Oxygenates

Wander LUST

by Hal White

A column by Hal White that explores "a dimension as vast as space and as timeless as infinity—representing the middle ground between light and shadow, science and superstition . . . between the pit of man's fears, and the summit of his knowledge."

Do Monitoring Wells Monitor Well? Part II

The Regulatory Basis for Monitoring Well Design, Siting, and Monitoring

In Part I of this article (LUSTLine #40) I discussed the function of monitoring wells and presented several of their many shortcomings. To recap from the last article, the primary function of a groundwater monitoring well is to provide subsurface access for (a) the measurement of liquid levels and (b) the collection of liquid samples for analysis. Monitoring wells may also be used to collect gas/vapor samples and measure vertical transport properties, and they are convenient (although rarely optimally located) places to install various components of a remediation system. I also asked the questions, "Why is it that so little consideration is actually given to the question of whether the data we derive from them is of adequate quality? Are we somehow bound by inflexible rules that defy common sense?"

In Part II of this series, I'll take you through an in-depth look at the federal regulations (and preamble) to identify potential constraints and then develop a defensible strategy to overcome whatever obstacles we may encounter. Beware! The sections titled "Regulatory Language" and "Preamble—Clarification and Guidance" contain material that may induce narcolepsy in all but the most detail- and academically oriented readers. To prevent serious bodily injury in the event of loss of consciousness, skip these two sections and dive right into "A Probing Analysis." You can always refer back to these sections in case of insomnia.

Regulatory Language

By now *LUSTLine* readers should be intimately familiar with 40 CFR 280, the federal regulations for the technical requirements for underground storage tank systems. Considering the extremely broad scope of these regulations, and the amount of detail in some of the sections (e.g., release detection), it is somewhat remarkable that the regulations are only 13 pages in length—a mere footnote by normal regulatory standards! It is somewhat disconcerting, however, that in the corrective action portion of the regulations (Subparts E and F) the word "well(s)" is only mentioned three times (and then only once within the context of a "monitoring well"), whereas in the prevention section (actually only in Subpart D) "monitoring well(s)" is used 10 times.

Granted, this frequency or infrequency of occurrence isn't the issue, it's what's actually said that's important. And it's important to note that the corrective action sections of the regulations provide no guidance with respect to monitoring well design, siting, and sampling. None. The free-product-removal regulations merely spell out the information requirements for the free-product-removal report that must be submitted to the implementing agency within 45 days after confirming a release.

The sections on release detection provide substantially more detail, though these sections don't apply to wells used for environmental monitoring. Because vapor monitoring and groundwater monitoring are allowable release-detection methods, it isn't at all surprising that Subpart D makes frequent mention of "monitoring well(s)." Monitoring wells are also mentioned in the requirements for the interstitial monitoring release-detection method. Let's look at what these release detection regulations say about monitoring wells.

■ **Vapor Monitoring** Regulatory language for vapor monitoring in the first five subsections of §280.43(e) describes requirements for "monitoring device(s)" and only in the final two sections does it refer to "monitoring wells" per se. Section §280.43(e)(6) requires that the UST excavation zone be assessed to "...establish the number and positioning of monitoring wells that will detect releases *within* the excavation zone..." Note that this clause refers exclusively to releases within the excavation zone and not those (if any) in the soil surrounding the excavation (e.g., from piping or vent lines). The final section (§280.43(e)(7)) merely requires that vapor-monitoring wells be clearly marked and secured.

■ **Groundwater Monitoring** Section §280.43(f) mentions a few limited design specifications regarding

■ continued on page 18

■ **WanderLUST** *from page 17*

groundwater-monitoring wells. Section §280.43(f)(3) stipulates that "[t]he slotted portion of the monitoring-well casing must be designed to prevent migration of natural soils or filter pack into the well and to allow entry of regulated substance on the water table into the well under both high- and low-groundwater conditions." Section §280.43(f)(1) defines a "regulated substance" as being both immiscible in water and having a specific gravity of less than one.

The intent of these two passages is quite clear: groundwater-monitoring wells installed for the purposes of *release detection* must allow entry of regulated substances that float (having a density less than one) on the water table (i.e., a light nonaqueous-phase liquid [LNAPL]) and that they do so when the water table is at both its highest and lowest elevations (presumably on an annual cycle). If this weren't sufficiently clear, Section §280.43(f)(6) settles the issue as follows: "The continuous monitoring devices or manual methods used can detect the presence of at least one-eighth of an inch of free product on top of the groundwater in the monitoring wells."

Section §280.43(f)(4) requires that the annular space be sealed from the top of the filter pack to ground surface. This is a standard design feature of any well to eliminate a pathway for contaminants on the ground surface to reach groundwater. Section §280.43(f)(6) stipulates that these "monitoring wells or devices intercept the excavation zone or are as close to it as is technically feasible." As with the vapor monitoring section, there is a requirement (§280.43(f)(7)) for the UST excavation zone to be assessed to "...establish the number and positioning of monitoring wells or devices that will detect releases..." However, here they are not restricted to being within the excavation zone. Finally, there is a requirement that the monitoring wells be clearly marked and secured (§280.43(f)(8)).

■ **Interstitial Monitoring** The final occurrence of "monitoring well" in the UST regulations occurs in §280.43(g)(2)(vi) and merely requires that the monitoring wells be clearly marked and secured. These wells will not be considered further in this article.

Now that we've scoured the regulations for language relating to monitoring well(s), what have we learned? Not much. The next avenue is for us to look at language in the preamble and conduct a similar examination.

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Preamble—Clarification and Guidance

In contrast to the rule itself, the preamble is over 100 pages in length. The words "monitoring well(s)" occur with much greater frequency and, not unexpectedly, most of these occurrences relate to the same sections we've already examined in the regulation. For convenience I'll organize the discussion in the same manner as above, but I'll focus the discussion on what's different and (hopefully) more explanatory than the regulations.

■ **Vapor Monitoring** Vapor-monitoring wells serve functions that are very different than groundwater-monitoring wells. In the discussion of the effectiveness of vapor-monitoring wells, the preamble recognizes this by stating: "...a vapor-monitoring well does not necessarily mean a typical groundwater well. Instead, a vapor-monitoring well means any sampling point from which vapors are collected and brought to the monitor by any means." No additional clarification or description is provided for either the vapor-monitoring wells or "sampling points." These wells will not be considered further in this article.

■ **Groundwater Monitoring** The preamble acknowledges that "[t]he final rule still allows monitoring on top of the water table for free product but with several changes: well placement is no longer limited to the excavation zone; the well screen must be designed to prevent clogging and intercept the water table at both high- and low-groundwater conditions; and the well must be sealed from the ground to the top of the filter pack." This allows monitoring wells for release detection to be located even farther from the potential source of a release.

In the discussion of "Limitations" of this method, the preamble restates that groundwater monitoring is "limited to use with products that are immiscible in water and lighter than water so the product can be detected by the monitors." Further discussion of this issue reveals that U.S. EPA recognizes that this release-detection method is "...intended for use with gasoline and other substances that are, in fact, slightly soluble in water. Thus, the immiscibility requirement does not exclude substances that are, in fact, slightly soluble. The slight solubility will not interfere with rapid detection because most of the product is still floating on top of the water table where the monitor can sense it."

The final section on groundwater monitoring discusses the sensitivity of the monitoring device. For this the agency adopted a performance standard "requiring that the monitoring equipment be capable of detecting the presence of at least one-eighth of an inch of free product on top of the groundwater."

According to the preamble, "This value was selected because it is the maximum performance that manufacturers continue to claim can be achieved by existing automated monitoring equipment," although it is "intended to apply both to automated and manual monitoring techniques."

A bit later, the preamble recognizes that "manual methods of collecting and analyzing groundwater samples...may be more sensitive than automated monitors..." but dismisses this argument supporting the use of manual methods because they are "...very subjective and can only be conducted intermittently, whereas automated methods can be continuous and are less subjective."

Debating the "subjectiveness" of methods for measuring free product on the water table as release detection completely misses the more important point of whether or not a particular method is at all effective in detecting a leak *before* it causes a serious environmental problem. This is akin to rearranging the deck chairs on the Titanic.

A Probing Analysis

Now that we've completed a thorough examination of both the regulations and the preamble, what do we know about monitoring well design, siting, and monitoring? With respect to design, monitoring wells are only really discussed in the context of groundwater monitoring for release detection, and specifically for measurement of free product. Although language in the preamble does recognize that gasoline (and its components) aren't totally immiscible, applicability is explicitly restricted to substances that are immiscible or only "slightly soluble" in water.

At first blush this restriction may seem to be a material weakness (and it is) because the regulations only superficially address monitoring requirements for dissolved contaminants. But there is an unintended positive consequence. This consequence is that groundwater monitoring as release detection is implicitly disallowed for use with substances that are more than "slightly soluble" (e.g., MTBE, other ethers, alcohols). It's bad enough that the measurement criteria is explicitly set at one-eighth of an inch even for slightly soluble substances. So what are the monitoring requirements for dissolved substances?

The only explicit mention of "dissolved" substances appears in section §280.65(a): "In order to determine the full extent and location of soils contaminated by the release and the presence and concentrations of dissolved product contamination in the groundwater, owners and operators must conduct investigations of the release, the release site, and the surrounding area possibly affected by the release..." This section also lists several criteria, of which at least one must apply before §280.65(a) applies, and it is likely that at least one would apply at most release sites if an adequate investigation were conducted.

Alas, no substantive guidance is provided on how one would go about determining "the presence and concentrations of dissolved product contamination in the groundwater." Fortunately, however, other sections of the regulations that do not deal with release detection provide some insight into "measuring for contamination," although this too is rather vague.

Section §280.52(b) ("Site Check") requires that owners and operators "...measure for the presence of a release where contamination is most likely to be present at the UST site. In selecting sample types, sample locations, and measurement methods, owners and operators must consider the nature of the stored substance, …the depth of groundwater, and other factors appropriate for identifying the presence and source of the release."

Similar language appears in sections §280.62 ("Release Response") and §280.72 ("Out-of-Service UST Systems and Closure"). Language in the preamble explains that the agency intentionally did not prescribe a given sampling method or measurement technique because it "may not provide representative results for all types of regulated substances and site conditions."

With respect to the siting of monitoring wells for release detection purposes, section §280.43(f)(5) directs that such wells are required to be sited as close to the tank excavation as is technically feasible so that a release may be detected as quickly as possible. Section §280.65(a) makes it clear that the area of investigation includes not only the release site but the surrounding area that might be affected by the release, so presumably environmental monitoring wells may be sited virtually anywhere.

Piecing Together a Strategy

From the above dissection of the regulations (and preamble) we see that 40 CFR 280 presents a rather disjointed collection of guidance and requirements for monitoring wells that, although good-intentioned, is incomplete and sometimes incongruous. Bear in mind that the regulations were written in the mid-to-late 1980s, and a lot of what we now know about how fuel releases behave in the subsurface has been learned in the years since promulgation of the regulations. For instance, the writers were blissfully ignorant of the characteristics of MTBE and the other oxygenates. They hadn't had the benefit of having spent several years dealing with the MTBE issue on a day-to-day basis. Even the transport and fate characteristics of free product, in general, and its more soluble components (i.e., BTEX), were at best incompletely understood.

Today we cannot credibly hide behind those same excuses. Although there's still a lot that is unknown, we can't afford the luxury of ignoring some of the most basic principles governing the transport of dissolved contaminants in groundwater. And although the regulations are far from perfect, we *can* piece together an improved strategy for dealing with fuel releases that is defensible from a regulatory perspective.

The starting point is language directing responsible parties to "measure for the presence of a release where contamination is most likely to be present at the UST site" considering "the nature of the stored substance,...the depth of groundwater, and other factors appropriate for identifying the presence and source of the release." So, let's see what we've got:

■ **We all need to recognize that conventional monitoring wells that are screened over long vertical distances are inadequate and unsatisfactory.** Such wells absolutely cannot provide the three-dimensional data that is essential for delineating the extent of dissolved contamination. All monitoring wells should have relatively short screens (no more than two to five feet), and a sufficient number of wells should be installed in close proximity (as in a "nest") such that there is continuous coverage from the seasonal high water elevation down to a depth below the water table, beneath which it is unlikely that a dissolved plume will dive. This generally will be an increasing depth with distance from the source.

■ *continued on page 20*

■ **WanderLUST** *from page 19*

■ **New monitoring wells should be installed in transects spaced at appropriate intervals along the length of the plume.** The network of wells should be dense enough to provide a high degree of confidence that the plume is not migrating undetected, either between wells or beneath them. The plume should be surrounded by wells that lie outside the plume (i.e., samples collected from these wells should contain no trace of contamination at any depth).

■ **Discrete samples collected from each of these new monitoring wells should be analyzed for the major fuel components (i.e., BTEX) plus all potential oxygenate additives (e.g., MTBE, ETBE, TAME, TAEE, DIPE, TBA, TAA, ethanol, and methanol) each and every time a sample is collected.** EPA has recently completed a study that demonstrates that Methods 8015 and 8260 are appropriate for determination of MTBE and the other fuel oxygenates using appropriate sample preparative methods (e.g., Methods 5021, 5030 [at elevated temperature] or 5032). The protocol for using these methods is only slightly different than current practice, so any cost increase should be insignificant in relation to the improvement of the quality of the data thus produced. Whatever the incremental increase may be, it is certainly worth paying a little more to obtain data that are accurate, comprehensive, and credible. Information on these methods will soon be available from a variety of sources. An article will be published in *LUSTLine*, an EPA fact sheet is in production and should be circulated soon, and SW-846 (EPA's methods compendium) will be updated in the near future (visit **http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm**).

■ **New monitoring wells should be "monitored" on a frequent basis.** Quarterly events are not unreasonably frequent, especially where oxygenates are concerned. Water table elevations fluctuate in response to local influences (e.g., thunderstorms, tides) as well as annual weather patterns. Dissolved contaminant concentrations in wells may also vary significantly over the course of a year. Sometimes this is in conjunction with water level fluctuations; sometimes it isn't.

Without sufficient data to identify such trends, it is impossible to make credible predictions about plume behavior. Further, the increasing reliance on degradation rates calculated from plume centerline behavior is predicated upon data from wells that are in fact located on the centerline. In many cases the primary direction of groundwater flow, and hence migration of contaminants along the "centerline," may exhibit seasonal variation by as much as 90 degrees.

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Such variation is problematic enough for determining whether receptors may ultimately be impacted—data from wells that aren't actually on the centerline (or which are sometimes and are not at other times) can yield an erroneous and overly optimistic calculated degradation rate. This in turn leads to an erroneous calculated time frame for achieving cleanup objectives and points out the importance of regular monitoring to track remedial progress.

Decisions about site closure should only be made based on actual field data. Under no circumstances should a site ever receive a "no further action" determination until it's been confirmed that remediation objectives have, in fact, been achieved and demonstrated to remain at or below the desired level for a specified period of time thereafter.

■ **Groundwater monitoring for release detection should be abandoned.** The presumption that free product floating on the water table will serve as a timely first indication of a release is just plain wrong! Especially with fuel oxygenates present in just about any UST at any time, a significant dissolved plume could have formed and begun migrating long before one-eighth of an inch of free product is noticed in a monitoring well that might be checked every 30 days.

If groundwater monitoring is used for release detection, then *daily* collection and analysis of groundwater samples for dissolved contaminants should be required. Once every 30 days is insufficient, especially when another month is allowed to confirm the first month's results. By this flawed strategy, a release could have been ongoing for 60 days before the "suspected" release was even reported. Months could pass before any remedial efforts would occur, and in that amount of time the plume would continue to grow.

If dissolved contaminants are detected in a monitoring well, then there's no doubt that a release has occurred; it isn't "suspected," it's a fact! Only the magnitude and cause of the release are unknown. (Unfortunately, implementation of this recommendation at the federal level would require a change in the regulations, which could take decades. Perhaps implementation at the state level could be achieved more quickly?)

The third article in this series will consider existing "conventional" monitoring wells. We'll look at examples both from real sites and from hypothetical situations to reinforce the points I've tried to make in the two preceding articles. Perhaps then there will no longer be any lingering doubts about the answer I've provided to the eternal question, "Do monitor wells monitor well?" ■

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