Community Input on the Cleanup of the MEW-Moffett Regional Plume
Mountain View, California

The “Regional Plume” in Mountain View, California is nearly a half-mile wide and just under two miles long. Multiple aquifers are contaminated with TCE, its breakdown products, and other contaminants. It consists of four Superfund sites, and there are numerous private and federal responsible parties. As a local activist, I have been involved at this site for nearly three decades.

In the late 1990s, our community was generally satisfied with site remedies. The portion of our drinking water supply, drawn from a deep aquifer upgradient from the Plume, was protected. Still, neighbors expressed concern about the release of airborne contaminants from air-stripper treatment systems, and there was broader concern about the slowing rate of contaminant removal.

In 2002, U.S. EPA recognized the threat of vapor intrusion at the Regional Plume and two other groundwater contamination sites in the area. Hundreds of people showed up at a community meeting in early 2003, stimulating a new series of investigations. In 2009, EPA found that the Regional Plume’s existing remedies were unprotective. It developed a new Record of Decision for vapor intrusion. Working with the community, commercial property owners, and the responsible parties, EPA is developing a strategy for accelerated groundwater remediation in portions of the plume.

Since the discovery of the Regional Plume nearly thirty years ago the local community has been directly engaged in cleanup oversight through advocacy organizations, Mountain View’s city government, and a number of advisory boards. Since 1993, community groups—first the Silicon Valley Toxics Coalition and now the Center for Public Environmental Oversight (CPEO)—have received a series of Technical Assistance Grants from U.S. EPA. Peter Strauss has been the community’s principal technical consultant throughout the process.

The following memo was developed by Strauss with input from CPEO and its Community Advisory Board. We believe it will help EPA and the Regional Plume’s responsible parties implement a strategy for accelerated groundwater remediation, particularly in the upper aquifer that is the source of actual and potential vapor intrusion. We also believe it serves as a mode in two waysl: First, it shows how informed, empowered communities can move the remediation process forward, providing a framework for including Community Acceptance in remedial decision-making. Second, it lays out a strategy for accelerating cleanup at large, complex sites where complete, rapid aquifer restoration is difficult to achieve.

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April 15, 2011

FOCUSED FEASIBILITY STUDY FOR THE MEW—MOFFETT REGIONAL PLUME COMMUNITY CRITERIA AND SUGGESTED STRATEGY

Prepared by Peter Strauss for the Center for Public Environmental Oversight (CPEO)
and its MEW[1]-Moffett Community Advisory Board
April 2011 version

EPA is preparing a Focused Feasibility Study (FFS) for groundwater at the MEW-Moffett Superfund sites. As with the Remedial Process Optimization (RPO) studies that were prepared a few years back, the FFS aims to find new solutions to accelerate groundwater remediation. This is in part because the remedial action objectives (RAOs) established in the 1989-ROD aimed at reducing concentrations of chemicals in soil and groundwater so that the groundwater would meet drinking water standards. In 1981, the threat of vapor intrusion was not understood and no RAOs for the vapor intrusion pathway were identified in the ROD. In 2010, a ROD Amendment was signed which required a response to vapor intrusion at the sites. The ROD Amendment articulated the following new Remedial Action Objective (RAO) that is a key element in the FFS:

> To accelerate the reduction of the source of vapor intrusion (i.e., Site contaminants in shallow groundwater and soil gas) to levels that are protective of current and future building occupants, such that the need for a vapor intrusion remedy would be minimized or no longer be necessary.

It is worthwhile to re-acquaint ourselves with the old RAOs and cleanup levels. These RAOs and cleanup levels will not change as a result of the Vapor Intrusion Remedy, except with the addition of the heretofore-mentioned RAO.

RAOs	
Protect local drinking water supplies	
Restore the shallow and deep aquifers to meet Maximum Contaminant Levels (MCLs) and 10^{-6} risk levels, respectively	
Control and remediate contamination in subsurface soils	
Prevent vertical migration of contamination to aquifers	
CLEANUP GOALS	
Soil	
Outside slurry walls	0.5 ppm TCE
Inside slurry walls	1.0 ppm TCE
Groundwater	
Shallow aquifer	5.0 ppb TCE
Deep aquifer	0.8 ppb TCE

[1] MEW stands for three street names (Middlefield, Ellis, and Whisman) that define a Superfund Study Area with three National Priorities List sites and multiple responsible parties.

Remedies at the site consist of the following:

- Operation of an area-wide Regional Groundwater Remediation Program (RGRP), which is largely a pump-and-treat operation both north and south of Highway 101. There are currently 30 operating Regional Recovery Wells. In most cases, clean water that is removed is piped to Steven's Creek, although efforts have been made to re-use some of the water.
- Excavation of soils greater than cleanup levels.
- Construction of a number of slurry walls that were installed to up to depths of 100 feet to contain the deepest and most contaminated areas.
- A series of source control actions, largely pump-and-treat operations, so that each of the Responsible Parties would take responsibility for their own sources of contamination. There are currently 58 operating source-control recovery wells.
- North of Highway 101, the Navy and NASA have been working on their own source control measures, also largely pump-and-treat, although the Navy also used a pre-treatment system that removed much of the contamination. NASA's efforts have been through Voluntary Clean-up Agreements with the State, except for areas overlying the regional plume.

The figure attached to this memo shows the general location of the regional plume in the upper aquifer.

As explained at the last meeting of the Moffett Field Restoration Advisory Board (RAB) and expounded upon in each of the RPO Evaluations, one of the principal reasons why remediation of the groundwater at the MEW-Moffett Field sites has been so difficult is the phenomenon of "matrix diffusion." The underlying subsurface is heterogeneous. That is, it consists of ribbons and layers of sand that transmit water easily, and layers of silt and clay that don't allow much movement and tend to sorb the contaminants to fine particles. Thus, although a great deal of progress has been made in the last 20 plus years of active remediation in terms of mass removal, containment of the plume, and generally lowering groundwater contamination levels, several systems have reached a level where the contaminant removal has leveled off after an initial period of steady reductions. This is referred to as reaching the asymptotic limit. The costs in terms of dollars, water withdrawn from the aquifer, and energy to keep operating the system as it has been are substantial. Thus a focused strategy of getting the biggest bang for the buck and resource use is needed.

The community, represented by the Community Advisory Board and Center for Public Environmental Oversight believes that the new Feasibility Study and remedy selection should focus on the following:

- Areas with high mass
- Areas that continue to act as a source
- Areas that reduce the need for long-term Vapor Intrusion mitigation
- Where the detectable plume encroaches on residential areas, schools, and other sensitive uses
- To enable reasonable future use of the property.

In addition, as contamination from upstream areas (i.e., MEW) continues to flow downstream, all remedies should be closely coordinated among the responsible parties. Additionally, there should be additional characterization of the subsurface to identify those areas most amenable to remediation. It goes without saying that continual improvements in long-term monitoring should also be part of the equation.

The community also believes that the Feasibility Study should require an adaptive optimization strategy that continually looks at new ways to attain clean-up standards. This should be a requirement that occurs every two years. That is, every two years the Responsible Parties should take a systematic look at the entire remediation process and determine what is working, what can be improved, and if there are new techniques and technologies that can enhance remediation performance.

Optimization of Existing Remedies

In 2009, CPEO, after consultation with the Community Advisory Board, sent EPA a short paper entitled "Remedial Process Optimization—Community Criteria." The Remedial Process Optimization (RPO) Evaluations required of each responsible party in 2008 were the first step at re-evaluating the remediation system and seeing how it could be improved. Results from these evaluations should be incorporated into the FFS. Many of the detailed criteria below and the list of technologies to be considered flow from the previous criteria for the RPO evaluations and the analysis of those evaluations. Detailed criteria are listed below.

- Alternatives that replace current systems must speed up remediation (increasing progress towards remediation goals), remove or destroy contaminants that are not being addressed by the current system, and/or increase mass removal rates.
- The remedy selection process should evaluate hot spot removal.
- The remedy selection process should evaluate, where appropriate, the effectiveness of existing institutional controls (e.g., restrictions on drilling wells) as well as the need to establish new institutional controls (e.g., establish requirements to restrict use).
- The remedy selection should consider energy use and natural resource use/re-evaluate treated water recycling.
- The remedy selection process should evaluate the need for additional extraction wells and/or increasing extraction rates, particularly upstream from the slurry walls.
- Long-term monitoring and a contingency plan (e.g., failure of slurry walls) should be part of the scope of the FFS. We note that in 2008, the Northgate efficiency evaluation found that the slurry walls were "leaky," yet we know of little that has been done to address this problem.
- Remedy selection is complicated by the fact that property owners must give consent to the Responsible Party to conduct pilot tests and implement new technologies. The FFS should account for this complication.

Alternative Technologies

We think that the following technologies should be considered for application to certain areas:

Ultraviolet/Hydrogen peroxide treatment followed by air stripping. (See Optimization Evaluation at 405 National Ave.)

In-situ Chemical Oxidation (hydrogen peroxide, with or without iron sulfate, sodium or potassium permanganate, and ozone). We note that Intel found in-situ chemical oxidation less favorable based on its limited success at similar sites and since it had the potential of producing hexavalent chromium and manganese dioxide during the oxidation process. Hexavalent chromium is a toxic metal that is of particular concern in California. Therefore, if this is the case at other MEW and Moffett sites, we find this reason enough to reject this technology. Also, the precipitation of manganese dioxide tends to reduce the pore space in soils and further restrict ground water flow and the permeability of the aquifer. This reduction in permeability could affect the distribution of oxidants and directly impact the effectiveness of the remedial technology.

Mixed results were observed with chemical oxidation pilot tests using potassium permanganate. In 1999, a chemical oxidation pilot test at the Raytheon 350 Ellis Street property was conducted using existing vapor extraction wells and three existing monitoring/extraction wells. The test showed a 30% reduction in the volatile organic compouns (VOCs) in groundwater and no adverse effects on groundwater quality were observed (Locus, 2003; IT, 2000). In 2000, a pilot test using injections of potassium permanganate was conducted in the A-zone at the Siemens-Sobrato Properties at 455, 485/487 and 501/505 East Middlefield Road. TCE concentrations decreased immediately after upgradient potassium permanganate injection, but rebound occurred. (Property owners rejected a follow-on pilot test due to concerns about the temporary shutdown of buildings). At a site in Sunnyvale, California (located approximately two miles from the MEW), permanganate injection in a recirculation mode has been conducted since December 2001, with periodic spot treatment into additional injection wells. Rebound of VOC groundwater concentrations continues to occur, likely due to the presence of residual VOCs trapped in the less permeable sediments.

All chemical oxidation techniques rely on the chemical being in contact with the contaminant. Thus, ISCO treatment is generally most effective in coarser-grained sediments. Also, permanganate is very messy, it is corrosive in liquid form, and storage has some safety concerns.

In-situ enhanced bioremediation and bioaugmentation. Intel has a pilot project underway. Monitoring indicates that bioremediation has been an effective method for remediating trichloroethylene (TCE) and its daughter compounds and for containing the VOCs on-site. Application of the emulsified oil was very successful in inducing highly reducing conditions. Based on monitoring results and calculations, VOC mass removal and mass flux reduction has been at least as robust under bioremediation as it was under pump-and-treat operations. While the Intel in-situ bioremediation project has been very successful, some improvements could be made in certain areas where reductive dechlorination appears to have "stalled" at cis-1,2-Dichloroethylene (DCE)—that is, augmenting the population of dechlorinating microorganisms Dehalococcoides ethenogenes and adding emulsified oil substrate to the area in question.

Other biostimulation pilot tests have been conducted at the Westside Auifer Treatment System (WATS) area and at 455 and 487 East Middlefield Road. At the WATS area, sodium propionate (an electron donor) was injected into groundwater through a well screened across two high conductivity layers between 10 and 25 feet bgs (upper unit) and 30 and 40 feet bgs (lower unit). The addition of electron donor successfully stimulated reductive dechlorination of cDCE and vinyl chloride (Northgate, 2008). SMI conducted a laboratory microcosm study between January and April 2003 using a groundwater sample collected from well SO-PZ2 in December 2002. Three electron donors (lactate, whey, and propylene glycol) were tested as well as bioaugmentation using culture NJ-E from Bioremediation Consulting Inc. (BCI). The results indicated that groundwater contained dehalococcoides ethenogenes capable of converting TCE to ethane, however the dechlorination from vinyl chloride to ethane occurred more rapidly when augmented with the NJ-E culture from BCI. The most favorable results were obtained using lactate as an electron donor.

Permeable Reactive Barriers (PRBs). PRBs may be appropriate in the shallow groundwater zones, and as a potential replacement for portions of the slurry walls. (Both the upstream and downstream sides of the slurry walls could be retained as a funnel-and-gate system, and only a relatively small portion of the slurry wall would have to be removed). It was noted in the Raytheon Optimization Study (Locus) that it might be possible to modify the existing slurry wall to install elements of a PRB, although access may be difficult due to presence of buildings. A pilot-project PRB filled with zero-valent iron (ZVI) was installed in the WATS area at Moffett Field in 1996. Results indicated that the zero valent iron was capable of reducing VOCs to below their respective MCLs or analytical reporting limits within the first 2 to 3 feet of the 6-foot long iron cell. Hydraulic studies showed that there was some contaminated flow under and around the hanging wall.

Monitored Natural Attenuation. This technology should only be used in locations where concentrations are below 100 ug/L, there are no overlying buildings, and where there is conclusive evidence that matrix diffusion has caused contaminants to become sorbed to the less-transmissive zones of the aquifer.

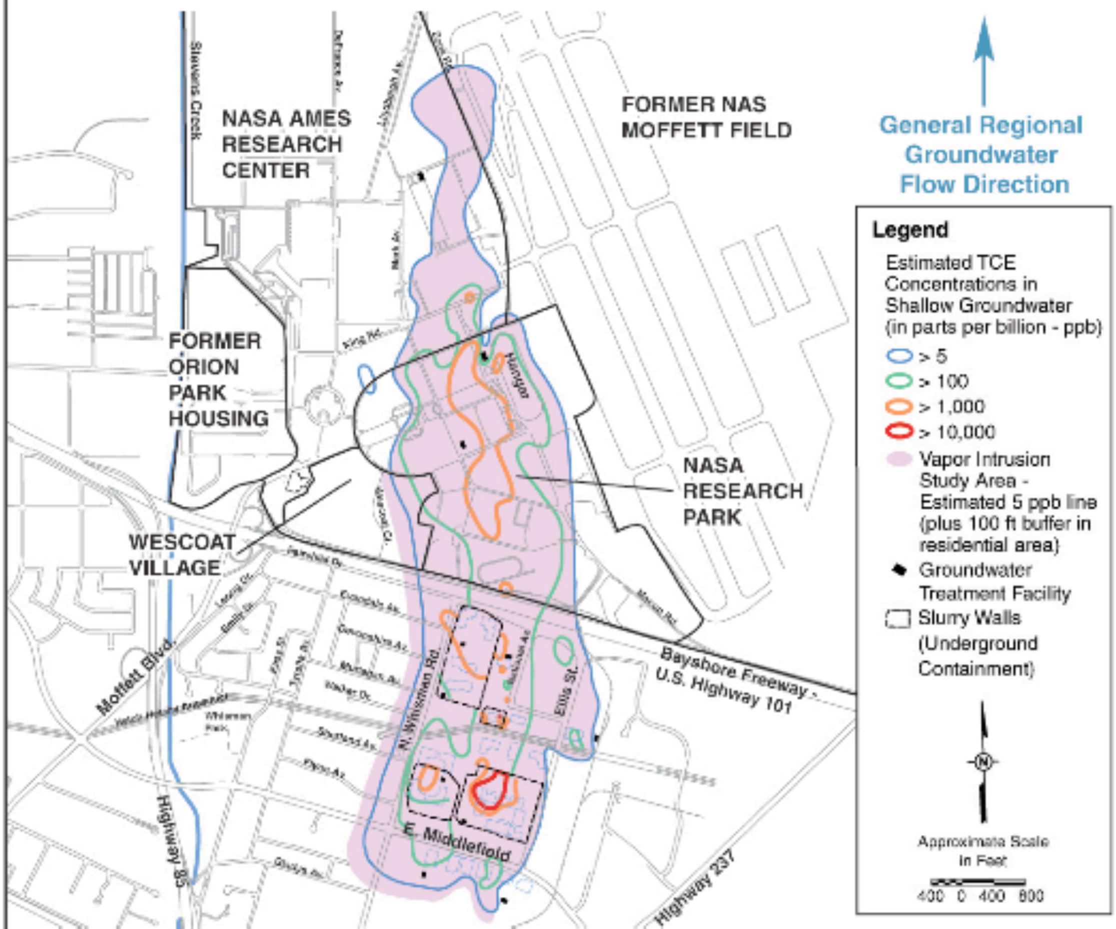
Advanced Oxidation followed by Granular Activated Carbon (GAC) polishing. The Advanced Oxidation Process destroys the majority of the influent VOCs at the WATS. The liquid-phase GAC units polish the discharge water of any remaining VOCs.

Pulsed Extraction. Cyclic operation of the systems may allow matrix diffusion processes to temporarily regenerate higher concentrations and thereby improve the mass removal efficiency of the source control remedy. Pulsed extraction includes modifying the operational mode of the pumping systems from continuous operation to cyclic operation, with monitoring of the influent VOC concentrations to assess potential increases in concentration from the end of one cycle to the start of the next (i.e., “rebound” in concentrations). This technology could be readily implemented because the extraction systems are already in-place.

Air Sparging and Soil Vapor Extraction. At the former Siemens/Sobrato properties an air-sparging system combined with soil vapor extraction (AS/SVE) was pilot tested in 1995 and operated at full-scale beginning in 1997. The system was operated until rising water levels forced closure of the air sparging wells.

Phytoremediation. Phytoremediation uses vegetation to remediate contaminated groundwater through several mechanisms. Some plants destroy organic pollutants by degrading them directly, while others aid in degradation indirectly by supporting microbial communities. In addition, plants can also be used to take up water in large amounts, and thus help to contain contaminants in subsurface environments. Phytoremediation is best suited for wide areas where contaminants are in low to medium concentrations. The key element in the design of a phytoremediation project is that the roots of the selected plant must be in contact or in very close proximity to the target contaminant. This technology is readily implementable over portions of the site, with the exception of paved areas (roads and airplane parking areas), structures, which are not amenable to tree planting/maintenance. The subsurface lithology (layered fine-grained soil) should not represent a significant barrier to root transport.

Combined Abiotic/Biotic Treatment. Combined abiotic/biotic treatment refers to amendments that contain ZVI along with a slow release organic electron donor. The ZVI component serves to rapidly generate strongly reducing conditions and promote chemical dechlorination processes that are insensitive to contaminant concentrations over a very broad range, and the organic component stimulates biological reductive dechlorination. ZVI is purportedly rapid and leads to a more complete degradation than biotic treatments. The organic component is nutrient-rich amendment that provides support for growth of bacteria in the groundwater environment. These processes combine to create an extremely reduced environment that stimulates chemical and microbiological dechlorination of VOCs.



ESTIMATED REGIONAL TCE SHALLOW GROUNDWATER PLUME AND VAPOR INTRUSION STUDY AREA

Second Five-Year Review Report
Middlefield-Ellis-Whisman (MEW) Study Area
Mountain View and Moffett Field, CA

Figure 2-5