

A.M. Pelayo, 10/7/2008, Retrospective Study of Closed Leaking UST Sites in Wisconsin

1. My presentation this morning is on our recently-concluded study of closed UST sites in WI. The focus of our study is the use of NA as a closure tool.
2. Closure is an administrative decision. It is a N F A determination by the state. In WI, closure involves proper abandonment of MW. So after the closure date, no MW will be available.
3. I list here 2 important dates related to WI's handling of contaminated sites. In Nov. 1996, WI began allowing closures of sites that still have not met the state's cleanup standards. In May 2001, a web-based tool we now call the GIS Registry became available. Anyone going to the GIS Registry webpage can view and download maps and site-specific information on sites that closed above WI's cleanup standards. In the 2 year period, 1999 and 2000, before the GIS Registry, in fact in anticipation of the GIS Registry, there was a huge influx of UST site closures – over 1300 UST site closures.
4. Our study has 2 parts as listed here. We were interested in the 1300+ sites that closed above state cleanup standards in 1999 and 2000. We initially devised a stratified random sampling plan to get a good representative no. of sites that we can review. Our review included entering specific site information into a database. We collected over 200 pieces of information from 133 sites that we ended up reviewing. Briefly, we're looking for clear insights on the data collected at these sites, and perhaps evaluate a collective metric or metrics to show whether NA as a remedy is effective. Our analysis of the data from the database sites will be what I'll be presenting now. The 2nd part (the results from our Post-Closure Field Study) I will cover later.
5. This map shows the relative locations of the 133 sites we reviewed. The highlighted counties are where the sites were. From our stratified sampling, we average about 1 review for every 10 closures in the counties with the most closures. I labeled in the map the 3 counties with the most closures. Sites selected from these 3 counties together constitute a 3rd of the total sites we reviewed.
6. We can do simple queries to the database. For instance, we get a median number of 7 MWs installed at the database sites. We can get information on active remediation. We found that 38 sites (or over a quarter of the database site) did not have any remedy apart from the tank pull.
7. This plot shows the depth to GW info from the database sites. We plotted the depths into a histogram to conveniently show their distribution. For about 7 out of 10 sites, the depth to groundwater is at 10 ft or less. The shallow groundwater explains why there are relatively plentiful MWs in WI. Much easier to install a MW in WI than say, a state like AZ where the median depth to water found in a recent UST study there was 50 ft. With plentiful MWs, WI sites are generally reasonably well characterized.
8. This slide shows the historical maximum VOC concentrations found in GW samples from the database sites. I've arranged the VOCs from the least water-soluble naphthalene to the most soluble MTBE. When the data is arranged like this, we can plot the effective solubilities for the VOC. Effective solubility is the concentration above which we can expect a NAPL to be present. Effective solubility is usually expressed as a fraction of the pure-phase solubility of the volatile compound, with the fraction being its mole fraction in the NAPL. For instance, here we plot the effective solubilities for when we have fresh gasoline as our NAPL, with 1% Naphthalene, 8.5% xylenes, 2% ethylbenzene, 1% benzene and 10% MTBE. After we do so, we can count how many sites exceed the effective solubilities. We come up with different counts depending on which VOC. What seems apparent, however, is a systematic decreasing count with increasing solubility for the VOC. An insight here is that the source is probably a weathered product. And when we have a weathered product for a NAPL, the less-soluble VOCs, like N, X and E, may be more indicative of the NAPL than either B or MTBE. The count of sites here for N may actually be an underestimate because more than a quarter of the database sites did not

have N data! For the next slide, I'll be focusing on the Benzene data. Almost all site investigations are benzene-centric, and as such, we have a more complete set of benzene observations

9. This slide shows the histogram for the historical maximum benzene-in-groundwater concentrations from the database sites. The x-axis has the concentrations increasing by a factor of 10 for each unit going to the right. In WI, the cleanup standard is called ES (or enforcement standard). For benzene, ES is set at 5 ppb. You can see how high the concentrations are relative to ES by the "RED" factors at the bottom of this slide. For instance, the highest B we found was over 10 thousand times its ES. Note the highest bar: over 50 sites with benzene concentrations between 100 to 1,000 X ES. The next slide is another set of benzene concentrations corresponding to the maximum B at closure.
10. Note the drop in the # of sites for the bar from 100 to 1,000 x ES. Let's go back to previous slide. Then back to this slide for a "before and after" comparison. As I'm doing the back and forth between the slides, note the shift to the left of the previous historical high bar. We can find that there's a factor-10 decrease at closure compared to the historical max. Benzene.
11. So between the historical max and the closure max, how much time has elapsed? Interestingly, not a long time. Here is the histogram to show the time interval between them. The x-axis bins are in 6-mon increments. At the bottom of the slide are the 1-, 5-, and 10-yr markers. Notice the longest interval is just over 10 years. For this histogram, we made a distinction between sites that were remediated (BLUE) and sites that did not have any remediation (BLACK). For sites with no remedy, a shorter time has elapsed. The median times we found are: 3 and a half years for site that had active remediation, and just over a year for sites with no remediation.
12. Given the B data, we found factor-10 decrease in a span of a few years. Will we see this decrease 5 to 10 yrs post closure? Let's now look at our field study to get post-closure data.

13. We have 10 field sites in all. 4 were former retail stations (shown as red stars in this map) and the rest are non-commercial sites. Notice the cluster of sites at or near Dane county in proximity to UW-Madison. Jean Bahr's students collected all the samples for this post-closure study.
14. Briefly, with our P-C investigation, we installed MWs near where B was previously detected, and further downgradient.
15. 2 MSc theses have been written up on this study. The theses contain comparisons of the total BTEX plumes. This slide summarizes the comparisons. The blue outline is what was found at closure; the black outline is more recent. Briefly, we found longer BTEX plumes at all 4 former retail stations, and at 1 non-commercial site. Next slide is a close-up of one of the former retail stations.
16. In 1998 was when the historical max was found. Then 2 years afterwards, right before closure, plume has shrunk some. More recently, 5 years after closure, we can define a larger BTEX plume. At this 3 time periods, we obtained a swing of about 40 degrees in the groundwater flow direction.
17. This slide just focuses on the B data. We show bar graphs with the historical max, closure max and the post-closure max. Where you see red bars and symbols, that means we found post-closure benzene levels at those sites higher than found at closure.
18. At 10 sites, we found 5 with higher P-C benzene, but we did not really find B as frequently as before. Let me show what I mean in the next slides.
19. Here's another former retail site. During SI, benzene was found S and also North of USH-12, as indicated by the arrows.
20. Post-Closure, we can define an elongated BTEX plume extending to the North of USH-12, but the B remains just to the S of the Hwy. We did not detect B in any of the wells we installed N of the Hwy.
21. Did we miss the B plume? If we did, how about the TEX. Let's look at the N data.
22. N detection frequency, except at 2 sites, were at 50% or less. When we did our post-closure, we found comparatively higher N detection frequency at sites with previously $\leq 50\%$. Basically, what this means is that N detection is more prevalent than before.
23. Was there any N improvement? For 4 sites, we found N higher than even the the previous Historical max. For sites with improvement, it was not a factor-10 improvement.
24. Post-closure VOC plume is different. B remains near the source, but N plume seems to have expanded.
25. Benzene remains near the source, but ...
26. N extends farther, as shown by light green arrows. The 2 farthest N detections were from piezometers with the tops of their screens deeper than 15 ft below the water table.
27. Conclusion/Recommendation. Given the data at hand, can't make realistic projection when ES will be met at former UST sites. Prudent state action is to have LUC emplaced far into the future.