

ENVIRONMENT

The fight to clean up the toxic legacy of semiconductors

President Joe Biden has promised to revitalize American manufacturing. Longtime Silicon Valley residents hope hazardous chemicals won't be coming back with it.

By **Justine Calma**, a science reporter covering the environment, climate, and energy with a decade of experience. She is also the host of the Hell or High Water podcast.

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Building for tomorrow

Husband and wife Ted Smith and Amanda Hawes spent decades working to expose toxic working conditions and pollution at the semiconductor plants that gave Silicon

Valley its name. Now, with the Biden administration working to bring back the once-roaring industry, they're gearing up for another fight.

President Joe Biden signed the CHIPS and Science Act last year, setting aside \$52.7 billion in funding for domestic chip manufacturing. The move was supposed to ease the pain of a global shortage of chips used in everything from cars to gaming consoles while creating tens of thousands of good jobs for Americans. It promises a return to the days before the 1990s, when the US was one of the leading producers of semiconductors — before global competition pushed many manufacturing jobs to Asia.

But the old semiconductor fabrication plants, known as fabs, had an ugly side. Toxic chemicals seeped into the ground and water sources near semiconductor plants and made their way into the bodies of workers and even their children.

Thanks to Silicon Valley, Santa Clara County is littered with more Superfund sites than any other county in the US. Those are sites so contaminated that the federal government has put them on a National Priorities List for cleanup. At a site where Intel made semiconductors between 1968 and 1981, for example, the Environmental Protection Agency lists more than a dozen different "contaminants of concern," including arsenic, chloroform, and lead in groundwater. The agency has been working to clean up the groundwater since 1982, and the work will still take "many decades" to get to safe levels of trichloroethene (TCE), a known carcinogen.

While the semiconductor industry has phased out some dangerous substances, without more transparency about the kinds of chemicals they're working with now, Smith and Hawes worry that a new generation of semiconductor workers could be blindsided by the risks. Health and labor advocates tell *The Verge* that the US still lacks fundamental protections for workers. Federal limits for how much of a toxin a worker can be exposed to haven't been updated in decades.

"Put these protections in place from day one instead of learning the hard way. We've been through that once already," says Hawes, a longtime occupational health attorney. "Let's do it right this time."

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When Smith and Hawes moved to San Jose, the biggest city in what's now Silicon Valley, in the 1970s, the fruit and vegetable canning industry was still king. Smith thought it would be a great place to raise kids. Hawes fought for fair compensation for young women working in the canneries. Then, when the electronics industry started to take over, they hired many people from the same immigrant communities. Hawes started representing them, too, as they faced new problems at work.

Many of the fab employees worked in so-called "clean rooms," highly controlled environments meant to prevent dust or any impurities from damaging a chip. Workers might wear "bunny suits" that covered them from head to toe to prevent particles from falling off their bodies and onto the silicon wafers they worked with. They weren't designed, however, to protect workers from breathing in fumes that might come from "cleaning" the wafers with industrial solvents like TCE.

The risks didn't stay in clean rooms. TCE wound up leaking out of IBM's underground storage tanks and contaminating residents' drinking water in San Jose. More toxic spills were spotted after that high-profile case.

"When it got into the water, it was like, 'Oh my God, this could be me. This can be my family,'" Smith tells *The Verge*. He started an advocacy group with other residents called the Silicon Valley Toxics Coalition. Hawes, meanwhile, co-founded the Santa Clara Center for Occupational Safety and Health (SCCOSH) to fight for workers.

In the 1990s, the dangers associated with toxic chemicals used at semiconductor plants were finally coming to light. By 1992, three separate industry-backed studies had found higher than expected rates of miscarriages among women who worked in semiconductor plants. They traced the problem back to ethylene glycol ethers (EGEs) used in the photoresist substances that coat semiconductors.

In 1999, an article in the journal *Environmental Health Perspectives* named 10 "chemicals of concern in the semiconductor industry" that include known carcinogens and other substances tied to reproductive health problems, like arsenic, lead, and TCE. IBM and other manufacturers also faced a slew of lawsuits filed by former workers who had developed cancer, suffered miscarriages, or whose children were born with intellectual disabilities or birth defects. Many of them were ultimately settled out of court.

Together, and with the help of workers sounding the alarm across the US, Smith and Hawes secured some key wins. The industry pledged to phase out the use of EGEs. After SCCOSH pushed for a ban on TCE, California adopted the strictest exposure limit for the substance anywhere in the world, according to Hawes.

Even after several decades of work to clean up the semiconductor industry, though, risks to workers have persisted. A 2017 Bloomberg investigation found that reproductive toxins phased out in the US in the 1990s were still used years later in semiconductor plants run by Samsung and other companies in Asia and were making workers sick.

And one fundamental thing hasn't changed in the US: exposure limits set by the Occupational Safety and Health Administration (OSHA) are still woefully inadequate, Smith, Hawes, and other labor advocates say. Most of those "permissible exposure limits" (PELs) were set in the 1970s and haven't changed since. As a result, many PELs "are outdated and inadequate for ensuring protection of worker health," OSHA's own website says. Online, OSHA lists its own standards alongside more stringent thresholds developed by California, the National Institute for Occupational Safety and Health (NIOSH), and the nonprofit American Conference of Governmental Industrial Hygienists (ACGIH). While California has its own state regulations that are often more stringent than national limits, the stricter thresholds from other groups are only "recommendations."

Meanwhile, public agencies and private companies are racing to launch more fabs in the US. Within the first year of the CHIPS and Science Act becoming law, companies have submitted more than 460 statements of interest to the Department of Commerce for funding. On top of that, companies have cumulatively announced more than \$230 billion in private investment for semiconductor manufacturing in the US since Biden took office.

Without tougher legal standards, Hawes says, “we’re getting ready to repeat the same stuff... My concern is that [companies are] still adhering to exposure limits that have never been health-protective.”

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OSHA spokesperson Kimberly Darby said in an email that “the agency’s rulemaking capacity is much less than the need for new rules or for updating PELs.” Developing a new rule takes “years” because of requirements to conduct analyses on risk and feasibility and to give stakeholders opportunities to comment, according to Darby. The agency actually tried to update 212 of its exposure limits in 1989 and create 164 new PELs for previously unregulated substances. But the proposed rulemaking faced legal challenges, and a court vacated the whole thing. And in 1980, Ronald Reagan campaigned on a promise to get rid of OSHA altogether.

“OSHA has been highly underresourced for many years. They’re constantly under attack by the regulated community,” says Tracey Woodruff, an expert in chemical and regulatory policy and the director of the Program on Reproductive Health and the Environment at the University of California, San Francisco. “It’s just been a neglected agency for so long.”

But the fight for tougher environmental and health protections is picking up momentum alongside the push for manufacturing. “When we found out the chips were coming back to the US through the CHIPS program, we decided that we better get our information out to people who have not heard about any of this,” Smith says.

The husband and wife team have joined a new coalition called Chips Communities United, which also has backing from Sierra Club, the Communications Workers of America union, and other labor groups. In October, they published a letter addressed to semiconductor industry execs asking them to work collaboratively on protections for semiconductor fab workers and nearby communities. Specifically, they're asking them to sign legally binding community benefit agreements wherever they build these new fabs. On top of hiring diverse staff and respecting the right of workers to organize, they're calling on companies to replace chemicals that can cause cancer, miscarriages, or birth defects and fetal brain damage. In cases where there are no substitutes, they're asking companies to go beyond following OSHA's outdated exposure limits and adhere to more stringent standards instead.

"Legal doesn't mean safe when it comes to toxics in this industry, and a focus on compliance with existing law will not keep workers and community members safe," says Etana Jacobi, a senior campaign lead with IUE-CWA, the industrial division of CWA.

The letter also asks for a "review of facility design to ensure protection of air and water resources." Members of the coalition say they'd like to see more transparency from companies when it comes to sharing what kinds of chemicals workers are handling — an issue they say the industry has historically been tight-lipped about in the name of protecting trade secrets.

The Verge reached out to the Semiconductor Industry Association, but it declined to speak on the record. We also contacted Intel, Samsung, and IBM to ask about their safety protocols and what chemicals workers might come in contact with in fabs. IBM didn't respond. (The company still designs chips but partners with other companies for manufacturing now.) Samsung says it follows the law wherever it

operates and has protocols to prevent chemicals from coming in contact with workers but did not specify what those chemicals might be.

Intel says it stopped using underground storage tanks at its facilities “decades ago.” The EPA took one of three Intel Superfund sites off its National Priorities List in 2019 after deeming the cleanup complete. “While there are many chemicals used in our facilities, the equipment used to process wafers in our fabs is required to achieve SEMI’s [a trade group] semiconductor industry standards during normal operations and maintenance activities,” Intel spokesperson Chelsea Hughes said in an email. Smith also gives Intel credit for joining the Clean Electronics Production Network, a network that includes companies, NGOs, researchers, and the EPA. He says Intel was involved in developing a guidance document (which Smith also worked on) on how to establish occupational safety and health committees in electronics plants.

“It still takes people to actually make these things run”

Both Intel and Samsung say that much of their operations have become nearly fully automated over the years. Even so, Smith doubts that’s a cure-all. “It still takes people to actually make these things run even though they’re highly automated. And so there still is the opportunity for exposure — and it’s never to one chemical, it’s mixtures of chemicals.”

The chemical cocktail changes faster than toxicologists can keep up with, says Bruce Fowler, an adjunct professor of environmental health at Emory University and co-founder of Toxicology and Risk Assessment Consulting Services. Fowler has studied the health risks of chemicals used in semiconductor fabs for decades. Despite the tireless work, “the synthesis and use and application of chemicals is outracing the ability of the toxicology community to make safe evaluations,” he says.

“The chip industry is constantly experimenting or looking at new materials,” Fowler tells *The Verge*. “A lot of the issues that were raised in the early ’90s, well, they’re

still there. But they have different names.” 

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