NEIWPCC
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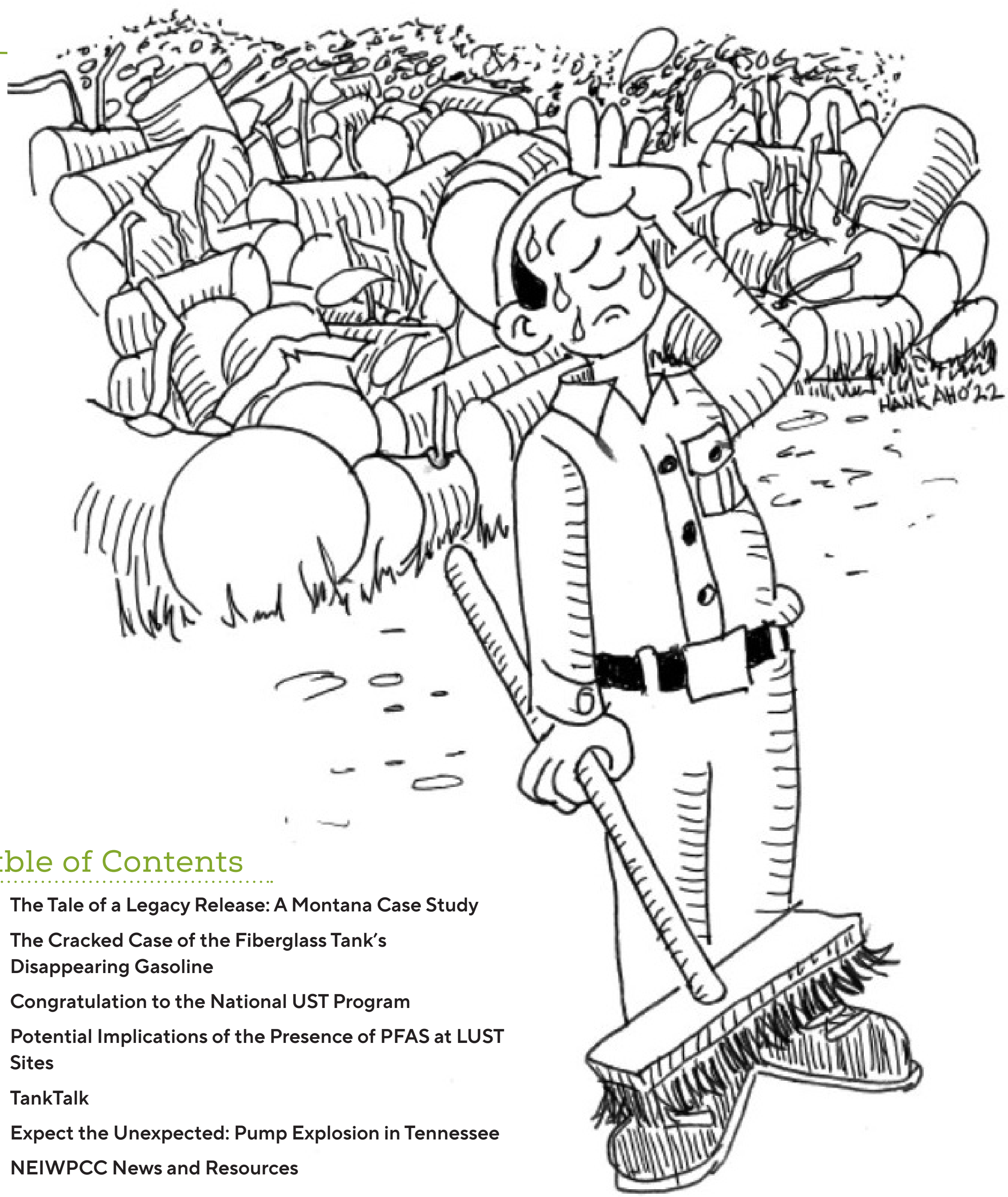
L.U.S.T.LINE

A Report on Federal & State Programs to Control Leaking Underground Storage Tanks



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The Tale of a Legacy Release: A Montana Case Study

by Shannon Williams Cala

Everyone hears about legacy petroleum release sites, but some don't comprehend the reasons behind why a release is a legacy site. I'd like to tell you a story about a petroleum release that was discovered in 1990 when fuel was found to be oozing up from a crack in the paved surface. This story involves:

1. Working in an isolated part of Montana.
2. Environmental changes.
3. Protecting the owner from liability associated with surrounding environmental concerns/Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA).
4. A lawsuit.
5. Lack of contractor continuity.
6. Delays in remediation and an unclear path forward.
7. Remediation pilot tests and treatments that haven't met expectations, and
8. The Montana Petroleum Tank Release Cleanup Fund (State Fund).

L.U.S.T.Line

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> The Montana Petroleum Tank Release Cleanup Fund only covers costs that they determine are reasonable, actual, and necessary. Just like any insurance, it isn't guaranteed that all costs associated with remediation of a petroleum release will be covered by the State Fund.

In the Beginning

There's a small town in Montana, close to the Canadian border called Havre (have -er) with a population of just over 9,000 people. Havre is in the middle of the hi-line (the area of northern Montana between the Canada–U.S. border and U.S. Highway 2).

Back in 1971, a gas station located in town installed their first petroleum storage tank. The station continued to expand over the next decade, eventually installing five bare steel underground storage tanks (USTs) on site.

The station ran smoothly until 1990, when fuel was discovered coming out of a crack in the paved surface. The owner responded by completing a tightness test of the product line in September of that year. It failed, prompting the station to close on November 13, 1990.

Six months passed before the tanks were finally removed in March 1991. (In Montana the installation, removal, and permitting of petroleum storage tank systems is regulated by the Tanks, Waste & Recycling Bureau.) Unfortunately, the owner did not use this lag time to put a remediation plan in place to address the regulated free product found at the site or the impacted soils from the UST removal. Regrettably, we don't know why there wasn't a plan in place to take advantage of the open tank basin, petroleum free-product and impacted soils could have been excavated at that time limiting continued impacts to the environment as there are no records explaining this. Instead, impacted soils were placed back into the tank basin after disturbing the individual lithologic layers allowing for the petroleum contamination to continue spreading.

Havre is home to the Wahkpa Chu'gn Archaeological Site, which is home to the most extensive and best-preserved Buffalo Jump in the U.S.

Figure 1 *Havre, Montana is located about 30 miles from the Canadian border.*

1991: Remedial Investigation

At the request of Montana Department of Environmental Quality (MTDEQ), the owner hired their first environmental consultant, based out of Colorado, to complete a remedial investigation to determine the extent and magnitude of petroleum contamination to the environment. In Montana, remediation of petroleum releases to the environment is regulated by the Contaminated Site Cleanup Bureau. This consultant identified several potential sources of contamination, including an up-gradient muffler shop with four USTs; an up-gradient gas station also with four USTs; a cross-gradient gas station with three USTs; a down-gradient railway yard with one UST; a railroad fueling facility identified as a CECRA site; two cross-gradient chlorinated solvent CECRA sites; and of course, our site.

> MTDEQ requests that owners hire an environmental consultant as the state does not have a regulatory agency that oversees environmental consultants. Consultants submit investigation, cleanup, and compliance monitoring work plans to MTDEQ on behalf of the owner. Once a submitted work plan is determined to meet the rules, regulations, and guidance of the state of Montana, the project manager approves the scope of the work in writing to the owner and work may commence.

The on-site utilities were also assessed: power was running overhead and was not threatened; both the sanitary sewer and water service lines run from the street and onto the property, which will require additional evaluation; and storm drains follow the road rights-of-way, which will also require additional evaluation. Finally, the nearest surface water is about 1,000 feet northeast of the property.

This assessment perfectly illustrates UST situational awareness, but the consultant makes an important misstep by not collecting a single environmental sample to determine the extent and magnitude of petroleum contamination associated with this petroleum release.

It was also during this time that the owner applied for funding through the State Fund and was determined to be eligible for up to $982,500 in costs after meeting a $17,500 co-pay. The owner also had this first consultant complete an investigation that included drilling five soil borings and installing four groundwater monitoring wells. The results indicated there was plenty of contamination, which was not a big surprise.

1992-2000: Source Removal Excavation

The following year, the owner switched to a second consultant, hiring a firm out of Great Falls, Montana. The reason why is not clear, but the State Fund does not pay for mobilization of consultants or subcontractors outside of state lines. For context, it is over 300 miles, one-way, from Colorado to the Montana state line, and then another 350 miles to Havre.

The new consultant, located 120 miles from the site, completed 10 test pits to ensure that they would have an effective source removal excavation. The goal of the excavation was to remove most of the petroleum impacted soils from the two source areas, the UST tank basin, and the dispenser island, and included evaluating impacts to the water and sewer service lines. This resulted in removal, pumping, and dumping of:

Figure 2 *A modified Google Maps rendition of the release site with potential sources of contamination identified.*

- 1,450 cubic yards of impacted soil from the UST tank basin and the dispenser islands.
- 1,550 cubic yards of soil to access free-product, emulsion, and dissolved phase hydrocarbons petroleum in and on the groundwater.
- 3,000 gallons of petroleum-impacted groundwater on the previously excavated, land-farmed petroleum impacted soil.

The evaluation of the water and sewer service lines indicated that they were over the plume, but above any contamination, were not impacted, and nor were the corridors being used as a preferential pathway for contamination migration.

Additional excavation and groundwater pumping was not completed because of CECRA plumes adjacent to the site. Based on CECRA rules, if we impact the CECRA groundwater plume, the responsible party for our site could become a potential liable party.

Over the next eight years groundwater monitoring occurred not just at the petroleum release site, but at the surrounding environmentally impacted areas. During CECRA groundwater monitoring in 1999, methyl tert-butyl ether (MtBE) was found in wells down-gradient of our site. And while our site seemed to be the likely source, it wasn't detected in the soils or groundwater sampled from the property source areas. In response, the MTDEQ requested the current consultant (#3; also located in Helena, Montana) to evaluate the likelihood that the MtBE originated from this petroleum release. At the same time, two more complications arose.

2000: Drought

There had been a drought in Havre in 1996, but beginning in May 2000, the area saw its longest drought on record which didn't end until March 2006. During this time, groundwater elevations became deeper and sampling groundwater became difficult due to the increase in groundwater depth and recharge rates, if groundwater was found in the monitoring wells at all.

2003: A Lawsuit Impacts Progress

In 2003, a neighboring property owner sued the responsible party claiming that petroleum contamination was impacting their soil and groundwater and remediation efforts were not restoring the property to acceptable standards within a reasonable time frame. Following the lawsuit, the responsible party had their consultant (#3) review additional area information to develop a path forward for cleanup.

2005: Site Characterization

The first objectives were to determine the effectiveness of the excavation, the current extent of contamination, and who was responsible for the MtBE contamination. A subsurface investigation and groundwater sampling was conducted by the consultant in 2005, which determined that the soil contamination extended well below the original excavation limit of 10 feet below ground surface and extended down to at least 20 feet below ground surface.

Based on this investigation, MTDEQ and the consultant believed that the extent and magnitude of the petroleum release had been defined and verified that the petroleum contamination did not extend to the nearest down-gradient surface water. As for the MtBE, it wasn't refined or blended with petroleum, not found in the on-site source area soils or groundwater and was using the storm drain utility corridor to migrate. This was outside of the state program's regulatory authority and would need to be managed by the CECRA program. At this point, the consultant was left scratching their head in identifying a path forward without impacting the CECRA petroleum, chlorinated solvent, and MtBE contaminant plumes. In particular, the chlorinated solvent plume was comingled with the responsible party's petroleum plume. And finally, how was the drought going to impact any of the potential cleanup options?

With the third consulting firm stumped, the responsible party hired a fourth environmental consultant to work in tandem. This fourth consultant firm was based in Utah, which meant that the responsible party would have to cover costs associated with a one-way mobilization of about 375 miles to the Montana state line. To save costs, the two firms worked together to identify a path forward that could be implemented by the in-state consultant (#3). The fourth consultant, who had done work across the western U.S., had experience with similar sites and was able to provide additional potentially effective cleanup alternatives. However, it wasn't until 2007 that the first pilot study of a cleanup method was tried.

2007: Cleanup Methods are (Finally) Piloted

Sixteen years after fuel began oozing from a pavement crack, the first pilot consisted of air sparge (AS), soil vapor extraction (SVE), chemical oxidation injection, and ozone injection. The cleanup goal was to reduce contaminant concentrations in groundwater. The consultant ran the AS/SVE with ozone injected into the lower screen and hydrogen peroxide into the upper screen. Following the injections of ozone and hydrogen peroxide, air was cycled through the well to mix the injectants resulting in hydroxyl radicals.

The pilot study ran between 2007 and 2008 and resulted in an initial reduction in petroleum concentrations in groundwater followed by a rebound in concentrations likely caused by two factors. First, there was likely stripping of sorbed material from the soils caused by the chemical oxidation of the injectants. Second, the rebound is indicative of a submerged smear zone, which was known to exist based on contaminants left in place during the 1992 excavations and soil borings completed as part of the 2003 and 2005 investigations to determine the extent and magnitude of contamination.

2009: Lasers and Rem

With no end in sight, MTDEQ decided to go back to the consultant (#4) and the responsible party to request a remedial alternatives analysis which would be supported by more site information. A laser induced fluorescence (LIF) investigation was completed in 2009, which provided us with a 3-D image of the free-phase petroleum. The LIF showed that free-product was trapped beneath the groundwater (trapped by a rapidly rising water table following droughts that ended in 1996 and 2006) and a smear zone found from 10 to 20 feet below ground surface consisted of more than 2,000 cubic yards of impacted soil. With this important information in hand, we moved forward with another pilot test.

2010: Well-ARTiculated

Using the LIF information, the consultant proposed and then installed a system called Accelerated Remediation Technologies (ART) in 2010. Again, the cleanup goal was to reduce contaminant concentrations in groundwater, but also to reduce source mass from within the soils. With an ART system, the groundwater is pumped through a hose in the well to the top of the well and then sprayed through a showerhead to aerate

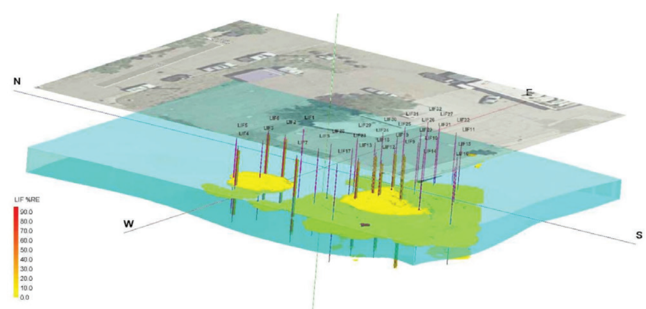

Figure 3 *LIF 3-D Model Of Free-Phase Petroleum Contamination*
Johnston Leigh, Inc., Additional Remedial Investigation Report, April 20, 2018

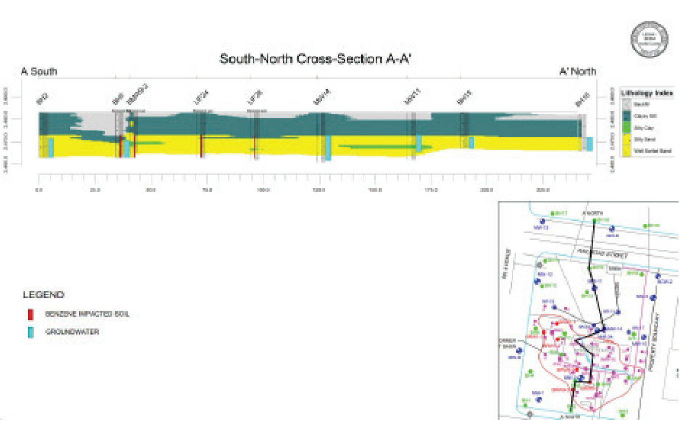

Figure 4 *LIF Cross-Section Johnston Leigh, Inc., Additional Remedial Investigation Report, April 20, 2018.*

the water. Simultaneously, the water is air sparged above the pump and the air is removed by a SVE blower. The ART system was piloted in five wells. One down-gradient well used chemical oxidation of ozone and had the hydrogen peroxide injection running to polish any contamination that wasn't below the risk-based screening levels prior to the groundwater migrating off-site.

The system was so effective that MTDEQ had the consultant expand it. Unfortunately, two issues with the system resulted in the dissolved phase contamination migrating off-site faster than it could be treated to levels above drinking water standards. First, the ART system was flushing petroleum contamination from the submerged smear zone into the groundwater, evidenced by an increase in groundwater contaminant concentrations, in the source area after the system was turned on. The mass in soil was greater than what the ART system could effectively remove in a reasonable time frame based on the size of the system installed. Second, the down-gradient chemical oxidation system was shut down so there wasn't any polishing occurring before the groundwater migrated off-site. There was a total mass reduction of petroleum contamination at 17% after running the system for three years, but MTDEQ and consultant decided to scale back the ART system to stop the off-site migration. And so, MTDEQ asked the consultant to go back to look at the remaining cleanup alternatives.

Behind the Scenes

My name is Shannon Cala, and I was born and raised in Helena, Montana. The tanks in this article went into the ground before I was born and the release occurred when I was a sophomore in high school, before I had any idea of what I was going to be when I grew up. College, for me, was non-traditional, and after 13 years, I earned a bachelor's degree in biology. I've been working as a petroleum release project manager for the Montana Department of Environmental Quality (MTDEQ) for almost 15 years and have been managing this project since April 2010.

At MTDEQ, the Permitting and Compliance, Remediation, and State Fund programs are all separately organized and managed. As the project manager for remediation, it falls to me to regulate the remediation of petroleum releases according to Montana's Rules, Regulations, and Guidance.

The responsible party for the petroleum release is tasked with hiring a qualified environmental consultant who is expected to properly conduct work on their behalf and meet MTDEQ requirements.

Environmental consultants in Montana are not a regulated community, which can add difficulty in getting useable and complete data.

As the remediation project manager, it is my role to ensure that the responsible party's environmental consultant submits investigation, cleanup, and compliance monitoring work plans specifically outlining what the environmental consultant plans on behalf of the responsible party. If these plans meet state requirements, I can approve the scope of work and the consultant may begin executing on the plans.

2013: Are There any Options Left?

More than two decades and four consultants later, we were running out of options. The next two alternatives considered were completing additional soil excavation, and in-situ thermal desorption. Both options would result in petroleum source mass removal and over time a decrease in groundwater concentrations. Soil excavation isn't cost effective or feasible due to the potential impacts to the structural stability of both on-site structures and nearby roads.

MT DEQ approved the in-situ thermal desorption option based on proposed effectiveness, time of implementation, ease of implementation, and costs. However, the State Fund did not support the in-situ thermal desorption option and indicated that if the existence of the CECRA plumes increased the costs of cleanup, those increased costs would not be covered. This led to yet another delay impacting remediation at the site.

2014: Plagued by Complications

It's now 2014, and the consultant presents another alternative in-situ treatment called oxygen biochem plus (OBC+). With this cleanup pilot study, the goal was to reduce contaminant concentrations in groundwater but also to reduce source mass from within the soils. OBC+ is a combination of sodium persulfate and calcium peroxide which promotes anaerobic biological oxidation.

Later that year, 500 gallons of OBC+ was injected into the source area. In monitoring its effectiveness, we estimated a reduction of about 16% of the total hydrocarbon mass. We saw a reduction in benzene of almost 39%, but after two years, concentrations rebounded to near pre-test levels. While OBC+ wasn't effective in reducing petroleum concentrations within the source area, it would be effective on groundwater near the edge of the plume where concentrations were lower. We saw the same with the chemical oxidation used as part of the ART pilot study. Both are more effective as polishing agents.

After completing two separate pilot tests, ART and OBC+, and following the removal of the on-site building, the consultant went back to the site and completed another LIF study to determine the extent and magnitude of contamination beneath the former structure and to evaluate the effectiveness of the pilot tests. What we saw was an estimated mass of 2,200 cubic yards of impacted soil. Along with the results of the LIF, the consultant provided four more alternatives:

- High vacuum dual-phase extraction (HVDPE).
- AS/SVE; AS/SVE + HVDPE.
- BOS-200 injection.
- Either shore or slope excavation.

We chose HVDPE as it would reduce contaminant concentrations in groundwater and reduce source mass from within the soils.

2019: Testing Two More Options

I was concerned that the groundwater drawdown produced by the HVDPE would potentially cause changes to the CECRA plumes during this pilot, so I limited the scope of the system. We ran the system for 9 hours a day over 10 days. What we saw limiting the effectiveness for our HVDPE pilot is that our site had a low aquifer porosity. We had steep draw-down but hardly any laterally away from the well, which limits the amount of soil exposed to the vacuum. We decided to not move forward with this alternative as we would have to pincushion

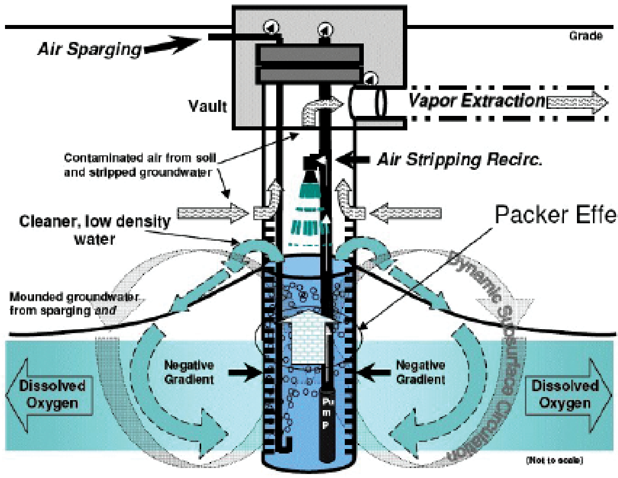

Figure 5 *ART Accelerated Remediation Technologies, Inc. In-Well Integrated Technologies*
File source: https://bit.ly/artcrs-section

the site, re-inject groundwater, and ensure no impacts to the CECRA plumes.

Following the pilot studies, I've had the ART system working to try and treat contamination that has been mobilized and is migrating, but ART is wearing out. However, there is a new design currently available for the ART system which includes the previously described system, but the chemical oxidation step occurs within the same well. Any updates to ART will have to wait to determine the effectiveness of the current work plan. We went back to the alternatives analysis and BOS-200 was the second choice after HVDPE.

> Montana State Waters require that the water meets the MTDEQ's human health water quality standards. The standards continue to be exceeded across the source areas of the property. The groundwater in Havre is naturally high in salinity, and the quality is marginal for drinking, agricultural, and industrial uses. Although we will be cleaning groundwater up to our drinking water standards, future use of the groundwater is unlikely.

The new plan has been approved for injection of BOS-200 which is a blend of activated carbon, sulfate reduction media, micronutrients, and facultative microbes with the goal of trapping and treating the free-phase contamination at the source, which will minimize the remaining petroleum source mass in the soil from leaching to groundwater. The area has once again entered an exceptional drought, and we have a dropping water table. We will see how effective this treatment is in conjunction with drought conditions and how long ART can last. BOS-200 is scheduled to be injected into the subsurface during 2022.

Currently, the consultant has submitted $459,657.96 in claims to the State Fund. Of that total, $401,327.74 has been reimbursed. As was mentioned in the beginning of the article, the project was eligible to receive up to $982,500 after a co-pay of $17,500. Approximately $581,172 of available Petroleum Tank Release Cleanup Funds remain.

Legacy Sites Are Tough, We Are Resilient

Over the last 30 years we have identified and dealt with:

- Environmental changes including three separate droughts.
- Four CECRA sites, limiting our cleanup alternatives.
- Protecting the owner from CECRA liability.
- An angry neighbor and lawsuit.
- Four different consultants.
- Isolated location of the release, which led to increased mobilization, and operation and maintenance costs, for on-site active remediation.
- A State Fund that pushes for less expensive cleanups.
- Lack of a clear path forward for cleanup.
- A treatment train that has included excavation; AS/SVE; ART; a plethora of injectants; HVDPE; and BOS-200 on its way.

These issues and complications have led to creative thinking in terms of cleanup alternatives but has also increased cleanup costs and the time it takes to complete.

Montana's backlog (releases older than 15 years since date of discovery) sits just below 68% of our open releases at the end of 2021 because of any number of issues. The backlog of releases has continued to shrink as Montana makes a concerted effort to evaluate historic releases, evaluate data and risk, identify current property owners, identify funding opportunities, and find a path forward to closure.

This is just one of the MTDEQ backlog of releases assigned to me and I must remind myself that I am blessed with work and there is no giving up. I often remember a quote by Helen Keller: "Be of good cheer. Do not think of today's failures, but of the success that may come tomorrow. You have set yourselves a difficult task, but you will succeed if you persevere; and you will find a joy in overcoming obstacles."

Shannon Williams Cala is a project manager with the Montana Department of Environmental Quality. She can be reached at scala@mt.gov.

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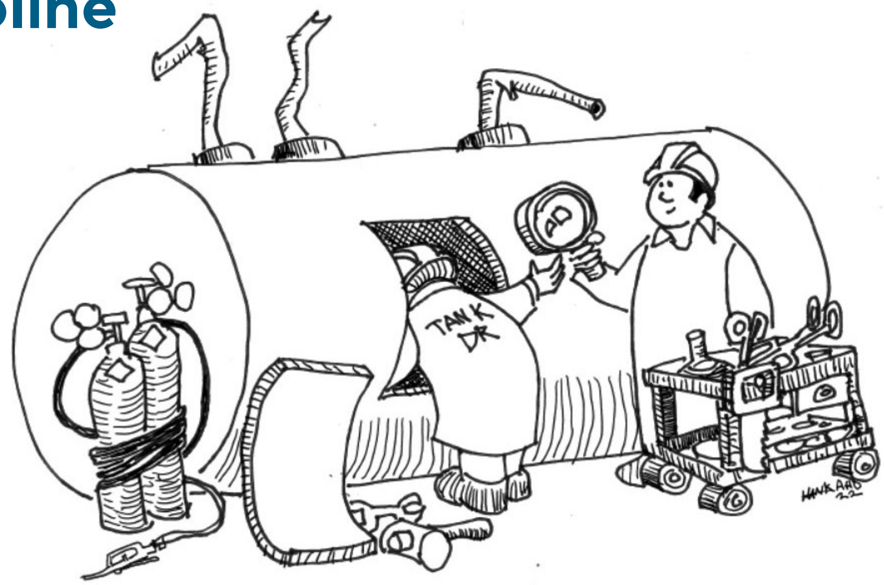
The Cracked Case of the Fiberglass Tank's Disappearing Gasoline

by Mike Pecorelli



It was one of those late winter days in February 2019 when you plan to catch up on paperwork in the office. Instead, you get that upending call from an owner reporting an inventory shortage of approximately 500 gallons. The call came from a single-station owner who tracks their fuel inventory as much as the snacks and drinks they sell. At the time, no one in our group — the Petroleum Storage Tank (PST) Trust Fund section of Utah's Department of Environmental Quality (DEQ) — knew that this would be the start of a long journey.

It is difficult to determine the cause of many releases as they are not always obvious and often hard to solve. In this case, the DEQ needed to establish what was causing such a fast-moving release in a short amount of time. We knew that the owner was diligent in reconciling their gasoline sales and inventory on a regular basis. We also recognized that not all owners are as diligent in watching their fuel inventories and that determining the cause of the release would assist other owners and operators.

Was it a random release? Or was this an indication of a more significant problem that could potentially be costly to the PST Fund. We needed to determine where this release was coming from, and, in the process of figuring it out, we learned a lot about fiberglass reinforced plastic (FRP) underground storage tanks (USTs). Here's what happened.

Just One Tank?

The release report stated that the owner found an inventory shortage and then immediately scheduled a tank tightness test for all the station's tanks. Only one tank failed, the single UST designated for premium unleaded. The owner then took the tank out of service. Although only one tank failed, every UST at this fueling station was fiberglass reinforced plastic. This raised a few eyebrows for multiple reasons.

It is thought that older FRP tanks might be incompatible with common fuel additives, and it was this hypothesis that led us to consider incompatibility as a reason for the loss of tank integrity. It was also troubling to our team that roughly a year earlier (March 2018), another fiberglass UST, installed only a few miles away from the release we were currently investigating, experienced a catastrophic failure. That release totaled more than 50,000 gallons. For context, a fuel delivery request was generated by an automated system (whenever the UST volume was low), until the delivery driver notified the owner that he was suddenly making an abnormally high amount of fuel drops to that UST. Both tanks had been installed in 1988.

Now we were aware of two tanks of similar age, both experiencing a release within 12 months of each other. Could this be an early warning sign of what was yet to come? Would our program be prepared to manage an onslaught of failing tanks? And what impact would an issue of this magnitude have on the PST Fund? These were all questions that needed answers. The March 2018 release would undoubtedly reach the maximum $2 million of coverage provided by the PST Fund and would require additional work at the owner's expense. If this theory was true, how would we be able to manage multiple releases requiring financial support from the PST Fund? We needed answers, not only to address the current release, but to determine if more releases were on the horizon.

On a Mission

The initial sampling to determine the extent and degree of the leak revealed that the release went mostly down in a vertical direction due to the coarser nature of the soil in this area. It was also determined that any further definition or any cleanup measures would be difficult while keeping the USTs in place. These findings, coupled with the age of the tanks, led the station owner, DEQ and PST Fund to agree to replacing all the USTs and performing a tank autopsy on the one that failed the tightness test.

Normally, USTs are broken down during the removal process, but to complete a tank autopsy, we needed to have it removed intact. How would we accomplish that? And more importantly, what did we need to know to effectively conduct an UST autopsy? This was new to everyone involved, and it required efficient coordination with the station owner, the UST removers, and the DEQ personnel. We also enlisted the help of Thomas Schruben who, at the time, was working as an environmental consultant with experience inspecting approximately 50 failed FRP USTs and other experts to advise on how to go about the autopsy process and analysis.

Preparing for the Autopsy

Coordinating with the tank removers and station owners was the first step, because the removal process would take longer than normal and would incur additional costs not normally associated with tank removal. Two vacuum trucks were used to remove the pea gravel surrounding the USTs. This

Figure 1 *View of the pea gravel fill being removed by a vacuum truck.*

Figure 2 *Camera system and operator from local sewer district setting up to take video of the inside of the FRP USTs.*

step added a significant amount of time to the process. While the USTs were in the initial stage of removal, a state UST inspector spent several days onsite taking measurements and images. Specifically, the inspector wanted to verify if the proper amount of backfill was used, determine what kind of backfill was used, measure around the UST system as it was uncovered, and record additional information.

Pictures and video from inside the tank were also collected. The first images were taken by one of the consultants using a GoPro attached to a stick, but this did not yield useful results. The lighting was not adequate, making it difficult to see detail or determine where in the tank the images were highlighting.

Luckily, with a phone call, we enlisted help from the local county health department's sewer district staff. They were willing to use camera equipment normally used for inspecting pipes to inspect the interior of the empty USTs before removal. Although we were provided with a nice video of the inside of all the USTs onsite, the footage did not provide us with an answer to what caused the tank failure.

Big Tank, Big Fanfare; No Luck

When it came time to remove the tank in question, the UST removal team used extra care and slowly lifted it out of the tank pit intact and in one piece. Unfortunately, we were not so lucky with a second tank that we wanted to take a closer look at. It broke during removal and could not be analyzed further. The remaining two tanks were removed, and since they had passed the tank tightness test, they did not need to remain intact. Like a roadside attraction, the 12,000-gallon tank drew much attention as it dangled mid-air off the back of a track-hoe prior to being placed at its temporary resting place. We needed a lot of space to be able to conduct the tank autopsy, and it was no easy feat to find a location that was secure and didn't impact the process of removing the remaining USTs.

You can imagine the interest once the autopsy tank was secured and could be inspected. People took pictures like it was a celebrity, walking around the tank looking for any signs of cracks or holes. Everyone had a theory. Surprisingly, there was nothing obviously wrong with this UST that could be seen just by walking around it. You could even look under most of it, but still there was no smoking gun. Further investigation on the UST would have to take place later,

Figure 3 *Bottom of the FRP UST during the pressurized soap test showing the location of the crack.*

Figure 4 *Consultant collecting a sample from the FRP UST using a masonry grinding wheel.*

as the UST removal was ongoing.

The next day the consultant decided to seal and pressurize the UST. Once it was under pressure, a soapy water solution was used to test for leaks. It did not take long to see bubbles forming along the bottom of the UST near the seam of the rib. This confirmed that the UST in question had a crack in it that couldn't easily be seen.

Figure 5 *View of inside of the FRP UST sample that was collected showing the groove.*

Figure 6 *Closeup view of the groove.*

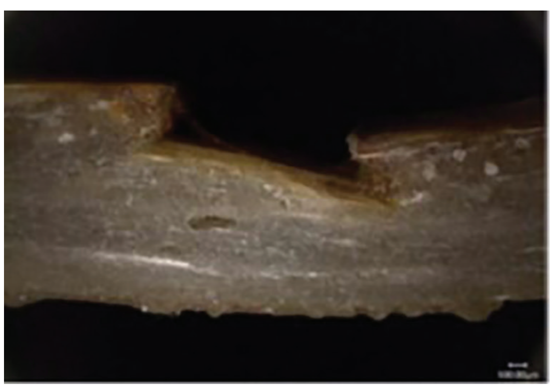


Figure 7 *Magnified groove cross section showing sand particles and a void space.*

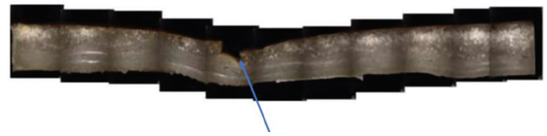


Figure 8 *A composite photo of the groove.*

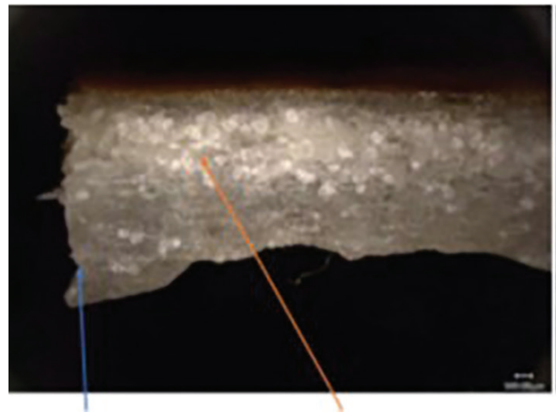


Figure 9 *Magnification of the crack location. Blue arrow indicates the crack location.*

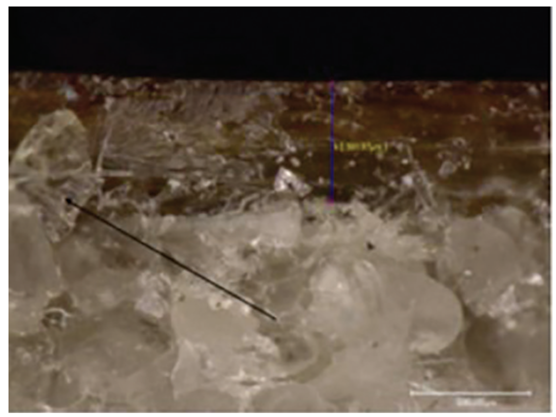


Figure 10 *Magnified photo of the gel coat and sand particles.*

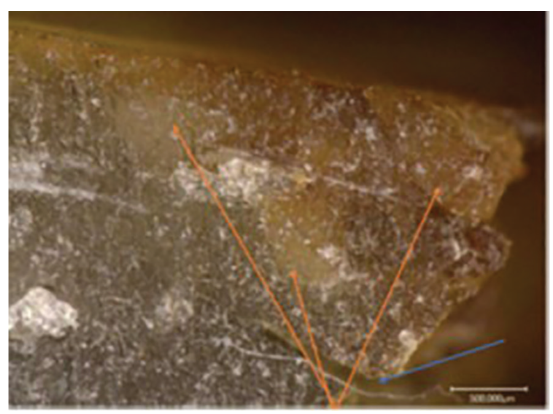


Figure 11 *Magnified photo of crack location with permeation in the gel coat.*

Regrouping and Obtaining a Sample

At this point, we had answered a few questions about the leak from this FRP UST. We knew it had a crack in it. We knew where the crack was located. Unfortunately, we did not know why it had a crack, and we were not going to be able to determine that from looking at it. This would need further analysis and require enlisting additional help. We needed to take a much deeper dive into how an FRP UST is made.

Knowing where the crack was located helped to determine where to collect samples from the tank for analysis. While this type of tank looks brittle and as likely to break as an eggshell, we learned that they are not very easy to cut into. A word of advice: if you are thinking a Sawzall approach, think again. An FRP UST is not part of the "all" in Sawzall, because using one did not work. A masonry grinding wheel did the job, but it was not easy, and a respirator was necessary. The sample location on the UST was labelled, and the samples were documented with photos. A chain of custody was also kept. This was all done to preserve evidence if this were to be part of a court case later.

If anything did not look right on the inside of the UST, it was important to document it with photos, since the UST would be crushed at the end of collecting samples. We did not have a long-term storage solution. The photos allowed us to see patches on the inner wall. It is not uncommon for this type of tank to have patches placed during manufacturing. We saw parts where it looked like the protective gel coating was starting to peel away from the walls of the UST, and we saw what looked like a groove on the inside. Neither of these issues are desirable. A sample of the FRP UST was taken at the groove and crack location. After consulting with others who had experience with this type of tank on what we had observed, we decided to send samples out for additional analysis.

More Analysis Needed

We contacted Christopher Daniels, associate professor of engineering practice with the University of Akron, and had analysis done on the samples collected by Polymer Diagnostics, Inc. It was pointed out that a small sample of a UST, approximately one foot by one foot, is not too difficult to send off for analysis. If you collect a large piece, say around three feet long, the curve of the UST could make it difficult to pack and ship. This is an important point to keep in mind that you may not expect.

> It is difficult to make proactive decisions, policies and rules without the knowledge and evidence of why a UST failed.

The results of the analysis provided additional details about the tank failure. Along the groove shown in Figure 6, there was a pathway for gasoline to permeate into the tank's wall, causing integrity issues. The protective gel coat was thinner near the groove, and you could see the fiberglass fibers in this section. As you can see, the gel coat is thicker near the bottom of Figure 6, and the fiberglass fibers are not visible.

A look at a cross section of the groove in Figure 7 showed that it was approximately a quarter of the thickness of the wall. This was a weak spot in the UST. Sand is used in the construction of this type of UST. A few grains of sand can easily be seen on the right of the groove near the top. However, more sand should be present, and it should not be so close to the inner surface of the tank. A void space, which can weaken fiberglass reinforced plastic tanks, was also observed just left of the center of the photo under the groove.

A look at a composite photo of the same groove in Figure 8 shows that the tank had a bow in it and varying thickness. Notice the irregularity of the sand reinforcement and locations near the surface. Sand should be more towards the middle of the wall, and there is less sand near the groove than is usual.

A magnified photo of the crack in Figure 9 shows the crack location on the left (blue arrow). The sand is not uniform (orange arrow) at the crack location when compared to other locations in the tank. The sand is also close to the inner wall (top of the picture) instead of in the middle.

In Figure 10, you can see the gel coat and the sand grains. The gel coat is the amber colored area at the top of the photograph, and the black arrow points to a grain of sand near the inner surface. The sand is causing a weak point, because it is decreasing the thickness of the gel coat in that area of the UST wall.

Figure 11 shows permeation of gasoline into the gel layer (upper right of the photograph), as illustrated by the orange arrows in the location of the crack. Notice the color near the crack versus the bottom left of the photograph for comparison. The blue arrow shows another crack perpendicular to the main crack. I have noticed this discoloration in other FRP USTs on other tank removals but did not realize it was an indication of gasoline permeation of the gel coat.

Lessons Learned

Fiberglass reinforced plastic tanks are difficult, but not impossible, to remove intact. Careful planning, coordination, and teamwork between the UST inspector, PST Trust Fund, station owner, UST remover, and consultant was essential in accomplishing this tank autopsy. Everyone involved learned something new about FRP tanks and what signs to look for that might be the root cause of failure.

While we initially set out to confirm whether there was a compatibility issue with fuel additives being stored in older FRP tanks, instead, our investigation into the tank failure revealed problems in the manufacturing process that were not resolved before the tank installation in 1988. Despite these findings, we cannot dismiss the fuel additives incompatibility issue because of compromises observed in the gel coating.

From a knowledge management standpoint, DEQ staff learned a great deal about fiberglass reinforced plastic underground storage tanks including:

- How to conduct an autopsy on these types of tanks.
- Developing a stronger grasp on what to look for during removal.
- Gaining insight on what observations might be indicative of a problem.

In this instance, we learned the location where the tank was leaking fuel into the subsurface. Using this knowledge combined with the coarse soil type in the area, we knew the contamination trajectory would be downward with little lateral spreading. This helps us understand that we need to drill and collect samples near the source location of the release to accurately determine the depth (of this release) for the subsurface investigation. Drilling and sampling outside the tank farm area for boring location convenience would bias the sample results indicating a smaller release extent. Large diameter piping was installed during the new UST installation to guide any future drilling activities in the release location to protect the new USTs.

Tank autopsies, such as this one, do not occur frequently in the state of Utah, mainly due to the additional time and expense involved. The time, effort, and outcome from this autopsy is invaluable to the Utah underground storage tank community. It is difficult to make proactive decisions, policies and rules without the knowledge and evidence of why a UST failed. This has been a great learning process for the staff and management while developing another tool that can be used in investigating why a release occurred.

Longer term, this effort will help the DEQ in evaluating potential negative impacts on the PST Trust Fund from USTs of similar age, make, material, etc. and where to attribute the cause of the release and potential cost recovery.

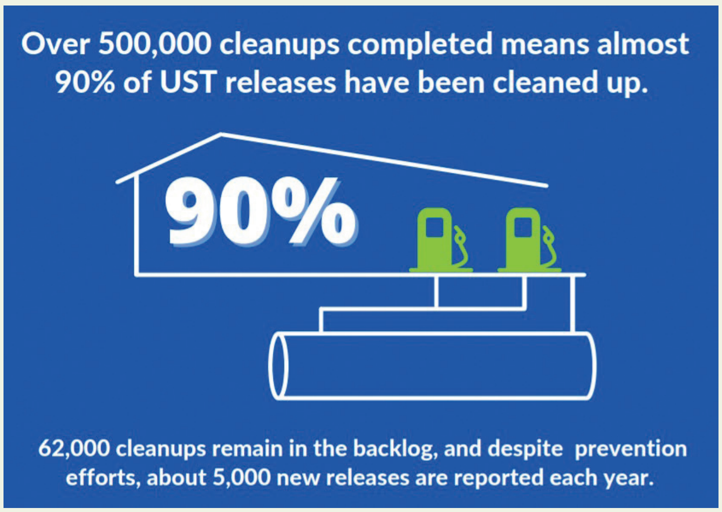
Michael Pecorelli is the Petroleum Storage Tank Fund section manager with the Utah Department of Environmental Quality's Environmental Response & Remediation Division. He can be reached at: mpecorelli@utah.gov.

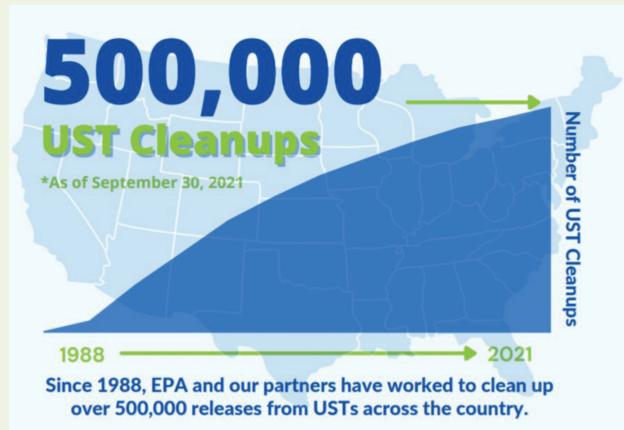
Do you have an interesting release or remediation story to share? Contact Christina Stringer (cstringer@neiwpcc.org) to have your experience featured in a future issue.

A Message from Mark Barolo

Acting Director, U.S. EPA's Office of Underground Storage Tanks

Congratulations to the National UST Program for Cleaning up Over 500,000 UST Releases





As of the end of September 2021, the national underground storage tank (UST) program cleaned up 502,786 releases. You can see our steady progress and significant achievement over the last 33 years as illustrated on this line chart. This is an impressive accomplishment for the national UST program, and it is certainly cause for celebration.

During my 25 years working in the national UST program, I have witnessed firsthand the determination, dedication, and progress of all UST partners — states, territories, tribes, industry, along with U.S. EPA — in cleaning up UST releases and protecting our environment. I feel great pride for the program's collective achievement. And I have a deep sense of gratitude for all the people I've worked with and who have contributed so significantly to the UST cleanup program's success.

Surpassing one-half million UST releases cleaned up means that almost 90% of UST releases in our country no longer pose a threat of harmful contamination to the public's health and our soil and groundwater. Our country's groundwater is a precious resource; it provides drinking water for nearly half of the people living in the United States.

We know that underground storage tanks, and releases from USTs, exist in thousands of communities in the United States, and their locations range from remote to large urban settings, with many releases in overburdened communities. Approximately 81 million people — roughly 25% of our country's population — live within 0.25 mile of an UST release, which includes releases already cleaned up and those awaiting cleanup. And over 21 million people — roughly 6% of our population — live within 0.25 mile of those UST releases remaining to be cleaned up. These communities are made up of populations with greater percentages of racial and ethnic minorities, low-income residents, linguistically isolated persons, and individuals without a high school education than the United States' population as a whole.

Cleaning up UST petroleum releases benefits our country by:

- Protecting human health as the result of reducing human exposure to both on-site and off-site contaminants.
- Increasing land productivity and economic benefit because cleaned-up abandoned UST release sites are safer, better hosts for productive land use activities, and attract higher-valued activities.
- Providing aesthetic and recreational opportunities when cleaned-up UST release sites are redeveloped into attractive and appealing neighborhood assets, such as nature parks, recreational areas, or preserved historic buildings.

Achieving this significant milestone is the collective work of many UST partners — states, territories, tribes, industry, and U.S. EPA — all of whom are dedicated to managing and cleaning up UST releases. I am grateful for the thousands of former and current staff who gave, and continue to give, their time, expertise, and energy to identifying and solving

A Message from Mark Barolo... continued

UST-related problems, culminating in protecting the health of people living in our country and our environment. Thank you to all our UST partners for your achievements and many contributions. Congratulations on reaching this remarkable and noteworthy milestone!

> Achieving this significant milestone is the collective work of many UST partners – states, territories, tribes, industry, and U.S. EPA – all of whom are dedicated to managing and cleaning up UST releases.

What Helped us Achieve This Milestone?

We reached this achievement because of the dedication and determination of the national UST program cleanup staff. Their tenacity, displayed repeatedly over the past 30 years, fostered our ability to surpass cleaning up more than 500,000 UST releases. Moreover, there are many advances and partnerships which contributed to attaining this milestone.

Creative Funding Solutions

In 1986, Congress created a dedicated source of money — the Leaking Underground Storage Tank (LUST) Trust Fund — to provide annual appropriations that support and augment state cleanup programs with seed money. In addition, states created state financial assurance funds that raise money and spend it to clean up UST releases. According to the Association of State and Territorial Solid Waste Management Official's (ASTSWMO) 2020 annual state fund survey (https://astswmo.org/2020-annual-state-fund-survey/) since 2002 state UST financial assurance funds have paid approximately $20 billion to clean up UST releases.

For the 36 states with established state financial assurance funds, UST owners receive help in complying with the federal financial responsibility regulation and the state funds pay to clean up newly reported releases as well as ongoing cleanups. Originally envisioned as a short-term solution to historical contamination, state funds have endured as critical sources of money for newly discovered releases and are key to many states cleaning up UST releases.

Through the American Recovery and Reinvestment Act of 2009, Congress appropriated $200 million from the LUST Trust Fund to U.S. EPA for cleaning up UST releases. Through this one-time infusion of money, more than 7,800 UST releases were assessed and cleaned up. Some states, realizing that abandoned underground storage tanks can contaminate our environment, created programs specifically to address abandoned tank releases that might otherwise languish absent this type of support. Ohio's Abandoned Gas Station Cleanup Grant program (https://bit.ly/AbGasOhio) is one example of a state creating a resource that provides money to help assess and clean up abandoned USTs throughout the state.

Additional sources of money are available to assess and clean up petroleum brownfields with relatively low-risk UST releases. Cleaned-up petroleum brownfields sites offer numerous opportunities for reuse, which can help revitalize previously blighted neighborhoods. U.S. EPA's petroleum brownfields financial resources web area (https://www.epa.gov/ust/petroleum-brownfields#financial) provides more information.

Modified Processes and Procedures

In the early years of the national UST program, we evaluated UST releases with the goal of cleaning up all pollution from USTs. But cleaning up releases to the point where all traces of contamination are removed can be technically impractical and cost prohibitive, so we looked at how we could modify our policies, processes, and procedures yet still protect human health and the environment in a less expensive and still protective manner. Risk-based corrective action (RBCA), a strategy developed by the American Society of Testing Materials in 1999, and EPA's support of that strategy, helped states embrace the importance of identifying receptors and risk to UST releases, and if both are absent, ask what level of cleanup and amount of effort are needed. Using risk-based corrective action strategies to assess and clean up releases frees up money, which can then be used for cleaning up additional UST releases. As a result, more money is available to assess and clean up more UST releases.

States' adoption of risk-based decision making in cleaning up UST releases means they assess the risk each release poses, and then apply sound science and common-sense cleanup approaches that are flexible, cost effective, and protect

A Message from Mark Barolo... continued

human health and the environment. This flexibility allowed individual states to tailor solutions based on site-specific circumstances. Here are a couple examples.

- California's low threat closure policy promotes consistent closure criteria for low-threat UST releases across the state and resulted in closing over 1,000 releases a year for three consecutive years.
- Colorado enhanced its RBCA criteria by establishing two additional tier options that allow for site closure in situations where contamination extends beyond the property boundary, as long as certain conditions are met; this resulted in closing older releases that were difficult to close under previous tier criteria, even after years of active remediation efforts.

Improvements in Technology

Over the last 30 years, we've seen significant advancements in assessment and cleanup technologies. New and more sophisticated site characterization technologies using sensors and increased computing power now give us a better understanding of UST releases. In the early years of cleaning up UST releases, results from three drilled wells were often used to characterize a release; now we are using high-resolution site characterization and other sophisticated techniques and technologies to characterize particularly difficult, stalled releases, and this in turn helps us determine and tailor the best cleanup approach for each release.

Decades ago, the default approach for cleaning up UST releases was often pump and treat. Now we use a wide array of remediation technologies and our own improved knowledge of how and when to use them. These include air sparging and soil vapor extraction as well as numerous in-situ injection technologies. Taking it a step further, some states combine multiple technologies and products to manage, reduce, and control risks from petroleum UST contamination. This approach, known as a treatment train, includes a plan to use the most effective aspects of multiple technologies or products, or both, in succession to make cleanup progress. Our increased understanding and awareness of how contamination behaves has also positively impacted cleanups. Examples include our evolving understanding of light non-aqueous phase liquids transmissivity and the impact of biodegradation on contamination and vapor intrusion.

Partnerships

The national UST program's founders built the program on the premise that our partnerships are the most effective way to address USTs in the United States. They recognized that the large size and great diversity of the regulated UST community meant we needed help with managing the huge UST universe of over 2 million tanks at the time. As a result, we have always welcomed and embraced states, territories, and tribes as our co-regulators and essential partners. U.S. EPA and the national UST program have benefited greatly from our longstanding relationships with two organizations — NEIWPCC and the ASTSWMO — both of which have supported our UST partnership and the national UST program by sponsoring the National Tanks Conference, educational trainings, and informative seminars.

Our partnerships include other state-led organizations, such as the Interstate Technology Regulatory Council (ITRC). We value and welcome their work in developing helpful technical documents and guides about technical UST cleanup issues. Resources from organizations such as ITRC help our state, territorial, and tribal partners apply innovative technologies and processes to discovering, characterizing, cleaning up, and closing UST releases. These are just a few examples of useful documents available through ITRC's Guidance & Documents web area (https://ois-isrp-1.itrcweb.org/):

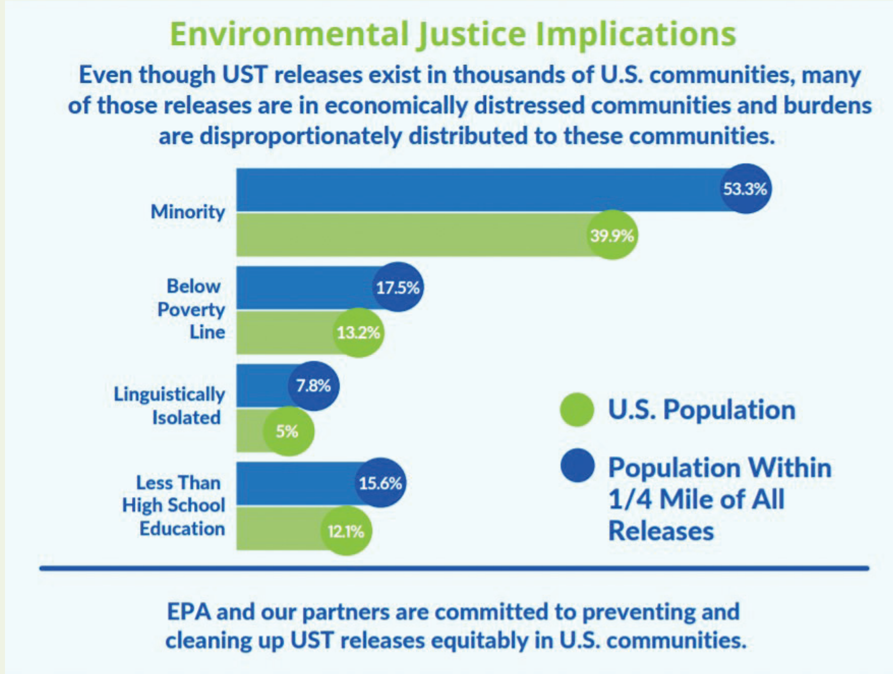
- "Optimizing Injection Strategies and In situ Remediation Performance" (OIS-ISRP-1)
- "Implementing Advanced Site Characterization Tools" (ASCT-1)
- "Light Non-Aqueous Phase Liquid (LNAPL) Site Management: LCSM Evolution "Decision Process, and Remedial Technologies" (LNAPL-3)

Over many decades, U.S. EPA's Office of Research and Development (ORD) has been an essential partner by providing research that supports states, territories, tribes, and U.S EPA in cleaning up UST releases. ORD's laboratory, pilot, and field-scale efforts resulted in innovative approaches to site characterization, fate and transport, modeling, technology development, and evaluation and training — all of which advanced cleaning up UST releases. Examples of ORD's support include:

- Assessing the fate and transport of methyl tertiary-butyl ether.
- Conducting research on monitored natural attenuation.
- Examining passive and active biotreatment of UST releases and influence of ethanol on benzene, toluene, ethylbenzene, and xylene groundwater plumes.
- Researching approaches to investigating and addressing petroleum vapor intrusion.
- Developing UST Finder, (https://www.epa.gov/ust/ust-finder) the first national inventory of USTs and UST releases, to improve UST management; protect water resources; and address effects of climate change on UST facilities, the public's health, and our environment.

Our industry partners are also a vital part of our success. When I refer to industry, I include a wide swath of people — owners and operators; tank system installers, testers, and service providers; equipment manufacturers; cleanup contractors and consultants; and UST insurance providers — involved in preventing and cleaning up UST releases. I also think of others, such as standard-making organizations, tank owner associations, and equipment and service organizations, that represent people who have a hand in preventing and cleaning up UST releases.

A Message from Mark Barolo...continued



Are We Done Yet?

Let's take a moment to savor our collective success before I bring up...you guessed it...the 61,981 UST releases remaining in the cleanup backlog. There are a variety of reasons UST releases persist for many years. Perhaps those releases have been in cleanup for several years because they are complex and difficult cleanups. Others might be nearing closure but have not been closed because states need to address higher priority releases first. Perhaps some releases are from abandoned USTs. And despite our best prevention efforts, we continue to confirm approximately 5,000 UST releases each year, and they add to our backlog, even as we make progress in cleaning up UST releases.

Nonetheless, the national UST program must keep progressing and identifying opportunities to reduce the UST backlog. U.S. EPA's backlog study (https://www.epa.gov/ust/national-lust-cleanup-backlog-study-opportunities) sparked us to take a more thorough look at the characteristics of UST releases and barriers to cleaning them up, as well as potential opportunities and strategies to reduce the backlog. Many states followed suit and U.S. EPA's UST cleanup web area contains examples of cleanup strategies states are using to help reduce their backlog of cleanups remaining (https://www.epa.gov/ust/cleaning-underground-storage-tank-ust-releases#states). Recently, Michigan and Illinois, with the second and third largest cleanup backlogs in the country, respectively, partnered with U.S. EPA to analyze their backlogs, determine impediments to cleaning up UST releases, and identify strategies to address stalled cleanups. Both states are now implementing initiatives to address those stalled cleanups and reduce their backlogs of releases remaining.

Cleaning up UST Releases, Next Year and Beyond

In the months and years ahead, cleaning up UST releases will continue to evolve. Certainly, we will see changes and improvements in technologies, and as we identify areas to modify processes and procedures, we will do so. We will be mindful of the effects of climate change, such as the potential of increased flooding and elevated wildfire threats, and we will share information to help owners prepare for and recover from those natural disasters. We will strive to address the disproportionate impact of UST releases on overburdened communities by continuing our work on pilot projects in three states and Indian Country, with the goal of better addressing environmental justice concerns in cleaning up UST releases. And, of course, the national UST program will continue to rely on the strengths of our partners and our collective commitment to keeping our soil and groundwater safe for people living in the United States.

Thank you, again, to all our partners — states, territories, tribes, and industry — for your accomplishment in cleaning up over 500,000 UST releases, which means we are protecting our environment and the public's health. I admire and appreciate the dedication, creativity, and perseverance of the many current and former UST partners whose work resulted in achieving this decades-long accomplishment. Because of your combined efforts, our country is a better place for all.

Potential Implications of the Presence of PFAS at LUST Sites

By Joe Cunningham

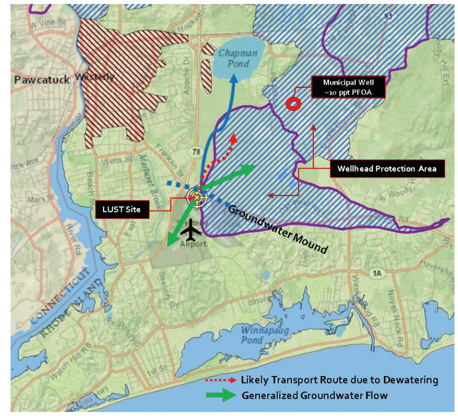


Figure 1: *Map of the site remediation area illustrating the likely dewatering transport route and groundwater flow, which may have increased PFOS and PFOA levels in groundwater in the wellhead protection area.*

Per-and Polyfluoroalkyl substances, commonly referred to as "PFAS," are a class of fluorinated compounds that have been used in many industrial and commercial processes and in consumer products since the 1940s. Only within the last decade have the health effects of PFAS been widely acknowledged and investigated, and exposure is associated with cancers, low birth weight, endocrine system disruption, and reduced immune system response[1,2]. PFAS compounds have been dubbed "forever chemicals" due to their persistence and general resistance to degradation, and they are believed to be pervasive in the environment.

Complications to Petroleum Remediation

While PFAS-containing compounds are not thought to be routinely used at gasoline dispensing facilities or present in significant concentrations in petroleum products, their proximity to other sources, including on-site car washes, may result in elevated on-site PFAS concentrations. However, it is common for no clear source of PFAS to be identified. PFAS analysis is not routinely performed at leaking underground storage tank (LUST) sites, and as a result we have a poor understanding of LUST sites co-contaminated with PFAS compounds.

This is unfortunate, as common LUST remedial methods, most notably dewatering and in-situ chemical oxidation (ISCO), have been shown to increase mobility and in some cases toxicity[3] of PFAS compounds.

With significantly lower retardation (R) values relative to BTEX (Benzene, Toluene, Ethylbenzene and Xylenes; volatile organic compounds that are found in petroleum and petroleum products), the real-world mobility of PFAS compounds is often orders of magnitude higher and may result in a much larger plume and impacted area relative to BTEX. When coupled with dewatering, which increases transport of the contaminant, or ISCO, which often oxidizes PFAS compounds to more mobile and toxic progeny, the potential exists for common LUST site remediation techniques to unintentionally increase the mobility, spatial extent, plume size, and toxicity of existing, and often unknown, comingled PFAS contamination.

Case Study: Unknown PFAS at a LUST Site

An example of the potential for unintended mobilization and transport of PFAS occurred at a LUST site located in Westerly, R.I. Upon removal of the underground storage tanks (USTs), free-floating petroleum (LNAPL, or Light Non-Aqueous Phase Liquid) was observed, and due to the shallow water table — less than three feet below ground surface — dewatering was performed to aid in source removal and facilitate installation of replacement USTs.

However, due to the owner's insistence that the convenience store remain open during construction and remedial activities, as well as the large dispenser system footprint and multiple release points, work was performed in stages over a period of six months. This required continuous dewatering for approximately three months, much longer than typically necessary, and resulted in a substantial volume of groundwater to be pumped and discharged.

Groundwater was sampled, treated, and discharged to a catch basin connected to a stormwater management system under a Rhode Island Pollutant Discharge Elimination System (RIPDES) permit. The effluent was routinely sampled and met all permit requirements (e.g., BTEX, turbidity, basic chemistry). Over the course of three months, more than 3 million gallons of groundwater were discharged into the stormwater system.

An Accidental Discovery

Late in the project and after dewatering had ceased, RIDEM learned that monitoring wells at a municipal airport approximately 4,500 feet south of the LUST site as well as a municipal water supply well approximately 5,000 feet northeast, had both reported having elevated PFAS concentrations. This prompted RIDEM to require PFAS analytical analysis to be performed at the site out of an abundance of caution. Results showed PFAS constituents were present in several groundwater monitoring wells, ranging from 10-40 parts per trillion (ppt) [The current groundwater standard for total PFAS in Rhode Island is 70 ppt; however, this level is anticipated to decrease in the near future].

The proximity of the LUST site to both a designated wellhead protection area (less than 500 feet) and a public water supply well (less than 5,000 feet) raised concerns about the impact the discharge of more than 3 million gallons of presumably PFAS-tainted groundwater from the extended dewatering had on the stormwater system, and, if the dewatering inadvertently contributed to the transport of PFAS into the wellhead protection area. PFAS is not currently a constituent evaluated as part of RIPDES discharge permits, and at the start of the project RIDEM had no reason to suspect PFAS would be present at this facility, and therefore was not considered during dewatering or in the corrective action plan. As the first steps in evaluating the potential impact of dewatering and discharge of groundwater to the stormwater system, the design was investigated, and field reconnaissance was performed.

Tracing the Discharge Flow

We found that the stormwater system discharged to a wetland approximately 500 feet north of the LUST site and that the wetland appeared to be a source for a stream which flows north (Figure 1) through the wellhead protection area and adjacent to the municipal well. Interestingly, a review of groundwater elevations suggest that the LUST site is immediately downgradient from a groundwater divide, with groundwater flowing in a southerly direction on-site, while across the street and in the wetland the groundwater flows in a northernly direction.

Mapping the groundwater and surface water flow proved to be significant. The hydrology pattern suggests that it is unlikely the nearby airport is the source of PFAS as it is downgradient of the LUST site; contamination at the LUST site – including PFAS and BTEX – would, if dewatering had not occurred, flow in a southerly direction away from the wellhead protection area.

Dewatering Disrupts Natural Flow

Dewatering is a LUST remediation method that can, even when executed perfectly, unintentionally transport and introduce contaminants, including PFAS, to unimpacted areas. In this case, the magnitude of the problem was exacerbated by the volume of water dewatered and discharged, as well as

> Dewatering is a LUST remediation method that can, even when executed perfectly, unintentionally transport and introduce contaminants, including PFAS, to unimpacted areas.

unfavorable ground and surface hydrology that was not adequately assessed prior to discharge. Unfortunately, the presence of a groundwater and surface water divide at the stormwater discharge area did not appear to be fully assessed and considered by the performing contractors, consultants, or when the RIPDES permit was issued. As a result, assumptions about the fate of discharged groundwater were not accurate.

With the benefit of hindsight and the knowledge that the discharged groundwater likely contained PFAS, it appears that the dewatering activities performed as part of the LUST remediation may have inadvertently transported PFAS into the wellhead protection area, potentially impacting a municipal drinking water well. The full extent of the impacts are not known. However, groundwater samples at the LUST site were consistently similar to the PFAS concentrations at the public water supply well. Therefore, in this case, the potential impact is anticipated to be low. Nevertheless, the Rhode Island Department of Health performs routine monitoring of public water supply wells, and as of the date of this publication, no substantial change in PFAS concentrations at the public water supply well has been detected.

Considering PFAS During LUST Remediation

As demonstrated by this case study, it is important to consider PFAS when working with LUST sites, as commonly used treatment methods for petroleum may have unintended consequences in comingled plumes. Due to the significant difference in retardation (R) rates between BTEX and PFAS compounds, BTEX plume size and concentration gradient are not a good indicator or surrogate for PFAS plume size, mobility, or potential exposure, and stratified plumes are likely to develop. As a rule of thumb, PFAS plume length is typically two to five times longer than BTEX plume length, however, with some PFAS compounds, or in situations where PFAS has been exposed to ISCO agents, this may be increased by up to two orders of magnitude.

Unintentional mobilization of PFAS during LUST remedial activities and dewatering, especially when ISCO has been utilized, is likely to occur. Current best practices for BTEX plume

> …it is reasonable to assume all LUST sites contain PFAS unless proven otherwise by analytical analysis.

sampling, modeling, and risk assessment do not adequately account for the presence of PFAS and the impacts LUST remediation may have in mixed plumes. In sensitive groundwater areas, sampling for PFAS at LUST sites should become routine and guide LUST remedial and dewatering strategies to reduce the risk of inadvertent mobilization or oxidation of PFAS into more toxic or mobile constituents. Due to the pervasive and persistent nature of PFAS compounds, even a detailed site history may not adequately predict if PFAS is likely to be present, as there are countless examples of PFAS presence at sites with no known source, including this case study. Therefore, it is reasonable to assume all LUST sites contain PFAS unless proven otherwise by analytical analysis. Knowledge of the impacts of LUST remedial techniques, most notably ISCO, on PFAS is in its infancy, and additional research and routine testing at LUST sites is required to better understand both the magnitude and frequency of potential impacts.

Joe Cunningham is a principal environmental engineer with the Rhode Island Department of Environmental Management. He can be reached at Joseph.Cunningham@dem.ri.gov.

Do you have a story that connects PFAS to UST/LUST? Contact Christine Stringer at cstringer@neiwpcc.org.

Footnotes

1 Grandjean et al. "Severity of COVID-19 at elevated exposure to perflourinated alkylates". PLOS One. 2020; 15(12):e0244815 (https://pubmed.ncbi.nlm.nih.gov/33382826/)

2 Looker C, Luster MI, Calafat AM, et al. Influenza vaccine response in adults exposed to perfluorooctanoate and perfluorooctanesulfonate. Toxicol Sci. 2014;138(1):7688. doi:10.1093/toxsci/kft269 (https://pubmed.ncbi.nlm.nih.gov/24284791/)

3 Bolan et al. "Remediation of poly- and perfluoroalkyl substances (PFAS) contaminated soils – To mobilize or to immobilize or to degrade?" Journal of Hazardous Materials. 2021; 401: 123892 (https://pubmed.ncbi.nlm.nih.gov/33113753/).

TANKtalk

with Rick Long

Thank you, Rick for joining me for our inaugural Tanktalk. I'm looking forward to our conversation.

We selected you to be our first interview as you are retiring at end of the year (2021; this interview will be published in early 2022) and we wanted to capture some of your departing thoughts, insight, and predictions for the future before you begin the next phase of your life.

●●● **Q:** You've committed the last 12 ½ years to Petroleum Equipment Institute (PEI), first as general manager and associate general counsel (from 2009-2017), and then as executive vice president and general counsel when Robert Renkes stepped down from the role in 2017. Tell us a bit about your background, what brought you to PEI, and what prompted you to shift industries

●●● **A:** Well, let me first say thanks for the invitation to do this interview, Michelle. LUSTLine has played—and continues to play—an important role in our industry. So, I'm honored to join in this conversation.

I started my career in 1982 as an attorney focusing on banking, business transactions and related matters. Two years later, I left the practice of law to join a small business publishing company started by a dear friend who also was one of my firm's clients.

The move may have looked crazy on the surface. I went from a highly respected law firm in a Tulsa skyscraper to a three-person office in an old, converted apartment building that didn't even have an elevator.

But the move allowed me to realize a lifelong dream of being a writer. And from the instant I started, I just loved it. Every day, I wrote and edited articles advising business owners how to better market their products, manage their operations and improve their profitability.

In 1989, I started my own company, Source Publications (later SourceMPI). And I should mention that I didn't burn any bridges when I went out on my own. The friend who had rescued me from the practice of law was my first client.

As time went on, Source began doing marketing, branding and creative services for trade and professional associations. Sometime in 2008, PEI became one of our clients. The work must have gone well because in 2009 Bob Renkes asked if I would consider joining PEI full-time.

It wasn't an easy decision. I absolutely loved being an entrepreneur and growing a business. But I was intrigued by the petroleum equipment industry. And, frankly, as the great 2009 recession gained steam, the idea of a stable, monthly paycheck became pretty appealing.

Ultimately, I found a way to say yes to PEI without completely abandoning my company. I accepted the full-time PEI position but kept an ownership interest in Source. That arrangement has worked quite well for the past 12 ½ years.

●●● **Q:** How did your career path prepare you for your work at PEI?

●●● **A:** That's a fair question! I think my previous experience was great preparation.

Source's primary mission was to provide large and small businesses with management advice, including expert analysis of key legal and regulatory issues.

That's largely what trade associations like PEI do.

And even though I didn't know the petroleum equipment industry well when I joined PEI, that didn't really frighten me. Source had successfully served a bunch of different economic sectors—retail, travel and healthcare, among others. So, I had confidence in my ability to master a new industry.

I also had learned lots about building and leading a staff, which has been a big part of my role at PEI.

●●● **Q:** What stand out as major accomplishments during your tenure?

●●● **A:** I'll mention two.

First, the relaunch of the "PEI Journal," which had gone dormant shortly before I joined PEI. Thanks to a completely new business model and editorial strategy, the new and improved "PEI Journal" was an instant success. And the magazine continues to be an important voice in the industry and a major contributor to PEI's revenue.

Second, the growth of PEI's recommended practice program. In 2009, PEI had nine recommended practices. The association now has 17 published documents, each serving an important need in the industry.

●●● **Q:** Retirement is a time of reflection. Have you contemplated what could have been done differently [as it applies to your time with PEI] and would you want the opportunity to turn back time and try something else?

●●● **A:** I'm quite sure we could have done some things better or differently. But our annual surveys show that PEI member satisfaction is quite high. And I would rather look forward than back. I am proud of what PEI has done for the industry. And I hope we laid a strong foundation for the association to do even more in the years ahead.

●●● **Q:** PEI's Recommended Practices (RPs) are essential to the Underground Storage Tank community. What, in your opinion, were the most significant/impactful RPs during your time with PEI and what changes, new practices are expected in the near future?

●●● **A:** Historically, RP100: "Recommended Practices for the Installation of Underground Liquid Storage Systems" has been the most widely read and most influential document. Thanks to RP100, UST owners, operators and contractors have had the guidance they need to meet and exceed the all-important 1988 EPA equipment regulations.

In the last few years, RP900 (UST inspection and maintenance) and RP1200 (testing of spill, overfill, leak detection and secondary containment equipment) have filled a similar role with respect to the 2015 EPA regulations.

The fact that all three documents have been incorporated by reference into the federal EPA regulations and adopted by many states is a testament to their importance in the industry.

Looking ahead, PEI is developing the first RP focused specifically on safety. SRP001: Safety Recommended Practices for Fall Protection and Working at Heights at Fueling Facilities will provide a concise reference for developing and managing fall protection programs that will increase worker safety, meet regulatory requirements, and reduce the risk of liability. The document should be out by Fall 2022.

●●● **Q.** It's time for predictions. What might the petroleum equipment industry look like in the year 2072 (or 2042, 2052…), and how will those changes impact an organization like PEI and the larger UST community?

●●● **A.** In the coming decades, the transformation of energy that already is underway will accelerate.

Some of the biggest changes will be at the macro power generation level. But the transformation also will trickle down to transportation and fueling infrastructure. Liquid fuel will be around for a long time. But as time goes on, it no longer will be the only game in town.

Savvy PEI members will adjust their business models accordingly. In fact, some 23% of PEI distributors and contractors already are involved in electric vehicle charging station installation and maintenance. Another 30% say they intend to jump in. Hydrogen, CNG and/or LNG fueling may also play a greater role in the future.

As an association, PEI will support members with the knowledge they need to succeed as this transformation takes place. In fact, at the 2021 PEI Convention at the NACS Show, PEI partnered with NACS and the Fuels Institute to release our first two EV charging station resources. One explains how to safely and economically incorporate EV charging into new liquid fueling facilities. The other supplies guidance for retrofitting existing liquid fueling facilities to add EV charging station.

●●● **Q.** Do you have any parting words of advice to newcomers? What about for those who have who've "been around the block?"

●●● **A.** I would remind newcomers that this industry is foundational to the world's economy. It's a great place to build a fascinating, fruitful career.

And for "old-timers," I guess I would offer two encouragements. First, draw from the past, but don't live in it. The changing world of energy will bring all sorts of new opportunities. So, welcome change, don't resist it. Second, enjoy the ride. Work is hard, stressful and challenging. But it also ought to be fun.

●●● **Q.** Thank you for your time and good luck. We appreciate all that you've done for the petroleum equipment industry and PEI's membership.

●●● **A.** Thank you, Michelle. This was fun. All the best to you and LUSTLine!

Expect The Unexpected: Pump Explosion In Tennessee

By Mac Pointer

Gas stations are not immune to accidents and explosions. According to the National Fire Protection Association, between 2014 through 2018, there were an estimated 4,150 fires in or on gas station properties per year[1]. The Tennessee Division of Underground Storage Tanks (USTs) recently dealt with one such explosion. Incidents, such as the one described here, while having the potential to yield tragic outcomes, can provide important lessons in safety and an environmental regulator's response to an emergency.

The Car Chase

On Saturday July 3, 2021, at approximately 5:20 p.m., deputies with the White County Sheriff's Department were dispatched to a stolen vehicle call. While on their way to the call, a truck matching the stolen vehicle's description sped past in the opposite direction, traveling westbound at a high rate of speed and illegally passing other vehicles. The deputies turned to chase the truck that matched the report's call. As the deputies pursued the vehicle, they witnessed an explosion in the vicinity of the Peacock branded gas station on East Bockman Way in Sparta, Tennessee.

Upon their arrival to the scene, they observed that the truck had crashed into several gas pumps and a parked car, causing an explosion and fire.

After the fires were put out, the facility's owner arrived and contacted their UST compliance contractor to respond and ensure no product was escaping and no further risks remained from the fueling system.

Workers with Pro Tech Services made sure each dispenser's shear valve was tripped and cut power to each tank's submersible turbine pump and ensured power was cut to each dispenser. Pro Tech Services continued working for the next three days at the facility. Each of the remaining dispensers were removed and stored on-site. All three product lines were blown back into the tank so that no fuel remained in the lines. The canopy was then taken down as it was damaged beyond repair and was at risk of falling onto anyone that walked or worked under it.

The Division of Underground Storage Tanks' Response

Once the debris was cleared and the station was safe from additional harm, staff from the Tennessee UST began working with the owner and the compliance contractor to determine the best course of action to repair the damage so that the facility could begin selling fuel again. It was determined that a full system replacement was the best course of action.

The age of the USTs (installed in 1988), the apparent fire damage to each of the facility's fiberglass lines, and the payout from the facility's insurance plan all aided in this decision. The facility's fiberglass lines were removed from the ground on October 1, 2021. Division staff will receive sampling results from this line closure in the coming weeks to determine if any remediation activities will be required.

Replacement equipment is on order. The facility's compliance contractor will complete the install when all the equipment arrives.

And as for the stolen vehicle that caused the explosion, the story continues…

The vehicle was later discovered to be driven by an individual from out of state. The driver lost control while attempting to make a turn off the highway and driving straight into a support beam, two dispensers, and an occupied car parked under the canopy near the facility's entrance. The impact also hurled one of the struck dispensers into an unoccupied minivan causing it to catch fire. There were injuries—both the driver of the stolen vehicle and individuals in the car he hit next to the gas pumps. Legal action is pending.

A vehicle impacted dispenser is a relatively uncommon experience. The severity of this impact and subsequent fire is even rarer. The prompt response from emergency services and the local sherriff's office aided greatly in containing any further damage to the persons on site, building, and all associated UST equipment. While this instance showed no damage to the environment through a petroleum release, it should be noted that such vehicle impacts have a high probability of damaging equipment that routinely contains product. The speed at which the vehicle impacted the facility, combined with the damage from the explosion and fire, could easily impact shear valves, piping, or any other safety measures, and allow petroleum to escape into the environment.

Footage of the crash is available (https://bit.ly/TNgasexplosion).

Mac Pointer is an environmental manager with the Tennessee Department of Environment and Conservation, Division of Underground Storage Tanks. He can be reached at frank.pointer@tn.gov.

Footnote

1. Aherns, M. "Service or Gas Station Fires," NFPA, December 2020.

NEIWPCC NEWS & RESOURCES

Recent Webinars

NEIWPCC coordinates with partners to provide LUST Corrective Action and UST Inspector Training webinars. We would like to thank our partners for helping to plan and provide four such webinars in 2021 and we appreciate "seeing" hundreds of our readers join these virtual sessions.

Corrective Action

Our goals for the series are to:

- Improve LUST program performance.
- Increase technical capability and understanding.
- Minimize the impact of UST releases to the environment.

Air Sparge, Soil Vapor Extraction, and Dual-phase Extraction at LUST Sites

In this webinar, speakers discussed the tools and data that inform the design and use of these systems to remediate LUST sites. Conditions and geology encountered at LUST sites were discussed, as were system costs, optimization, and exit strategies. Special thanks to Edward Tung of MK Environmental, Inc. and Matthew Lahvis of Shell Global Solutions (U.S.), Inc., for presenting.

The recorded webinar and slides can be accessed in the Corrective Action archive on the NEIWPCC website (https://bit.ly/neiwpcc-webinar-corrective).

Inspector Training

The important training series aims to:

- Improve UST program performance.
- Educate inspectors on policy and UST systems and equipment.
- Prevent UST releases to the environment.

We hosted three webinars in 2021.

UST Systems at Marinas

Speakers Tim Smith (U.S. EPA), J. David Stone (Tennessee DEC), and Steve Latimer (Wilson/Rogers & Associates) discussed the design and testing of UST systems at these unique sites and covered applicable standards, recommended practices, fire codes, and the Federal UST regulation.

Emergency Power Generator UST Systems – Part 2

This webinar was offered as a follow-up to our webinar from 2020 (available on demand at the NEIWPCC website). Topics included EPA OUST's guidance regarding these systems and discussion focused on the technology and limitations of line leak detection. We appreciate both Tim Smith and John Cignatta (Datanet Engineering, Inc.) for continuing to collaborate with us on this important topic.

UST Overfill Prevention

Speakers discussed the installation, testing, and repair of UST overfill prevention devices and emphasized what is encountered in the field based on their experience. Thanks to Russ Brauksieck (U.S. EPA), Spruce Wheelock (retired, formerly with New Hampshire DES), and David McKamie (DATZ UST Management, LLC) for speaking.

The recorded webinar and slides can be accessed in the UST Inspector Training archive on the NEIWPCC website (https://bit.ly/neiwpcc-webinar-inspector).

Great Trainings Start with You

Do you have something to Share about LUST corrective action or UST inspection and compliance? We want to hear from you! Our ability to provide useful content is only as strong as the people willing to provide it.

Biofuels Compatibility Webinar Under Development

NEIWPCC is excited to be working with EPA's Office of Underground Storage Tanks (OUST) and other interested agencies to develop a national webinar that explores how different agencies handle biofuels requirements.

The webinar(s) will offer multiple perspectives on how biofuels have grown over the last three years and how, during the same timeframe, states have enacted new rules after EPA updated the requirements for storing biofuels in the compatibility section of the 2015 UST regulation. State agencies, local implementing agencies, and possibly owners will be invited to attend what we expect to be a very interesting topic for the UST community. We are actively recruiting individuals interested in joining the planning efforts.

Tribal Workgroup Efforts In Progress

Last year, NEIWPCC began working with tribal partners to establish a Tribal UST/LUST workgroup. Meeting regularly, we've been exploring opportunities for NEIWPCC to provide training and knowledge share with workgroup participants,

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tribal environmental personnel, UST owners/operators on tribal lands, and other interested stakeholders.

These meetings have generated much excitement and we are currently discussing ways to provide training and information opportunities to assist with maintaining Federal UST regulation compliance at tribal facilities. If you work on UST/LUST issues on behalf of a tribe and are interested in participating or learning more about this workgroup, please let us know!

National Tanks Conference

The 27th National Tanks Conference (NTC) will take place September 13-15, 2022, in Pittsburgh, Pennsylvania. Pre-conference workshops will be held September 12.

NEIWPCC is co-sponsoring the NTC in partnership with U.S. EPA OUST and the Association of State and Territorial Solid Waste Management Officials (ASTSWMO). We are committed to providing an event that keeps participants as safe as possible and promotes the well-being of our community. View NEIWPCC's COVID-19 Policy for more information. (https://bit.ly/neiwpcc-COVID).

Abstracts and Conference Planning

We've received some excellent abstracts for the conference. Our presenters help make the NTC what it is — an opportunity for UST professionals to meet, share lessons learned, best practices, and more.

NEIWPCC is working with our planning team of state, tribal, and federal partners to develop a conference agenda covering important topics related to UST compliance and release prevention, LUST cleanup, and state funds and financial responsibility. To join the NTC mailing list, email ntcinfo@neiwpcc.org.

Questions/comments may be directed to cstringer@newipcc.org. Readers are invited to visit our website for more information.(https://bit.ly/neiwpcc-tanks).