When Is Enough, Enough?
Community Perspectives on Groundwater Treatment at Department of Defense Facilities

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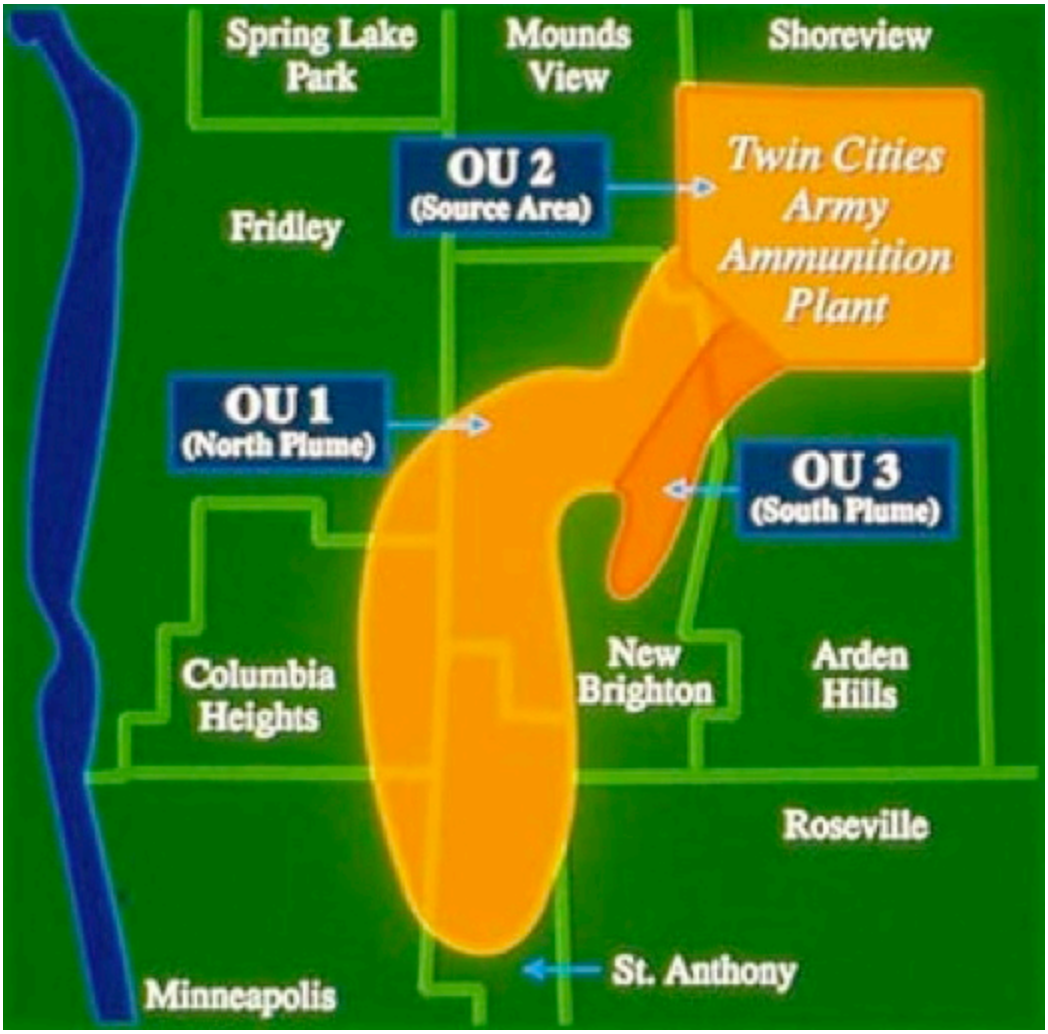
Groundwater treatment systems are in place and operating at hundreds of Department of Defense facilities, controlling plumes, removing contaminant mass, and destroying contaminants of concern such as chlorinated solvents and petroleum products. A large number of these systems are conventional groundwater extraction technologies, known colloquially as "pump and treat," but an increasing number of sites employ innovative technologies such as biotreatment, *in situ* chemical oxidation, and permeable reactive barriers. As cleanup programs mature, the key question is no longer what the initial remedy should be. Rather, the Defense components responsible for cleanup, regulatory agencies, and the public are discussing how long these systems should remain in operation—that is, "When is enough, enough?"

To help answer that question, Lenny Siegel, Executive Director of the Center for Public Environmental Oversight (CPEO) evaluated community perspectives on the cleanup of trichloroethylene (TCE) plumes at the closed Twin Cities Army Ammunition Plant (TCAAP) in Minnesota (New Brighton and Arden Hills) and former Moffett Naval Air Station in the San Francisco Bay Area (Mountain View and Sunnyvale). Specifically, Siegel reviewed the decision to shut down treatment at TCAAP's Operable Unit 3 (OU3)—the South Plume emanating from the former arsenal—and the debate over future treatment at Moffett Field's Site 26, the Eastside aquifer. Trichloroethylene is the principal contaminant at both sites, and at both facilities there are larger plumes that normally attract more public attention, as well as ongoing challenges over installation reuse.

Both TCAAP and Moffett have strong, mature cleanup programs, overseen by both state and federal regulatory agencies. Both installations are on the "Superfund" National Priorities List. Both have active community involvement programs, including Restoration Advisory Boards (RABs) that meet regularly. Both communities bring their own expertise to the table. As a member of the community adjacent to Moffett Field, I have been involved in the oversight of its environmental program for nearly two decades. This puts me in the unusual position to reporting on the views of a community that I have played a role in shaping.

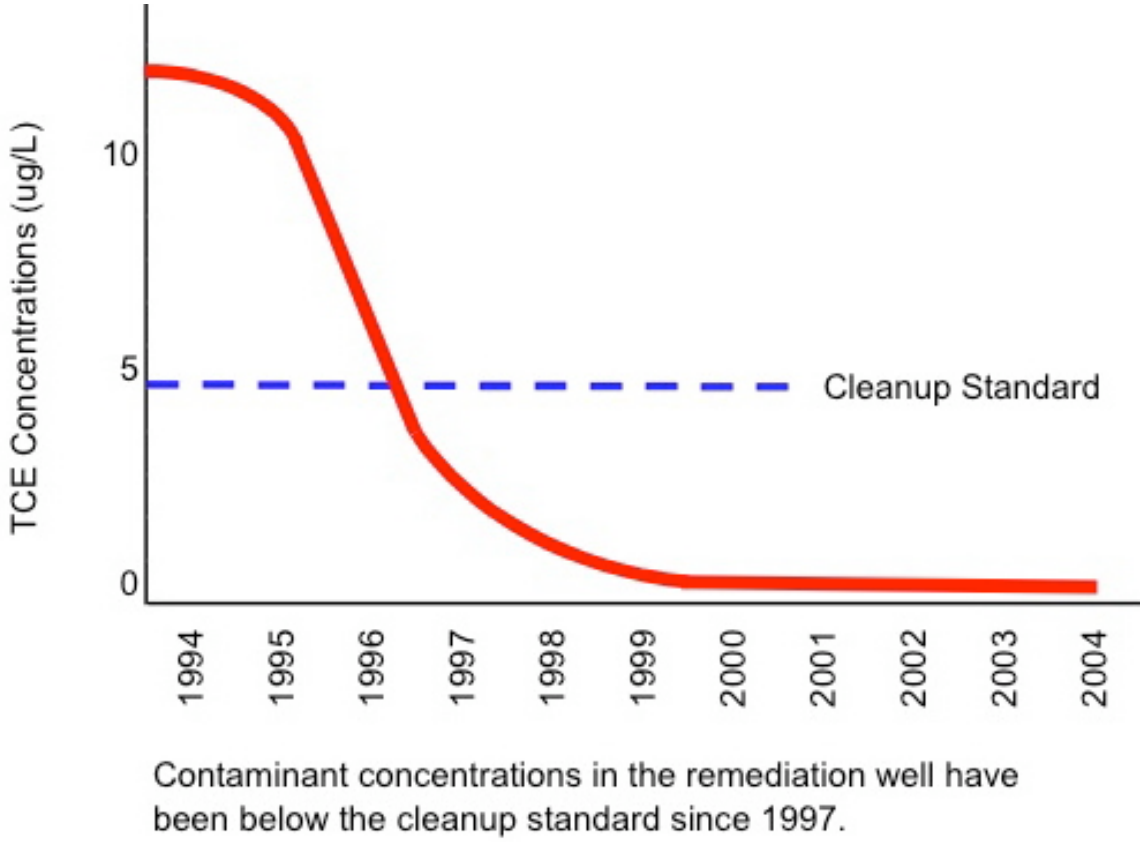
TCAAP's Operable Unit 3



Operable Unit 1 and Operable Unit 3 at the Twin Cities plant are the two deep aquifer plumes emanating southward from the facility. OU1 is the historic source of New Brighton's municipal drinking water supply. In the early 1980s, New Brighton discovered that VOCs from TCAAP were contaminating that supply, and eventually the Army agreed to use the city's wells as extraction wells for groundwater treatment, to pay for carbon filtration so the city could use the extracted water, and pay for the city's past costs in addressing the contamination.

The Army also proposed to install an extraction well at OU3, which until then was not used by the city as a drinking water source. In 1992 the Army, U.S. EPA, and the Minnesota Pollution Control Agency signed a Record of Decision (ROD) prescribing a three-part remedy: 1) A deep groundwater extraction well was installed at the leading edge of the southern plume. It began pumping, at 1000 gallons per minute, in 1994. 2) The city of New Brighton operated a water treatment facility, in which the pumped water was run through a granular activated carbon filter. And 3) New Brighton channeled the cleaned water into its municipal water system. ATK (formerly the Defense branch of Honeywell)—a former private tenant at the plant—paid the bills.

Pump-and-treatbrought down the wellhead concentrations of TCE below the five part per billion (ppb) remedial objective by 1997.



The pumping rate of the well was reduced in 1999 and then the well was shut off on an interim basis in 2001. Based on a historical and statistical evaluation of monitoring data, the USEPA, MPCA, and Army concluded that the South Plume has been shrinking since the well was shut off and that the well is no longer needed.

In August 2006 the three agencies signed a ROD Amendment ending active remediation, replacing it with monitored natural attenuation. However, since higher levels of TCE, above the 5 ppb standard, remained upgradient of the well, the ROD Amendment specified continued monitoring, institutional controls preventing the drilling of private drinking water wells in the area, and a contingency plan requiring action if concentrations are found to rebound.

Once there were assurances that there would be careful, continuing monitoring, the community, including the RAB and the city of New Brighton, supported the decision to shut down the OU3 pump-and-treat system, as long as the OU1 wellfield could make up for lost volume. From the graph above, it's easy to see why. At the extraction well at the historic leading edge of the deep TCE plume, the remedy had worked. However, the city did not accept the Army's argument that natural attenuation would drive down the upgradient concentrations. Rather, it believed the OU1 pumping would continue to

impact OU3 levels. Furthermore, its focus was on the quality of the water it served to its population, leaving upgradient compliance to the environmental regulatory agencies.

Finally, the community does not see the OU3 shutdown as an abandonment of cleanup because most of TCAAP's remedial activities continue. The Army has spent about $160 million on cleanup there, and it expects to spend nearly $30 million more. In particular, TCAAP continues to ensure the safety of New Brighton's water through the OU1 treatment system while it addresses the deep groundwater source area as Operable Unit 2. Starting 2003, with the agreement of the regulators, the Army has adjusted the 17 OU2 extraction wells to optimize mass removal. It currently projects that it will reach remediation goals around 2040. The city of New Brighton isn't so optimistic; it is prepared to insist on carbon treatment until the OU1 wells, like the single OU3 well, show no VOC detections.

TCAAP Operable Unit 2 Boundary Well House

Moffett Field's Eastside Aquifer

The Eastside Aquifer VOC plume at the former Moffett Naval Air Station, at the southern end of the San Francisco Bay, is the smallest of the installation's three major plumes. Now known as Site 26, it historically has been less controversial than the Westside Aquifer and the Orion Park Housing plumes because the Navy is the only potentially responsible party. East of the Moffett runways and emanating from two huge hangars, the Eastside plume is divided into northern and southern sections, both of which were first measured in the early 1990s. The smaller northern plume has high levels of total dissolved solids—greater than 3,000 parts per million—due to saltwater intrusion from the San Francisco Bay and its historic salt evaporation ponds. Thus, when site remediation was first discussed in the 1990s, the Navy, environmental regulators, and community activists all agreed that no cleanup of this portion of the aquifer was required because there is no potential drinking water source.

Aerial View of Eastside Aquifer area at Moffett Field

However, the southern portion of the Eastside Aquifer is a potential drinking water supply, and under California's Porter-Cologne Act, it should be cleaned to meet drinking water standards. That is, the point of compliance is not the distant facility boundary or even more distance public water wells, but zones of highest concentration within the plume.

Covering about 17 acres, the southern section contains tetrachloroethylene (PCE), TCE, and their breakdown products, 1,2,dichloroethylene (DCE), and vinyl chloride. The maximum recent concentrations of PCE and TCE are 77 ppb and 28 ppb, respectively. In the early 1990s, the Navy removed the leaking underground storage tanks believed to be the principal source of the contamination, and under a 1996 Record of Decision it began extracting groundwater in 1999 and treating it with an air stripper and carbon filtration system. By the time the Navy turned off the pumps in 2003, it had removed more than 67 million gallons of water containing only 24 pounds of VOCs. Complete remediation—to the 5 ppb objective for both compounds—is difficult because contamination is sorbed to soil particles in the saturated zone.

In 2003, the Navy undertook an 18-month natural attenuation study. That is, it turned off the pumps and measured the consequences. It found that degradation was taking place fast enough to prevent the spreading of the plume, but that 1,2 DCE concentrations increased.

In 2005, with enthusiastic support from members of the community—the Restoration Advisory Board—the Navy conducted a nutrient enhancement pilot study:

> A total of 7,190 lbs (3,261 kg) of HRC was injected using direct push technology (DPT). Groundwater chemistry and microbiology were monitored for the following 18 months. Reduction in TCE and PCE concentrations was observed in a majority of the samples from wells in or near the pilot test areas, with a corresponding increase in cis-1,2-DCE. Concentrations of cis-1,2-DCE increased in samples from some wells with no change in VC concentrations. These data confirm that reductive dechlorination was occurring, but also indicate that the process was not likely proceeding to completion. Increasing cis-1,2-DCE concentrations coupled with the lack of significant generation of VC and ethene were interpreted to suggest that DHC [a specific bacteria strain] was not present in sufficient quantities or was incompetent to complete the reductive dechlorination process.

Drilling to inject nutrients at Moffett's Eastside Aquifer

Despite the apparent success of the pilot study, the Navy concluded that the innovative technologies were not good enough. In an April 2008 Technical Memorandum, the Navy concluded:

> There are no remedial technologies that can be successfully applied to Site 26 groundwater contamination that will reduce VOC concentrations to those specified in the ROD that are not inordinately cost prohibitive. The Site 26 dissolved COC groundwater plumes are stable under natural, non-pumping conditions. A stable plume indicates that one of the purposes of the ROD (reduce plume migration) is satisfied. COCs are likely being contributed from the fine-grained soils to the more permeable soils, providing a relatively slow and near-constant concentration release of COCs to maintain a steady-state plume configuration (TtEC, 2008). Due to the complex hydrogeology of the site area, it is technically impractical to remediate groundwater to ROD cleanup standards without incurring inordinate costs. Therefore, it is recommended that a Technical Impracticality waiver be evaluated for the southern plume at Site 26.

In essence, the Navy believes that the contamination is not a threat to anyone, and it is unwilling to spend money to reduce concentrations from already low levels to levels that still won't meet official standards.

Community activists, however, recall that the Navy never wanted to conduct active remediation at the Eastside aquifer. We point to a nearby site where a private respnsible party has supplemented nutrient enhancement with bioaugmentation, the addition of a specific strain of bacteria. The series of treatments appears to be effective. Community members, backed by state and federal regulators, believe that the Navy has not made the case that enough remediation has been done. We want the Navy to add bioaugmentation to the treatment train, employ phytoremedation (with poplar trees, for example), *or* try out another innovative technology.

We are not insisting that the Navy continue indefinitely any treatment method that removes very little contamination. While the cleanup standards remain a goal, we're more concerned about the slope of the concentration vs. time curve. Once extraction or any other method becomes asymptotic—that is, the concentration levels off—we want the Navy to seek ways to re-accelerate remediation. The following notional graph, taken from a National Research Council report that I helped write, illustrates what we think is possible. *(Environmental Cleanup at Navy Facilities: Adaptive Site Management*, 2003).

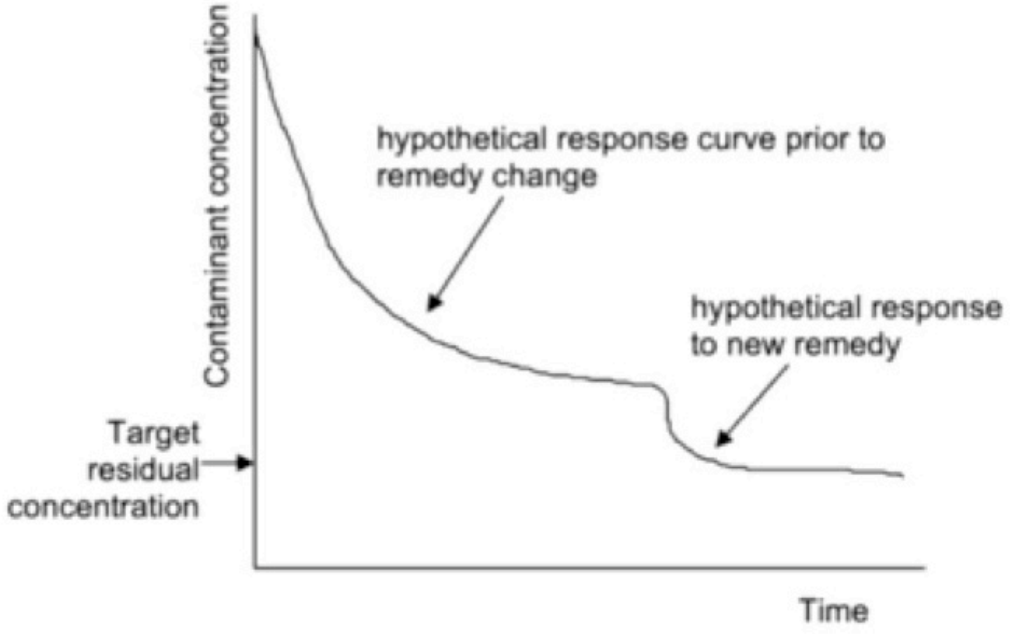


FIGURE 3-9 Hypothetical effect of changing the remedy on the concentration versus time curve.

It might be that complete remediation of this site is not technically practical, but it is the position of the community, as well as the Bay Area Regional Water Quality Control Board and U.S. EPA, that the Navy has to try harder. The regulatory framework leads the agencies to emphasize the numerical remedial action objectives, but the community is

primarily interested in technologies that will reduce contaminant concentrations in the most practical way.

National Lessons

In conducting these two case studies, I also briefly reviewed other sites with similar issues. Though more case studies are needed to reach definitive conclusions, here are four key findings of when communities think enough treatment is enough:

1. Communities are more willing to accept cutbacks or even shutdowns of some treatment systems on an installation when other systems remain active on other parts of the facility.

2. Communities accept technical impracticability waivers when there really is no way to clean a site with known technologies.

3. It is more immediate that drinking water meet official standards than groundwater away from recognized exposure pathways.

4. When treatment "goes asymptotic," communities want responsible parties to try innovative technologies to increase the rate of removal.

Of course not all communities, or even members of any single community, think alike. The best way to know when a community thinks enough treatment has been completed is to convene continuing advisory groups such as restoration advisory boards, inform the participants, and make sure they have access to independent technical expertise.