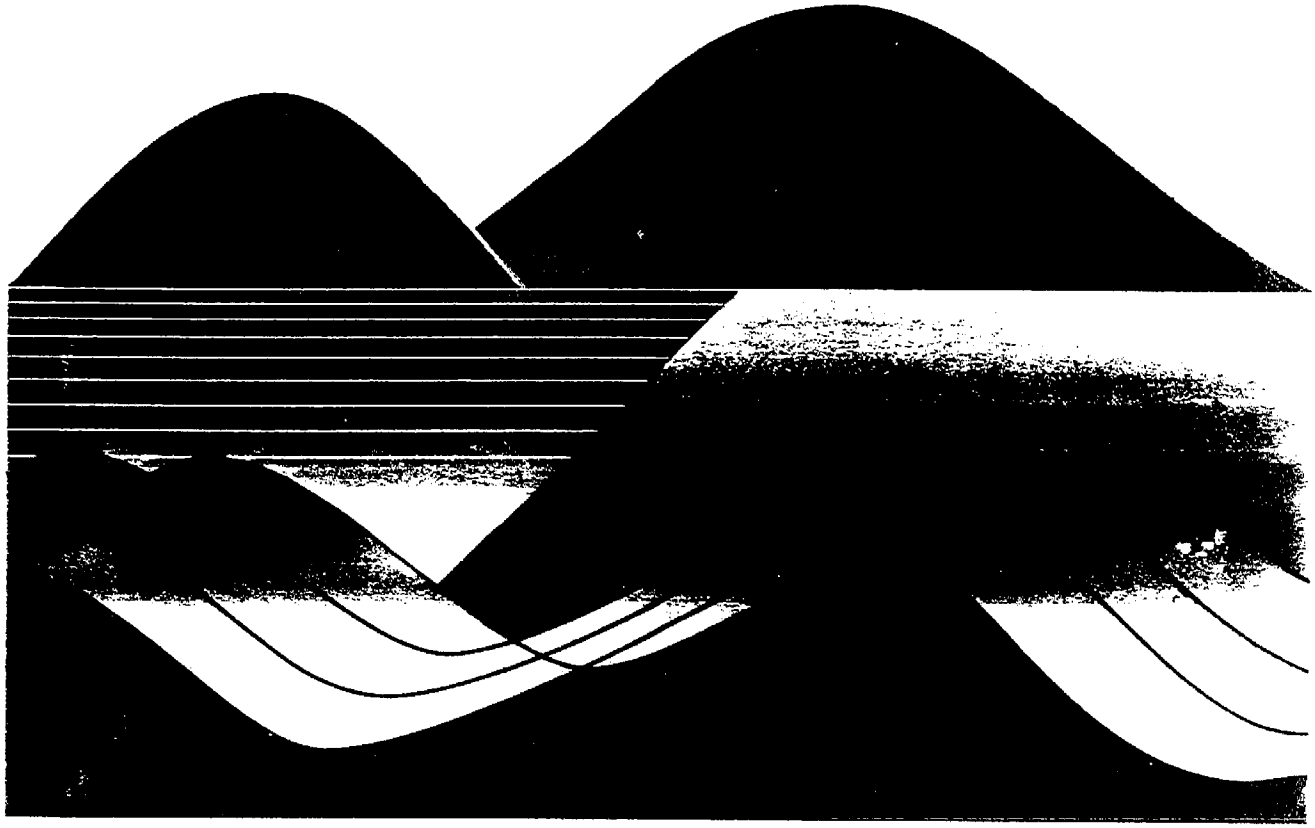
Investigation and Cleanup of Soil and Groundwater at South Bay Superfund Sites



1981 Investigations Implementation Challenges 1993

A Progress Report

August 1993

SOUTH BAY DIVISION
SAN FRANCISCO BAY
REGIONAL WATER QUALITY CONTROL BOARD

California Regional Water Quality Control Board
San Francisco Bay Region
2101 Webster Street, Suite 500
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Preface

The Regional Water Quality Control Board (RWQCB) of the California Environmental Protection Agency (Cal/EPA) prepared this report in cooperation with the Department of Toxic Substances Control (DTSC) of Cal/EPA and the United States Environmental Protection Agency (Federal EPA). In the early 1980s, soil and groundwater contamination was discovered at industrial and government facilities in the South Bay. In April of 1989, the federal EPA published a progress report titled Groundwater Contamination Cleanups at South Bay Superfund Sites. Since that time, investigations of soil and groundwater contamination have been completed and final cleanup plans adopted at 19 RWQCB-lead Superfund sites and 5 Federal EPA-lead South Bay Superfund sites. This report presents an updated summary of groundwater and soil cleanup in the South Bay over the last decade, with an emphasis on the current status of cleanup of groundwater contamination at Superfund sites. As used in this report, Superfund sites are facilities which are listed, or have at one time been proposed for listing, on the federal EPA's National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund. The term "South Bay" is used in this report to refer to the southern portion of San Mateo County and the northern portion of Santa Clara County as shown in Figure 1. The report describes the following:

- discovery and investigation of soil and groundwater contamination in the South Bay
- nature of the contamination and its effect on the South Bay area
- assessment and management of risk, and setting standards for cleanup
- involvement of the various government agencies
- participation of responsible parties in investigation and cleanup
- progress made in cleaning up the sites

While this report focuses on federal Superfund sites, it also provides some information on other soil and groundwater contamination sites in the South Bay which are being investigated and cleaned up under California state authority.

Many different public agencies and other organizations have been involved in the investigation and cleanup process. A condensed list of these agencies is included at the back of this report. A form is also included which you can return if you wish to be placed on the RWQCB mailing list for future information on any of the sites included in this report.

For additional copies of this report, please contact the RWQCB Community Relations staff at (510) 286-3815.

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Investigation and Cleanup of Soil and Groundwater at South Bay Superfund Sites

The area of northern Santa Clara County and the southern tip of San Mateo County commonly called Silicon Valley is well known for its electronics industry. The area, now heavily urban, was a very productive agricultural area. The temperate climate and the broad alluvial valley with a large, deep, aquifer produced an abundant variety of fruits and vegetables. In the past three decades, this combination of climate, water, easily developed land, and proximity to major universities, attracted a large number of high technology industries. Small agricultural communities grew into full-fledged cities. This South Bay area (Figure1) is the subject of this report.

In the early 1980's, both industrial and government facilities discovered contaminated soil and groundwater from leaks in underground tanks, spills, and other chemical handling practices. A survey by the Regional Water Quality Control Board (RWQCB) in 1982 indicated that a large number of sites in the South Bay used and stored chemicals in underground tanks and sumps. When the owners were required to investigate the condition of their chemical and waste storage facilities, 83 sites were found to have released chemicals into the soil or groundwater. Since that time, approximately 200 additional sites have been discovered. Twenty eight of these sites posed a sufficient potential health threat to be listed or proposed for listing on the Federal EPA National Priorities List for Superfund. Since the RWQCB had initiated regulatory action on these sites under California law, the federal EPA enlisted their assistance in also carrying out the additional requirements of federal law. The two agencies entered into a Multisite Cooperative Agreement (MSCA) whereby the RWQCB managed the investigation and development of cleanup plans for 21 of the 28 listed or proposed Superfund sites. Under the MSCA, the RWQCB agreed to regulate the sites according to federal EPA Superfund procedures, as well as appropriate California laws and regulations. In exchange, the federal EPA would use the state Remedial Action Plan as part of the federal Record of Decision under CERCLA or Superfund.

Government agencies at all levels became involved in what turned out to be a complicated and time-consuming process.

The process was complicated by the fact that:

1) Government agencies were not initially organized or prepared to conduct a coordinated investigation and cleanup effort of this size.

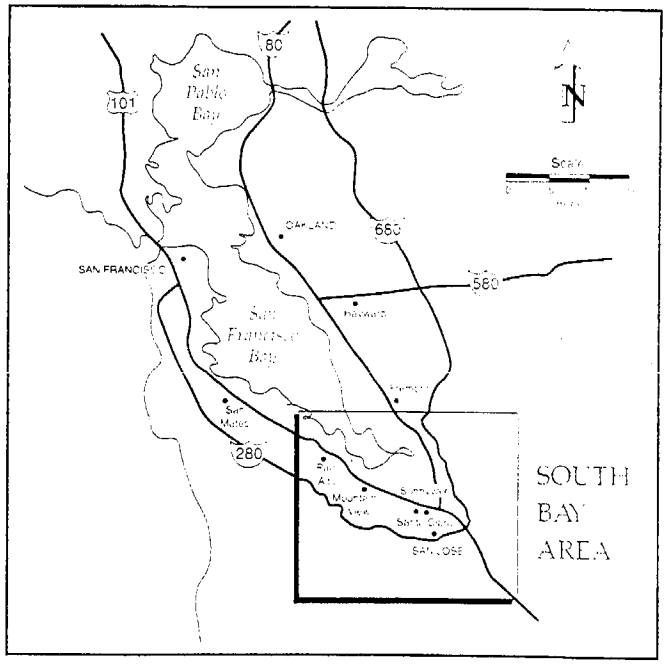
2) Unlike the landfills and other hazardous waste disposal sites envisioned in the Superfund law, the South Bay contamination was mostly underground. Determining the breadth and depth of the pollution involved drilling monitoring wells, taking soil samples, and piecing together data to form a picture of something not seen at the ground surface,

3) The general knowledge about how chemicals move through soil and groundwater was insufficient to accurately predict occurrence and movement of pollutants.

4) Techniques and theories had to be developed and tested for an entire range of investigation, cleanup, and removal techniques.

Local, state, and federal governments, as well as environmental groups, and industry in the South Bay responded aggressively to these challenges, often setting national precedents in the process.

Figure 1: San Francisco Bay Region and South Bay Area



Groundwater and Soil Cleanup; *What was expected? What was discovered?*

The investigation and cleanup of contaminated soil and groundwater in the South Bay has been underway for approximately ten years. In order to assess what has been accomplished in that time, it is helpful to understand the situation as it was at the time the problems began to be discovered. The expectations and discoveries which follow are a composite of those expressed by a number of government and industry officials as well as members of community groups.

What was expected?	*What was discovered?*
A large number of sites would be discovered based on the number and type of facilities present in the area.	A large number of sites were discovered. The rate of discovery of new sites has declined.
The site investigation process would be relatively straightforward.	Site investigations have often been much more difficult than anticipated and subsurface conditions are often very complex. Sources of contamination cannot always be found.
Agency policy and guidelines would be consistent and clear.	Agency policy and regulations were of necessity evolving as knowledge of the situation improved.
Rigorous cleanup standards would be established to protect public health and the environment, and would be achievable with existing technology.	Groundwater investigation/cleanup is not an exact science. While effective standards have been established, there is growing recognition that cleanup may not meet all standards in all cases (especially low parts per billion levels).
Most responsible parties would cooperate in the investigation and accept responsibility for cleanup of contamination.	Dischargers and owners have in most instances accepted responsibility for the problem. They have also learned that cleanup is a long-term business activity with ongoing regulatory oversight.
Community members would be interested in the problem and methods for cleanup.	A high level of community involvement is possible. The level of interest has been directly proportional to the proximity of the site to residential areas.
Effective cleanup techniques were available. In particular, groundwater pumping and treatment, properly applied, would be an effective cleanup method.	While groundwater pumping has removed large amounts of contaminants,, it is most effective in containing the spread of contaminants. Removal efficiency drops rapidly as contaminant concentrations decrease. Soil vapor extraction is effective in removing volatile organic compounds from soil.

Ten years of experience have taught regulatory agencies, industries, and consultants a number of lessons about investigating and predicting the behavior of contaminants in soil and groundwater. From this, new methods for investigation and cleanup have been developed. The difficulty and the cost of cleanup have encouraged industry to investigate and adopt different manufacturing processes which eliminate or reduce the use of organic solvents. In combination, the experiences of the last decade have also brought about changes in regulatory policy and practices. All of these are discussed later in this report.

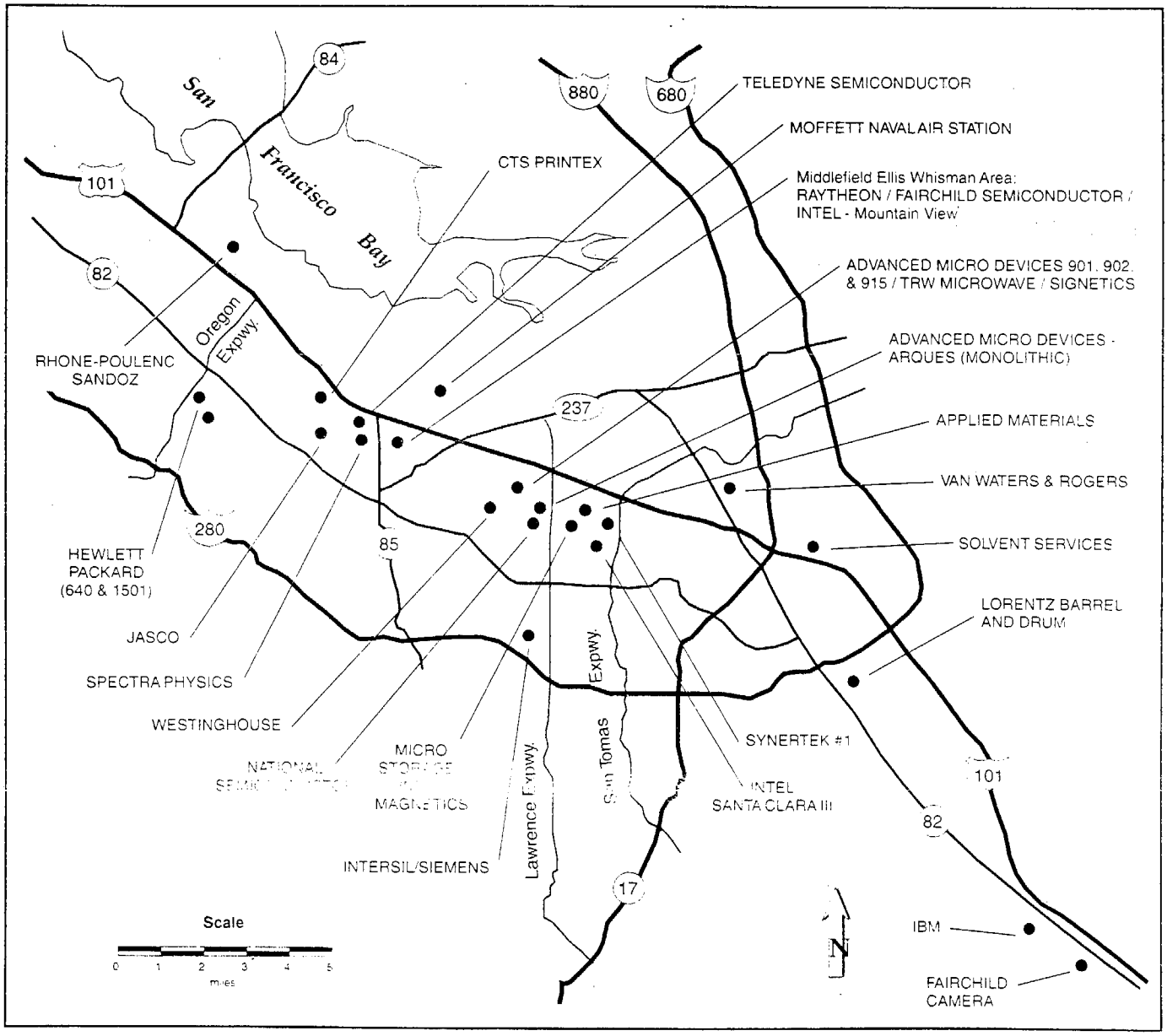
In order to understand the problem and its scope, we begin with the discovery of groundwater contamination in the south bay, a description of what it is, and how it affects public health and the environment. This is followed by a description of the investigation and cleanup process. A summary of cleanup progress to date and a brief forecast of the future conclude the report. An appendix is included which summarizes the status of the cleanup sites in the South Bay which have been listed or proposed for listing on the federal EPA Superfund National Priorities List.

How Was the Problem Discovered?

Groundwater contamination first came to light in the South Bay in late 1979 when IBM found contaminated soil near underground tanks at its facility in South San Jose. In 1981, Fairchild Camera and Instrument Company, also located in south San Jose, determined that 60,000 gallons of solvents mixed with water had leaked from an underground waste storage tank. Groundwater drawn from a nearby public water supply well contained trichloroethane (TCA), a solvent commonly used in industry. TCA concentrations were above safe drinking water levels, and the well was immediately removed from service.

Acting on this discovery, the RWQCB investigated other potential contamination sources. Over 2,000 facilities in the South Bay were sent questionnaires regarding the use or storage of hazardous materials. Based on the RWQCB survey and subsequent investigations, the federal EPA listed or proposed for listing 28 South Bay sites on the Superfund National Pritorities List. Figure 2 shows the locations of these sites. State and local agencies are also investigating over 200 non-Superfund sites with soil and/or groundwater contamination. In addition, more than 1,500 leaking fuel tanks are being investigated and removed.

Figure 2: Federal Superfund Sites in the South Bay Area



What is Contamination?

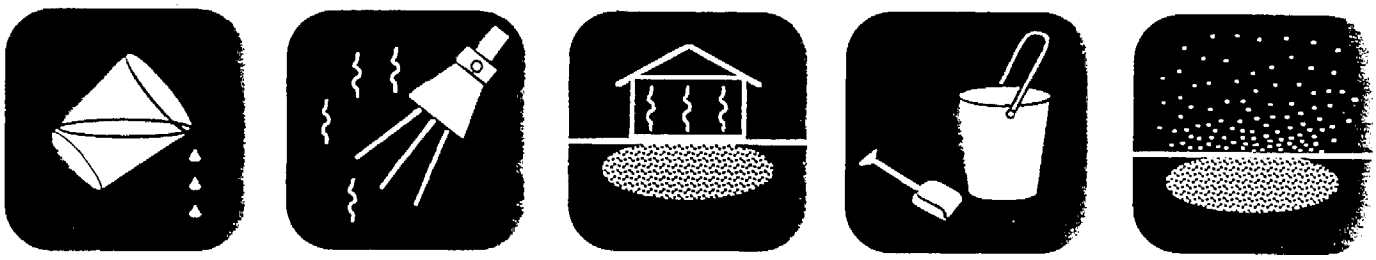
Contamination is the presence of chemicals, either in the air, water, or soil, in concentrations which are detrimental to human health and the environment. Often these chemicals are present as a result of human activities. The type and amount of contamination varies from one area to another, but the most common industrial contaminants in the South Bay soil and groundwater are volatile organic compounds (VOCs). Industry often used VOCs as solvents and metal degreasers. Table 1 lists VOCs that are commonly found at the South Bay sites. Heavy metals are also chemicals of concern. They can be harmful to wildlife if they reach local streams or San Francisco Bay either as a result of natural groundwater flow, surface runoff, or from discharge of extracted groundwater. Polychlorinated biphenyls (PCBs) and pesticides are also present at a few sites. Other possible groundwater contaminants include herbicides, nitrates, and other fertilizers from agricultural use; bacteria and inorganic substances from septic systems; and fuels from leaking fuel tanks and pipelines.

Table 1: Commonly Found Volatile Organic Compounds

Common Name	*Other Names*
BTEX & BTX*	benzene, toluene, ethylbenzene, xylenes
DCA	dichloroethane
DCE	dichloroethene, dichloroethylene
Freon	Freon 113, CFC-113
PCE	tetrachloroethene, tetrachloroethylene, perchloroethene, perchloroethylene, Perc
TCA	trichloroethane
TCE	trichloroethene, trichloroethylene

**BTEX and BTX refers to benzene, toluene, ethylbenzen and xylenes collectively. These chemcials may be found and referred to individually. TPH or Total Petroleum Hydrocarbons is another similar and commonly used measure of contaminantion.*

What is the Potential for Exposure to Contaminated Soil or Groundwater ?



Some chemicals released into the soil and groundwater at the various sites in the South Bay have known or suspected harmful effects on human health and the environment. When investigating a contaminated site, an assessment is made of the possible ways in which humans or wildlife could be exposed to the contaminants, and how they might be affected. If VOC's are present in a public water supply, exposure can occur by dermal or skin contact, by ingestion, or by breathing VOC vapors while bathing or showering. In the South Bay, the exposure pathway of most concern is the possible contamination of public water supplies.

Another potential exposure pathway is the migration of VOC vapors from contaminated groundwater upward through soil, possibly accumulating in enclosed spaces. Mathematical models have predicted that this pathway could exist at two South Bay sites. Actual field measurements have detected only very small concentrations at ground surface. These small concentrations do not create a significant health risk.

At sites where heavy metals such as arsenic or lead are the major contaminants, contact with soil by children, or general exposure to air-borne dust are pathways of concern. All of these exposure pathways are investigated and are considered when setting cleanup standards and selecting appropriate cleanup methods.

Where Does South Bay Drinking Water Come From?

Over 1.5 million South Bay residents are connected to public water supply systems. These systems deliver local and imported surface water and groundwater from a deep aquifer. Groundwater currently provides about half of the public water supply. As Figure 3 depicts, groundwater comes from underground layers of porous rock, gravel, or sand, called aquifers. Groundwater moves very slowly in comparison to water in rivers. Groundwater velocity depends on many factors, including the type of materials through which it moves. In general, under natural conditions, groundwater in the South Bay flows toward San Francisco Bay at rates which vary from several feet per year to several feet per day.

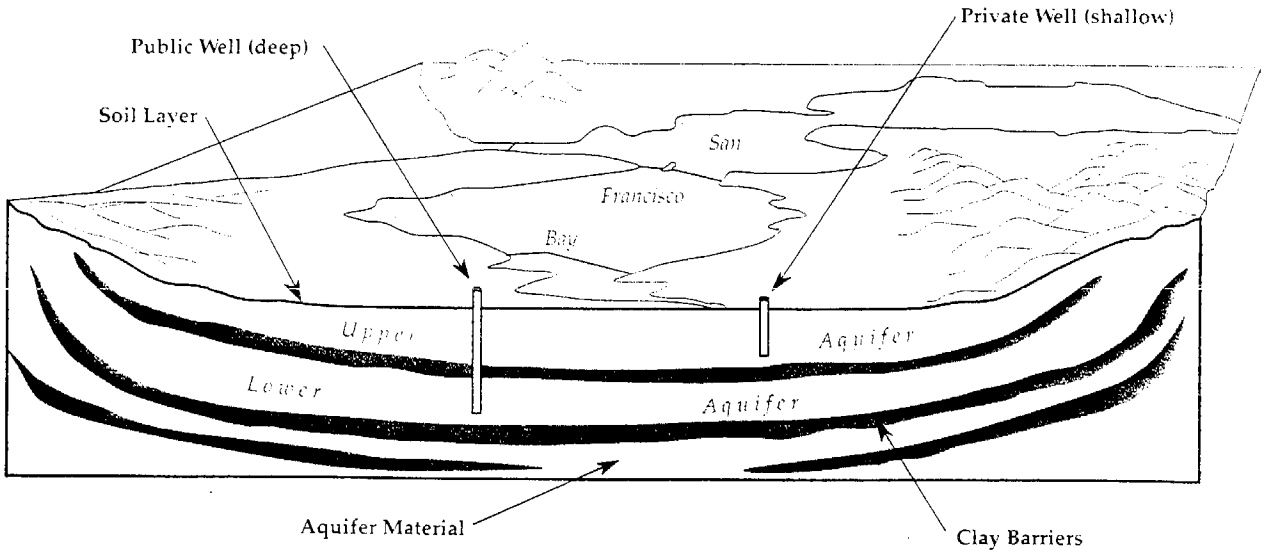
Throughout much of the South Bay, there are two main aquifers. The shallow aquifer is separated from the deep aquifer in most places by a clay layer, which begins anywhere from ground surface to a depth of 100 feet. The deep aquifer is the aquifer usually used for municipal drinking water supplies. The clay layer varies in thickness; in the northern area, closer to the Bay, it can be approximately 100 feet thick. This clay layer acts as a barrier, preventing water and contaminants released near the ground surface from easily reaching the deep aquifer. In some areas the clay layer may contain natural cracks or gaps through which water and contaminants can move. Improperly constructed and sealed wells which penetrate the clay layer may also allow contaminants to migrate from one aquifer to another.

While the two-layer aquifer structure is generally present throughout the South Bay, site specific geology varies widely. These differences are especially important in the south and near the mountains, where the separating clay layer "pinches out" or thins. In some areas, the shallow and deeper aquifers are not separated by a clay layer and the deeper aquifer is directly replenished or recharged by water filtering down from the surface. If this "recharge" water becomes contaminated, the deeper drinking water aquifers are immediately threatened.

Public water systems in the South Bay also make extensive use of local and imported surface water. Imported surface water comes primarily from the South Bay Aqueduct and the San Felipe and Hetch Hetchy projects. Imported surface water is treated in water treatment plants and distributed to public water systems. Local surface water and a portion of the imported surface water is used to recharge the groundwater basin. While surface water supplies are vulnerable to various environmental contamination hazards, they are not directly affected by contaminants in the subsurface.

A few residents continue to use private wells, which draw water from the less protected shallow aquifer. There is currently no requirement for regular testing of private wells.

Figure 3: Representation of South Bay Aquifer System



How have Superfund Sites Affected Drinking Water Supplies?

Table 2: Wells Affected by VOC Contamination at South Bay Superfund Sites*

Site Name	Public Water Supply Wells	Private Wells	Site Name	Public Water Supply Wells	Private Wells
AMD, Arques	none	none	Intersil/Siemens	none	1
AMD, 915	none	none	Lorentz Barrel & Drum	none	none
AMD Bldg. 901/902, TRW, Signetics	none	none	Middlefield-Ellis-Whisman area, Mountain View	none	3
Applied Materials	none	none	(Fairchild Semiconductor, Intel Corp., Raytheon Company)		
CTS Printex	none	1[1]	Moffett Field Naval Air Station		
Fairchild Camera	1[2]	2	National Semiconductor	1	1
Jasco Chemical	none	none	Rhone Poulenc, Sandoz	none	none
HP, 1501 Page Mill Rd.	none	none	Solvent-Service	none	none
HP, 640 Page Mill Rd.	none	none	Synertek	none	none
Intel Facility III	none	none	Teledyne/Spectra-Physics	none	34
Intel Magnetics/Micro Storage	none	none	Van Waters & Rogers	none	none
IBM	17	8	Westinghouse Electric Corp.	none	none

* Sites listed, or at one time proposed for listing, on the federal EPA National Priorities List. Public Water Supply Well contamination data obtained from DHS ODW Report No. 91-VN-01 (1984-1989 supplemented with data through 1991

[1] Not detected since spring, 1992 [2] Great Oaks Well #13 abandoned and sealed [3] Area now served by City of Mountain View municipal supply

Site investigations

Investigations conducted at federal Superfund sites have identified 19 public water supply wells and 50 private wells which were contaminated by chemical releases at these sites (Table 2). At state Superfund sites, VOCs have been found in one public water supply well at the Hillview Eleanor site in Los Altos. In the Hillview-Porter State Superfund area of the Stanford Research Park, there are 16 known private wells, none of which are used for domestic supply. Fourteen of these wells are monitored regularly, and VOCs have been found in 10 of them. According to data compiled by California Department of Health Services Office of Drinking Water(ODW), VOCs are found at some level in 44 public water supply wells in the South Bay (DHS, ODW Report No. 91-VN-01, Volatile Organic Chemical Analysis, 1984-1989 supplemented to include data through 1991). In most cases, it is very difficult to determine the source of the VOCs despite state programs to do so. To date, most contamination has been restricted to local areas within the shallow aquifers. There is concern that VOCs may migrate through the shallow zones into the deeper drinking water aquifer. This potential for migration is a primary factor in the design of site cleanup systems.

Public water supplies

All water suppliers in the South Bay are providing water that meets state and federal drinking water standards. Public water supply wells are monitored routinely by water suppliers, as required by the ODW under state and federal law. Large public supply wells are tested for VOCs and other potential organic chemical contaminants at least once every two to three years depending on vulnerability of the supply. If the samples contain contaminants, the wells are tested more often. Several wells have been removed from service when contaminant levels exceeded drinking water standards. Several other wells, with contaminant levels below drinking water standards, have been put on standby as a precautionary measure. These wells, with marginal water quality, will only be used in times of emergency. Wells with contaminant levels far below drinking water standards have remained in active use.

There are also a number of "small public water supply systems" (serving 5 to 199 households). These are usually located in rural areas. The Santa Clara County Health Department (SCCHD) monitors these wells for

What are Drinking Water Standards?

The federal EPA and the California Department of Health Services, Office of Drinking Water (ODW) establish drinking water standards. These standards are used to determine what levels of contaminants are unacceptable in public water supplies. Under the federal and state Safe Drinking Water Acts, the federal EPA and the state ODW have established "Maximum Contaminant Levels" (MCLs) for most of the contaminants found in the South Bay. MCLs are established based on the contaminant's potential health effects, as well as on the technological and economic feasibility of treatment. ODW may adopt MCLs that are equal to or more stringent than those set by the federal EPA. If a water supply exceeds a federal or state MCL, the water supplier must notify its customers and take action to reduce the contamination.

ODW also sets Action Levels for numerous contaminants withput MCLs. Based solely on health criteria, these standards are not legally enforceable, but are offered as guidelines. If a water supply exceeds an Action Level for a particular substance, ODW recommends that the supplier notify its customers and reduce the contamination.

organic chemicals on a case-by-case basis. A county ordinance requires that a permit be obtained from the Santa Clara County Environmental Health Director before constructing a small domestic water system with less than five service connections. In order to obtain a permit, the SCCHD requires the finished water to be tested. The director of the health department must be satisified that water quality is adequate before issuing a permit.

For a list of public water supply contacts, see Appendix, B-2.

Private wells

No formal regular monitoring requirement currently exists for private wells. These wells generally draw from the shallow aquifer and thus have a greater chance of contamination than public wells. In 1988, the Santa Clara County Health Department conducted a survey of 338 private wells in the Santa Clara Valley. Some amount of VOCs were found in 28 of these, and 8 contained VOCs at levels greater than drinking water standards.

Santa Clara County recently passed an ordinance requiring that private wells be tested when title for the property it serves is transferred. The ordinance is to assure water quality information is available to the buyers. Testing is also required when obtaining a permit for new constructtion which involves a private or small water supply system.

What Happens When a Site is Discovered?

What is the investigation/cleanup process?

Listing of site on the National Priorities List - A Preliminary Site Assessment and sometimes an onsite investigation is conducted at potential sites. This information is used to determine if the hazards at the site warrant federal response and listing on the National Priorities List (NPL). Once the site is proposed for the NPL, investigation and cleanup must meet the requirements of the comprehensive environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Ammendments and Reauthorization Act (SARA). At the same time, a lead agency, with responsibility for managing investigation of the site, is determined. The federal Superfund process is outlined in Figure 4 on page 9.

Interim removal and cleanup - After a groundwater or soil contamination site is discovered, the first step taken is to identify any immediate health threats. Nearby drinking water wells that could be affected by the site are tested. Water supply agencies have acted whenever contaminants were found in drinking water wells. Depending on the level of contaminants, water from the affected wells is either blended with unaffected well water, or the wells are pumped on a modified schedule, or shut down completely.

At the same time, the risk of direct contact with contaminated water, soil, or air is evaluated. If any immediate health threats are discovered, short-term cleanup is undertaken. If possible, the sources of contamination are removed to prevent further release and spreading. This typically includes removing leaking underground tanks, sumps, and piping. Contaminated soil near the tanks or spill areas is also removed where possible. Interim groundwater extraction wells and treatment systems may also be installed to remove contaminated groundwater and control its spread. Interim cleanup has been conducted at almost all of the South Bay sites, and will continue as necessary until the final cleanup actions are implemented.

Remedial Investigation - While the immediate environmental and public health threats are being addressed, a comprehensive investigation of the nature and extent of contamination is conducted. This study is referred to as the Remedial Investigation (RI). During this phase, extensive soil and groundwater samples are taken to determine the types and amounts of chemicals released, and the degree to which they have spread both horizontally and vertically. At most South Bay sites, knowledge of the subsurface geology was limited and soil borings were required to determine the location of water-bearing soil layers, which were potential pathways for migration of chemicals. Records were also searched to determine whether there were any abandoned wells in the area which could act as vertical conduits for contaminated groundwater.

Baseline Public Health Evaluation - A Baseline Public Health Evaluation (BPHE) is conducted at every Superfund site. The health effect which the site would have on workers, neighbors, and the general public if it were to remain uncontrolled in its existing, contaminated condition is assessed. The BPHE examines the chemicals present at the site and the current and potential future

What is the Superfund National Priorities List?

The National Priorities List (NPL) is the list of sites posing the greatest threat to human health and the environment. These areas or sites must be cleaned up in accordance with the Comprehensive Environmental Response Compensation and Liability Act and the Superfund Amendments and Reauthorization Act (SARA).

CERCLA established a trust fund also known as "Superfund" which is primarily financed by a tax on the petroleum and chemical industries. The federal EPA can use Superfund monies for investigation and cleanup of any site included on the NPL. Monies from the trust fund may be used when the parties responsible for contamination are unknown, unwilling, or unable to finance site cleanup on their own. The federal EPA has the authority to then seek financial reimbursement for the costs of any investigation and cleanup activities from the responsible parties. This cost recovery authority allows the federal EPA to sue the responsible parties for up to three times the cost of the cleanup activities. In the South Bay, Superfund monies have been used at only one site. Initial cleanup at Lorentz Barrel and Drum was conducted with federal funds. The responsible parties are now funding the cleanup.

Figure 4: Superfund Investigation and Cleanup Process

Listing on National Priorities List	Remedial Investigation	Baseline Public Health Evaluation	Feasibility Study	Public Comment Period	Record of Decision
A site is investigated to assess possible hazards to human health and the environment. Results of the investigation are used to determine if the hazards warrant federal response and listing on the National Priorities List (NPL).	The Remedial Investigation (RI) assess the nature of the substances which were released, and the vertical and lateral extent of contamination at a site.	The Baseline Public Health Evaluation (BPHE) assesses the health effect which the site would pose to the public if it were to remain uncontrolled in it's existing condition.	The Feasibility Study (FS) identifies and evaluates the available methods for containing, treating, or eliminating the contaminants. A cleanup strategy is prepared based on the information collected.	Following development of a proposed cleanup plan, the lead agency holds a public comment period of at least 30 days. Formal comment is invited from all interested parties.	After considering and responding to public comments, the lead agency selects a final cleanup plan. EPA then prepares a Record of Decision (ROD) documenting the cleanup decision.
Time Required	18mo. - 4 years	3 mo. - 1 year	18 mo. - 4 years	At least 30 days	4 to 8 months

pathways of exposure. At each site, the BPHE identifies "chemicals of concern" and makes "worst-case" assumptions regarding concentration, distribution, toxicity, and potential exposure routes. The possibility of future exposure depends on planned development of the site, and whether shallow groundwater will be used for domestic water supply. Typical chemicals of concern at South Bay sites are listed in Table 1 on page 4.

Feasibility Study - Once a site is characterized, and cleanup standards are established, a range of possible cleanup alternatives is developed. Each cleanup alternative is evaluated against a set of selection criteria. The alternative which best meets the criteria is selected as the final cleanup plan or remedy. Once the cleanup plan is approved by the state and the federal EPA, the actual design and implementation is carried out. Regular monitoring is required, as well as reports to the appropriate agencies on progress and effectiveness.

Community Involvement - The continuing degree of community interest in various sites appears to depend on the proximity of the site to a residential neighborhood, the perceived threat, and other factors such as previous history of neighborhood organization around other issues. Community leaders and government officials were interviewed to determine the issues of most concern to community members. Concerns over safety of drinking water, exposure to chemicals through soil contact, vapors, or consumption of home grown fruits and vegetables were common to all South Bay communities. Persons interviewed also expressed concern over property values, and their ability to sell or purchase homes, especially the availability of financing. Advertisements were placed in local and general circulation newspapers inviting community members to become involved and place their names on mailing lists prepared for each site. Flyers were also mailed to all residences of the neighborhoods surrounding each site as well as businesses located in the community. Businesses with a public health interest, and financial or real estate firms were especially targeted in the mailings. In some neighborhoods where there was particular interest in a site, fact sheets and notices were hand carried to all residences. Two local organizations have been awarded Technical Assistance Grants from the federal EPA. Funds from these grants allow these groups to hire technical experts to assist in interpreting technical reports, and preparing suggestions and comments on the investigation and the plans for cleanup.

Who is involved?

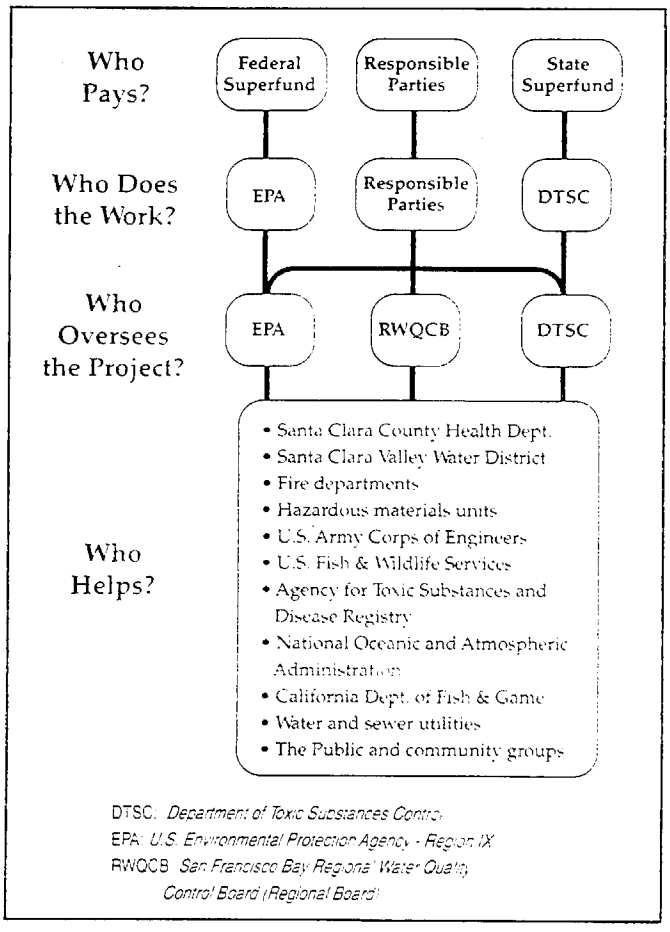
The federal EPA, several state agencies and a number of facility owners or responsible parties are involved in the investigation and cleanup of soil and groundwater contamination in California (Figure 5). Under a formal agreement with the federal EPA, the RWQCB is the lead agency for twenty-one federal Superfund sites in the South Bay. DTSC also administers the California Hazardous Substance Act and the Cleanup Bond Act which together are similar to the federal Superfund. The federal EPA has retained the lead agency role for sites owned by

the federal government, and those where the actual cleanup was financed or expected to be financed with Superfund monies. The RWQCB's policy of strongly encouraging the responsible parties to complete the investigation and cleanup, under RWQCB direction, without the use of federal Superfund monies has been largely successful. At most South Bay sites it has not been necessary to use either the federal or state Superfund for direct site cleanup. Initial cleanup at the Lorentz Barrel and Drum site involved the use of state and federal cleanup funds, but responsible parties are now conducting the remainder of the cleanup.

Federal Superfund Program

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) passed by Congress in 1980 established the"Superfund" program. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) in 1986. Superfund was designed to clean up the nation's worst hazardous waste sites by either 1) compelling the responsible parties to conduct the cleanup, or 2) through EPA action (financed by the Superfund) where no responsible party was willing or able to do it. The federal Superfund process is outlined in Figure 4 on page 9.

Figure 5: Regulatory Agency Responsibility



DTSC: *Department of Toxic Substances Control*
EPA: *U.S. Environmental Protection Agency - Region IX*
RWQCB: *San Francisco Bay Regional Water Quality Control Board (Regional Board)*

State Superfund Program

The state Superfund process is similar to the federal program. The Carpenter-Presley-Tanner Hazardous Substance Account and Bond Act of 1984 established a $100 million fund to cleanup hazardous waste sites in California and to address health and environmental effects from the sites. The DTSC is the agency which administers the California state Superfund program. The parties responsible for the hazardous waste are responsible for conducting the site cleanup. If the responsible parties cannot be found or will not comply with State law, DTSC can assume the cleanup activities and associated cost. The state can later recover these expenses from the responsible parties, including all investigation and cleanup costs, and interest on the bonds. There are three State Superfund sites in Palo Alto. These include the former Aydin facility, Varian Inc., and the Hillview-Porter site (which includes 21 companies) Other State Superfund sites in the South Bay include: the Plessey Microscience site in Mountain View; the Precision Media site in Sunnyvale; the Mansion Grove site in Santa Clara; and the Hillview/Eleanor site in Los Altos.

Other agency involvement

Another federal agency, the Agency for Toxic Substances and Disease Registry is also involved in assessing the public health impact of the federal Superfund sites (see inset on page 12). Many local and regional organizations are also involved in decisions that affect site cleanup. These include several Santa Clara County departments, the Santa Clara Valley Water District, and the city fire departments or hazardous materials offices as well as industry and community groups. The Santa Clara Valley Water District as the major wholesaler of drinking water in the area has been actively involved in providing advice on the scope and design of investigations as well as reviewing study results. Representatives from the City Managers' offices and the public water supply agencies from the various cities have also been involved in the review of study results and have provided comments and suggestions for cleanup plans.

How Are Cleanup Standards Established?

Before a final cleanup plan can be prepared, appropriate cleanup standards must be set. A cleanup standard is the concentration of a contaminant that can safely remain after cleanup is completed. Since cleaning up to non-detect levels is usually physically impossible, selecting cleanup standards involves two phases. The first phase, called "Risk Assessment" evaluates the risk to human health and the environment posed by the site. The second step determines the acceptable amount of risk remaining after cleanup is complete. This step is called "Risk Management." Cleanup standards are then selected which will 1) assure the site poses no more than the acceptable amount of risk, and 2) comply with any applicable, relevant and appropriate laws or regulations (ARARs).

Table 3: Carcinogenic Risk Numbers and Associated Probabilities

Risk Number	Probability*
10^{-3}	1 in 1,000
10^{-4}	1 in 10,000
10^{-5}	1 in 100,000
10^{-6}	1 in 1,000,000

* For comparison, the risk of being hit by lightning is estimated at one in 30,000 or approximately 3×10^{-5}. The risk of being killed in an earthquake in California is approximately one in 8,000 or 1.2×10^{-4}.

Determining risk

Risk assessments - Using site-specific data, a risk assessment is performed as part of the Baseline Public Health Evaluation. Each potential exposure pathway and chemical of concern is considered. The risk assessment examines existing contaminant levels and quantifies possible risk to human health and the environment.

For known or suspected carcinogens, risk is expressed as the probability that one person will develop cancer due to exposure to contaminants at a site. For example, a risk number of 1 in 1,000,000 means that if one million people are exposed to the contaminants, one additional case of cancer may be observed above what might normally be expected in the general population (approximately 1 in 4). A cancer risk of "one in one million" is often expressed as 10^{-6} (ten to the minus 6). Table 3 shows a series of risk numbers and the corresponding probabilities.

For noncarcinogens, risk is expressed as a Hazard Index number. The Hazard Index is calculated by dividing the concentration of each chemical a person might be expected to consume over time, by the concentration for each chemical above which specific adverse health effects (liver, hair, etc.) may occur. The sum of these ratios for all chemicals of concern is the Hazard Index. A Hazard Index of 1.0 or less for each effect means that no adverse health effects should occur from drinking the water.

EPA protocol uses very conservative assumptions in preparing risk assessments to determine a "worst-case scenario". Ninety-five percent of the time, the calculated risk exceeds the actual risk.

Managing risk

Acceptable risk - Based on the risk assessment, the regulatory agencies must determine what actions, if any, are necessary to reduce the risk to acceptable levels. Under the Superfund regulations, any carcinogenic risk number within the range of 10^{-4} to 10^{-6} and any Hazard Index less than 1.0 is generally considered an acceptable risk. If the risk is greater (for instance 1 in 1,000 for carcinogens or if the Hazard Index is greater than 1.0 for noncarcinogens), then cleanup actions must be taken to reduce exposure to the contaminants.

Setting standards - Under federal Superfund law, site cleanup must meet two requirements: 1) protect human health and the environment, and 2) comply with all "legally applicable or relevant and appropriate requirements" (ARARS).

Using the same types of calculations as those used in estimating risk, cleanup standards are developed for each chemical of concern, and each exposure pathway. These standards state the amount of chemical which may remain at the site, and/or the level of risk which will be allowed. These standards, and the procedure for implementing the cleanup, are then compared to the ARARs for air, water and soil. Frequently, the ARARs include numerical standards which are based on more general health or risk studies. These requirements generally meet the test for protection of public health and the environment. If there are no ARARs for the chemicals of concern, or if the risk assessment indicates that complying with the laws and regulations will not protect public health at a particular site, then more stringent risk-based

cleanup standards are set which will achieve a cancer risk between 1 in 10,000 and 1 in 1,000,000 and a Hazard Index of 1 or less.

State and federal drinking water Maximum Contaminant Levels (MCLs) are ARARs for most South Bay sites. Shallow groundwater in the area is not currently being used for drinking water. It is, however, a potential drinking water source and must be protected. Also, the State Water Resources Control Board "Statement of Policy with Respect to Maintaining the High Quality of Waters in California", Policy Number 68-16, states that

> *"...Any activity which produces ... a waste ... and which discharges ... to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that ... the highest water quality consistent with maximum benefit to the people of the state will be maintained."*

The State Water Resources Control Board also set water quality objectives for a number of chemicals in two statewide plans, the Water Quality Control Plan for Enclosed Bays and Estuaries and the Water Quality Control Plan for Inland Surface Waters. These objectives must be applied when contaminated groundwater migrates to or is discharged into a surface water body.

At sites where the cleanup plan includes Soil Vapor Extraction, or where Air Stripping is the method for treating extracted groundwater, the emission of chemicals to the atmosphere must meet the substantive requirements of both federal and state air quality regulations. Such emissions are governed by the Bay Area Air Quality Management District Regulation 8, Rule 47, and the federal EPA Policy on Air Strippers. The permitted emission limits are designed to meet ambient air quality standards. These standards are, in turn, based on health effects studies.

There are no ARARs established for contaminated soil. However, at most sites, the Regional Board sets a soil cleanup standard of one part per million total VOCs. Experience to date shows this level will prevent recontamination of groundwater. Air emissions which occur from excavating contaminated soil must comply with substantive requirements of the Bay Area Air Quality Management District under Regulation 8, Rule 40.

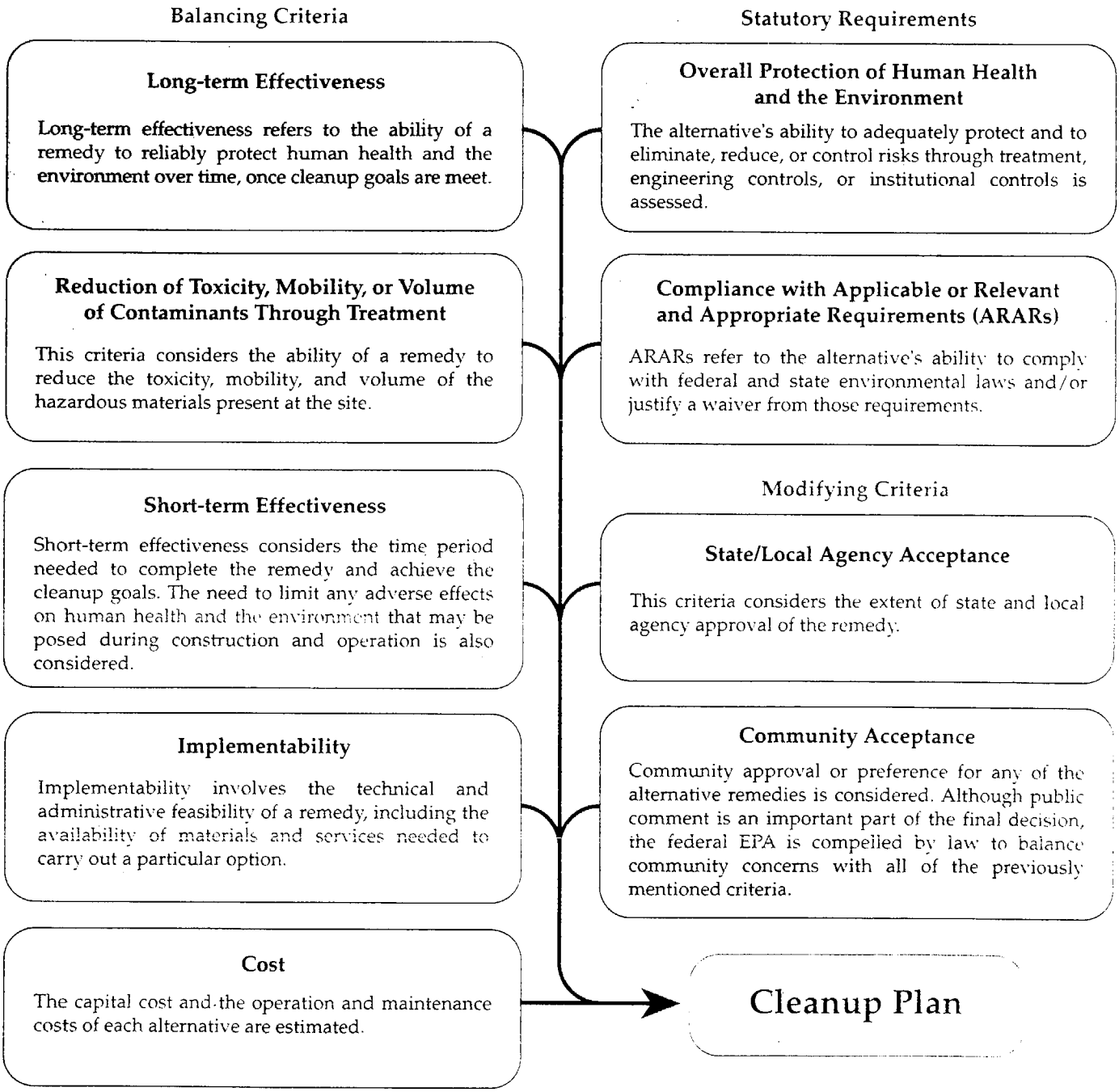
Superfund Sites, Impacts on Public Health, A Second Opinion

The Superfund Amendments and Reauthorization Act included a provision establishing the Agency for Toxic Substance and Disease Registry (ATSDR). ATSDR was given the task of preparing an independent public health assessment for each Superfund site. The ATSDR uses information from the BPHEs as the basis for the Health Assessments. The purpose of the Health Assessment is to gather information about hazardous substances at a site and to evaluate whether the substances are causing any harm to the environment, or to people living near the site. In California, the Department of Health Services Environmental Epidemiology and Toxicology Branch prepares the Health Assessments under a formal agreement with ATSDR. The results of the ATSDR Health Assessment are considered when setting cleanup standards and developing site cleanup plans.

How is the Cleanup Plan Developed?

Once Cleanup Standards are selected, a Feasibility Study is carried out to determine which combination of cleanup techniques should be employed. A set of feasible alternatives is developed for each site using combinations of the techniques described in the next section. Each cleanup alternative considered at a federal Superfund site is assessed using the nine criteria described in Figure 6. This approach is designed to provide decision makers sufficient information to compare the alternatives, select an appropriate remedy for a site, and satisfy legal requirements. Based on the assessment, a preferred alternative is selected which is judged to be the most cost effective solution. This proposed solution is then offered for public comment. After public comments are received, the plan is modified and a formal response to comments is prepared and distributed. The plan is then adopted by the RWQCB and approved in a Record of Decision signed by the Regional Administrator of the federal EPA.

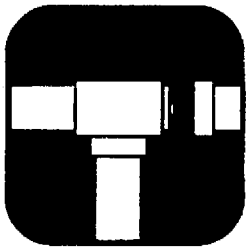
Figure 6: Criteria for Evaluating Potential Site Cleanup Alternatives



What Cleanup Techniques have been used at South Bay Sites?

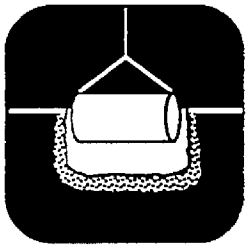
The same pioneering spirit that made many Silicon Valley companies successful was also applied to the contamination problems facing these same companies. Faced with contamination problems that often did not have textbook solutions, many companies, in coordination with their consultants and the regulators, designed their own solutions. The following section briefly describes cleanup and treatment technologies that have been or may soon be used at South Bay sites.

Provide Alternative Water Supply



When drinking water supplies have been affected by contamination, the first action is to provide another source of water. While this is not cleanup per se, it immediately reduces the potential for human exposure to the chemicals.

Source Removal

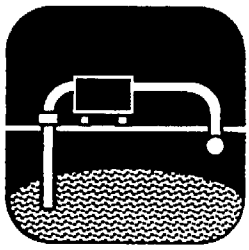


Leaking drums and underground storage tanks, sumps and piping, are common contaminant sources at South Bay Superfund sites. Removing these sources can prevent further site contamination.

Soil Removal

Shortly after a contaminant source is discovered, highly contaminated soil around the source is often excavated and treated or taken to a hazardous waste landfill. Such soil removal reduces the amount of contaminants that may be washed from the soil and carried into the groundwater by rainfall. In addition, removing highly contaminated soil minimizes the possibility of people coming into contact with the contaminants by breathing dust or handling soil. Once longer term studies are completed, and the extent of contamination is better defined, additional soil removal or treatment is often undertaken.

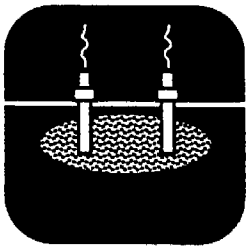
Groundwater Extraction and Treatment



The most common interim action at South Bay sites is groundwater extraction designed to stop the movement of contaminants and reduce their concentration. About 200 wells are pumping contaminated water at 24 of the 28 Superfund sites. Groundwater extraction is effectively limiting the spread of contaminants at these sites and in most cases reducing the size and concentration of the contaminant plumes. Extensive groundwater pumping may also deplete groundwater supplies which have been reduced by the recent drought. Reinjection of treated groundwater to enhance VOC removal is a technique which can be considered if the geology of the site is well understood. The possibility of reinjection causing the contamination to spread must be considered. At the IBM site in south San Jose and the Synertek (Honeywell) site in Santa Clara, treated groundwater has been reinjected to increase the volume of groundwater flow through the contaminated area and thus aid in cleanup.

At many South Bay sites, extracted groundwater is treated before being reused, or discharged into a sewer or stream. Discharge of extracted water into surface waters is regulated by the Regional Board under the federal Clean Water Act's National Pollution Discharge Elimination System program. Various treatment systems, including air stripping and carbon adsorption, are used to reduce contaminant levels before reuse or discharge. The type and amount of contamination found at a site governs the selection of a treatment system.

Soil Vapor Extraction



Soil vapor extraction, also called soil venting or soil gas removal, is a relatively new technique which provides an alternative to soil removal and disposal. Vapor extraction is used to remove contaminants from soils located above the shallow groundwater table. The technique employees a well, drilled into the contaminated soil, to which a vacuum is applied. Contaminants in gas or vapor form are drawn out of the soil and, in most cases, are passed through carbon filters to remove the VOCs. Soil vapor extraction does not require excavation, transportation, or relocation of soil. Beginning with the Intersil Siemens site in 1986, soil vapor extraction has been used at numerous South Bay sites. The technique works well in sandy or loose soils, but is less effective in clay soils.

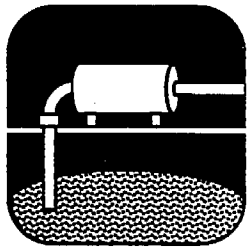
At the Solvent Service Inc. site in San Jose, a pilot study of enhanced soil vapor extraction was conducted using steam injection. In general, the solubility of VOCs in water increases, and their tendency to adhere to soil decreases as temperature increases. In order to increase to mobility of the VOCs, steam was injected into the soil as a means of raising the ambient temperature of the soil and water. The results of the pilot study were promising enough a full scale system was implemented in 1989. The system has removed 71,200 lbs. of VOCs from the subsurface.

Air Stripping

Air striping is an effective way of removing VOCs found at many of the South Bay sites. Groundwater extraction systems with air strippers are in use at 14 South Bay Superfund sites. The extracted contaminated groundwater is sprayed down through a tower containing packing materials, and air is blown upward through the cascading water. Because of their chemical properties, the VOCs evaporate leaving significantly reduced materials in the water. Air stripping usually removes at least 95 percent and sometimes all VOC contaminants.

The VOCs released into the air are regulated by the local Air Quality Management District to ensure that they do not exceed health standards. If release of contaminants to the air might exceed federal, state, or local standards, additional treatment to control air emissions is required.

Carbon Adsorption

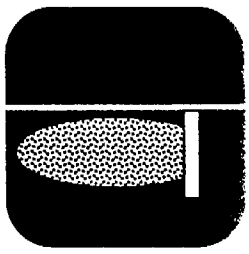


Carbon adsorption is the other predominant technology used to treat extracted groundwater contaminated by VOCs and is in use at 7 South Bay Superfund sites. The contaminated water is pumped through tanks containing activated carbon particles that have been specially treated to attract contaminants. The contaminants "cling" to the carbon and are thus removed from the water. Carbon adsorption can remove 95 percent or more (sometimes 99+%) of the VOCs. The contaminated carbon can then either be regenerated to be used again, or transported to a hazardous waste landfill for disposal.

Ultraviolet Light and Hydrogen Peroxide

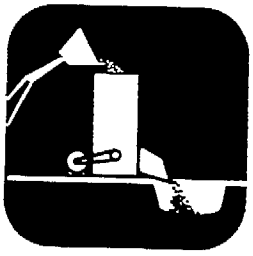
An innovative treatment technology is currently in use at the Lorentz Barrel and Drum site in San Jose. The treatment uses ultraviolet light and hydrogen peroxide to break down toxic compounds in extracted groundwater into smaller, less toxic molecules. In this method, hydrogen peroxide is bubbled into extracted groundwater, which is exposed to high intensity ultraviolet light at the same time. In some cases, ozone is used instead of hydrogen peroxide.

Underground Barriers



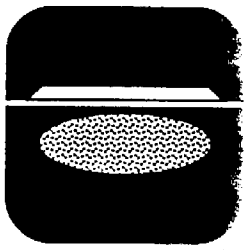
Underground barriers are sometimes constructed to contain contaminated groundwater. The most common form of underground barrier is a slurry wall which is constructed by digging a trench around a contaminated area and filling the trench with an impermeable material (usually a slurry mixture of water, soil, and clay). This filled trench provides a barrier to groundwater flow. Groundwater trapped by the slurry wall can be extracted and treated more efficiently. Slurry walls have been constructed at the Fairchild Semiconductor and Raytheon sites in Mountain View, and the Fairchild Camera site in San Jose. Slurry walls at the Fairchild and Raytheon sites have been in place since 1987 and have been successful in containing contaminants.

Chemical fixation or encapsulation



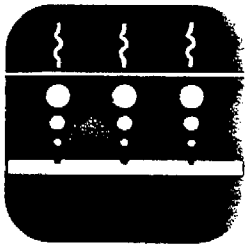
Fixation or encapsulation are techniques used to prevent spreading and reduce exposure to chemicals which cannot easily be treated or removed. Soil fixation is usually used for heavy metals which are in their elemental form and cannot be destroyed. Since they also often occur naturally in soil, removal is impractical. Encapsulation processes employ a compound (usually some form of silica cement) which is combined with the contaminated soil creating a physical encapsulation of contaminants. Chemical fixation is a technique which employes compounds which combine chemically with the contaminants forming less soluble or mobile compounds thereby reducing or eliminating their hazard. This technique has been used at the Rhone Poulenc site in East Palo Alto to immobilize the arsenic and thereby reduce the risk of exposure.

Surface Cap



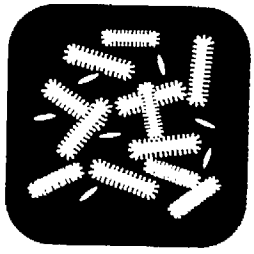
A paved surface cap is often used in conjunction with other techniques to prevent surface water from percolating through the soil and spreading contaminants or leaching them into the groundwater zones. Such caps are usually asphalt paving sometimes underlain with an impermeable membrane of plastic or special clay.

In-stream Aeration



At the Hillview Porter State Superfund site in Palo Alto, groundwater containing VOCs emerges in Matadero Creek. In-stream diffused aeration is being tested as a method for removing VOCs. Compressed air is pumped through bubblers in pooled areas to volatilize the VOCs.

Bioremediation



Bioremediation has been used both in-situ (with the waste or contamination left in place), or ex-situ (with the waste or contamination removed from its original location). Ex-situ bioremediation has been used at the Solvent Service site in San Jose. Fixed film biological reactors have been used following air stripping to remove acetone from extracted groundwater. At the Memorex site (non Superfund) in Santa Clara, fixed film biological reactors have been used to remove MEK, and Cyclohexanone. In-situ bioremediation has been employed extensively for treatment of hydrocarbons from fuel leaks. No full scale in-situ bioremediation of VOCs has yet been employed in the South Bay. Pilot tests for in-situ treatment of VOCs have been conducted at the Moffett Field site in Mountain View by Stanford University. The results have been promising, and a larger scale field trial is contemplated. Ex-situ bioremediation is planned for the Jasco site in Mountain View.

Reuse of treated - extracted groundwater

The Regional Board has required that reuse of 100% of extracted and treated groundwater be a goal at each Superfund site. Typical uses include landscaping, industrial process water, and toilet flushing. These types of reuse, reduce a company's dependence on potable water and help conserve resources. Despite the goal, most sites have not been able to reuse a substantial portion of the extracted treated groundwater.

What Progress Has Been Made in Investigation and Cleanup ?

A great deal of progress has already been made even though the cleanup of groundwater and soil will take a long time to complete . Not only have actual cleanup actions been carried out, but the knowledge of how chemicals behave in in soil and groundwater has improved. With this has come better knowledge of what cleanup techniques will work effectively and under what conditions. The cleanup plans which have been approved call for monitoring to determine progress, and required periodic assessments of the methods being employed. If more effective cleanup techniques are developed, they can be implemented through the required 5 year periodic progress reviews.

Sites have been investigated and cleanup plans prepared

Federal Superfund Sites - Twenty eight South Bay sites are listed or have been proposed for listing on the federal EPA National Priorities List for Superfund. Investigation is complete at 23 of these sites, and final cleanup plans are approved for 21 sites. The figures below and on the next page show how these sites progressed from listing through initial investigation, interim cleanup, complete investigation, and final cleanup plan approval. The status of individual Superfund sites is summarized in Appendix A.

State Superfund sites - In addition to the federal Superfund sites,there are 16 State Bond Fund (or Superfund) sites in the South Bay. Investigation is complete at 12 sites, interim cleanup actions are underway at 8 of the sites, and final cleanup plans have been approved for 4 sites.

Non-Superfund sites - In addition to these federal and state Superfund sites, state agencies conducted investigations at approximately 150 other non-Superfund sites (not counting leaking fuel tanks) in the South Bay.

Fuel Leak Program - Over 1,700 sites with leaking fuel tanks (automobile service stations and other fuel tanks) have been investigated. Under a contract with the RWQCB, the Santa Clara Valley Water District is managing the investigation and cleanup of over 1200 of these sites. Cleanup actions have been completed at over 280 fuel leak sites.

Contaminant sources have been removed

At the federal Superfund sites, most known sources of contaminants were removed in the early stages of investigation. Removal of tanks, sumps, piping, and contaminated soil is complete or underway at all 28 sites in the South Bay.

Figure 7: Superfund Sites Discovered

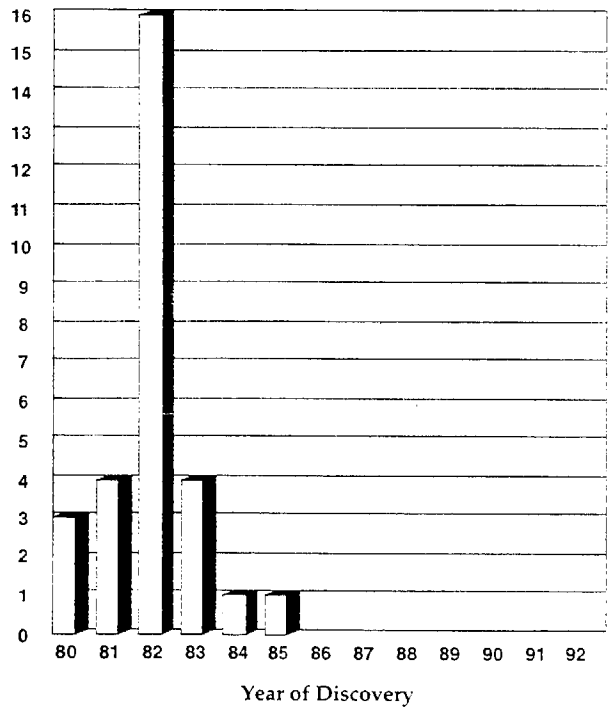


Figure 8: Site Investigations Begun

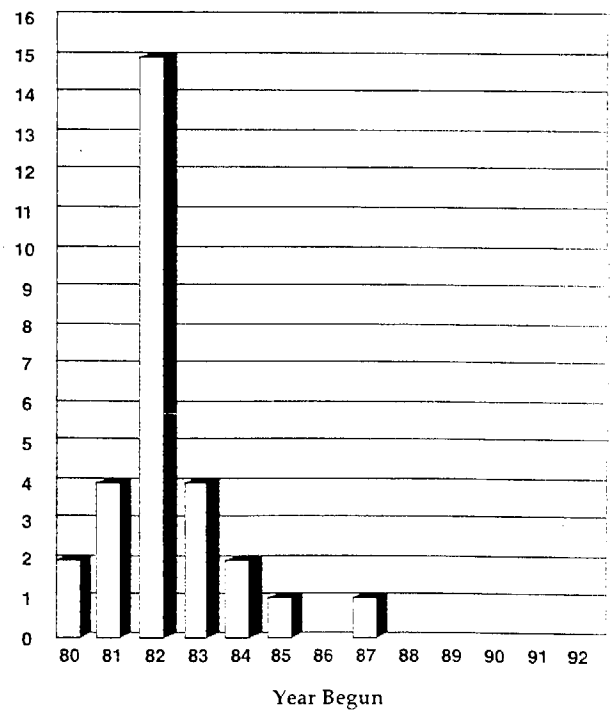
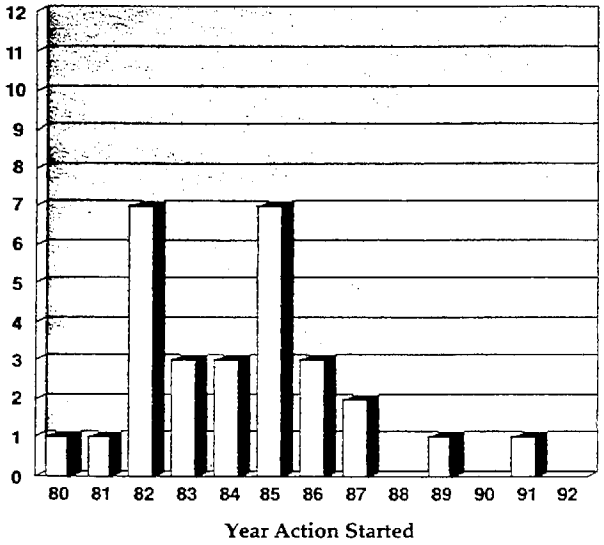


Figure 9: Sites Where Interm Cleanup Action Started



Cleanup actions are well underway at all South Bay Superfund sites

Interim soil and groundwater cleanup actions were initiated at most of the Superfund sites in the early stages of cleanup plan development. This interim action allowed cleanup actions to be evaluated and cleanup to begin while final plans were completed (see Fig 9). Early cleanup actions included groundwater extraction and treatment and also soil vapor extraction (see Cleanup Techniques on page 14).

Figure 11: Sites Approved for Final Cleanup

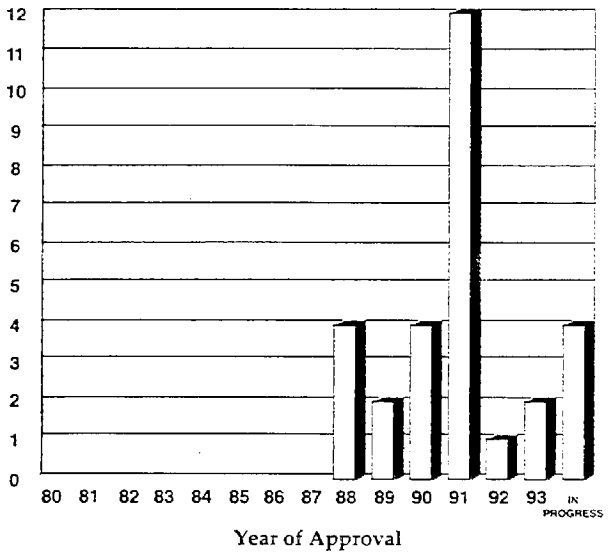
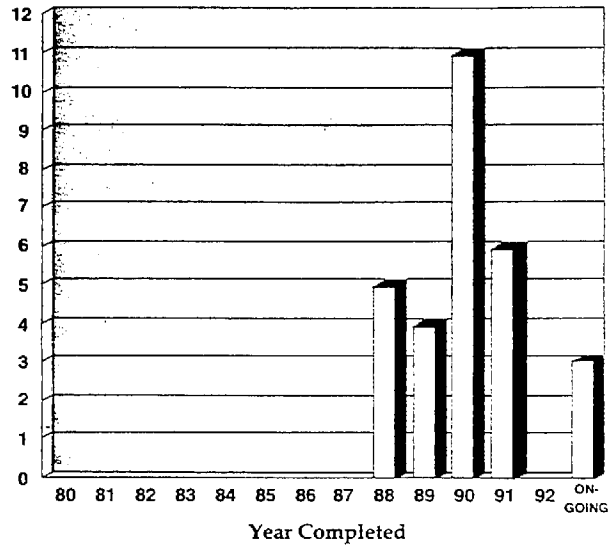


Figure 10: Site Investigations Completed



Cleanup is being conducted by private parties at non-Superfund sites

Because of the publicity and attention given to larger Superfund sites, and investigation by the regulatory agencies, almost all non-Superfund sites are in the process of being cleaned up by private parties. These parties either anticipate government action, or wish to conduct cleanup to facilitate property transfer or development. There is also increasing interest in being "good corporate citizens".

Agency procedures and coordination have been improved

The discovery of contaminated groundwater in south San Jose in 1979 created a unique regulatory problem. No single agency was charged with overseeing the groundwater investigation and cleanup. Initially, a number of federal, state and local agencies worked simultaneously on the problem. However, in 1986 the Regional Board, the DTSC (now part of Cal/EPA), and federal EPA approved an enforcement agreement that allowed for a more efficient regulatory response to the numerous groundwater and soil problems in the South Bay. A lead agency was designated for each site, and review procedures were developed. Also, a South Bay Groundwater Contamination Task Force, with representatives from the community, industry, and federal, state, and local agencies, was formed to coordinate government efforts and assist in sharing of technical information.

Manufacturing processes have been changed, and chemical use has been reduced

Companies in Santa Clara County lead the country in reducing use and discharge of chemicals. Reduction in chemical use has come about through process changes. A typical manufacturing change is the replacement of Freon 113 as a degreaser with an aqueous (soap and water) process. Actual release of chemicals to the environment has also been reduced. Between 1987 and 1990, chemical releases by industries across the United States, was down 31.3%. Reduced chemical discharge across California was 33.5%; led by Santa Clara County with 52.7%. This reduction in chemical release is driven by many factors such as increasing cost of hazardous material disposal, rapidly changing manufacturing techniques, and public pressure from annual announcements of chemical discharge with names and data from individual companies.

Chemical storage methods and regulations are improved

In 1982, suddenly confronted with the emerging groundwater contamination problem, representatives from government, industry, and the community cooperatively drafted the first model Hazardous Material Storage Ordinance (HMSO) in the country specifically designed to detect and prevent contamination from underground storage tanks. By 1983, most local governments in Santa Clara County had adopted the ordinance. State and federal laws based on this ordinance soon followed.

The HMSOs require secondary containment such as a vault around a tank on all new underground storage facilities. Existing facilities must be tested for leaks and install monitoring systems. All facilities must submit plans for managing their hazardous materials, report suspected leaks or spills, and clean up contaminants if a leak or spill occurs. By 1987, the ordinance was in full effect for underground tanks. Tank owners had complied with the requirement for leak testing and monitoring. Chemical storage and handling facilities are subject to inspection by local HMSO Officers.

Abandoned wells have been located and sealed

Well Investigation Program - This program authorized by AB 1803 was designed to detect and monitor organic chemicals and pesticides in public water systems. The ODW had the primary responsibility for approving the monitoring plan for each public water system. The RWQCB has the primary responsibility for locating the source of chemicals detected during the public water system's regular monitoring. Even with a concentrated effort, identifying sources of contamination was often difficult or impossible.

Well sealing - Abandoned wells can potentially allow contaminants to migrate from the shallow aquifer to the deep aquifer used for drinking water. (At federal Superfund sites, the responsible party is required to seal any abandoned wells found within the plume area.) The Santa Clara Valley Water District, conducted a well sealing program from 1984 to 1991. In that time the district sealed 418 private wells throughout Santa Clara County. In addition over 2,500 wells were sealed by private parties from 1984 to the present.

Additional drinking water standards have been adopted

The Federal Safe Drinking Water Act of 1974 and its 1986 amendments, as well as the California Safe Drinking Water Act of 1986, are intended to insure the quality of public water supplies. The federal EPA and the California ODW set standards and monitoring requirements for water utilities.

Initially, in 1982, there were no MCLs or other drinking water standards for VOCs. However, by 1982, the California Department of Health Services had recommended "Action Levels" for five of the most common VOCs. Action Levels were developed by DHS staff to provide guidance to water suppliers regarding chemical levels in water supplies. Action Levels were developed prior to formal establishment of MCLs because development of Action Levels did not require legislative approval and could be accomplished more quickly. Since 1982, 34 federal and/or state MCLs have been adopted for various VOCs.

In addition to MCLs for VOCs, there are also MCLs for other chemical classes (e.g., metals and semi-volatile chemicals). There are now more than seventy regulated constituents. Most are either not detected in the South Bay drinking water supplies or are only found at levels below existing or proposed standards.

Technical knowledge of the behavior of chemicals in soil and groundwater has improved

Groundwater contamination sites have been investigated throughout the country. Site investigation results, as well as tests of cleanup methods, are shared through professional meetings and through various technical publications. The federal EPA has also published numerous documents on their research projects. Technical information sharing among government agencies and the consulting community has improved the quality of site investigations and cleanup plans.

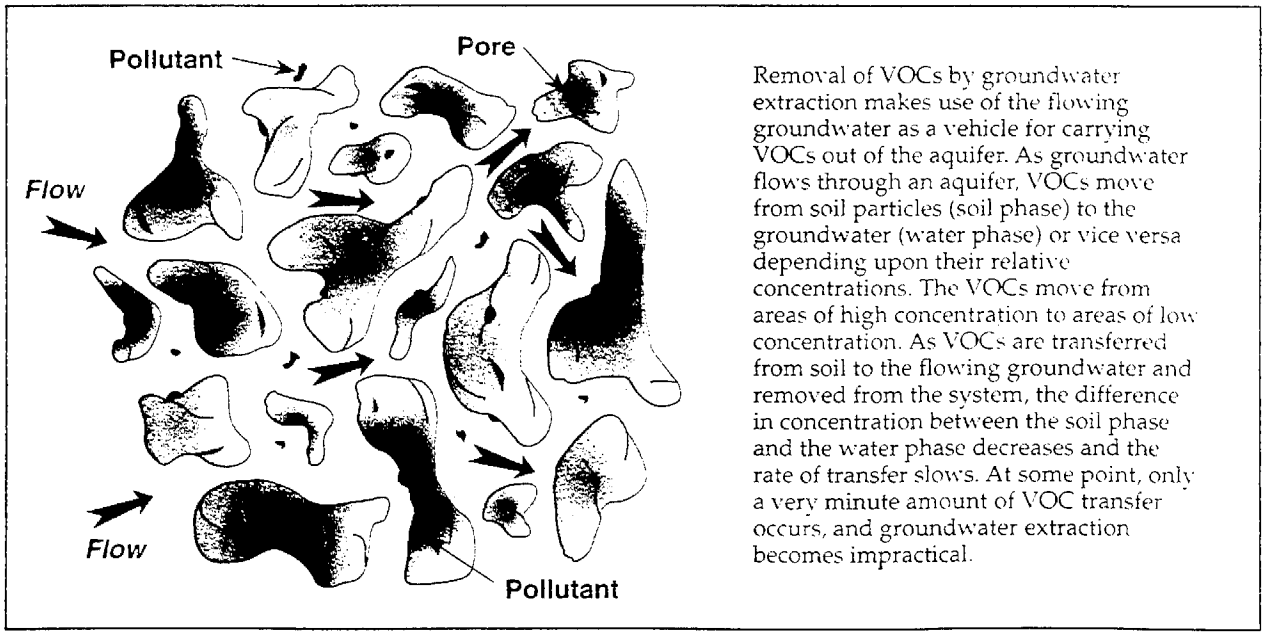
To minimize time consuming drilling many reconnaisance studies now use cone penetrometers to determine geologic stratification beneath sites and pushed probe sampling techniques which allow quick collection of samples from a discrete subsurface zone. Soil gas surveys are also useful in determining the extent of volatile and semivolatile chemical contamination by measuring the amount of volatile compounds present in the void spaces in gaseous form.

While investigating contaminated sites in the South Bay, investigators developed a better understanding of how VOCs move through soil and groundwater. The rates at which different chemicals move through soil are now better understood. At several sites, the contamination has followed buried stream channels or other preferential migration pathways. Locating these pathways has been difficult, but there is now a much better understanding of their significance.

After ten years of development, testing, and monitoring, the limitations of various cleanup techniques are better known. One example is groundwater extraction and treatment. Monitoring results show that the largest amounts of chemicals are removed during the early stages of extraction, and the removal rate declines over time. This reduction in removal rate has been investigated. The studies revealed that simple pumping or extraction would probably never remove all VOCs from the soil particles. The fundamental chemistry and physics of chemical attraction to soil particles dictates that some molecules of VOCs will remain on the soil particles (Figure 12). Cleanup plans must be adjusted to allow for this fact. This has led to experiments such as at the Intel site where groundwater extraction pumps are cycled on and off to obtain higher concentrations of VOCs while lowering the total amount of groundwater pumped.

Predictive models have indicated that VOC vapors may escape from groundwater and migrate upward to the soil surface. Actual field test to determine the actual extent of such migration, and conditions under which this may occur is limited. Tests to determine whether VOC vapors from groundwater appear at the soil surface have been required as part of the continued monitoring at the AMD 901/Signetics/TRW Microwave site in Sunnyvale. These tests indicated only very small concentrations of VOCs are detected at the ground surface, and that these VOC concentrations do not create a significant health risk.

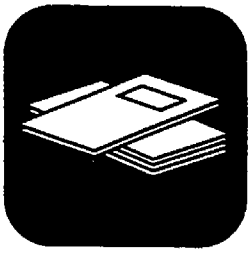
Figure 12: Aquifer Enlarged



Removal of VOCs by groundwater extraction makes use of the flowing groundwater as a vehicle for carrying VOCs out of the aquifer. As groundwater flows through an aquifer, VOCs move from soil particles (soil phase) to the groundwater (water phase) or vice versa depending upon their relative concentrations. The VOCs move from areas of high concentration to areas of low concentration. As VOCs are transferred from soil to the flowing groundwater and removed from the system, the difference in concentration between the soil phase and the water phase decreases and the rate of transfer slows. At some point, only a very minute amount of VOC transfer occurs, and groundwater extraction becomes impractical.

Future for Groundwater Cleanup in the South Bay

Policy Changes

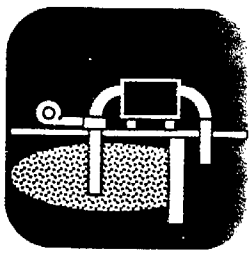


The RWQCB continues to amend the Basin Plan to better define the beneficial uses of groundwater as well as the water quality objectives for protection of these uses. Other policy changes which are being considered include;

- More focus on the objective instead of the process
- Clearer definition of agency roles where multiple agencies are involved
- Balance the need for better site characterization with the need to expedite cleanup
- More realistic expectations regarding the cleanup levels
- Further consideration of the potential and probable use of the shallow groundwater resource
- Technical and economic feasibility of requiring extensive cleanup

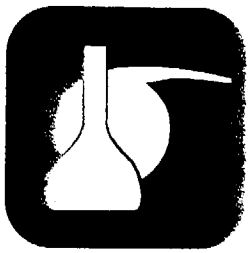
The risks to public health and the environment will be compared to the total economic cost of extraction and treatment and the degree of protection it provides. Risk management policies and strategies will have to consider the benefit of cleaning groundwater to very low levels versus devoting resources to other environmental and health hazards. Treatment at the wellhead prior to use or distribution as opposed to aquifer cleanup will be considered. This thinking will also be applied to forms of cleanup other than extraction and treatment. A greater emphasis will likely be placed on treating or destroying VOCs, rather than air stripping directly to the atmosphere, as air quality regulations are tightened.

Technology Changes



In order to meet the challenges for less extraction and less air stripping, emphasis will be placed on newer and more innovative methods for removal and treatment or destruction. One of the most important aspects of pumping and treating groundwater is to control the spread and reduce mass and concentration of contaminant plumes. But pump-and-treat often takes a long time to reduce concentrations to cleanup standards, uses large volumes of water, and, in many cases, may not completely "clean" the groundwater. Use of new technologies is increasing. Various versions of enhanced soil vapor extraction are being tried. The transfer of contaminants from soil to vapor or liquid phase occurs at a higher rate at higher temperatures. In-situ steam flushing is one method of enhanced extraction which has been tried at the Solvent Service site in San Jose. With this method, recovery of both liquids and vapor is possible. A similar technique that has been considered is heating the intake air as part of vapor extraction. This is less costly , but because it works at lower temperatures than steam flushing, desorbtion of chemicals from the soil is also slower. Another method called sparging introduces air under controlled pressure below the water table to volatilize contaminants. Techniques for destroying the removed VOCs also are being investigated. These include exposure to ultraviolet light (UV) and peroxide or ozone, as well as in-place biological treatment. Temporary excavation and high temperature roasting of contaminated soil will also receive further consideration. Contaminant immobilization through fixation in the soil is an innovative technique for treating soil contaminated with arsenic or other heavy metals as found at the Rhone-Poulenc site. This is an effective method for chemicals which cannot be broken down into simpler elements or destroyed.

Analytic Techniques



Development of new laboratory methods will probably continue in five major areas; sample cleanup, sample separation, compound detection, data reduction and portability. Sample preparation and cleanup involves extracting the sample from the soil or water and removing other impurities. One method being developed is supercritical fluid extraction using high pressure carbon dioxide. Sample separation is the process of separating the various chemicals from each other so they can be detected. Nanoscale liquid chromatography is an example of developing work in the area of sample separation. Detection, identification and quantification of individual compounds is the third area of development. Ion trap and infared detection are under continuing development. Data reduction which involves statistical methods for determining the true amount of compounds present is the fourth area of development. Investigations in each of these areas will be aimed at conducting analyses quicker, with more accuracy, and at lower cost; often in real time using field portable instruments. The areas which may have the greatest impact on soil and groundwater cleanup

are separation and detection. Additional impact will come from the development and approval of methods to separate and detect compounds at trace or ultra trace levels. There are in existence, tens of thousands of compounds, with more being introduced each year. Cleanup requirements are based on that limited suite of compounds for which approved analytical techniques are available. As analytic techniques are improved, new and possibly more protective cleanup standards may be included in site cleanup plans.

Water Conservation and Reuse

The past years of low rainfall have made the term "water resource" quite real to residents and businesses of the South Bay. As the population of the area increases, the demand increases. Since the available supply remains relatively fixed, the need to conserve and reuse water wherever possible will become more important. This could affect groundwater cleanup in at least three ways. The first will be an increased demand for reuse of all extracted groundwater. The second will be to re-examine pump-and-treat as a cleanup technique. This will be especially true after the first few years when the highest concentrations of chemicals have been removed. The third will come in the form of a new look at risk assessment and especially risk management. Pumping large amounts of groundwater containing very small amounts of chemicals and operating expensive treatment systems will come under closer scrutiny. Regional Board staff are beginning to work with staff of the Santa Clara Valley Water District to develop a joint policy on infiltration/injection of treated groundwater. Such a policy would encourage reuse in a way that meets the intent of the RWQCB Policy 88-160. The DHS Office of Drinking Water is also working on revisions to their groundwater recharge regulation.

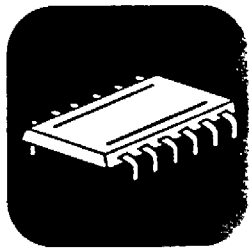
Soil and groundwater contamination sites in the South Bay (or other parts of the United States), may be affected by these future developments. Water reclamation is already a requirement for South Bay cleanup plans.

Health Effects Research

The federal EPA continues to sponsor research into the health effects of various chemicals. More infomation will be gained about how chemicals interact with the human body, and about the cancer process itself. With this additional information, toxicity ratings for various chemicals may be reivsed; some may be deemed more hazardous, and some less hazardous. The status of TCE and DCE as carcinogens is being reviewed by the federal EPA and DTSC. DCE may now be included in risk calculations for noncarcinogens, unless it causes the Hazard Index to exceed 1.0, whereupon it must be analyzed as a carcinogen. Research is also being conducted into the effect of chemicals on the reproductive process, and immune effects. This will most likely be considered in addition to acute and chronic health effects.

There is also more emphasis on ecological risk assessment. Cleanup at sites where metals in surface water are the major concern is governed more by ecological impact than human health effects. Results of current and future research will likely alter risk calculations and, in turn, modify the choice of technologies. Cleanup Standards will also be revised if the risk changes significantly.

Industrial Process Changes



Many companies are developing water reuse plans to incorporate treated extracted groundwater into their manufacturing processes. All companies in the South Bay have stopped using trichloroethene (TCE) in their production process. Different techniques, including deionized water or some version of a soap and water wash, are being implemented. Chemical storage is now more sophisticated. Underground tanks and sumps are being replaced with tanks inside vaults where leaks and spills can be detected more easily. Inventory control is also improved.

Conclusion

Over the past decade, significant progress has been made in reducing soil and groundwater contamination in the South Bay. At the 29 federal Superfund sites, actions to remove sources of contamination, abate immediate health threats and halt the spread of contaminated groundwater were implemented in the mid 1980s. Interm or final cleanup actions are now underway at all 29 sites. Water provided to customers by Public Water Supply Agencies is safe to drink and is closely monitored to ensure a safe supply in the future. Progress has been achieved through cooperative cleanup efforts involving industry and government agencies at all levels. This effort will continue until cleanup has been achieved.

When chemical releases were discovered in the late 1970s, industry, government agencies, and technical experts were faced with a problem which required new approaches, new organizational procedures and improved technical knowledge. All parties involved rose to the challenge, and significant progress has been made in investigative techniques, cleanup methods, and interagency cooperation.

Even though significant progress has been made, achieving cleanup standards at all sites may take decades. In the future, general knowledge of the fate and effect of contaminants will continue to improve providing a better understanding of associated risks. New cleanup methods will be developed, and existing methods will become more effective. As cleanup is monitored, and formal progress reviews are conducted, questions regarding the cleanup standards and methods will continue to be asked. The challenge of appreciating and meeting our need for a clean environment along with our demand for industrial products will continue.

The federal Environmental Protection Agency, the Regional Water Quality Control Board, the Cal/EPA Department of Toxic Substances Control, local government, and industry will continue to involve the public in solving hazardous waste problems in the South Bay. With increased information and an understanding of the risks of an industrial society, the public can assist government agencies and industry in setting and meeting environmental priorities for the South Bay area.

Appendix A
Status of Federal Superfund Sites in the South Bay (April, 1993)

ADVANCED MICRO DEVICES - ARQUES
1165 East Arques Avenue, Sunnyvale
(formerly Monolithic Memories)

Discovered: May 1982
National Priority List
Final: July 22, 1987
Investigation
Began: May 1982
Completed: November 1989
Types of Chemicals Released
TCE, 1,2-DCE, ethylbenzene
Extent of Contamination
Soil: surrounding tanks and chemical handling/storage areas
Groundwater: shallow aquifer; lateral extent of plume is 4300 feet
Public Health or Environmental Impact
Current potential pathway is due to indoor exposure to vapors migrating from contaminated groundwater at the downgradient extent of the plume. Future potential pathway only if the shallow aquifer is used as for domestic purposes.
Cleanup Activities
Tanks, sumps and adjacent contaminated soils removed, groundwater extraction and treatment, in-situ vapor extraction for subsurface contaminated soils. Additional future cleanup activities include property title restricting use of shallow groundwater, excavation of surface soil contamination and treatment of soil by disposal or onsite aeration of excavated soil.
Final Cleanup Plan: approved by RWQCB September 18, 1991
ROD: approved by EPA September 1991
Current Status
Continued groundwater extraction and treatment, and soil vapor extraction.
Oversight Agency: RWQCB
Item of Special Interest
The Advanced Micro Devices - Arques (AMD) site is a part of a larger study area which includes the National Semiconductor (NSC) site and has been combined due to the comingling of the two groundwater plumes. The recently approved Remedial Action Plan describes cleanup activities for the two sites and is known as Operable Unit 1, or the eastern portion of the Study Area. The western portion of the study area, also known as Operable Unit 2, as yet needs further investigation, and involves parties other than NSC and AMD, Arques.

ADVANCED MICRO DEVICES - 901, 902,
901 Thompson Place, Sunnyvale
(See also Signetics and TRW Microwave)

Discovered: 1982
National Priority List
Final: June 1986
Investigation
Began: 1982
Completed: 1991
Types of Chemicals Released
TCE, PCE, 1,2-DCB
Extent of Contamination
Soil: surrounding acid neutralization system
Groundwater: shallow aquifer; plume comingled with plumes from Signetics and TRW sites extends 3/4 mile downgradient
Public Health or Environmental Impact
Potential pathway via domestic use of the groundwater is ingestion or inhalation.
Cleanup Activities
Onsite contaminated soils removed, treated, and disposed; groundwater extracted and treated; property title has restriction on use of shallow groundwater. Offsite soil vapors above groundwater plume are monitored.
Final Cleanup Plan: approved by RWQCB June 1991
ROD: approved by EPA September 1991
Current Status
Continued groundwater extraction and treatment; soil removal complete.
Oversight Agency: RWQCB
Item of Special Interest
Due to community interest in this site and concerns about pathways of exposure to contaminants, indoor air sampling was performed by the Environmental Epidemiology and Toxicology Branch of the California Department of Health Services. The study indicated no increased risk due to groundwater contaminants. RWQCB staff have held one formal and five informal public meetings in the community, and continue to provide updates of ongoing studies at the AMD, TRW, and Signetics sites.

ADVANCED MICRO DEVICES - BUILDING 915
915 Deguigne Drive, Building 915, Sunnyvale

Discovered: 1984
National Priority List
Final: September 1990
Investigation
Began: 1984
Completed: 1991
Types of Chemicals Released
TCE, 1,2,4-trichlorobenzene
Extent of Contamination
Soil: surrounding acid neutralization system
Groundwater: shallow aquifer
Public Health or Environmental Impact
Potential pathway via domestic use of the groundwater is ingestion or inhalation.
Cleanup Activities
7,000 cubic yards contaminated soils removed and disposed offsite; groundwater extracted and treated; property title has restriction on use of shallow groundwater.
Final Cleanup Plan: approved by RWQCB June 19, 1991
ROD: approved by EPA August 1991
Current Status
Continued groundwater extraction and treatment.
Oversight Agency: RWQCB

APPLIED MATERIALS
3050 Bowers Avenue, Santa Clara

Discovered: November 1983
National Priority List
Final: May 1987
Investigation
Began: November 1983
Completed: August 1992
Types of Chemicals Released
TCE, TCA, DCA, 1,2-DCE, Freon 113, Freon 11
Extent of Contamination
Soil: surrounding tanks and associated piping to a depth of eight to twenty feet
Groundwater: in upper zones of shallow aquifer; plume remains onsite 700 feet downgradient of tanks
Public Health or Environmental Impact
Potential pathway only if the shallow aquifer is ingested or vapors are inhaled.
Cleanup Activities
Three underground tanks removed, 65 cubic yards of contaminated soils removed, groundwater extracted and treated, property title restrictions on new use or development.
Final Cleanup Plan: approved by RWQCB June 1993
ROD: approved for groundwater September 1990, approval for soil pending
Current Status
Groundwater extraction and treatment ongoing.
Oversight Agency: RWQCB

CTS PRINTEX
1950 Colony Street, Mountain View

Discovered: January 1985
National Priority List
Final: date February 22, 1990
Investigation
Began: 1985
Completed: 1990
Types of Chemicals Released
TCE, TCA, trans-1,2-DCE
Extent of Contamination
Soil: beneath sump and wet floor processing area
Groundwater: confined to upper zones of shallow aquifer; extends 800 feet offsite
Cleanup Activities
Sump removed, wet floor decontaminated, 300 cubic yards of soil removed, groundwater extracted and discharged to sanitary sewer.
Final Cleanup Plan: approved by RWQCB January 1989
ROD: approved July 1991
Current Status
Company implementing approved cleanup plan.
Oversight Agency: RWQCB

FAIRCHILD CAMERA CORP.
101 Bernal Road, San Jose

Discovered: November 1981
National Priority List
Final: October 4, 1989
Investigation
Began: 1981
Completed: October 1988
Types of Chemicals Released: TCA
Extent of Contamination
Soil: surrounding underground tank
Groundwater: affected shallow and deep aquifer; plume length is 2900 feet
Cleanup Activities
Affected public water supply well taken out of service, underground tank removed, 3,440 cubic yards of contaminated soils removed, soils treated by vapor extraction, slurry wall installed, sealed wells that were potential conduits for contaminant migration, groundwater extracted and treated.
Final Cleanup Plan: approved by RWQCB January 1989
ROD: approved January 1989
Current Status
Reduced groundwater extraction and treatment; remedial actions have reduced the size of the plume.
Oversight Agency: RWQCB
Item of Special Interest
In December 1991 as a water conservation measure, the company was allowed to cease pumping outside the slurry wall for one year, based on modeling that predicted no net effect on plume migration. Predicted effect has been verified. There has been no plume migration or significant change in VOC concentration after one year.

FAIRCHILD SEMICONDUCTOR CORP.
464 Ellis Street, Mountain View

Discovered: February 1982
National Priority List
Final: October 4, 1989
Investigation
Began: July 1982
Completed: November 1988
Types of Chemicals Released
TCE, TCA, trans-1,2-DCE
Extent of Contamination
Soil: surrounding tanks, neutralization and wastewater treatment systems
Groundwater: affects shallow and deep aquifer, extends 6000 feet
Cleanup Activities
Tanks removed, soils removed and treated, in-place soil treatment by vapor extraction, slurry walls installed, groundwater extracted and treated.
ROD: approved June 1989
Current Status
Ongoing extraction and monitoring of the groundwater according to the approved cleanup plan; design and construction of an area-wide extraction and treatment system to be conducted in 1993/94.
Oversight Agency: US EPA

HEWLETT-PACKARD
640 Page Mill Road, Palo Alto

Discovered: June 1981
National Priority List
Final: February 1, 1990
Investigation
Began: July 1981
Completed: Investigation is ongoing
Types of Chemicals Released
TCE, TCA, DCA
Extent of Contamination
Soil: surrounding underground tank
Groundwater: confined to upper aquifer; plume length is 2,000 feet
Cleanup Activities
Underground tank removed, 1,000 cubic yards of soil removed, groundwater extracted and discharged to sanitary sewer.
Final Cleanup Plan: mid 1994
Current Status
Ongoing groundwater extraction and treatment on-site; off-site interm cleanup to be installed by March, 1994.
Oversight Agency: RWQCB

HEWLETT-PACKARD
1501 Page Mill Road, Palo Alto

Discovered: December 1981
National Priority List
Proposed: October 15, 1984
Dropped: September 12, 1989
investigated under RCRA authority
Investigation
Began: 1982
Completed: investigation is ongoing
Types of Chemicals Released
TCE, TCA, DCE, benzene, toluene, xylene, acetone, Freon, MEK
Extent of Contamination
Soil: surrounding underground tanks
Groundwater: confined to upper aquifer, plume length is 300 feet
Cleanup Activities
Six underground tanks removed, soils treated by vapor extraction, groundwater extracted and treated.
Final Cleanup Plan: due late 1993
Current Status
Ongoing groundwater extraction and treatment; investigations to refine the boundaries of the groundwater plume continuing.
Oversight Agency: RWQCB
Item of Special Interest
In July 1989, The Barron Park Association Foundation was awarded a second EPA Technical Assistance Grant for $42,000 to provide the community with technical assistance in understanding the site documents.

INTEL CORP
365 East Middlefield Road, Mountain View

Discovered: September 1981
National Priority List
Final: June 1, 1986
Investigation
Began: December 1981
Completed: November 1988
Types of Chemicals Released
TCE, Xylene, 1,2-DCE
Extent of Contamination
Soil: in and around process and manufacturing areas
Groundwater: plume length is approximately 6000 feet
Cleanup Activities
Tanks removed, 46,000 cubic yards of soils removed, soils treated by vapor extraction, slurry walls installed, groundwater extracted and treated.
ROD: approved June 1989
Current Status
Ongoing extraction and monitoring of the groundwater, and soil treatment continuing according to the approved cleanup plan, ongoing investigations to continue to define extent of soil contamination.
Oversight Agency: US EPA

INTEL CORP./SANTA CLARA III
2880 Northwestern Parkway, Santa Clara

Discovered: June 1982
National Priority List
Final: June 1, 1986
Investigation
Began: June 1982
Completed: March 1990
Types of Chemicals Released
TCE, TCA, Freon 113
Extent of Contamination
Soil: none detected
Groundwater: in upper zones of shallow aquifer; plume extent is 400 feet x 300 feet
Public Health or Environmental Impact
Potential pathway only if the shallow aquifer is used as drinking water source.
Cleanup Activities
Above ground storage tanks retrofitted, groundwater extracted and treated, property title has attached restriction on use of shallow groundwater.
Final Cleanup Plan
approved by RWQCB July 1990
ROD: approved by EPA in September 1990
Current Status
Discharger is continuing a pilot project of pulsed pumping of groundwater which is projected to minimize volume of groundwater removed, yet increase amount of contaminants removed.
Oversight Agency: RWQCB

INTERSIL/SIEMENS
10900 Tantau Avenue, Cupertino

Discovered: May 1982
National Priority List
Proposed: June 24, 1988
Investigation
Began: 1982
Completed: 1990
Types of Chemicals Released
TCE, TCA, Freon 113
Extent of Contamination
Soil: surrounding sumps, tanks and associated piping
Groundwater: plume extends 2500 feet in shallow aquifer
Cleanup Activities
Tanks removed, soil treated by vapor extraction, groundwater extracted and treated.
Final Cleanup Plan: approved by RWQCB August 1990
ROD: approved August 1990
Current Status
Companies implementing approved cleanup plan.
Oversight Agency: RWQCB

INTERNATIONAL BUSINESS MACHINES (IBM)
5600 Cottle Road, San Jose

Discovered: September 1980
National Priority List
Proposed: Oct.1984
Dropped:, June 1988; currently being managed under RCRA authority
Investigation
Began: 1980
Completed: 1988
Types of Chemicals Released
TCA, Freon, DCE offsite; TCE petroleum napthas onsite
Extent of Contamination
Soil: in and around solvent tank farm
Groundwater: affected drinking water aquifer; plume length is three miles
Cleanup Activities
Tanks removed, 30,000 cubic yards of contaminated soil removed, soils treated by vapor extraction, groundwater extracted and treated.
Final Cleanup Plan: approved by RWQCB October 1988
ROD: approved October 1988
Current Status
Ongoing groundwater extraction and treatment both on and off-site plus soil vapor extraction onsite.
Oversight Agency: RWQCB
Items of Special Interest
IBM is currently re-using 100% of the treated groundwater extracted onsite, and 2% of ground-water extracted offsite. The total nets out to 75% on a volume basis. Reuse includes irrigation, reinjection and cooling water. The Silicon Valley Toxics Coalition (SVTC) has received a federal EPA Technical Assistance Grant for this site.

JASCO CHEMICAL CORP.
1710 Villa Street, Mountain View

Discovered: December 1982
National Priority List
Final: October 4, 1989
Investigation
Began: 1987
Completed: February 1991
Types of Chemicals Released
TCA, 1,1-DCE, 1,1-DCA, Methylene Chloride
Extent of Contamination
Soil: due to surface water runoff from the facility to swale behind building
Groundwater: confined to upper zones of shallow aquifer; longitudinal extent 300 feet
Cleanup Activities
Some contaminated soils removed, groundwater being monitored.
ROD: approved September 1992
Current Status
Remedial design underway. Groundwater cleanup will include extraction with carbon treatment. Soil cleanup will include ex-suit enhanced bioremediation.
Oversight Agency: US EPA

LORENTZ BARREL & DRUM CO.
1515 S. 10th Street, San Jose

Discovered: August 1981
National Priority List
Final: Date October 4, 1989
Investigation
Began: 1982
Completed: November 1990
Types of Chemicals Released
Volatile organics, PCBs, pesticides
Extent of Contamination
Soil: surface and subsurface of the former operating facility
Groundwater: affected municipal water wells; confined to upper zones of shallow aquifer, horizontal extent of plume is 700 x 2,000 feet
Cleanup Activities
Closure of facility, removal of most highly contaminated soils, waste storage drums and associated drum wash equipment removed, surface soils temporarily capped.
Final Cleanup Plan
Final cleanup plan for shallow groundwater has been selected and implemented. Final cleanup plan for soil scheduled to be issued in May, 1993.
ROD: scheduled August 1993
Current Status
Implementation of shallow groundwater extraction and treatment began April 1992; proposed plan for on-site soil remediation issued May, 1993; ROD expected late 1993.
Oversight Agency: US EPA
Items of Special Interest
Implementation of an innovative technology for treatment of extracted groundwater, using an ultra-violet light and hydrogen peroxide process for destruction of organic contaminants.

MICRO STORAGE/INTEL MAGNETICS
2986 Oakmead Village Court, Santa Clara

Discovered: 1982
National Priority List
Final: June 1, 1986
Investigation
Began: 1982
Completed: March 1989
Types of Chemicals Released
TCE, TCA, Freon 113
Extent of Contamination
Soil: surrounding above and below ground tanks
Groundwater: in upper zones of shallow aquifer; plume extent is 450 feet x 850 feet
Public Health or Environmental Impact
Potential pathway only if the shallow aquifer is used as drinking water source.
Cleanup Activities
Tanks and adjacent contaminated soils removed, groundwater extracted and treated, property title has attached restriction on use of shallow groundwater.
Final Cleanup Plan
approved by RWQCB July 1991
ROD: approved by EPA in August 1991
Current Status
Continued groundwater extraction and treatment.
Oversight Agency: RWQCB

MIDDLEFIELD ELLIS WHISMAN AREA
(See Fairchild Semiconductor, Intel Corp., Raytheon)
The SVTC has received a federal EPA Technical Assistance Grant for this site.

MOFFETT NAVAL AIR STATION
Moffett Field, Mountain View

Discovered: June 1982
National Priority List
Final: July 22, 1987
Investigation
Began: 1982
investigation is ongoing
Types of Chemicals Released
solvents, fuels
Extent of Contamination
Soil: surrounding tanks and associated equipment, other areas to be investigated
Groundwater: shallow aquifer near wetlands adjacent to Bay; extent not yet defined
Public Health or Environmental Impact
Not yet determined.
Cleanup Activities
Tanks and surrounding contaminated soils removed.
ROD: Five operating units, each on separate schedule
Current Status
Investigation is continuing; groundwater extraction and treatment on going for source control.
Oversight Agency: US EPA
Items of Special Interest: The SVTC has received a federal EPA Technical Assistance Grant for this site.

NATIONAL SEMICONDUCTOR CORPORATION
2900 Semiconductor Drive, Santa Clara

Discovered: March 1982
National Priority List
Final: July 22, 1987
Investigation
Began: March 1982
Completed: December 1990
Types of Chemicals Released
TCE, TCA, DCE
Extent of Contamination
Soil: surrounding tanks and throughout the site
Groundwater: shallow aquifer; longitudinal extent of plume is 6300 feet
Public Health or Environmental Impact
Current potential pathway is due to indoor exposure to vapors migrating from contaminated groundwater at the downgradient extent of the plume. Future potential pathway only if the shallow aquifer is used as for domestic purposes.
Cleanup Activities
Tanks, sumps and adjacent contaminated soils removed, groundwater extracted and treated. Additional future cleanup activities include property title restricted use of shallow groundwater, excavation of surface soil contamination and treatment of soil by disposal or onsite aeration of excavated soil, and in-situ vapor extraction for subsurface contaminated soils.
Final Cleanup Plan
approved by RWQCB September 18, 1991 for O.U. #1
ROD: approved by EPA September 1991
Current Status
Continued groundwater extraction and treatment.
Oversight Agency: RWQCB
Items of Special Interest
The National Semiconductor (NSC) site is a part of a larger study area which includes the Advanced Micro Devices, Arques (AMD) site. the two sites have been combined due to the comingling of the two groundwater plumes. The approved Remedial Action Plan describes cleanup activities for a portion of the two sites (known as Operable Unit 1), or the eastern portion of the Study Area. The western portion of the study area, also known as Operable Unit 2, needs further investigation, and involves parties other than NSC and AMD, Arques.

RAYTHEON CORP.
350 Ellis Street, Mountain View

Discovered: November 1982
National Priority List
Final: June 1, 1986
Investigation
Began: 1982
Completed: 1988
Types of Chemicals Released
TCE, TCA, 1,2-DCE
Extent of Contamination
Soil: in and around process and manufacturing areas
Groundwater: affects shallow and deep aquifers; plume is 6000 feet in length
Cleanup Activities
Tanks removed, soil removal and treatment, construction of slurry walls, groundwater extracted and treated.
ROD: approved June 1989
Current Status
(See Fairchild Semiconductor, Mountain View)
Oversight Agency: US EPA

RHONE-POULENC
1990 Bay Road, E. Palo Alto

Discovered: October 1980
National Priority List
Proposed: 1985
Dropped: October 1989
investigated under RCRA authority
Investigation
Began: 1980; investigation completed on the upland portion of the site only; wetland investigation is ongoing
Types of Chemicals Released
arsenic, cadmium, lead, mercury, selenium
Extent of Contamination
Soil: 13 acre area, surrounding underground tank and shallow sludge pond
Groundwater: shallow aquifer
Public Health or Environmental Impact
Potential risk only if there is dermal contact, ingestion with or inhalation of the soil or groundwater. The shallow groundwater is not potable. Wetlands environmental impact not yet determined.
Cleanup Activities
Approximately 4,000 cubic yards of the most highly contaminated soils removed; final cleanup for the upland portion of the site includes removal of highly contaminated soil, soil treatment, capping of the site surface, installation of a slurry wall, extraction and treatment ofgroundwater inside the slurry wall, and deed restrictions.
Final Cleanup Plan
Approved by RWQCB for the upland unit - February 1992
ROD: approved for the upland unit March 1992
Current Status
Remedial activities on the upland unit have all been completed except the slurry wall. The wetland unit Ecological Assessment is being revised and will be resubmitted by early Fall, 1993.
Oversight Agency: RWQCB
Item of Special Interest
Due to the proximity of the site to the wetlands of San Francisco Bay, an extensive Ecological Assessment was performed at the site; results and recomendations of the Assessment are under review.

SIGNETICS
811 East Arques Avenue, Sunnyvale
(See also AMD 901, 902, and TRW Microwave)

Discovered: 1982
National Priority List
Proposed: October 1984
Dropped: October 1989
investigated under RCRA authority
Investigation
Began: 1982
Completed: 1991
Types of Chemicals Released
TCE, Freon, TCA
Extent of Contamination
Soil: surrounding tanks
Groundwater: shallow aquifer; plume comingled 3/4 mile downgradient with plumes from TRW and AMD - 901, 902 sites
Public Health or Environmental Impact
Potential pathway via ingestion of groundwater or inhalation of vapors from groundwater.
Cleanup Activities
Tanks, sumps, and 4700 cubic yards of surrounding contaminated soils removed; remaining contaminated soils treated by vapor extraction; groundwater extracted and treated; property has restriction attached to deed on use of shallow groundwater.
Final Cleanup Plan
approved by RWQCB June 1991
ROD: approved by EPA September 1991
Current Status
Continuing groundwater extraction and treatment.
Oversight Agency: RWQCB
Item of Special Interest
(See AMD 901)

SPECTRA-PHYSICS, INC.
1250 West Middlefield Road, Mountain View
(See also Teledyne)

Discovered: October 1982
National Priority List
Proposed: June 24, 1988
Investigation
Began: 1984
Completed: November 1990
Types of Chemicals Released
TCE, DCE, PCE, DCA
Extent of Contamination
Soil: up to 18 ppm TCE and 1 ppm toluene in soil
Groundwater: affects shallow and intermediate zones of the upper aquifer; plume extends 4200 feet downgradient
Cleanup Activities
One underground tank and three sumps removed, some contaminated soil removed, in-situ vapor extraction in remaining soils, groundwater extracted and discharged to the sanitary sewer.
Final Cleanup Plan: approved by RWQCB January 1991
ROD: approved by EPA March 1991
Current Status
Implemented joint groundwater extraction system with the Teledyne Semiconductor facility.
Oversight Agency: RWQCB
Item of Special Interest
Contaminated groundwater from the site has merged with a contaminant plume orginating from the Teledyne Semiconductor site.

SOLVENT SERVICES, INC.
1021 Berryessa Road, San Jose

Discovered: Feb 1983
National Priority List
Proposed: June 1988
Investigation
Began: April 1983
Completed: May 1990
Types of Chemicals Released: TCE, Acetone, Freon
Extent of Contamination
Soil: highly contaminated soils restricted to areas beneath operational pad
Groundwater: confined to upper zones of shallow aquifer; extent of plume is less than 100 feet off site
Public Health or Environmental Impact
Property title has deed attached which restricts use of shallow groundwater or soil excavation.
Cleanup Activities
Contaminated soils treated by steam injecting vapor extraction; infiltration trench installed in the shallow aquifer to remove contaminated groundwater; some organic contaminants are recovered and fed to on-site solvent recovery system.
Final Cleanup Plan: approved by RWQCB August 1990
ROD: approved by EPA September 1990
Current Status
Additional steam injection recovery wells have been proposed; surface capping is pending approval by City of San Jose of site improvements.
Oversight Agency: RWQCB

SYNERTEK, INC. - BUILDING ONE, 3050
Coronado Boulevard, Santa Clara

Discovered: February 1983
National Priority List
Final: October 4, 1989
Investigation
Began: 1983
Completed: June 1989
Types of Chemicals Released: TCE, TCA, Freon 113
Extent of Contamination
Soil: surrounding tanks and acid neutralization system
Groundwater: shallow aquifer; plume extends 1200 feet and is 500 feet wide
Public Health or Environmental Impact
Potential pathway only if the onsite shallow aquifer is used as drinking water source.
Cleanup Activities
Tanks and adjacent contaminated soils removed, groundwater extracted and treated, property title has attached restriction on use of shallow groundwater.
Final Cleanup Plan: approved by RWQCB March 1991
ROD: approved by EPA June 1991
Current Status
All elements of the cleanup plan have been implemented.
Oversight Agency: RWQCB
Item of Special Interest
Discharger evaluated hydraulic control using groundwater re-injection. Reinjection has not worked due to high hardness of the water which clogs pumps, pipes, etc.

TELEDYNE SEMICONDUCTOR
1300 Terra Bella Avenue, Mountain View
(See also Spectra Physics)

Discovered: November 1982
National Priority List
Final: Date July 22, 1987
Investigation
Began: 1982
Completed: November 1990
Types of Chemicals Released
TCE, DCE, vinyl chloride, PCE, DCA
Extent of Contamination
Soil:
Groundwater: affects shallow and intermediate zones of the upper aquifer; plume extends 4200 feet downgradient
Cleanup Activities
One underground tank and sumps removed, some contaminated soil removed, in-situ vapor extraction in remaining soils, groundwater extracted and discharged to the sanitary sewer.
Final Cleanup Plan: approved by RWQCB January 1991
ROD: approved by EPA March 1991
Current Status
Implemented joint groundwater extraction system with the Spectra-Physics facility.
Oversight Agency: RWQCB
Item of Special Interest
In 1984 the RWQCB determined that approximately 50 private wells had been affected by contaminants from the site, and alternative sources of drinking water were provided affected residents.

TRW MICROWAVE, INC. (FEI MICROWAVE, INC.)
825 Stewart Drive, Sunnyvale
(See also AMD901,902, and Signetics)

Discovered: 1983
National Priority List
Final: February 1990
Investigation
Began: 1983
Completed: 1991
Types of Chemicals Released
TCE, 1,2-DCE, Freon 113, xylene
Extent of Contamination
Soil: surrounding tanks
Groundwater: shallow aquifer; plume extends 3,000 feet and comingles 3/4 mile downgradient with plumes from Signetics and AMD - 901, 902 sites
Public Health or Environmental Impact
Potential pathway via ingestion of groundwater or inhalation of vapors from groundwater.
Cleanup Activities
Tanks and 120 cubic yards of surrounding contaminated soils removed; groundwater extracted and treated; property has restriction attached to deed on use of shallow groundwater.
Final Cleanup Plan
approved by RWQCB June 1991
ROD: approved by EPA September 1991
Current Status
Continuing groundwater extraction and treatment; continued soil vapor monitoring.
Oversight Agency: RWQCB
Item of Special Interest
(See AMD 901,902)

VAN WATERS & ROGERS INC.
2256 Junction Avenue, San Jose

Discovered: May 1982
National Priority List
Dropped: October 1989; investigated under RCRA authority
Investigation
Began: December 1982
Completed: November 1990
Types of Chemicals Released
TCE, PCE, xylenes
Extent of Contamination
Soil: contaminated soils restricted to areas beneath underground tank farm and near rail spur at loading dock
Groundwater: confined to upper zones of shallow aquifer; extent of plume is less than 100 feet off-site
Public Health or Environmental Impact
Property title has deed attached which restricts use of shallow groundwater.
Cleanup Activities
Groundwater extraction and treatment; maintain capped surface.
Final Cleanup Plan
approved by RWQCB September 1991
ROD: approved September 1991
Current Status
Soil vapor extraction system and additional groundwater extraction system to be installed; soils beneath tank farm will be investigated when tanks are removed, monitoring indicates contaminants are contained and being reduced.
Oversight Agency: RWQCB

WESTINGHOUSE ELECTRIC CORPORATION
401 East Hendy Avenue, Sunnyvale

Discovered: December 1980
National Priority List
Final: June 1, 1986
Investigation
Began: 1981
Completed: June 1991
Types of Chemicals Released
PCBs, trichlorobenzene, dichlorobenzene, fuels
Extent of Contamination
Soil: surrounding tanks and associated piping, along fencelines and railroad spurs
Groundwater: shallow aquifer; dissolved contaminants in two plumes extending slightly beyond property boundaries; denser undissolved fluids in two areas of the lower portion of the shallow aquifer
Public Health or Environmental Impact
Potential pathway via ingestion of groundwater or dermal contact with soils to underground utility workers.
Cleanup Activities
Tanks and surrounding contaminated soils have been removed; final cleanup activities include permanent containment of onsite contaminated groundwater by extraction and treatment; additional removal of contaminated soils and treatment by incineration at an offsite facility; property title will have has restriction attached on use of shallow groundwater or excavation of remaining soils.
Final Cleanup Plan
approved by RWQCB 1991
ROD: approved by EPA October 1991
Current Status
Remedial design; activities to begin late 1993; pilot groundwater extraction and treatment system started December 1992.
Oversight Agency: US EPA
Item of Special Interest
Quarterly community workshops are being held in Sunnyvale to provide regular activity updates.

Appendix B

Glossary of Acronyms

ARARs - Applicable or Relevant and Appropriate Requirements

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

Cal/EPA - California Environmental Protection Agency

DHS - California Department of Health Services

DTSC - Department of Toxics Substance Control, Cal/EPA

EPA - United States Environmental Protection Agency

MCL- Maximum Contaminant Level

MGD - Million Gallons per Day

NPL - National Priorities List (part of CERCLA)

ODW - California Department of Health Services, Office of Drinking Water

PCB - Polychlorinated Biphenyls

RCRA - Resource Conservation and Recovery Act

RI/FS - Remedial Investigation/Feasibility Study

ROD - Record of Decision

RWQCB - Regional Water Quality Control Board

SARA- Superfund Amendments and Reauthorization Act

SCCHD - Santa Clara County Health Department

SCVWD - Santa Clara Valley Water District

SVTC - Silicon Valley Toxic Coalition

TCA - Trichloroethane

TCE - Trichloroethylene

VOC - Volatile Organic Compounds

For More Information

For more information on public involvement programs for the South Bay Superfund sites, contact one of the Community Relations Coordinators listed below:

Office of Community Relations

US Environmental Protection Agency
75 Hawthorne St H-1-1
San Francisco CA 94105
(415) 744--2175

Community Relations
Regional Water Quality Control Board
2101 Webster, Suite 500
Oakland CA 94612
(510) 286-3815

Community Relations
Dept. of Toxic Substance Control, California EPA
700 Heinz, Building F
Emeryville CA 94710
(510) 540- 3909

If you would like to know more about your drinking water supply, contact:

Cupertino
Director of Public Works
10300 Torre Avenue
Cupertino CA 95014
(408) 252-4505

Mountain View
Director of Utilities
231 North Whisman Road
Mountain View CA 94043
(415) 903-6329

Santa Clara Valley Water District
Public Affairs
5750 Almaden Parkway
San Jose CA 95118
(408) 927-0716

Santa Clara
Director of Water & Sewer Utilities
1500 Warburton
Santa Clara CA 95050
(408) 984-3183

San Jose
San Jose Water Company
374 West Santa Clara Street
San Jose CA 95196
(408) 279-7818

County of Santa Clara
Health Department
2220 Moorpark Way
San Jose CA 95128
(408) 299-6930

Palo Alto
Utility Resource Department
P.O. Box 10250
Palo Alto CA 94303
(415)

City of San Jose
Office of Environmental Programs
801 N. 1st Street
San Jose, CA 95110
(408) 277-5533

State of California
Department of Health Services
Office of Drinking Water
2151 Berkeley Way
Berkeley CA 94704-1011
(510) 540-2160

East Palo Alto
Director of Public Works
City of East Palo Alto
2415 University Avenue
East Palo Alto CA 94303
(415) 853-3100

Sunnyvale
Env. Manager
Sunnyvale WPCP
P.O. Box 3707
Sunnyvale CA 94088-3707
(408) 730-3707

For information on the Santa Clara County well sampling program, or to obtain a list of state certified laboratories who will sample your private well, contact Glenn Hildebrand at the Santa Clara County Health Department (408) 299-6930. Call 1-800-231-3075 for additional information about the federal Superfund program.

Mailing List Sign-up Form

If you or someone you know would like to receive future information on groundwater and soil cleanup activities at any of the South Bay Superfund sites, please fill out the form below. Please return the form to: Community Relations Office California Regional Water Quality Control Board, San Francisco Bay Region, 2101 Webster Street - Suite 500, Oakland, California 94612, (510) 286-3815. (If you are already on our mailing list, you do not need to send in your name again.)

NAME _____

ORGANIZATION/COMPANY _____

STREET ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____

TELEPHONE NUMBER (optional) _____

I would like to be included on the following mailing lists;

- ☐ **Advanced Micro Devices** Building 901/902, **TRW Microwave & Signetics** - Sunnyvale
- ☐ **Advanced Micro Devices** Building 915 - Sunnyvale
- ☐ **Applied Materials** - Santa Clara
- ☐ **CTS Printex** - Mountain View
- ☐ **Fairchild** - San Jose
- ☐ **Hewlett-Packard** 640 & 1501 Page Mill Rd. - Palo Alto
- ☐ **IBM** - San Jose
- ☐ **Intel Santa Clara III** - Santa Clara
- ☐ **Intel Magnetics/Micro Storage** Santa Clara
- ☐ **Intersil/Siemens** - Cupertino
- ☐ **Jasco** - Mountain View
- ☐ **Lorentz Barrel and Drum** San Jose
- ☐ Middlefield-Ellis Whisman area, Mountain View **Fairchild, Intel, and Raytheon**
- ☐ **Moffett Naval Air Station**
- ☐ **National Semiconductor/ Advanced Micro Devices - Arques** (formerly Monolithic - Memories), Santa Clara and Sunnyvale
- ☐ **Rhone-Poulenc/Sandoz** East Palo Alto
- ☐ **Solvent Service** - San Jose
- ☐ **Spectra-Physics/Teledyne Semiconductor** - Mountain View
- ☐ **Synertek** - Santa Clara
- ☐ **Van Waters & Rogers** - San Jose
- ☐ **Westinghouse** - Sunnyvale

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- ☐ **Van Waters & Rogers** - San Jose
- ☐ **Westinghouse** - Sunnyvale

What can you do to help?

A healthy emvironment is the result of a multitude of decisions and actions by individuals and businesses at all levels. You can help in this process in two ways. First, you can become aware of the consequences of your actions both at home and at work and take steps to minimize or eliminate adverse enviromental effects of those actions. Second, you can become involved in community and regulatory decisions which affect environmental quality.

Take action at home or at work

The best way to eliminate pollution is to prevent its occurence in the first place. Source reduction and waste minimization are the most effective approach to pollution prevention. Source reduction relies on the use of different raw materials and technological improvements to eliminate toxic wastes at the source. Waste minimization emphasizes changes in manufacturing packaging, storage, and distribution to reduce the overall volume of waste materials as well as their toxicity.

Many businesses have found that adopting these practices can reduce pollution, conserve water, and save money on waste treatment and disposal. Source reduction and waste minimization make better sence than expensive treatment or cleanup. Citizens can do some of these same things in their homes. They can help in the way they select, use, and dispose of household products, their gardening and landscape products and materials, the degree to which they buy durable products which can be reused, and or recycled, and the way they operate and maintain their vehicles. Everone can implement source reduction by altering or eliminating the use of hazardous materials, and waste reduction by recycling and by proper application and disposal.

Get involved in community decisions

The federal Superfund law encludes a strong program of public participation in the decision-making process at Superfund sites. The federal EPA, Cal/EPA, and the RWQCB all conduct public involvement activities at their respective Superfund sites in the South Bay. The goal of this program is to encourage informed input from the communities and/or individuals affected by these sites. The agencies conduct public outreach and public involvement activities throughout the investigation and cleanup process. In order for the agencies to respond to community concerns and ideas, they need citizen participation. Individuals and organizations canaffect site investigations and cleanup plans. However, they must take steps to be informed and get involved. Reports and other information about the site investigations and cleanup plans are placed in a local library for the review by the community. The federal EPA also has a Techinical Assistance Grant (TAG) program for community organizations. Funds from these grant are used to hire independent experts to help the local organization understand and respond to technical reports produced during the site investigations. In addition to participation at federal Superfund sites, the DTSC also conducts similar activities at State Superfund sites. All RWQCB meetings are open to the public, and comment is encouraged on items presented to the Regional Board. Local government agencies also conduct public meetings where community members can offer their comments on local decisions which affect environmental quality.

Be informed

To learn more about preventing pollution and getting involved in environmental planning in your community, contact your local government or utility agency. Most local libraries have literature or pamplets on the subject. You can also contact the federal Environmental Protection Agency Library Pollution Prevention Resources Center at 510-744-1510 in San Francisco or the Cal/EPA DTSC Public Information Unit at 916-324-2995 in Sacramento.