

# **The Toxic Legacy of the Gold Rush**

by

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## ABSTRACT

The California Gold Rush has often been told as a story of a brief, environmentally benign, even romantic ‘rush’ that ended as quickly as it began. In truth, gold mining in California was highly extractive and industrial, and continued well into the 20<sup>th</sup> century. Over time, miners developed increasingly invasive means of getting at the gold, adding chemical additives like mercury and cyanide to make the process more efficient and bringing up toxic heavy metals like arsenic and lead in the process. These contaminants persist in the environment and are known to be harmful to human health.

Today, there are 47,000 abandoned mines littered across California, many of which are gold mines concentrated in the appropriately named Gold Country region of the western Sierra Nevada mountains. Most of these sites were abandoned before federal and state laws required any sort of remediation of mining operations, and, in most cases, the companies and individuals who operated these sites are long gone. Though only a small percentage of these abandoned mines are contaminated, cleaning up toxic mines is a significant logistical, financial, and technical challenge.

The ongoing efforts by government officials and community groups to clean up contaminated gold mines in Gold Country highlights many of the larger challenges of environmental remediation. At Argonaut Mine, an EPA Superfund site, the project manager contends with a “cultural blindness” to the impacts of gold mining and dangerously high levels of contamination that will take several years and millions of dollars to address. At Lava Cap Mine, another EPA Superfund site, those challenges are exacerbated by an ongoing legal battle to hold accountable those that contributed to the problem. Meanwhile, in Nevada City, community groups like Sierra Fund and Sierra Streams Institute are tackling the challenge of the thousands of smaller sites that will never make EPA’s Superfund list. They’re also illuminating the health risks facing residents of Gold Country and the state’s failure to regulate the buying and selling of abandoned mines.

In an era of climate change, with new mining proposals under consideration, California must finally confront the toxic legacy of the Gold Rush.

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## The Toxic Legacy of the Gold Rush

Almost 175 years after the Gold Rush began, Californians are left holding the bill of thousands of abandoned mines

**IT'S A BEAUTIFUL**, 60-degree day, the sky a cloudless, vivid blue. Spunn Road is lined by stately houses looking down on the historic main street of Jackson, California. The high peaks of the Sierra Nevada mountains are visible in the distance. There's a slight bend in the road, and there it is. A chain-linked fence topped with barbed wire blocks access to a few dilapidated buildings and a 50-foot-tall rusting steel structure that once hoisted rock from the depths below. There's a sign on the fence: TOXIC HAZARD KEEP OUT.

Argonaut Mine was one of the deepest mines in the state, located in the middle of the literal Mother Lode at the heart of California's Gold Country. It operated on and off from the 1850s until World War II. Since then, the mine has sat largely vacant as the town of Jackson grew around it. Today, the only obvious remains are the buildings and, visible across the valley, the old mill of the neighboring Kennedy Mine where they'd crush tons of ore from deep underground day and night.

At Kennedy, the miners constructed an elaborate series of multi-story wooden wheels to lift the mine waste, called tailings, and dump it in the valley below. At Argonaut, they dumped the waste — full of arsenic, lead, and other heavy metals brought up from below, as well as cyanide and mercury the miners added to help extract the gold — a few blocks away.

From the road, all that's visible of the tailings area is a large, muddy vacant lot, marked by no more than a small sign on a flimsy-looking chain-linked fence. One can see where part of the fence was recently replaced after a drunk kid plowed through it.

But the brown muck here is acidic and has average levels of arsenic — an element that can cause cancer, diabetes, cardiovascular disease, and skin lesions — of 400 parts per million. The level at which the state requires a site to be cleaned up is 100 parts per million. John Hillenbrand, a geologist with the Environmental Protection Agency (EPA), says he once recorded a value of 90,000 parts per million. That's equivalent, he explains, to 1 in 50 exposed people getting cancer. Mercury and lead levels are also well above acceptable values.

The area visible from the road, which the EPA calls tailings area 4, is one of several contaminated hotspots across the property. There are eight concrete tanks left at the mill where the miners mixed in mercury and cyanide with rock to bind with the gold. There's the crumbling assay office where mine owners would test the quality of the deposit, dumping out cups of liquid lead into what is now people's back yards. There's an earthen dam built up over decades from a slurry of waste rock and sand.

At the bottom of the site, there's also an old, four-story tall concrete dam, built in 1916 to prevent the waste from the mine from flowing downstream. In 2015, the US Army Corps of Engineers declared the mine structurally unsound. If it failed, the agency said, it would send a 15-foot-deep mudflow past Jackson Junior High School, built directly below the dam, and into town. Within a year, Argonaut was listed on the National Priorities List, the list of so-called Superfund sites that are among the most contaminated places in the country.

Hillenbrand is the Remedial Project Manager for the Argonaut Superfund site. "Remedial as in remediation, not as in junior," he jokes.

Hillenbrand looks the part of a field geologist in jeans with muddy wellies, a faded baseball cap, and a bright yellow safety vest. A geology class his sophomore year in college changed the course of his career, he says, and he still has a child-like enthusiasm for his job. "It's totally geek geology stuff," he laughs, unable to go more than a few minutes without excitedly describing the "cutting-edge technology" miners employed at Argonaut was.

But that enthusiasm belies his decades of experience and seriousness of mission. Hillenbrand has the invaluable, difficult task of figuring out how to clean up, or at least contain, the contamination at Argonaut and protect the homeowners that live nearby. The EPA estimates that over 500 people live within a mile of the site.

For the last several years, they've just been undertaking "removal actions" in EPA-lingo to designate quick efforts to deal with urgent problems as the agency develops the official cleanup plan for the entire site. "We don't want to wait five years until the whole site is understood. It's impacting people right now," says Hillenbrand.

While the state shored up the failing dam, the EPA removed trucks-full of dirt contaminated with arsenic from a steep embankment next to the junior high school. They excavated the yards of eleven homes adjacent to the mine that had high levels of arsenic. This year, the agency is digging up all the contaminated dirt in tailings area 4 and will create a landfill nearby, capped with clean soil and clay to hold everything in place. "I did the old football field calculation," Hillenbrand says of the expected size of the landfill. "It'll be about a football field long, including the end zones, 47 feet deep." His goal is to get the field "solar ready," so it'll be clean and stable enough to build a solar farm on it one day.

A twelfth home down the road, which had dirt in the yard that was so acidic Hillenbrand says it was corroding the foundation of the house, has yet to be cleaned up. The homeowners refused to let the EPA on their property. In an area of the state known for high levels of, if not distrust, then certainly disinterest in government, Hillenbrand admits it's not an unusual reaction. A lot of this early work, he says, is about building trust and convincing neighbors that the EPA isn't there to tank their property values or destroy these mines that some locals consider part of their heritage.

Despite being in the early stages, though, and Argonaut being, as Hillenbrand describes it, “more straightforward” than most Superfund sites, the agency has already spent \$8 million over the last several years. They have at least \$14 million more to go.

Argonaut is one of thousands of abandoned mines littered across California’s historic Gold Country. Pre-1975, there was no state or federal law mandating cleanup of mining operations, and, in most cases, the miners or companies that operated these sites are long gone. Today, there’s an alphabet soup of state and federal laws and agencies that govern abandoned mines, but coordination is challenging, money is tight, and the projects themselves are complicated.

Though most abandoned mines aren’t toxic, those that are, continue to leach out harmful contaminants like lead, mercury, and arsenic. Some are large, complex sites like Argonaut, requiring years of cleanup and millions of dollars. Many are smaller, left in the hands of under resourced municipal governments or private landowners that are often unaware, unable, or unwilling to address the toxic legacy of mining.

“We do a really good job in California, and in the community, of telling the story of gold mining,” says Elizabeth Söderström, who used to work in the Sierra Nevada office of the environmental non-profit American Rivers. “But we don’t tell all the stories.”

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**IN JANUARY 1848**, James Marshall discovered gold in Coloma, California. “Boys, by god, I believe I’ve found a gold mine,” he’s said to have exclaimed.

What happened next is a story that’s been told countless times.

Thousands of people from around the world descended on California seeking their fortune. Solitary prospectors crouched by streams, shaking gravel in a pan to extract flakes of gold. Within a few years, the rush was over as quickly as it started. It’s a romantic story. It’s also a myth.

In reality, the deposits that could be excavated by hand were played out in a year. Once the visible flecks were gone, miners developed increasingly invasive means of getting gold.

They dammed and diverted waterways to strain whole stream beds. Massive barges trolled Sierra lakes, suctioning up bottom dirt. Occasionally, they used drift mining where miners would dig sideways into mountains of jumbled gravel, tracing the channel of ancient gold-bearing rivers.

In some places, like Argonaut, miners dug down to get at deposits of gold trapped in quartz veins deep underground. Contrary to the notion of a brief ‘rush’ in the 1850s, lode mining as it’s called took off in California much later and continued well into the 20<sup>th</sup> century.

In their maniacal search for gold, resourceful Californian miners also invented hydraulic mining. They discovered that they could attach a nozzle to a hose and increase the water pressure. The water cannon was directed at a hillside to wash it away and expose the gold within. What took nature millennia to build was brought down in a matter of minutes.

Once the hillside was washed away, miners flushed the slurry of mud, gravel, and rock down a long trough — or sluice box — and the heavier gold would settle along corrugated riffles at the bottom.

By the time hydraulic mining was essentially banned because of early environmental laws, it's estimated that hydraulic miners washed away 100 million cubic yards of debris from the western slopes of the Sierra, enough to cover all of New York City's Central Park with 70 feet of mud.

At the hydraulic mines, miners would dump hundreds of pounds of mercury a day into the sluice boxes. The mercury would bind with gold in the slurry of debris, creating a heavy blend that would sink to the bottom of the trough. At the lode mines, carts of rock would be pounded in industrial crushing machines called stamp mills and washed across plates coated with the silvery metal. Once miners extracted the amalgam, they would heat it up in furnaces to vaporize the mercury and isolate the gold.

"The California Gold Rush has been told as the kind of romantic adventure," says Andrew Isenberg, a professor of history at Kansas University. "Everybody gets rich and kooky things happen... it's also presented as environmentally benign."

Isenberg pushes back against the romantic narrative of the Gold Rush, emphasizing how industrial and destructive gold mining was. He describes how the noise from the stamp mills would have been deafening, how they used electric lights to keep the mines going night and day, and how everyone was breathing in all sorts of toxic fumes.

Meanwhile, at the hydraulic mines, the debris flowing downstream clogged rivers. Commercial navigation for ships that once plied California's inland rivers became impossible. Residents and farmers built higher and higher levees to confine the water, but the rivers regularly broke through, coating farmland in a layer of mud and fine silt, called slickens, full of mercury and toxic metals from the mines. By the 1870s, it's estimated that 15,000 acres of land along the lower reaches of the Yuba River was buried under five feet of debris, with finer silt flowing all the way to the San Francisco Bay.

In an 1873 guidebook, author Charles Nordhoff recounts stories from older residents who describe how hydraulic mining transformed the Yuba from a "swift and clear mountain torrent" into a "turbid stream."

"It once contained trout," Nordhoff writes. "Now I imagine a catfish would die in it."

Without any protections in place to require cleanup of mined lands, the Gold Rush — and the decades of invasive mining that followed — have left behind a legacy of safety hazards and toxic contamination.

The Department of Conservation estimates that there are roughly 47,000 abandoned mines across California. Over two thirds are located across acreage managed by federal agencies like the Bureau of Land Management and the Forest Service. The remaining third are mostly on private property or on state and local government land.

Experts admit that the 47,000 estimate is just that — an estimate. “For anybody to ever assert that there’s a determined number, a known a number of abandoned mine features... it’s absurd,” says Scott Ludwig, the head of the Forest Service abandoned mine lands program. “I mean every time we go out in the woods, whether it’s a trail crew, timber crew, or whatever, they find stuff.”

Hillenbrand at the EPA adds that the 47,000 number is also not helpful. “I don’t like that number. It’s just so intimidating,” he says. “There’s a lot of mines, but we need to focus on sites that are close to people, that pose a real environmental harm.”

According to Hillenbrand, the number “narrows down very rapidly” when one considers sites that threaten public health. The Department of Conservation, for example, estimates that only 5,000 or so mines are contaminated.

Of course, for the thousands of non-contaminated sites, being clean isn’t the same as being safe. Every year, several people in California are injured or die in abandoned mines. People fall into shafts hundreds of feet deep. They stumble upon old explosive or asphyxiate on poisonous gases like carbon monoxide. They get bitten by rattle snakes, trapped in derelict buildings, or lost in miles-long tunnels.

But the amount required for physical safety hazards is chump change compared to the costs of environmental remediation. A 2020 [report](#) found that, of the \$2.9 billion spent by federal agencies on abandoned mine cleanup from 2008 to 2017 across the western US, \$2.5 billion was for environmental contamination, 90 percent of which was spent by the EPA.

EPA has so-called CERCLA-authority under the Comprehensive Environmental Response, Compensation, and Liability Act that allows them to recoup some of these costs from anyone that’s “caused or contributed” to contamination. That includes modern mining companies trying to remine a site, landowners, or even well-intentioned state agencies and nonprofits trying to help with cleanup. But, even with the ability (and arduous responsibility) to sue any liable parties, the government has recouped less than half the costs of cleanup to-date.

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**THOUGH GOLD MINING** occurred throughout California, it's the western foothills of the Sierra, a large swath in the central-eastern half of the state, that retains the title of Gold Country. Everyone draws the boundaries a little differently, but the region roughly follows the north-south corridor of State Route 49, named for the 49ers of the Gold Rush and affectionately referred to as the Golden Chain Highway.

Gold Country, with its rolling, oak-covered hills, expansive open space, and post card-worthy historic towns has become a popular destination for tourists and outdoor enthusiasts. Only a few hours away from San Francisco, money and Bay Area transplants have poured into the region, and, today, wineries and wellness centers abut ranches and gun clubs.

But the region remains rooted in its 'frontier' history. Towns have names like Emigrant Gap, Chinese Camp, and Rough-and-Ready, which seceded briefly in 1850 to avoid mining taxes. There's Sutter Creek, the 'Jewel of the Mother Lode'; Cherokee, named for the band of Cherokee miners who founded it; and Placerville, nicknamed 'hang town' for a slew of Gold Rush-era public executions that took place.

Jackson, California is in Amador County, near the middle of Gold Country, where the North Fork of the Mokelumne River snakes down from the mountains. About an hour south is Columbia, the so-called 'Gem of the Southern Mines' and now a popular state historic park. An hour north of Jackson is another town-turned-state-park, Coloma, a world-class river rafting destination where gold was first discovered.

An hour north beyond that are the neighboring towns of Nevada City and Grass Valley, once booming towns (Nevada City was once the third largest city in the state), home to some of the region's largest and most lucrative mines. The legacy of mining is still imprinted on the landscape there. "There's little spots of contamination all over," says Joanne Hild, a long-time Nevada-City resident. "People don't even realize that the lump in their backyard could be mining contaminated."

But 'contaminated' means lots of things in Gold Country because there are so many possible sources of contamination at an abandoned mine. That's part of the problem.

Water flowing through old tunnels or waste rock left behind can produce acid mine drainage that's highly toxic and corrosive. The same geological processes that produced veins of gold throughout the Sierra Nevada also brought metals like arsenic, lead, and cadmium. Most of these metals are naturally occurring in the area, but mining brings them to the surface where they can contaminate water, absorb into plants, or be breathed in as dust.

Though these contaminants are known to be harmful to human health — with impacts ranging from pain and vomiting to long-term problems like asthma and cancer — linking contamination to specific health outcomes is challenging. "Exposure is complex," says Monica Ramírez-Andreotta, an environmental scientist at the University of Arizona. "You have not only multiple metals, but you also have multiple exposure routes."

Ramírez-Andreotta explains that health standards for contaminants are based on multiple things. Concentration, or how much there is, is part of the puzzle. But the calculation also considers *how* someone is exposed — whether that's through dust, food, water, or dirt — and the type of contaminant, since human bodies absorb different elements in different ways. The risk is also based on how long and how frequently one is exposed, as well as individual characteristics like weight, age, and sex.

In part because it's so complex, there's limited research on the long-term health effects of living near a gold mine. What's been done has mostly focused on the miners themselves or come out of South Africa, one of the world's largest gold producers. There, researchers have found that children and people who grow their own food are often exposed to concerningly high amounts of arsenic. Residents living within half a mile of a mine dump also have increased rates of respiratory diseases.

In California, though, there's been no long-term research on the risks faced by those living in Gold Country.

Sierra Streams Institute, a Nevada City-based nonprofit, is filling this gap. For almost a decade, Sierra Streams has been working with scientists at the University of California San Francisco and the Breast Cancer Research Project, and more recently with Ramírez-Andreotta in Arizona, to help residents understand the risks posed by toxic mining waste.

The work originally focused on breast cancer. Nevada County, where Nevada City is, is an anomaly, says Peggy Reynolds, a researcher at the University of California San Francisco, since breast cancer rates tend to be higher in urban areas. But Nevada County, which is mostly rural, has the third highest rate of breast cancer in the state. Number two is neighboring Placer County, another rural area and hot bed of historic mining activity. The Sierra Streams study found that arsenic and cadmium levels were higher in the urine of women living in Nevada County than the national average, which could increase their risk of breast cancer.

After the initial work, Sierra Streams branched out to look at *how* people are exposed to these harmful contaminants. They've recruited residents from around the region to gather samples of water, soil, vegetables, and dust from their homes and schools. The team is still sifting through the data, but it appears that residents are being exposed to arsenic and cadmium through water and locally grown vegetables, at levels well above state and federal recommendations in some cases. Ramírez-Andreotta recalls on several occasions having to call study participants after results came in to encourage them to immediately cover any dirt patches in their backyards.

With a small sample size and no way to control for every risk factor, the researchers can't directly link these contaminants with long-term health issues. But it does give them a starting point to understand how people are being exposed to mining waste and what to do about it.

“I want to allow people to make their own decisions about day-to-day activities, to know small precautions they can take,” says Taylor Schobel, the rural health coordinator for Sierra Streams. She sees these community-led studies as a way to start a conversation about the legacy of mining and give residents the knowledge they need to protect themselves. It’s about “simple changes anyone can make,” she says like wet dusting, using raised beds for gardening, or just taking one’s shoes off inside.

The options aren’t so simple when it comes to mercury, another toxic byproduct of gold mining that persists to this day. Scientists estimate that almost 13 million pounds of mercury was lost to the environment during the Gold Rush and is now trapped in streams, lakes, and reservoirs downstream.

Though the process remains poorly understood, the low oxygen environment at the bottom of reservoirs, in particular, seems to provide ideal conditions for microbes to convert mercury into methylmercury, a potent neurotoxin that can build up in fish tissue as it moves up the food web. In humans, methylmercury can cause tremors, headaches, insomnia, memory and vision loss, pain, and seizures. At least one Nevada city resident, Theresa Huck, has been diagnosed with peripheral neuropathy, a condition that causes pain and muscle weakness, because of mercury poisoning.

Once mercury is in fish, the only solution is to post advisories discouraging “sensitive” populations like children from consuming certain species. In Nevada County, almost all the lakes and rivers have fish advisories.

But personal actions like avoiding certain fish or keeping down dust only go so far. So, engineers and geologists have devised various methods to prevent mine waste from escaping into the environment in the first place. The list of options can sound like a foreign language — rhizofiltration, solidification, vapor extraction, thermal desorption — but the basic strategies are simple: take contaminated material to a landfill, treat contaminated water, or, as they plan to do at Argonaut Mine, bury the waste on-site under clean soil and plants.

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**DEVISING TECHNICAL SOLUTIONS** to clean up mines is only one challenge, though, in Nevada County where the legacy of the Gold Rush is everywhere.

There, locals spend summer days swimming in the Yuba River, which is contaminated with mercury. They go tubing below Englebright Dam, which was built in the 1940s to hold back mining waste. They picnic at Hirschman’s Pond, where historians believe hydraulic mining was invented, leaving behind a mercury-laden lake. Further out, they hike at Malakoff Diggins State Park, the open pit of the state’s largest hydraulic mine, which looks more like the Badlands of South Dakota than California.

The county's most lucrative mine — and one of its most popular attractions — is Empire Mine, now a state historic park. Empire has been shuttered since 1956, but contaminants still linger in hot spots around the property. In 2007, employees discovered concerning levels of arsenic and lead in a highly acidic tailings dump named the Red Dirt Pile. Because the lowest tunnels of Empire are flooded, they also found that arsenic-laden water would flow out of the mine into a creek every time it rained.

For the next several years, and for millions of dollars, California State Parks fixed up the property, creating a landfill for the most contaminated dirt and designing a water treatment system. Though the agency bore the brunt of upfront costs, in 2014, they settled with the international mining giant Newmont Mining Corporation. Newmont purchased the site after production had peaked in 1929 but continued to operate Empire until the 1950s. For that, they paid almost \$15 million to retroactively cover some of the cleanup and agreed to absorb most future costs.

Finding someone to help pay — a 'potentially responsible party' in EPA-speak — hasn't been so easy at other mines in the area.

Like Jackson, Nevada City also has a Superfund site, the Lava Cap Mine, about five miles outside of town. Unlike in Jackson, though, no one addressed the problem until it was too late. On New Year's Eve, 1996, a 30-foot log dam built to hold back mining debris failed during a rainstorm. 10,000 cubic yards of waste flowed downstream, enough to cover almost five football fields in one foot of contaminated dirt and mud.

"EPA, at that point, was asked to step in," says Brian Milton, who serves the same role at Lava Cap that Hillenbrand serves at Argonaut. In 1999, the site joined the Superfund list.

Since then, the EPA has undertaken several removal actions at Lava Cap, including digging up contaminated dirt and providing water filters to families whose wells were contaminated by arsenic after the dam failure. In 2014, they completed construction of a water system to connect residents to the municipal water supply. They still have years and millions of dollars to go.

Lava Cap is less contaminated than Argonaut based on EPA's esoteric rating system, but contamination stretches far beyond the original mine's boundaries. "The definition of a Superfund site is where contamination has come to lie," says Milton. For Lava Cap, that includes the waste that was carried downstream during the dam failure.

Unlike at Empire, the search for potentially responsible parties at Lava Cap has also been more contentious and convoluted, which Milton says is "typical."

In 2008, the Department of Justice sued several entities that had owned or operated Lava Cap Mine at various points in its history. Two subsidiaries of Newmont, who briefly owned the mine in a failed attempt to reopen it in the 1980s, quickly settled for \$3 million.

But the 2008 lawsuit also mentions Sterling CentreCorp, a Canadian real estate company who purchased the land in the 1950s. Milton says it's more challenging to recoup costs from foreign companies, and Sterling fought the lawsuit for several years. The lawsuit also included Stephen Elder, a private developer who bought the property in 1989. The EPA deemed Elder responsible in part because he had failed to comply with a state cleanup order from the 1970s that warned that the dam was already unstable. In 2018, a federal judge held Sterling and Elder liable for \$32 million to help cover cleanup costs.

Elder knew there was a mine on the property when he purchased it, but he claims he wasn't aware of how serious the problem was, nor was he told about the cleanup order or the state's warning. He's continued to fight the lawsuit, alleging that he's being mistreated by the government and doesn't have the financial ability to pay or appeal. The state toxics agency, though, says the law is clear: private landowners can be held responsible. They've argued that it was up to Elder to properly investigate the site before purchasing it.

But Carrie Monohan, the program director for Sierra Fund, a Nevada City-based nonprofit that works on mine cleanup, says that there needs to be clearer laws to help landowners do their due diligence before buying or selling Gold Country properties.

"The lack of curiosity has served as protection," Monohan says, suggesting that some developers don't undertake the necessary investigations so they can remain blissfully ignorant when developing a contaminated property. She adds that existing real estate disclosure laws, which require property owners to detail risks to a potential buyer (flooding being a common example) are insufficient when it comes to accounting for abandoned mines. As a result, there are several examples of public agencies purchasing, or being given, property with contamination that wasn't adequately disclosed or studied beforehand, including Hirschman's Pond, which the town of Nevada City purchased in 2003.

Cleanups are often driven by development, so if a landowner can't afford to do the work, they'll just sit on the property until they can, even if the site is leaching out contaminants. "You're stuck with it unless you can be creative in how you figure out to get rid of it," Monohan admits. Sometimes, developers will give contaminated portions of their property to local governments assuming they can fix the problem.

But Monohan says that many towns and counties in the area are too small and under resourced to handle an abandoned mine clean up, even if they intend to only build a trail or park on the property.

One benefit, though, of moving mines into municipal hands is that local governments can access funding that individuals can't. Local governments are eligible for EPA Brownfields Grants meant to help communities rehabilitate and reuse contaminated

land. With funding in hand, a small community like Nevada City can hire a nonprofit like Sierra Streams or Sierra Fund to manage the cleanup work.

That's exactly what's happened at Providence Mine.

In old photographs, Providence looks like massive industrial operations. Today, though, there's little left except for a crumbling foundation of an old building being overtaken by Himalayan blackberry. There's a flat clearing, no larger than a basketball court, at the edge of thick woods, ending at a steep 50-foot cliff into Deer Creek below. The property is part of the town's large network of open space that winds along the creek.

Kyle Leach, Sierra Streams' geologist, has the same casual manner, muddy boots, and fascination with these sites as Hillenbrand at the EPA. Like Hillenbrand, he also has a difficult job. For over a decade, Leach has been leading various projects funded by Brownfields Grants, backfilling old mine shafts and replacing contaminated dirt with clean soil and plants across Nevada City.

He's juggling grants in the hundreds of thousands of dollars range, not the millions of dollars available to a federal agency. It's too expensive to use concrete or multiple feet of clean soil to cover waste, so instead, he relies on a little bit of clean soil and a lot of new plants. Brownfields Grants also require a financial match, so Leach says they've had to get creative pulling together funding from various sources to cover project costs.

The difference in scale between what's happening at Providence versus Argonaut is clear walking around the property. Storm damage from last winter brought down trees and branches, and invasive species like scotch broom are thriving across the property. The old mine shaft in the middle of the clearing that they backfilled with dirt several years before is opening again, and they've had to put up a fence to keep people away.

Still, Leach thinks their cleanup is doing the trick, at least for the foreseeable future. The slope at the edge of the property is more gradual than it used to be, he says, and they don't get chunks of contaminated dirt sliding into the creek anymore. Most of the site is also revegetated, which is helping keep contamination in place. Plus, Leach has learned to phase projects so he can tie up loose ends and keep the site stable until more money comes through.

"With these cleanups, you've got money, until it's gone," Leach says. "That's why we had to do it in increments... they limit how much you can get in one year, but you can get more the next year."

The bigger problem, he says, is that they can't work beyond the property boundary. On one end of the site, there's a homeless camp on a bare, flat patch of dirt. Leach explains that it's flat because it's where the old mine furnace was, and so it's undoubtedly toxic. But there's a stark line between the bare ground and rocky, grassy material next to it, which Leach says marks the end of city land. The other side of the property where the homeless camp is remains in private hands.

“We’ll clean up right to the property line,” explains Leach, “but there’s all this contamination on the other side.”

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**MANY GOLD COUNTRY** residents fall on a spectrum explains Monohan at Sierra Fund. On the one side are those who don’t realize these sites exist. “It’s kind of out of sight, out of mind,” she says. “The other is those that are very much aware that there was a Gold Rush, and it’s part of their identity.” On that end of the spectrum, Monohan suggests, people are aware that these mines exist, but they don’t understand the ongoing nature of the threat. “There’s just a sense of it’s how it’s always been so there’s not really a problem,” she says. She describes this attitude as “cultural blindness.”

Schobel, who runs the community health projects at Sierra Streams Institute, says that recruiting participants to the project has been the hardest part, in part because of that blindness. For example, she tried to recruit residents to the study from the tiny town of Alleghany, about an hour northeast, but much deeper into the mountains, from Nevada City. Alleghany was one of the few places in Gold Country where gold mining remained an economic driver after World War II, and the local 16 to 1 Mine continues to operate intermittently. When Schobel got to Casey’s Place, the only bar in town — the only business really — she recalls that the owner flat out told her, “No one is interested in this.”

Schobel suggests that part of the issue is that the risk isn’t visible. Providence Mine, after all, just looks like a flat clearing in the woods. People can’t see arsenic. They can’t know for sure that mine contamination gave them cancer. As a result, Schobel says, she often gets the response from multi-generational residents that everyone in their family is fine, so what’s the problem?

Hillenbrand at the EPA agrees that the visualization is important. “If you can’t see it, human nature is to minimize it,” he admits. “It’s really important that it looks ugly if you’re going to convince people it’s a problem.” That’s been a challenge, he says, at Argonaut, where the priority cleanup area around the tailings piles looks smaller and more innocuous than people expect of a contamination hotspot.

At a Superfund site like Argonaut, EPA will pay to clean up neighboring properties that have been affected by contamination at no cost to the landowner. It seems like a good deal; yet, Hillenbrand says he must spend significant time convincing people that this is a good thing. “Part of it is just showing up. They see you out there. They know you have good intentions,” he says. “If you stick around long enough, people get it.”

Milton, the project manager for Lava Cap Mine, has run into similar attitudes. “Sometimes we get resistance, but we do our best and people tend to change their minds,” he says. But, he continues, “if they don’t want us on their property, there’s not much we can do.”

Hillenbrand and Milton both say, in their experience, people tend to get on board once one or two of their neighbors go through the process. If they don't, the EPA can use so-called institutional controls to ensure that any potential future buyers of the property would be informed that the site is contaminated. It's a "government way of checks and balances," jokes Hillenbrand.

Mary Rosellen, who manages abandoned mines work in California for the US Forest Service, knows all too well the distrust many residents hold towards government officials like herself. She grew up in Downieville, a small mining town at about 3000 feet, near the northern end of State Route 49. At the height of the Gold Rush, the town had a population of over 5,000; today, there are less than 300 people. Downieville sits on the North Fork of the Yuba River and is a popular destination for kayakers and mountain bikers, but the forests around town are littered with old mines.

Rosellen recalls hanging out at the mines as a child and describes the attachment many Downieville residents feel towards these places. "They live on those mine sites. They grew up there. They were born there," she says. "There's an empathy for these sites." Because of that attachment, there's a bitterness, she explains, when the government changes things, even if it's to keep people safe.

Fortunately, Rosellen says, things are getting better and attitudes towards the government are improving. "When I started in the Forest Service, especially in the 90s, I felt like we were kind of the bad guys," she admits. That's no longer the case, in part because the old timers, she says, who felt the deepest connection to these places are passing on.

But, in an area that many people moved to exactly to escape outside interference, some suspicion remains. "This is part of their history that they love. It's still a romanticized history," says Schobel. "They also just want to be left alone."

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**AS CHALLENGING AS** cleanup has been, it's going to become more critical in the future. In California, climate change is expected to bring more frequent and intense fires and floods to the steep slopes of the Sierra. At mines, that could bring toxic waste trapped in old tunnels and dirt piles back to the surface.

Research has shown how rain and floods facilitate the downstream flow of mining waste. "Fire puts that on steroids," says Sheila Murphy, a USGS hydrologist, explaining how fire-scarred lands are more prone to floods and mudslides. According to Murphy, the extreme fire seasons of recent years have been a "wake up call" as to water quality threats facing watersheds contaminated by mining.

Murphy has been involved with several projects looking at the impacts of fire and floods in mined areas in Colorado, which, like California, is expected to see the one-two punch

of rain following fire more often in an era of climate change. She and her colleagues have studied a mining district outside of Boulder, Colorado, which was affected by the Fourmile Canyon Fire in 2010 and the unprecedented 2013 Colorado floods.

Their research has shown that the floods transported thousands of tons of dirt, mud, and soil rich in mine debris into Fourmile Creek, producing hundreds of years' worth of typical erosion in one event. After the flood, arsenic levels at the mouth of creek were almost ten times higher than at the top of the watershed and well above water quality standards. The maximum acceptable amount of arsenic according to the EPA is only 10 micrograms per liter of water. After one storm, they measured levels more than seven times that.

Charles Alpers, a USGS chemist, says that the impact on fire and rain on mercury contamination is more complicated. Because mercury vaporizes at low temperature, lots of the mercury can be burned off during a fire. That's offset, though, by all the mercury-laden dirt being carried downstream by post-fire floods. Rain falling on fire-scarred lands, Alpers explains, could drive a "slug of sediment" right into Sierra reservoirs, reducing their water storage capacity and adding new mercury that can be converted into toxic methylmercury.

The future of mine cleanup is complicated further by the fact that mining isn't a thing of the past. Even with today's technology and environmental protections, gold mining is a risky venture. Yet, there have been several attempts to reopen 19<sup>th</sup> century mines across the region.

In the 1990s, a mining company reopened the North Columbia Diggins, north of Nevada City. As they dug new tunnels, the miners ran into a huge fracture in the rock, which flooded the mine and drained out the surrounding aquifer like a bathtub. At least a million gallons of water flowed out every day for months, and twelve private wells in the area went dry, including the water supply for a nearby elementary school. The company replaced the wells — going out of business in the process — but water quality issues continued for years.

More recently, the town of Grass Valley has contended with a push by Rise Gold, a Canadian company, to reopen Idaho-Maryland Mine, located just a mile from the town's main strip. It's the third time since the 1990s that someone has tried, but gold prices are higher now than they were during the previous attempts.

Ralph Silberstein, a Grass Valley local who has been a prominent voice in the campaign against the reopening, says they're concerned about several issues, including traffic, air pollution, real estate values, and drinking water after the experience at North Columbia. But one of the campaign's main concerns is that Idaho-Maryland was never cleaned up after the first wave of mining. Silberstein says there are still large piles of waste around the property that could be released into the environment if the mine reopens.

“We really don’t want there to be another legacy we create of toxic contamination that goes on for another 1000 years,” says Silberstein.

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**IN AUGUST 1922**, 47 miners died in Argonaut Mine after being trapped a mile belowground when a fire broke out. This summer, the town of Jackson will commemorate the disaster — the worst mining disaster in state history — with a series of events and public tours. After all, Jackson only exists because of the mine, and many of the residents are descendants of the original miners. In towns across Gold Country, people have developed an attachment to these places and often continue to rely on and enjoy the very mines that are contaminating their homes, whether they realize the threat or not.

Even today, mining tourism sustains Gold Country, almost 175 years after James Marshall stumbled upon his gold mine.

But the decades of extraction, the toxic legacy of gold mining, and the threats of the future are as much a part of the story of the Gold Rush as Marshall’s discovery or the Argonaut disaster a century ago. 175 years is a long time for a problem to build. California can’t afford to take that long to fix it.

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