are shifting our focus from cleanup only to cleanup *and* reuse.

To carry out our revitalization vision, EPA established the Land Revitalization Office to coordinate and promote efficient cleanup and reuse of contaminated properties across the agency's land programs and to remove or minimize barriers that may be preventing site reuse from occurring. Our success requires a cooperative effort among EPA, states, tribes, local governments and communities, potential developers, and others. We have nothing to lose and a whole lot to gain. Let's consider the sense of all of this and find out what EPA has to offer, so we can really begin to move forward.

Assets Galore!

The cleanup and reuse of contaminated sites is a critical element in ensuring the health and well-being of communities. This is particularly true for former gas stations and other properties with idle, abandoned, or leaking USTs, where the revitalization opportunities are tremendous. There are more than 250,000 of these sites across the country! Most of these properties are located in urban areas, along business corridors, and in places where people live or work. They tend to involve small parcels of land and are often situated on corner lots and other prime real estate locations.

Because these sites are often surrounded by other idle or abandoned properties, they also tend to be the linchpin to area-wide revitalization efforts. These points were not lost on Congress when it enacted national brownfields legislation three years ago to support the reuse of the vast majority of LUST sites, and these points are not lost on EPA.

The new law expanded the original U.S. EPA Brownfields Program by including relatively low-risk petroleum sites as eligible sites for brownfields assessment and cleanup grant funding. Under the law, EPA makes 25 percent of the total brownfields grant funds available each year for these sites. In 2005, EPA awarded approximately $22 million in brownfields grants to petroleum-contaminated sites. Recipients include abandoned sites, such as gas stations, and industrial and retail properties that have, or are believed to have, contamination from petroleum.

Imagine That!

Site reuse is an integral and invaluable element in our cleanup programs; more importantly, it allows us to get our creative juices going and use our imaginations. How? Well, for one thing, when site reuse is an explicit component of the cleanup process, we start to see constructive community involvement. Members of the community have something to look forward to—new parks, housing, and retail. They have more reason to find common areas of agreement. We begin to see stronger partnerships among government, private developers, and community organizations because everyone wins when a neighborhood springs back to life.

When you are looking forward to something better, you begin to develop cleanup plans that are tailored to future uses while ensuring their long-term protectiveness. Private funding is often more available because cleanup money is seen as an investment with a stream of future returns. Because the partnerships, planning, and funding are targeted at future potential, not past failures, contamination can be cleaned up more quickly.

Finally, by encouraging sustainable reuses such as green spaces, energy-efficient buildings, smart-growth community developments, and wetlands, we may also be able to prevent the recontamination of former contaminated sites. Imagine that!

Making a Vision a Reality

The Land Revitalization Office has identified the following 10 actions that U.S. EPA is (or will be) taking to make this revitalization vision a reality:

- Promote land revitalization as a national policy by ensuring that reuse options are considered explicitly in the evaluation of site cleanup options.

- Commit the necessary resources to address reuse as a top priority in cleanup decisions. In addition to the brownfields grants that are available, we will look for incentives to encourage private investment and explore ways to better leverage other federal funding. We believe that encouraging private investment is a means to further the public's goal of protection in a timely and cost-effective manner.

- Develop new comprehensive policies and programs to address unintended cross-jurisdiction and cross-program barriers to the safe reuse of previously contaminated properties. Because in the past we have created unintentional barriers to reuse and redevelopment activities that contribute to community well-being, EPA is reviewing its policies, practices, and guidance to reduce and in some cases tear down some of these unintended barriers to beneficial reuse.

- Promote safe, long-term reuse of sites. When we say a property is ready for reuses, we will mean it, for now and later. EPA will promote long-term stewardship by establishing and maintaining appropriate engineering and institutional controls that protect future generations from inappropriate reuse of sites. For example, we are working with states and local governments to address long-term safety issues systematically.

- Promote sustainable reuse to prevent recontamination and minimize other environmental problems that may result from some reuse. Sustainable reuses include such things as green spaces managed in environmentally sound ways, energy-efficient buildings, smart-growth community developments, and wildlife habitats.

- Develop and promote a Land Revitalization Research Agenda that improves our understanding of, and ability to reuse, contaminated or potentially contaminated sites.

- Build partnerships to leverage knowledge, expertise, and resources for revitalizing sites. This includes government-to-government partnerships at the local, state, tribal, and federal levels, as well as partnerships with nongovernmental, private, and community organizations. EPA is going to expand its use of partnerships that can stimulate private investment in cleanup activities, and we're going to do a better job of coordinating multiple federal cleanup programs at area-wide clusters of properties.

By designing cleanups to mesh with community-driven redevelopment plans, developers are able to avoid redundant construction activities, minimize public distrust or opposition, and increase certainty among all principall stakeholders.

- Expand community capabilities by providing improved public involvement tools and information systems on contamination, cleanup, reuse, and long-term stewardship. We hope to ensure early and continuing community involvement. EPA will work with states and tribes to develop a web-based tool so communities, investors, and developers have a national inventory of available clean sites.

- Expand and promote educational and training programs that provide needed tools to achieve land revitalization in such areas as real estate development of environmental properties, risk-management tools (e.g., insurance), and financing.

- Promote efforts to measure and report the status and impacts of our collective efforts to revitalize properties. EPA is exploring approaches for obtaining a better picture of total contamination and mechanisms for measuring progress in restoring and returning land back into use.

Back to Streamlining

This evolution of thought and clarity of focus is beginning to have significant impacts on how we assess and clean up sites under our government programs. For example, in the past, site assessments have been conducted to find contamination and determine whether a cleanup was necessary. Now, these assessments are also used to identify and document where there is no contamination or where cleanup is not necessary.

This information, when made available on a timely basis and in an easy-to-understand format, reduces uncertainty for developers and communities that want to use the land. EPA recognizes the importance of information in the real estate market and the need to ensure that environmental stigma, whether real or perceived, is appropriately managed.

In the area of cleanup, we are seeing more integrated cleanup and reuse activities, which can make revitalization projects happen faster and cost less without reducing their protectiveness. By designing cleanups to mesh with community-driven redevelopment plans, developers are able to avoid redundant construction activities, minimize public distrust or opposition, and increase certainty among all principal stakeholders.

Providing information about sites is equally important to lenders, mortgage companies, and others who may be in a position to support reuse of the sites. Through such information tools as ready-for-reuse determinations and clarification of liability for developers, lenders, and prospective purchasers, previous barriers to redevelopment of contaminated sites are being removed.

Through the Lens of Reuse

There are countless examples of site reuse that have led to increased employment opportunities, increased property values, increased tax revenues, and the potential for additional economic development on

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TANKS ON TRIBAL LANDS

This column focuses on the unique logistical and geographic issues, activities, solutions, and successes associated with USTs and LUSTs in tribal lands. In this issue, Greg Pashia, U.S. EPA Region 6, discusses two award-winning capacity-building projects undertaken by the UST programs of two Oklahoma tribes—the Choctaw Nation and the Chickasaw Nation. Jonathan Hook, Region 6 Office of Tribal Affairs Director, recognized the Chickasaw and Choctaw Nations for "environmental excellence above and beyond the call" during the Region's Ninth Annual Environmental Tribal Summit in Oklahoma City. Chuck Tillman (Choctaw UST program) and Josh Presley (Chickasaw UST program) accepted the awards for their work and the work of Brian McClain, Director, Choctaw Nation Office of Travel Plazas, and Darren Clinton, Regional Manager, Chickasaw Enterprises, in the tribal UST programs.

Kudos for Two Tribal UST Capacity-Building Projects

The Choctaw Nation has 13 tribally owned and operated travel plazas with a total of 43 USTs. The Chickasaw Nation had nine tribally owned and operated travel plazas. Two of the travel plazas have been closed and evaluated for release of gasoline to the environment (no releases were found). At present, the Chickasaw operate seven UST facilities.

The Choctaw, the Chickasaw, and the EPA Region 6 UST program developed capacity-building grant projects that started in 2003 and will conclude in 2006 to train a full-time staff member for each tribe. This staff member's main duty is monitoring the tribally owned active facilities for compliance with all applicable federal UST regulations with regard to the installation, upgrade, repair, removal, and investigation/remediation of any releases to the environment of petroleum product. UST monitors Chuck Tillman and Josh Presley provide their tribes with advice on and oversight of the compliance and maintenance of the UST systems. In addition, Chuck and Josh train the facility staff members who conduct the day-to-day operation of the retail fuel facilities on safety and leak detection.

Both the Choctaw and the Chickasaw have advanced very quickly to a level of expertise on the operation and compliance with federal regulations at all of their travel plazas. The parties involved in the project have willingly and expeditiously followed up on all recommendations from the UST monitors concerning the need for financial expenditures to have the UST facilities managers obtain equipment and UST contractors to address all deficiencies at the UST locations.

A Way of Life

The Choctaw and Chickasaw UST staff monitors continue to acquire knowledge and experience concerning the operation and maintenance of UST facilities through various training opportunities. This knowledge is effectively being transferred to the staff that conducts the day-to-day operation of the UST facilities.

"Prior to this grant," says Josh Presley, "the USTs within the Chickasaw Nation were assessed, but not as thoroughly as they are currently. With the economic growth of the tribe, it is vital that the environment be considered and every measure taken to protect it. The tribe's natural resources are an essential part of the Chickasaw culture and are worth the extra steps required to ensure their longevity. The UST program will continue to be an important aspect of tribal environmental protection. We expect that by the end of 2005, all Chickasaw travel plazas will be in full compliance with all federal UST regulations."

"We are now paying attention to our UST facilities," says Chuck Tillman. "For example, cathodic-protec-

Developing a Low-Cost, Low-Tech Hydrocarbon Sampling Tool. *Members of the Southern Methodist University (SMU) Department of Environmental and Civil Engineering conduct a field test to verify the use of a field-detecting device for hydrocarbons in soil. U.S. EPA Region 6 gave the Inter-Tribal Environmental Council a grant to develop a tool that would be portable, low cost, low tech, but accurate (>50 ppm) in detecting the mass of hydrocarbons in soil samples collected and analyzed in the field. The cooperation of the Choctaw Nation helped SMU validate its laboratory-developed data on the tool.*

tion testing had not been completed since the original installation of tanks that required CP at three sites approximately 10 to 15 years ago. This occurred simply due to the lack of knowledge of the type of tanks present and the lack of knowledge of federal compliance requirements.

"Now," says Tillman, "a full compliance inspection is completed for each facility once a quarter. The program has become more hands-on. As UST program monitor, I inspect spill buckets, oversee the installation of equipment, and track the required testing for LLD and lines, CP, and monthly leak detection. The Choctaw Nation has identified one facility that has had a release. Remediation efforts are currently underway, and the Choctaw Nation expects to be able to receive a no further action letter soon from EPA in regard to the release."

In spring 2006, training will commence at the Choctaw Nation travel plazas. The managers will receive training regarding the procedure to monitor the ATG equipment, recordkeeping, and spill response. Once this round of training is completed, training will be given to all Choctaw Nation travel plaza employees who are present for the day-to-day operation on the purpose and operation of ATG alarm systems and spill-response procedures. The Choctaw Nation is currently supplying each travel plaza with a spill-response kit. The tribe expects to achieve 100 percent Significant Operational Compliance by spring 2006.

Both Chuck and Josh have attended trainings on tank installation, tank removal, ATG operation, and compliance issues. The grant has allowed them to obtain UST Tribal Inspector Certification from the Inter-Tribal Council of Arizona.

The capacity-building projects have allowed the Choctaw and Chickasaw to develop a working relationship/partnership with U.S. EPA and other tribes throughout the United States. The partnership with EPA has been more of a trust-building program, because it has allowed for better communication among the organizations. As a result, EPA is not looked at solely as an enforcement authority, but also as a partner of whom questions can be asked and with whom information can be shared freely. ■

■ NAPL Using Imaging

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Acknowledgments

The authors would like to acknowledge the Oklahoma Corporation Commission, Petroleum Storage Tank Division, and especially Mary O'Kelley and Joseph Thacker, for funding this work and providing tremendous support for the project. We would also like to thank the U.S. EPA GWERD laboratory and John Wilson for providing a great intellectual sounding board for portions of this research. Thanks also to Aestus, Inc. and Hazlett-Kincaid, Inc. for supporting innovative methods and approaches to environmental problems. Finally, we would like to thank OSU faculty and students in the School of Geology for the field work and efforts expended to collect the confirmation data required of these ERI geophysical images.

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References

Conrad, S.H., Wilson, J.L., Mason, W.R. and Peplinski, W.J., 1992. "Visualization of residual organic liquid trapped in aquifers." *Water Resources Research*, 28(2): 467-478.

Halihan, T., Paxton, S.T., Graham, I., Fenstemaker, T.R. and Riley, M., 2005a. "Post-remediation evaluation of a LNAPL site using electrical resistivity imaging." *Journal of Environmental Monitoring*, 7: 283-287.

Halihan, T., Paxton, S.T., McPhail, M.L., McSorley, J.D. and Riley, M., 2005b. *Final Report for Characterization and Monitoring of LNAPL Using Electrical Resistivity Tomography (ERT) and Hydraulic Push Techniques.* Oklahoma Corporation Commission, Petroleum Storage Tank Division, Oklahoma City, OK.

Schwartz, F.W. and Zhang, H., 2003. *Fundamentals of Ground Water.* John Wiley and Sons, Inc., New York, 583 pp.

Walther, E.G., Pitchford, A.M. and Olhoeft, G.R., 1986. "A strategy for detecting subsurface organic contaminants," *Ground Water: Prevention, Detection and Restoration*. National Water Well Association, Dublin, OH, pp. 357-381.

■ Maine's Third-Party UST Inspection Program

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Our Ship Has Sailed

So our inspection ship has sailed, and we sure do hope that these third-party inspections count toward U.S. EPA's three-year inspection schedule as per the new Energy Policy Act! Without third-party inspections, we would be forced to limit our DEP inspections to only federally mandated tanks, leaving a large population of our tanks adrift on uninspected seas. We believe that annual third-party inspections, coupled with regulatory inspection spot-checks, will go a long way toward taking the wind out of our leaking UST problem in Maine. ■

OSRTI Publishes Results of Study of Triad at Petroleum Sites

The September 2005 issue of *Cleanup News II* contains the article "Triad Saves $109K on Three Petroleum Sites." The article describes the results of a study undertaken in fall 2004 with the South Dakota Petroleum Release Compensation Fund, evaluating whether the Triad approach could significantly improve the management of petroleum release sites.

South Dakota's experience showed that conventional assessment programs were providing an inadequate understanding of contaminant sources and the extent of contamination, which in turn led to inappropriately designed remediation systems—all of which were driving up costs to the Fund.

Triad is an innovative approach for remedial decision-making at contaminated sites. The approach was formulated to produce highly reliable "pictures" of contaminant locations and concentrations, promote efficient remedial actions, and lower costs. These benefits are achieved through integration of three primary components: systematic planning, dynamic work strategies, and real-time measurement systems. Triad offers a technically defensible methodology for managing decision uncertainty that leverages innovative characterization tools and strategies.

The full article can be read at *http://www.epa.gov/compliance/resources/newsletters/cleanup/cleanup21s2.pdf*.

A River Runs Through It

by Lynn A. Woodard

The facility just after the river rerouted through it. Only the tanks remain; the building was washed away during the flood.

The New Hampshire Department of Environmental Services (NHDES) requires that UST systems have a separation distance of at least 75 feet from surface water. But what about placing a surface water body on top of an existing UST system? This is exactly what happened on October 8, 2005, during severe flooding in Alstead, New Hampshire. The high intensity and long duration of the rain event caused extensive erosion. When a 12-foot culvert plugged up with debris, the hydraulic pressure built up and punched through, taking the road with it and diverting the course of Warren Brook, a tributary of the Cold River. Suddenly, the KMEC Garage was in the middle of the river and being washed downstream… except for its USTs.

The facility consisted of a composite 6,000-gallon gasoline tank with three 2,000-gallon compartments, and a 2,000-gallon diesel tank. The tanks were installed in September 1997 and closed on October 14, 2005. The tanks were pulled by an NHDES contractor, who pumped 1,000 gallons of a diesel/water mixture and 4,500 gallons of a gas/water mixture prior to removing the tanks. A total of 1,700 gallons of water was recovered from the two tanks. No contamination was in evidence. We will have to determine cost recovery later. The river has been redirected back to its original course; however, the land may not be recoverable. ■

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Floating Tanks in Kansas

Photos courtesy of Tom Winn, KDHE

On September 22, heavy rains caused three of the four gasoline tanks at Phillips 66/Miller Mart in Lawrence, Kansas to float out of their subterranean home, smashing through the concrete pavement. The tanks were not anchored and contained little fuel, which would have served as ballast.

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surrounding properties. Communities have also benefited from new recreational and ecological areas where the availability of land for such uses was limited.

Reused sites improve the aesthetic quality of the community through the creation of well-maintained properties, the removal of blight, and the discouragement of illegal waste disposal and similar unwanted activities. Reusing a site also benefits the cleanup itself through increased day-to-day attention to the site.

Through the lens of reuse, we have the opportunity to rethink how we approach sites in a way that meets the needs of the public and private sectors and, most importantly, affected communities. The reuse of sites represents a move beyond the singular, essential goal of protecting human health and the environment, and embraces the increasing importance of land as a source and a resource for community revitalization. It reflects the idea that sites cannot, and should not, be fenced, abandoned, and unavailable for use by the community.

In the decades to come, our cleanup programs will view sites with an understanding that these properties are woven into the fabric of their communities. We must approach them with the interests and needs of future generations in mind. We've come a long way, and we will continue to build on this excellent foundation to help communities become even more vibrant. ■

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Trenton, NJ, Mayor Acts to Spur Reuse of Abandoned Gas Stations

A news article in the *Trenton Times* on November 7, 2005, described the plans of Trenton Mayor Glen Gilmore and the township of Hamilton for contacting the owners of abandoned gas stations and involving them in planning for reuse of their properties. Trenton has been a leader in the reuse of abandoned gas station sites ever since it was awarded one of the first USTfields Pilot grants in 2000. The article can be seen at *http://www.nj.com/news/times/index.ssf?/base/news-0/1131356183151560.xml&coll=5.*

■ Michigan UST Assessment *from page 30*

Dan Yordanich is a geologist specializing in the enforcement of storage tank regulations for the Michigan Department of Environmental Quality's Waste and Hazardous Materials Division. Dan welcomes your comments and questions, and may be reached at yordanid@michigan.gov.

Disclaimer

Any opinion expressed herein is that of the author and does not represent opinions of the State of Michigan, Michigan Department of Environmental Quality, or EPA.

Acknowledgments

I would like to thank Andrea Zajac, Chief, and Mike Kadri, Senior Engineer, of the MDEQ's Waste and Hazardous Materials Division's Storage Tank Unit, for technical guidance and many long hours of file review. I would also like to give special recognition to MDEQ's Hazardous Materials Storage Inspectors for their persistence in dealing directly with the regulated community in successfully implementing the enforcement process, and without their efforts we would not have the photos for this article.

References

Federal Register. 52 FR 12665, December 23, 1987, Supplemental Notice. *Causes of Releases from UST Systems.*

Federal Register. Vol. 53, No. 185. September 23, 1988. Rules and Regulations. 40 CFR Part 280. Underground Storage Tanks; Technical Requirements.

American Society for Testing and Materials (ASTM) Designation: ES 40-94 *Emergency Standard Practice for Alternative Procedure for the Assessment of Buried Steel Tanks Prior to the Addition of Cathodic Protection,* January 1995.

American Society for Testing and Materials, *Technical Bulletin STP 1013,* January 1989.

J.B. Bushman and T.E. Mehalick, *Statistical Analysis of Soil Characteristics to Predict Mean Time to Corrosion Failure of Underground Metallic Structures,* ASTM STP 1013, American Society for Testing Materials, Phil., 1989, g. 2.

National Leak Prevention Association, Standard 631, *Entry, Cleaning, Internal Inspection, Repair and Lining of Underground Storage Tanks.* – with Appendix MI (Fourth Edition, 1991).

FAQs from the NWGLDE

...All you ever wanted to know about leak detection, but were afraid to ask.

CITLDS and Throughput

In this issue of the National Work Group on Leak Detection Evaluations' (NWGLDE's) FAQs, we discuss Continuous In-Tank Leak Detection Systems (CITLDS) protocol throughput limitations. It may help to look back at the last issue's (August 2005) FAQs concerning CITLDS protocols to better understand the following discussion. Please note: The views expressed in this column represent those of the work group and not necessarily those of any implementing agency.

Q. *Why does the CITLDS protocol (1/7/2000 edition) include a limitation on throughput?*

A. Before we can discuss throughput, we must first know how it is defined in the protocol. According to the CITLDS protocol, throughput is the volume of product dispensed from a tank in a month. The operation of CITLDS depends on "quiet time" (no deliveries and no dispensing operations). Jairus D. Flora Jr., author of the protocol, thought it was important to limit throughput because CITLDS is most commonly used on tank systems at high-throughput, 24-hour-operation facilities. Excessively high throughput could severely limit the amount of "quiet time." Without enough "quiet time" the CITLDS would be unable to perform a valid leak test within the required monthly time period. Dr. Flora believed limiting throughput was the best way to ensure that enough "quiet time" was available for CITLDS to operate properly. The throughput limitation of a CITLDS should be an important consideration for a prospective purchaser who intends to install a CITLDS at a busy location.

Q. *How should the monthy throughput limitation be applied to manifolded tank systems?*

A. The throughput limitation applies to manifolded tanks as follows. Since the statistical calculations in the protocol are based on dataset records from *tank systems*, the monthly throughput limitation must also apply to *tank systems*, including manifolded tank systems. This means that the throughput limit applies to all the tanks manifolded together and not each one separately. For example, if you have three 10,000-gallon tanks joined by manifolds to each other and are using CITLDS equipment where the evaluation limits the use of a tank system to a monthly throughput of 200,000 gallons, then the throughput limit for this storage system is 200,000 gallons, NOT 600,000 (3 x 200,000) gallons.

About NWGLDE

NWGLDE is an independent work group comprising 10 members, including eight state and two U.S. EPA members. This column provides answers to frequently asked questions (FAQs) NWGLDE receives from regulators and people in the industry on leak detection. If you have questions for the group, please contact them at *questions@nwglde.org.*

NWGLDE's mission:

- Review leak-detection system evaluations to determine if each evaluation was performed in accordance with an acceptable leak-detection test method protocol and ensure that the leak-detection system meets U.S. EPA and/or other applicable regulatory performance standards
- Review only draft and final leak-detection test method protocols submitted to the work group by a peer review committee to ensure they meet equivalency standards stated in the U.S. EPA standard test procedures
- Make the results of such reviews available to interested parties

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