

**TOXIC  
WASTE  
IN  
SILICON  
VALLEY**

# High-tech's clean image begins

Attractive industrial parks belie threats to ground water; California may serve as clean-

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San Francisco

**I**T reads like a page from Silicon Valley's Who's Who: Advanced Micro Devices Inc.; Control Data Corporation; Data General Corporation; Dysan; Fairchild Camera & Instrument; Hewlett-Packard; IBM; Intel Corporation; National Semiconductor Corporation; Raytheon Company; Signetics Corporation; Teledyne Semiconductor; Zymos Corporation.

But the table in a recent Environmental Protection Agency (EPA) document is actually a listing of the sites in Santa Clara County where leaking underground storage tanks have contaminated area ground water with toxic wastes.

try Clean Water Task Force.

One critic of the industry suggests that its "smokestacks" simply point underground rather than up into the air. The quantities of toxic wastes that it produces are small relative to some other industries, but they consist of a wide range of chemicals, many of whose health effects are not well understood.

High-tech's environmental difficulties have been in the limelight in Silicon Valley. Here it has become such a potent political issue that local representatives, including the area's Republican congressman, Ed Zschau, recently petitioned the EPA to put the entire valley on the nation's Superfund toxic-waste cleanup list. (EPA director William D. Ruckelshaus refused such blanket coverage, but 19 sites in the area have been proposed for listing.)

There have been similar problems in other places where the industry is concentrated. In Massachusetts, for instance, the public water supplies of 35 communities have been contaminated by industrial pollution. In a number of instances, the contamination was traced to industrial parks containing high-tech companies.

In southern Arizona, almost entirely dependent on underground water, contamination problems are widespread. So far 114 wells have been contaminated with man-made pollutants in the areas around Tucson and Phoenix. In some cases pesticides are involved, but most is industry-related. Of the six Arizona sites placed on the EPA's proposed and final Superfund lists, four have a high-tech connection.

"The more we look for problems, the more we find them," says Chuck Anders, assistant director of the state's health services department.

On the other hand, a number of other burgeoning high-tech centers have not reported similar problems. North Carolina's Research Triangle Park has had only one known incident, ground-water contamination from an IBM site. In Colorado and Utah no such difficulties have come to light. Washington has had only one minor incident. But officials in some areas admit that they have not seriously looked for them, either. Until they are searched out, ground-water problems tend to be invisible.

"The Bay Area could be the tip of a state and national iceberg," asserts Don Eisenberg of the San Francisco Regional Water Quality Control Board (RWQCB).

## Nation's most ambitious cleanup

As well as possible a harbinger of ground-water pollution problems in other regions, Silicon Valley may serve as a model for the costly cleanup that they will demand. In the nearly four years since the problems were discovered, the area has embarked on the most ambitious ground-water cleanup program in the nation's history, with widespread industry support.

**Relatively little attention has been given so far to the health of workers in high technology industries. It is scandalous that not a single occupational health study is being done in the high-tech area.**

— Dr. Joseph Labou  
Health specialist  
Santa Clara, Calif.

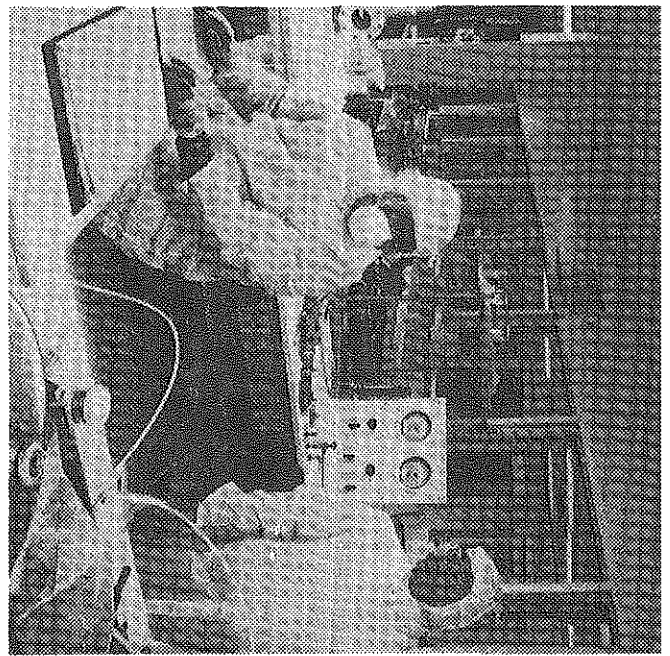


PHOTO BY GUY LAWRENCE

Not all of the 85 sites listed are high-technology companies. There are a couple of chemical companies. Ford Motor Company is included, as are two county transit facilities. But the bulk are microelectronics companies. The EPA report is part of a growing body of evidence indicating that high-tech is not as environmentally benign as once assumed.

## Factories like college campuses

Companies that produce silicon chips, the basic hardware of the information age, employ a broad spectrum of highly toxic materials. The semiconductor industry is a major contributor of toxic wastes in the nation's two oldest high-tech centers: Silicon Valley in California and Route 128 in Boston.

Nevertheless, the industry has an image of cleanliness. The new electronics plants look more like college campuses or office buildings than traditional factories. There are no towering smokestacks. The grounds are pleasantly landscaped. Community representatives from around the nation and the world come hat in hand to lure such companies to their areas.

As a result, "these [pollution] problems came as a real shock," confides Peter Giles of the Santa Clara County Manufacturers Group (SCCMG) and head of a recently formed indus-

The process has strained the resources of local government agencies and has already cost the industry \$70 million. The end is not yet in sight.

The issue burst on the valley in late 1981, when the first leak was discovered at Fairchild Camera & Instrument Company, one of the high-tech keystones of Silicon Valley. Subsequent investigation found that several thousand gallons of waste had seeped into the ground water over an 18-month period. IBM later announced it had a similar problem.

"Practices were very sloppy," acknowledges Mr. Giles of SCCMG. Local fire codes require that these tanks be buried underground. Once buried, "it was a case of out of sight, out of mind," he explains. According to local officials, in some places companies were pumping into these tanks twice as much toxic liquid as they were pumping out.

Although an alphabet soup of chemicals has been found in the contamination plumes beneath the various sites, a class of chemicals called organic solvents represents the largest problem. Ground water seeps slowly through sand and gravel. Many compounds in the wastewater combine chemically with the solid particles so they don't move far or fast. But the solvents spread freely. These chemicals are in widespread use, but the semiconductor industry is particularly heavy consumer.

With several exceptions, these pollutants have not seeped into the water supply of Santa Clara County's 1.4 million residents, local officials say.

When the Fairchild leak was found, a test of a nearby water well serving 700 people found levels of organic solvent 30 times higher than the level that triggers state-agency involvement. (The federal government has yet to establish drinking-water standards for a number of these chemicals.)

A subsequent survey of the area's large public water-supply wells found no other cases of contamination. Most of the pollution has been confined to shallow ground water, while most public wells tap deeper aquifers. Still, in the last three years, 19 public and 43 private wells have been contaminated. Most were shut down as soon as the contamination was discovered.

Organic solvents have been found in ground water in extremely low concentrations: parts per billion to parts per million. Still, there is serious concern about their health effects. A study is being conducted of the 700 people exposed to the Fairchild leak, and it will be released in a month or two.

Silicon Valley's ground-water problems have aroused considerable local concern. People whose drinking water has been tainted have initiated lawsuits against the companies involved. A citizen group, the Santa Clara Toxics Coalition, was formed to act as a watchdog on industry and government efforts and to push for cleanup. And the electronics industry's Midec Clean reputation has suffered.

## Assessing the magnitude

Although four years have elapsed, the magnitude of the problem remains unclear. A recent white paper on the subject, issued by EPA and the state and local agencies involved, estimates that as many as 200 additional industrial contamination sites may exist in the county. And Laurel Chun, the EPA engineer who oversees federal Superfund activities in the valley,

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there are a number of other chemicals that the agency has not even started studying.

With a few notable exceptions, local officials give the Silicon Valley entrepreneurs good marks for their operations.

"Industry has cooperated beyond what anyone could have expected," says Don Eisenberg of the San Francisco Regional Water Quality Control Board. Fairchild has spent \$18 million and IBM \$20 million to drill the dozens of monitoring wells required to determine the extent of the problem; to pump and filter water to keep the contamination from spreading; and to begin cleansing the aquifer.

The industry also cooperated with local officials to draft and endorse a model ordinance, adopted by all the cities in the area, that requires the installation of double-walled tanks and regular monitoring of them to prevent future problems.

### How clean is clean?

Now the question for corporate executives is how long the cleanup will take and what the final price tag will be. The process has been drawn out, in part by lack of staff and resources on the part of responsible state agencies. Some of those involved report that while the state agencies have focused on the large sites, very little progress is being made on the small and medium-size locations.

California Gov. George Deukmejian recently cut about \$3 million from the state's \$39 million toxic-waste program, making the likelihood of increased resources appear slight.

Industry, on the other hand, has begun applying more resources to the problem. The companies have banded together to form a Clean Water Task Force to work with the government and to share technical information on cleanup methods among the companies involved.

The group also intends to prepare and publicize "score cards" on the progress being made at each site, as well as putting peer pressure on the reluctant companies to act responsibly.

Now that the cleanup process is getting underway, officials are confronted with a difficult question: How clean is clean? Experts note that current ground-water cleanup technology — drilling extraction wells, pumping out contaminated water, and filtering or aerating it — cannot remove all of a pollutant from below ground. It may not even be possible to reduce pollutant concentrations below the level of detectability.

"When can we turn off the extraction wells, leaving what is left free to spread?" asks Mr. Kolb of the RWQCB. "Unless we intend to leave these wells pumping forever we must resolve this question."

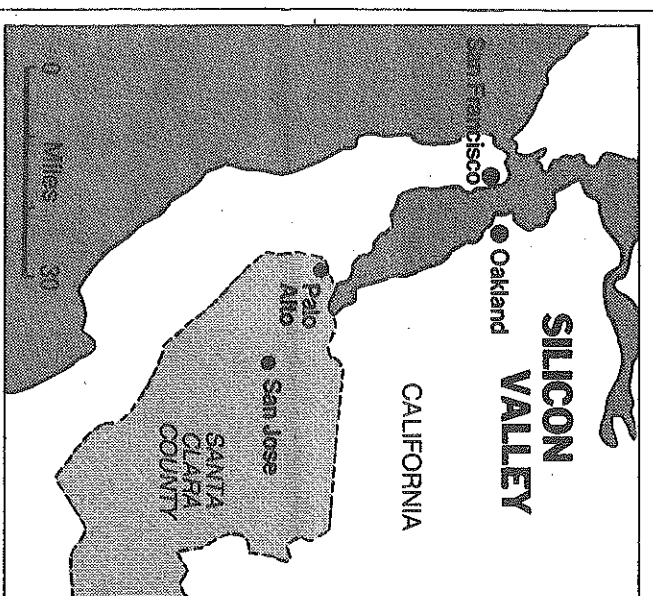
In the future, more-effective cleanup methods may be perfected. For instance, Perry McCarty, a professor of civil engineering at Stanford University, has been experimenting

with the use of specially developed bacteria to "eat" organic contaminants. A group of EPA researchers is working along similar lines. They have proven that this is feasible, but some problems remain: Under some circumstances the bacteria convert the chemicals into others that are more poisonous, rather than harmless.

### Toxic gases

While ground-water pollution has been the focus of public concern regarding high-tech operations, there is another potential hazard that concerns authorities: the highly toxic gases in common use in microelectronic plants.

Semiconductor companies use large quantities of highly toxic gases, including arsine,



## High-tech pollution sites

Proposed for national Superfund cleanup

- Hewlett-Packard
- Raytheon
- Intel (three sites)
- Teledyne Semiconductor
- Fairchild Camera (two sites)
- Advanced Micro Devices
- Westinghouse
- National Semiconductor
- Signetics
- Monolithic Memories
- Applied Materials
- Precision Monolithic
- IBM

phosphine, and diborane. Arsine, the most toxic form of arsenic, is of particular concern. It is also highly flammable.

"We're very concerned about arsine," says Peter Jones, manager of the San Jose Fire Department's toxics division. "We are worried about its use because a major accident could poison a large portion of the neighborhood."

The most responsible companies use these gases with extreme caution. Handlers wear full breathing apparatus. The industry recently drafted a model building code that has been adopted in the Western US. It requires gas systems to have double piping and seismic shutoff valves, to ensure that large amounts of toxic gas will not escape in an earthquake.

Despite the concern that prompted the building code, there seems to be little such discussion about the transportation of these gases. Open trucks bearing large gas canisters are a common site in Silicon Valley highways. No extraordinary precautions appear to be taken.

"My view is that arsine should be banned. It is simply too dangerous to handle, even in the best of circumstances," says Dr. Joseph LaDou, head of the University of San Francisco's Occupational Health Department.

Other critics take the more moderate view that these gases can be used if handled correctly.

## Not much research on workplace conditions

San Francisco

Public concern has highlighted the issue of pollution from high technology. But much less attention is being given to the health of workers in the microelectronics industry.

"It is scandalous that not a single occupational health study is being done in the high-tech area" in the United States, says Dr. Joseph LaDou, a health specialist in Santa Clara and the director of the Occupational Health Department at the University of California at San Francisco. The only major studies are being done in Europe.

The issue is stalled while the microelectronics industry and its critics are locked in a battle of statistics on workers' health. Companies tout a low injury rate; opponents say the statistics are flawed. Meanwhile, there have been increased health complaints over the last few years from workers exposed to solvents and acids.

Dr. LaDou charges that the industry, like others in the past, is taking a reactive rather than preventive approach to the problems of occupational illness. "The death last summer of a worker at M/A-Com, a Massachusetts telecommunications company, from the inhalation of a highly poisonous gas has begun to focus attention on worker safety in high-tech.

The Semiconductor Industry Association (SIA) cites 1982 government data showing the industry averaged only 3.8 cases of illness and injury per 100 workers, the third-lowest rate of 229 durable-goods manufacturing industries. "Most of these chemicals have been used by this industry for 30 years, and there simply isn't any evidence that they are causing any major health problems," says SIA head Thomas Hinkelmann. Jay Jones of the National Institute of Occupational Safety and Health in Cincinnati recently conducted a study of the technology used in the semiconductor industry to protect workers. "We saw some pretty good technology," he says.

In general, the industry has taken an engineering approach to worker safety. "Our attitude is that if the workers receive significant exposures, it is too late. It is better to do the engineering right," explains Larry Holbrook, director of Hewlett-Packard's health and safety division.

Despite this, concern that such measures have not been adequate appears widespread among occupational health specialists in Silicon Valley. These physicians see peculiarities in the industry that they say make its health statistics unreliable. "The data understate the problem, they say, because of the industry's high employee turnover rate. Workers tend to be young, minority women. Many simply quit if they experience health problems. Few file workmen's compensation claims.

Government standards for exposure to various substances, called threshold limit values (TLVs), are set chemical by chemical. This works well for most industries, because workers are exposed to only one or two different substances at a time. But in microelectronics they come in contact with a broad spectrum of chemicals. And workers, particularly in research and development labs, are exposed to a wide range of substances for which there is no prior industrial experience.

TLVs are normally averaged over a work day, an approach that works well in industries in which exposure levels remain relatively constant. But when a mishap occurs in the semiconductor industry, workers may experience a sudden, high exposure for a few minutes. When averaged over 8 hours, this may not exceed the TLV, but may have significant effects, doctors say.

Washington appears unlikely to support research to sort out the ambiguities. "The federal government has pulled extremely far back in the monitoring of industrial performance," says Nicholas Ashford of the Massachusetts Institute of Technology's Center for Policy Alternatives. "There is simply no money available for this sort of work."

"High-tech represents a tremendous opportunity to take a new approach to toxics," says Rand Wilson of the Communication Workers of America. "We would like to see the industry take a high-tech approach to worker protection, but it is not something you can leave up to the companies."

Asked why the industry isn't supporting such research, SIA's Hinkelmann replies, "Why? What's the evidence that there is any problem?" The issue, he says, is being fomented by union sympathizers to aid attempts to organize the largely nonunion industry. LaDou, however, says he's convinced that "the workers are telling us something profound, and we should be listening."