STOCKTON

Miners in front of the Jacobs Smelter in Stockton, circa 1890. The smelter was an important part of the town's "silver age," but the tailings water that flowed downhill (foreground) carried lead and arsenic contamination throughout the town.

Over 100 years ago, Stockton was a booming mining town in the Oquirrh Mountains of Central Utah. Even though the silver ore smelters are but a memory today, remnants of the past remain with lingering lead and arsenic byproducts in the soil. The Volpe Center has helped the U.S. Environmental Protection Agency to remediate the most contaminated sites in town, allowing residents to look to the future.

UTAH

A Hopeful Future

History lives on in this small Western town of 400, but not in antiquated saloons for tourists, nor in the grand old mansions of mining barons. Rather, history lives on in spirit—tales of early pioneers, memories of hard-working miners, and stories of the general store and dances at the Odd Fellows Hall. Stockton residents are quick to recall how their town began as a cluster of tents on the shore of Rush Lake, how it flourished as a center for mining and refining, and how the region's output of precious metals contributed to American efforts during two World Wars.

Through the years, vestiges of this past have become transformed: a slag pile is now a sledding hill; a tailings pond has grown over and is now a lush, flat pasture; an old mining shed now houses the family minivan. Unfortunately, more insidious remnants of the past remain as well. Lead and arsenic, byproducts of refining operations, linger in the soil throughout town. A recent U.S. Environmental Protection Agency investigation found that unsafe levels of lead existed on over 160 properties. Because lead can impair nervous system development, these ghosts from the past pose a serious threat to the town's future: the children who play daily on contaminated lawns and who eat fruits and vegetables grown on tainted soil.

When the EPA determined that the presence of lead and arsenic in the town's soil posed a serious threat to the health of the residents, the Agency called on the Volpe Center's Environmental Engineering Division to conduct a $5.8 million emergency response action to remediate the most contaminated properties in town. Utilizing staff resources and existing relationships with commercial engineering firms, the Division assisted the EPA in managing the removal of over 40,000 tons of contaminated soil. Environmental engineers from the Center also implemented an innovative new technology to remediate contaminated soil on-site; because transport and disposal of contaminated soil are a major component of any remediation effort, this approach saved the EPA over half a million dollars. More importantly, Volpe Center staff assisted the EPA with day-to-day operations and provided an almost constant field presence to ensure that the work was done safely and efficiently.

A Center for Environmental Excellence and Innovation

The remediation project in Stockton is just one example of the Environmental Engineering Division's role as a multidisciplinary center for environmental excellence and innovation. The two-dozen engineers, technicians, and information specialists from the Division provide "full-cycle" environmental management, assisting clients with everything from planning and record keeping to emergency response. As Environmental and Restoration Program Manager Glenn Goulet explains, "Full-cycle management means that we help our clients take a system-level approach to meeting their obligations through development and implementation of a comprehensive environmental strategy." For example, the Division assisted the U.S. Postal Service with the implementation of a comprehensive environmental management initiative that addressed water conservation, pollution prevention, fuel consumption, and occupational health. In order to provide these system-level services, the Division employs a highly trained, multidisciplinary staff who can assist agencies with needs assessments, planning, site assessment, emergency planning and response, evaluation of alternative technologies, and design. While the Division has, so far, focused on the unique environmental issues faced by the transportation community, its collaborations with different agencies have yielded lessons applicable in many other contexts.

Because environmental issues comprise many evolving disciplines, the Division has made it a priority to ensure that its staff is versed in the most modern techniques and technology, through the recruitment of recent graduates with advanced degrees in emerging fields and through continuing education of existing employees. Acting Division Chief Philip Mattson notes that the Division has strengthened its expertise through the Volpe Center's Fellows Program, which allows staff members to update their skills through classes and training opportunities. This approach has resulted in staff members with a solid engineering and sciences foundation complemented by the most modern technical skills. While the Division has maintained its sharp skills through continuing education, it has also gained an unparalleled perspective on environmental management through collaboration with many different agencies. This combination of education and experience has meant that the Division has found itself in demand by clients nationwide.

In Stockton, the EPA asked the Volpe Center to manage key phases of an emergency remediation effort designed to make Stockton residents feel safe again. In order to reduce the risk of exposure to lead, the remediation called for the removal of the top 18 inches of contaminated soil and replacement with clean topsoil. The EPA asked for Volpe Center support to manage excavation; transport and disposal of

Enviromental crews remove contaminated soil from yards and gardens on 29 properties in Stockton.

contaminated soil; soil replacement; site restoration; and landscaping. The cleanup effort was complicated by the fact that the contaminated area was not some remote location or industrial site—it consisted of the yards of the residents of Stockton. The lawns on which families gathered, the trees that shaded them, the gardens that fed them all had to be dug up and replaced. Despite the disruption, families in Stockton recognized that they must sacrifice a part of their past—the character and history that lived on their property—in order to protect their future. And while the EPA and Volpe Center staffs were helping to ensure a safe future, they were looking into the past to find the causes of contamination and to identify the sites most in need of remediation. Since the contamination and the town's history are so closely linked, digging into the contaminated soil requires digging into the rich history of the town.

Stockton's Mining Past

Stockton is situated on the former Rush Valley Military Reservation near the Oquirrh (pronounced "O-KER") Mountains of Central Utah. General P. Edward Connor established the town as the first non-Mormon settlement in Utah, in an area known as Shambip to the local Native Americans. The silver jewelry and trinkets possessed by those natives hinted at the riches that lay within the nearby hills, and General Connor encouraged his California Volunteer Cavalrymen to pursue prospecting during their off-duty hours. In April 1864, members of Company L discovered silver ore approximately 2 miles east of Stockton, on the western flanks of the Oquirrh Range.

The ensuing 30-year flurry of activity saw the construction of more than 100 mines with names such as Silveropolis, Little Jessie, Tynie Dog, and Hope. In order to extract the contents of some 80-odd ore bodies in the area, prospectors sank shafts to a depth of 600 feet below the surface, where they encountered groundwater. The Honerine Mining Company enabled deeper mines by constructing a 2-mile-long drainage tunnel that permitted excavation down to the 1,200-foot level. In all, miners

Environmental Remediation

From site assessment to closure, the Environmental Engineering Division is a valuable resource for agencies facing complex environmental contamination issues. Client agencies use the Division's project management skills and technical expertise to accomplish a wide variety of tasks, and are impressed with the Division's strategy of making the most efficient use of resources while maintaining an important Federal involvement through every phase of the remediation effort.

The multidisciplinary team at the Center has the resources to identify contaminants and to perform site investigations; staff members use the results of these efforts to assess risks to human health and the environment and to identify remediation options. The Center can also implement a complete remediation strategy, including engineering, design, project management, field oversight, and regulatory compliance. Glenn Goulet notes that juggling this array of tasks demands intensive coordination with Federal agencies, state and local regulators, and private contractors. Interaction with all these players has provided the Division's staff with a thorough working knowledge of the diverse issues– technical, regulatory, and logistical– making up each remediation effort.

For heavy-duty work the Center draws on a pool of construction and remediation contractors, including Environmental Chemical Corporation (ECC), Marcor Environmental Inc., and Weston Sampson. The Center also draws on private firms during the design phase of many projects, including Camp, Dresser, and McKee and the consortium, Environmental Engineering Services (EES, comprised of Parsons Brinkerhoff, Quade, and Douglas; CH2M Hill; and URS Granier Woodward Clyde). By developing strong relationships

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with nationwide private contractors, the Center can ensure complete technical and geographic coverage without having to support an excessively large staff.

The Environmental Engineering Division recently applied its expertise to a time-critical site remediation action for the Federal Aviation Administration. During the mid–1990s the FAA discovered a host of contamination issues at the Bucks Harbor Radar Facility in Maine; many of the site's World War II-era buildings contained asbestos insulation, lead paint, mercury electrical switches, and electrical transformers containing polychlorinated biphenyls (PCBs)—suspected carcinogens. Unlabeled waste drums dotted the site and diesel fuel and solvents had leaked into the soil, threatening the quality of a nearby public drinking water supply well. When the Maine Department of Environmental Protection (DEP) ordered the FAA to conduct a stringent cleanup of the site within a two-month time frame, the FAA turned to the Volpe Center. Staff from the Environmental Engineering Division, led by Goulet, provided site assessment, remediation design, project management, and field oversight for a complex effort, all under the watchful eye of the Maine DEP. Overall, Volpe staff coordinated the excavation and disposal of 24,000 cubic yards of contaminated soil and the removal or stabilization of numerous buildings.

During 1998, the Environmental Engineering Division staff was also busy designing and managing the removal and cleanup of 68 underground storage tanks across the country. These kinds of tanks range in size from 500 to 50,000 gallons in volume; they are found at service stations, airfields, military installations, and industrial parks, and may contain gasoline, diesel fuel, solvents, or other hydrocarbons. Unfortunately, many older underground storage tanks

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The Ben Harrison Mine

constructed a total of 35 miles of tunnels, drifts, rises, and shafts in the foothills east of Stockton. The production of all these mines was staggering—by 1900, the Stockton District had produced over 250,000 tons of ore.

This tremendous output was processed by a host of mills and refineries in the area. By 1873, four large smelters and numerous "mom and pop" operations were active around Stockton; countless others could be found in the nearby settlements of Bauer, Ophir, and Lewiston. The Jacobs Smelter, the largest in Stockton, sat perched on a terrace on the east end of town. At peak capacity, its Great Basin Concentrator milled 100 tons of ore into 20 tons of concentrate each day. Meanwhile, its three blast furnaces could each reduce 25 tons of concentrated ore to 5 tons of bullion, reprocessed elsewhere to yield roughly 32 pounds of silver. The byproducts of all this processing were simply dumped in slag heaps that now dot the hillsides all along the western slope of the Oquirrhs. The cooling water, laden with dust-sized particles of lead and arsenic, rolled downhill to tailings ponds, located on the level area in what is now the residential part of Stockton.

The mining activity fired an economic boom in the Rush Valley. The growth began with infrastructure: mining companies constructed water tanks, fuel sheds, ore sheds, and stables; and a narrow-gauge railroad provided a crucial link from nearby Bauer to Salt Lake City. Electric streetlights, the first in Utah, were installed in 1890. Boarding houses and hotels served miners and visitors. The once-hardscrabble settlement of Stockton could boast of refined cultural amenities such as barbershops and an opera house. Four general stores sold supplies to miners and refiners, and nearly a dozen saloons quenched their seemingly endless thirst; the local constabulary constructed a jail, hand-dug out of a hillside, as a quiet spot to sober up.

A horse team at the Ben Harrison Mine

After the turn of the century, refining activity in Stockton continued, subject to vagaries of the economy, mine production, and fuel supply. While mining activity in the Oquirrh Range continues to the present day, the Jacobs Smelter was fired for the last time over 80 years ago. Since then, the remnants of this and other mining operations have slowly decayed. As Stockton expanded east during this century, residents built houses right on the terrace that was the site of the Jacobs Smelter. Of the nine smelters known to have existed around town, only five can be located in the field. The rest have all but disappeared.

Now, 100 years after the boom, there is little left to remind the town of its mining history—the population has dwindled from a peak of 4,000 persons in the 1870s to

Stockton miners with a jig, an apparatus for separating metal-rich ore by agitation in water.

400 today. Many of the largest smelters have been demolished; all that remains of the Jacobs Smelter is the yellow ore that stains the ground at the site. The history of Stockton is not entirely lost. However, historical photos depict the town's silver age, and many "old-timers" have recorded the stories of former days. Stockton Day, held every July, is an opportunity for all the residents to celebrate the legacy that the past has left.

Until the summer of 1998, residents remained unaware that the past had also left behind dangerous contaminants. Fortunately, it was a horse, and not a child, that provided the first indication of danger. Grazing in a small pasture near the heart of Stockton, the horse grew disoriented, unpredictable, and weak—symptoms of lead poisoning. The horse's autopsy prompted an investigation by the Utah Department of Environmental Quality (DEQ). That agency's report found that the field was located directly over an old tailings pond and was tainted with lead and arsenic—a "poisoned field." Additional testing revealed elevated levels of lead throughout town, with "hot spots" over the tailings pond and at the site of the Jacobs Smelter.

The potential health threats associated with these contaminants prompted the Utah DEQ and the U.S. EPA to act quickly. While lead poisoning is unhealthy for people of all ages, it poses a special risk to children because they may accidentally ingest contaminated soil while playing outside; the presence of lead in a child's bloodstream can impair development of the central nervous system, resulting in learning disabilities, behavioral problems, and hearing impairment. Although it is present in lesser amounts, the arsenic in the soil also presents serious health risks to Stockton residents. Long-term exposure to arsenic may increase the risk of skin cancer and cancers of the liver, bladder, and lung.

Because both lead carbonate and arsenic can be transported by water, contamination that was once localized at the smelter and at the tailings pond has spread throughout town. Investigations by the State of Utah and by the U.S. EPA found that almost 160 properties in Stockton have lead or arsenic levels in the soil above the state limit of 500 parts per million (ppm). When an EPA Human Health and Ecological Risk Assessment found that the lead posed an "Imminent and Substantial Threat," the agency asked the Volpe Center to conduct an emergency remediation effort on the 30 most contaminated sites (those where lead is present in concentrations greater than 3,000 ppm, or six times the safe level). The remaining 130 properties in town will be remediated in a similar but separate effort, to be conducted by the State of Utah as a Superfund project.

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can develop leaks; when the stored liquid escapes, it may negatively impact water quality. In order to prevent possible soil contamination, recent EPA regulations required that all tanks be equipped with features that provide protection against leaks, spills, overfilling, and corrosion. As the FAA and the Western Area Power Administration struggled to meet a December 1998 regulatory deadline set by the EPA, the Volpe Center assisted them by conducting site investigations and providing design services for tank replacement or removal. Because many of these tanks had already leaked, the Center also managed many remediation activities associated with replacement or closure.

The Division will soon extend its expertise beyond site closure by helping to promote the reuse of remediated Superfund sites. Working with the EPA Region 5 Superfund Division, John McGuiggin and other staff will be contributing to the Pilot Program for Post Remediation Residual Risk Reports (PR4). These reports will supplement the required 5–year reviews of all closed Superfund sites by providing important information relevant to reuse of the site. Developers will be able to turn to the PR4 reports to find data on groundwater,

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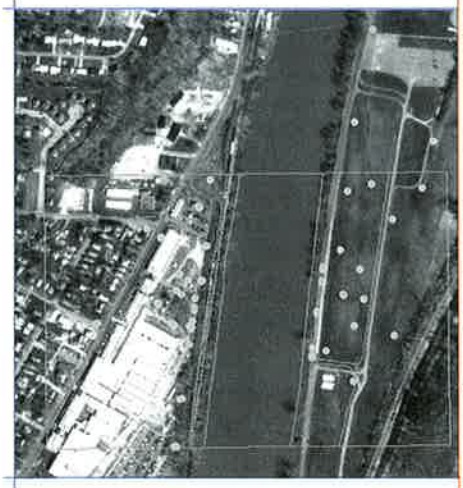
contamination levels, and other important site characteristics. By making this information more accessible, the PR4 reports will facilitate redevelopment of remediated sites, a primary goal of the EPA. Using its Geographic Information System (GIS) technical and graphic capabilities, the Volpe Center will develop a template model for the program, based on a remediated Superfund site in Zainesville, Ohio.



Working with the EPA, the Volpe Center will use aerial photos and GIS to facilitate the reuse of remediated Superfund sites.

Environmental crews excavated contaminated soil to a depth of 18", loaded it onto trucks for disposal, and replaced it with clean topsoil.

Managing a Complex Effort

The EPA contacted the Environmental Engineering Division in January 1999 and asked them to start field work by March 1999. Fortunately, the staff at the Volpe Center has considerable experience working on remediation efforts in time-critical situations due to safety threats or regulatory deadlines. For example, the Division recently managed the remediation of a U.S. Air Force Site in Maine, under a tight two-month time frame established by that state's Department of Environmental Protection (see sidebar). In the 2 months before fieldwork began in Utah, Goulet and Project Managers Bill Halloran and John McGuiggin spent time planning just how this time-critical deadline was going to be met. Using remediation designs developed by the U.S. Bureau of Reclamation, they wrote statements of work, developed cost estimates, and negotiated contracts with commercial contractors to conduct excavation, transport, and disposal. Bill Halloran also worked with the EPA to develop a remediation strategy and schedule for operations on over 30 different properties, in order to make the most efficient use of resources.

To conduct the remediation work in Stockton, the Volpe Center utilized an existing relationship with the engineering consortium Environmental Chemical Corporation (ECC). The arrangement provided significant cost savings; the Stockton contract that resulted from Volpe Center/ECC negotiations was almost $388,000 below initial EPA budget estimates. The EPA also asked the Volpe Center to contract for transport and disposal of the contaminated material and for security at the site; these two contracts negotiated by the Volpe Center yielded an additional cost savings of almost $400,000 against initial EPA budget estimates.

On March 8, a fleet of earth-moving equipment rolled into Stockton; staff members from the Environmental Engineering Division were on hand to ensure that the contractors fulfilled the EPA's objectives. Division engineers directed excavation activities to ensure that work adhered to approved plans and schedule. The Division also worked with the contractors to ensure a continuous workflow on the site, in spite of incremental funding from the EPA. Cost tracking and monitoring was also a key component of the Volpe effort; in order to forecast transport and disposal needs, information specialists from the Division monitored the quantity of excavated soil through calculations based on detailed engineering drawings.

During the excavation, Volpe staff also provided logistical support to EPA scientists who tested excavated soil through X-ray Fluorescence Analysis (XRF), a simple test that provides a fast estimate (within 5 percent) of the concentrations of lead in the soil. XRF results were used to measure contamination levels at the bottom of the

excavated area and to identify "hot spots" of contamination. One site on the slope nearest the smelter site was such a hot spot that the Volpe Center sought and received approval to continue the excavation below the top 18 inches of soil in order to ensure that deep contaminants did not re-contaminate the surrounding area.

Staff from the Center also worked to ensure fast and efficient communications between multiple contractors, the EPA, the Bureau of Reclamation, the Utah DEQ, local officials, and the public. Although the EPA handled media and public relations for the effort, Volpe staff worked closely with the EPA to ensure that local officials and members of the public were informed on specific issues; this type of interaction requires a keen sensitivity to the concerns of residents and the capacity to properly convey information about the project. In particular, says Goulet, it is important to provide facts without exacerbating the fears of the public.

As Volpe Center engineers oversaw the excavation of over 40,000 tons of soil, they also had to consider how to dispose of all that material. Some of the soil was so tainted it had to be transported and disposed of as hazardous material. Because of the significant difference in disposal costs between hazardous and non-hazardous materials ($99 per ton versus $27 per ton), the Volpe Center investigated on-site soil treatments that would render the material suitable for conventional disposal. Lead, which occurs in the soil in the form of water-soluble lead carbonate, can be rendered immobile through the addition of material that will bind to the lead. Although the addition of cement is an established method for such binding, it increases the weight of the material by roughly half, resulting in marginal cost-savings. After an extensive analysis of alternatives, the Volpe Center recommended the EPA use an innovative new technology that can render the lead immobile while increasing its weight only slightly. This method, which had been successfully tested but applied in the U.S. only once, adds phosphoric acid, cement kiln dust, and a catalyst to the contaminated soil. Crews spread out the tainted soil over a large area to a depth of one foot; added the acid, dust, and catalyst; and tilled the soil. Within hours, the lead dissociates from the carbonate and becomes lead phosphate, which is stable and inert. Following treatment, the Volpe Center assisted the EPA with a Toxicity Characteristic Leachate Procedure Analysis to assess the tendency for the lead to migrate out of the soil with water. When the tests found that the treated material met the Universal Treatment Standard for lead, the soil was hauled to a certified conventional landfill in Grassy Mountain,

The Volpe Center: Managing Information, Promoting Innovation

As the Volpe Center assists client agencies with comprehensive environmental management, it uses two strategies to achieve efficiency, excellence, and innovation: rigorous information management and implementation of new technologies. The two strategies are closely linked; detailed operational information can provide the foundation for system–level strategy decisions and evaluations of appropriate technologies. Operations Research Analysts at the Center work with clients to review an agency's environmental record, assess needs, and identify opportunities for improvement. Organized systems that provide more efficient access to information resources can also help agencies forecast environment-related expenditures, develop budget estimates, and evaluate the cost benefits of alternative strategies.

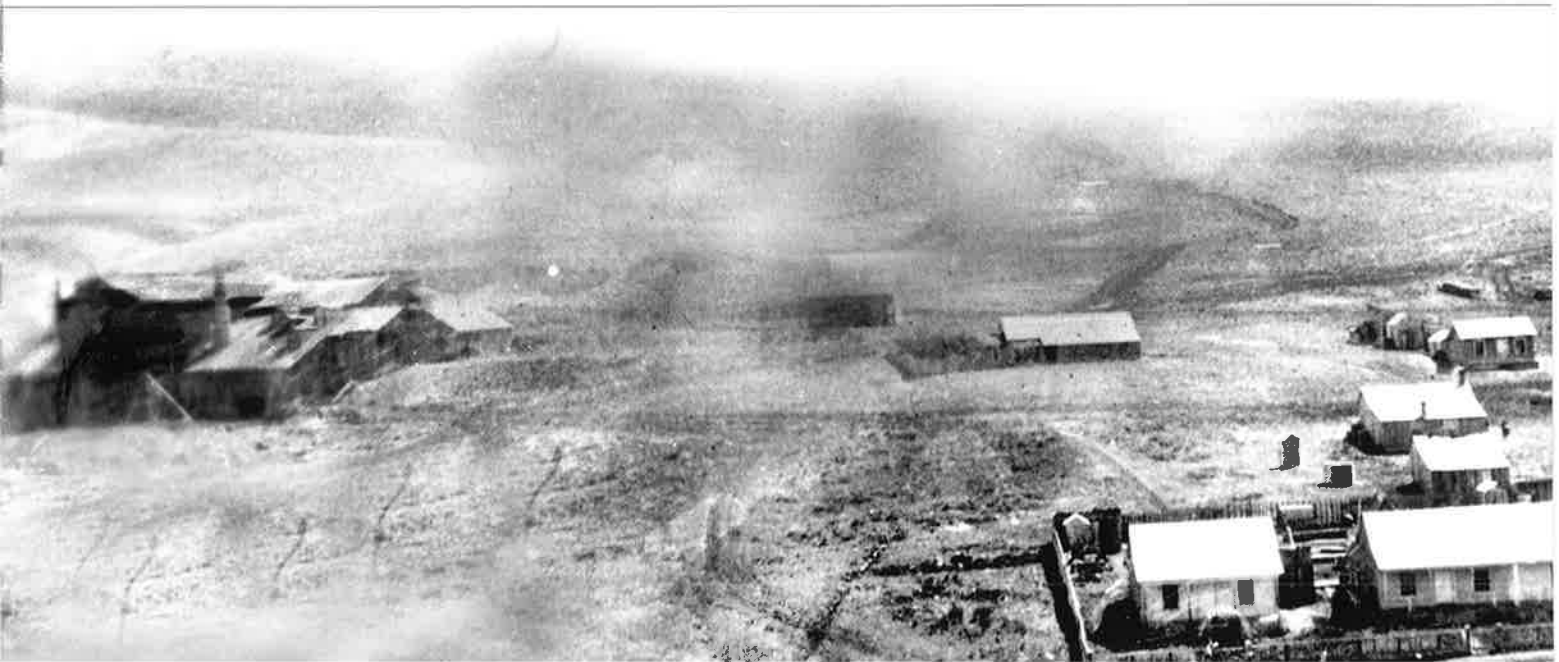
The Volpe Center can also help agencies evaluate and implement technology, as it did in Stockton with the on-site treatment of contaminated soil. The multidisciplinary team in the Environmental Engineering Division can identify a variety of established and experimental technologies, evaluate their effectiveness, assess the cost benefits of various options, and make recommendations.

Utah, 60 miles northwest of Stockton. The use of on-site treatment and conventional disposal resulted in a net savings of roughly $30 per ton, compared to disposal costs for hazardous soil. The EPA closely monitored the treatment and found it satisfactory; the agency also found the total cost savings of almost $550,000 to be a welcome savings. Stockton residents, on the other hand, were less concerned with cost savings than with the overwhelming presence of heavy machinery and with their ravaged lawns. The effort required a small army of workers and vehicles ranging from pickups to bulldozers; in order to perform a complete cleanup, the crews had to dig up gardens, uproot trees, tear out fences, and move structures such as sheds. Fortunately, the Volpe Center team was on hand to support EPA decisions in mitigating these temporary disruptions. The field crew reduced traffic problems to a minimum through careful and ongoing coordination efforts with contractors and town officials.

Contaminated soil is treated on-site with phosphoric acid, cement kiln dust and a catalyst – an innovative new technique that reduces disposal cost.

Project Managers Halloran and McGuiggin made restoration and landscaping a major component of the work, using the same contractor that conducted the excavation to restore properties and yards to an attractive condition. Addressing the concerns of residents gave the Volpe Center field crew a chance to demonstrate its sensitivity. Before contractors picked up a single shovel, staff members met with every property owner to discuss the work and to plan the restoration of their property. These meetings provided property owners with the opportunity to redesign their lawns, choose trees and shrubs, and direct their placement. Restoration efforts included re-grading, placement of sod, tree plantings, and reconstruction of fences and structures. This careful attention to landscaping won the support of many residents. They are also pleased with the results; trees are adapting to their new locations and gardens are thriving in the rich new topsoil that was trucked in to replace the contaminated soil.

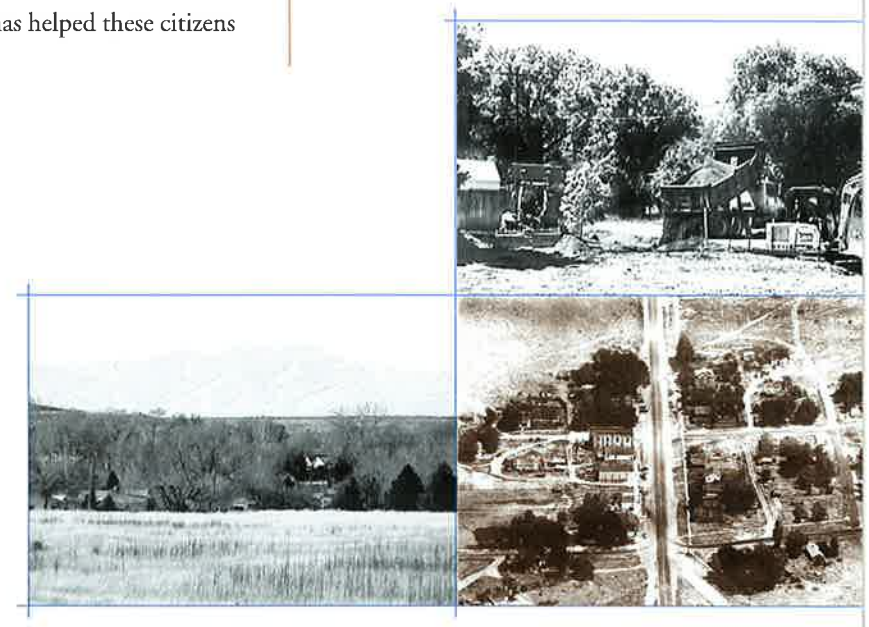
The Jacobs Smelter (below left), circa 1870. The two houses in the foreground are still standing and remain occupied.



A Stockton child clings to her mother and looks on as crews remove tainted soil. Next summer, she will be able to play on her lawn free from the threat of lead poisoning.

In fact, the restoration effort has been so effective that many residents are saying that the project may actually improve the appearance of the town. Prior to the cleanup, many of the affected properties had a somewhat "cluttered" appearance, having accumulated a good deal of what Stockton Mayor Barry Thomas terms "natural living stuff": scrap metal, old timber, odd parts, brush and limbs, and disabled vehicles. Remediation crews hauled off all that material; Mayor Thomas hopes that this will "kick-start" other residents to take the initiative to also spruce up their properties. "I'm sure it will just snowball," he commented.

This hopefulness about the future is energizing Stockton these days. As they embraced their past, many residents did not realize that certain remnants of that past threatened their future. When called upon, the Volpe Center helped to investigate these remnants, to organize the effort to remove them, and to ensure that the work was done right. By digging into the past, the Volpe Center has helped these citizens look forward to a safer future.



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