Kansas Department of Health and Environment

Bureau of Environmental Remediation/Remedial Section

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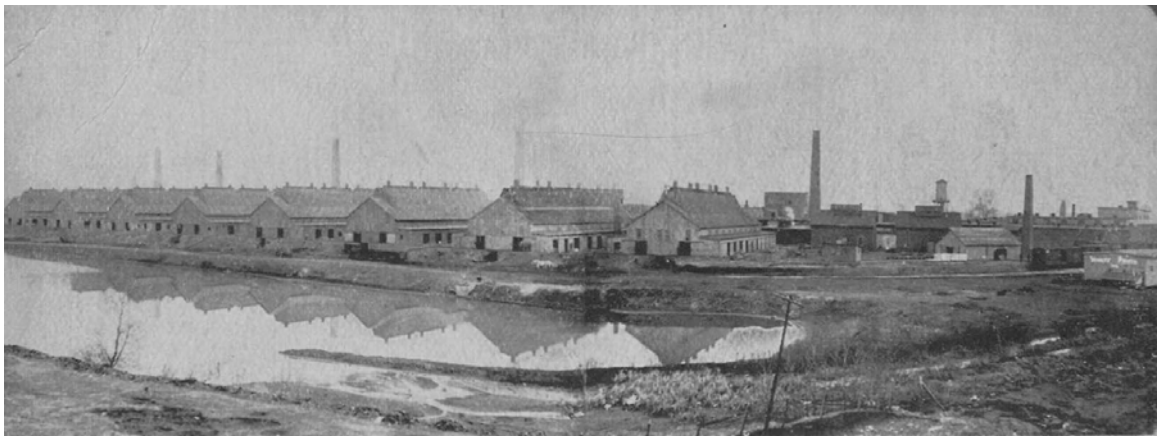
A Short History of the Zinc Smelting Industry in Kansas

The Industrial Age spawned in the late 1860's and spread prosperity westward across the nation. Portions of Kansas hoped to become an important part of this industrial movement. That hope was based on the availability of cheap fuel—coal, natural gas, and petroleum—found in great quantities from the 1860s onward. These fuels powered great factories producing glass, cement, building bricks and zinc. In southeastern Kansas, large areas of coal and zinc mining brought opportunity to thousands of workers. This area was part of the Tri-State Mining District. In the late 1870s the zinc smelting industry became an integral part of southeastern Kansas.

Zinc is a silvery metal which, combined with copper, is used to make brass. Modern pennies are made with a zinc core covered with a copper alloy. Zinc is used to galvanize steel, preventing it from rusting, and as a white pigment in paints. A hundred years ago, zinc was often used to make buckets, sinks, roofing shingles and gutters, and lids for canning jars (you can often find these in antique shops).

The Tri-State Mining District lies in southwestern Missouri, southeastern Kansas, and northeastern Oklahoma. For nearly fifty years, it was the world's richest producer of lead and zinc ores. More importantly, it was located next to the coal fields of southeastern Kansas. Coal was essential for smelting, the process of removing spelter—metallic zinc—from ore. The first zinc smelter in Kansas was built in Wier City in 1870.



The Edgar Zinc Company in Cherryvale. This was the largest zinc smelter in Kansas.
Photograph courtesy Kansas State Historical Society.

Right: A sample of galena, a type of lead ore found in the Tri-State Mining District.

Left: A sample of blackjack, a type of zinc ore found in the Tri-State Mining District.

Below: The Tri-State Mining District includes Cherokee County, Kansas; Ottawa County, Oklahoma; and Jasper and Newton Counties, Missouri. Many of the cities in this region were originally founded as mining camps.

Pittsburg Becomes a Smelting Center

Robert Lanyon was a British-born industrialist who operated a zinc smelter in LaSalle, Illinois. In 1877, he traveled to southeast Kansas to investigate the possibility of building another smelter in or near the Tri-State Mining District.

Lanyon quickly realized that Pittsburg was the ideal location for his new smelter. It was fewer than fifty miles from the richest zinc mines, and, more importantly, it was itself a coal-mining town. The local coal mining produced vast quantities of soft, or "slack" coal. Slack coal wasn't nearly as valuable as the harder coal found in deeper seams, and was stockpiled in favor of the higher-grade coal. The softer coal was, however, perfect for roasting and smelting zinc ore.

Robert Lanyon built a smelter at the southeast edge of town. Others soon followed; two, the S. H. Lanyon and Brother smelter built by Robert's brother and former business partner, and the W. & J. Lanyon smelter, built by his nephews William and Josiah, were located on the neighboring properties. Wier City Zinc Co. built the smelters north of Pittsburg (now 28th and North Broadway). The Pittsburg and St. Louis Zinc Co. built a plant to the east of town known locally as the East smelters (now on E. 20th St.), while the Granby Mining and Smelting Co. operated west of Broadway at 12th St.

The Smelting Process

The primary zinc ore, and the one found in the Tri-State Mining District, is sphalerite, a lustrous cluster of tetrahedral crystals that are often dark reddish-brown or black, hence its nickname, "blackjack." It is also known by its German name, blende. Sphalerite is mostly zinc sulphide (ZnS), with impurities of iron, lead, cadmium, and antimony, and sometimes gold and silver. The sphalerite from the Tri-State Mining District is extremely pure, about 60% zinc by weight.

Ruins of the former Pittsburg and St. Louis Zinc Company smelters in Pittsburg.

It took about four tons of coal to smelt one ton of sphalerite, which is why it makes sense to build smelters nearer the coal mines than the zinc mines. Ore from the mines was shipped to the smelters by rail. The first step in the smelting process was to crush the ore into a powder, which was loaded into small metal carts and placed into the roasting kiln to be heated for 24 hours. Large fans constantly blew fresh air over the roasting ore, and gradually the sulfur in the ore would be replaced by oxygen. The ore had to be stirred every half hour, and until stirring machines were invented, workmen did this with long rakes. Temperatures in the buildings were so high that the workers would leave the doors open all winter, and would walk off the job if they weren't provided enough ice water in the summer.

The roasted ore, now zinc oxide (ZnO), was ground into a very fine powder, where it was mixed with powdered coke, coal that had been heated to drive off impurities until it was pure carbon. This mixture was pressed into bricks and loaded into retorts, clay cylinders about

Broken retorts at the East La Harpe smelter. The extreme heat and minerals of the distilling furnaces cause the multiple colors on the surface of the retorts.

Ore residue after distilling.

10 inches in diameter and 8-10 feet long. The furnacemen would place a ceramic condenser on the open end of the retort and glue it in place with a dab of wet clay. Then they'd load the retorts into racks built into the furnace with the condenser end sticking out and slightly elevated.

The retorts would be heated for several hours, and the coke/ore mixture inside went through a chemical transformation. As the temperature in the retort approached 1975°C, the mixture would vaporize and the oxygen in the ore would combine with the carbon in the coke to form carbon oxides (CO and CO_2). The metallic zinc left behind would vaporize, move into the condenser, and condense into liquid zinc. Two or three times a day, the furnacemen would break the clay plug on the condenser and pour, or "draw", the molten zinc into giant ladles, then cool the zinc in molds holding 50 pounds of metal. After 24 hours, the charge in the retort would be exhausted and the furnacemen would pull the hot retort out of the furnace, clean out the slag with a blast of steam, and recharge it with a fresh mixture of coke and roasted ore. Smelters ran 24 hours a day, seven days a week.

Acres of smelter waste at the former Eagle Picher Smelter in Galena. Vegetation has not grown in this area for 100 years because of high levels of heavy metal contamination.

The furnaces were amazing sights—racks of hundreds of retorts, each with a multi-colored flame coming out of the end. Furnacemen could determine the temperature and purity of the ore by the flames' colors.

Smelting Operations Were Not Only Dangerous But Also Caused Massive Amounts of Pollution.

Burning coal releases sulfur and nitrogen oxides, which irritate the eyes and lungs and create acid rain. Also, burning 28 tons of coal a day created incredible amounts of soot to blacken the skies and cover items left outside with black soot. This soot was generally contaminated with elevated levels of lead, cadmium, arsenic, and zinc. Roasting the ore also put an incredible amount of additional sulfur dioxide into the atmosphere. Some smelters, like the United Zinc and Chemical Company plant located in Iola, were designed to capture these fumes and make sulfuric acid. It was possible to put a primitive cloth or paper filter in each smoke stack, but the most common way to handle air pollution was to raise the height of the stack so the smoke would catch higher breezes and disperse over a larger area. Farmers living downwind of the smelters saw their crops wither from the fumes, and some sued for damages.

In addition to airborne pollution, the smelting operation left large volumes of solid waste. This waste consisted of cinders from coal-fired furnaces, broken retorts, building materials removed

during repairs, impure smelting slag, and the slag blown from the retorts at the end of the smelting process. These materials are likely contaminated with sulfur and heavy metals like lead, cadmium, arsenic, and germanium. Some of the waste material was reprocessed for its iron, gold, silver, or copper content or used as construction fill or ballast on railroad lines. Most of the waste was left after the smelter closed for future generations to address. The former Eagle-Picher Smelter located in Galena has approximately 60 acres of waste, some of which is 15 feet deep.

During World War II, some of the waste piles in Iola were taken away to be re-smelted using more efficient processes. As waste slag erodes into dust, the contaminants become mobile and can be wind-blown or wash into surface waters.

A slag pile located south of Gas, Kansas.

Smelters were extremely dangerous places to work. This was before industrial safety standards and crippling accidents to workers were common. Workers could be crushed by ore cars, kicked by a horse or mule, or have their clothing caught in fast-moving machinery, resulting in horrific injuries. A few drops of water in a ladle or mold would, when used to draw zinc, immediately flash into steam, spattering drops of molten metal all over the unlucky furnaceman. At the time, there was almost no disability or workman's compensation insurance. To work in a smelter, or almost any other factory, was to risk your life and health for nothing more than your take home pay, which in 1902 was from 12 to 20 cents per hour.

Consolidation Of The Smelting Industry.

Most of the early zinc smelters were owned and operated by entrepreneurs, who raised capital locally and ran the plants themselves. They purchased both coal and zinc ore directly from mines that were similarly run as small to medium-sized enterprises. In 1895-1896, a few industrialists in St. Louis decided that a consolidation of smelting interests would stabilize prices and lead to a more profitable market. Led by James J. McDonald, the Cherokee-Lanyon Spelter Co. purchased or leased almost every coal-fired zinc smelter west of the Mississippi River (the single holdout was the W & J Lanyon smelter in Pittsburg).

Unfortunately for Cherokee-Lanyon, it was never able to completely dominate the Tri-State Mining District zinc industry because of some new and interesting developments just to the north and west, in Allen County.

Opening the Gas Fields – New Opportunities

In 1895 there were coal-fired smelters operating in Pittsburg, Girard, Wier City, Scammon, and Argentine. There was also an interesting discovery being made in Allen County, slightly to the north and west of the Kansas coal region. Drillers had discovered a pocket of underground natural gas that could produce tens of

thousands of cubic feet of gas per day from a single well. The citizens of Allen County thought the supply of gas was inexhaustible, and offered free fuel to any manufacturer who would locate in the county. They especially appealed to zinc smelters.

The people thought there would be no end to the gas, and didn't even try to conserve it. Free gas was piped to every home in the county seat of Iola. Street lamps were left burning all day, and those with gas stoves would open windows in the winter rather than turn down the heat.

Robert Lanyon sold his Pittsburg smelter to Cherokee-Lanyon and built a new one in Iola. Unfortunately, the furnaces were not well designed for gas-fired smelting, and the new plant wasn't successful until new furnaces were designed and built. Once the new furnace designs proved successful, smelting companies flocked to the gas belt.

Iola, and its neighboring cities of La Harpe and Gas, was the biggest beneficiary of the smelter boom. By 1903, Allen County had eight smelters (one equipped for making sulfuric acid from the roasting fumes) and a rolling mill for turning pig zinc into sheets to use as gutters, shingles, and so forth. There were also gas-fired smelters operating in or planned for Altoona, Chanute, Caney, and Cherryvale.

Gas was plentiful, and provided to the smelters very cheaply or for free. The coal-fired smelters couldn't produce spelter cheaply enough to compete, and in 1900 all coal-fired smelters in Pittsburg, Bruce, Wier City, Girard, and Cherokee were closed. Cherokee-Lanyon built two smelters in the gas belt in order to stay in business. Other industries flocked to the gas belt, and Kansas became a producer of glass, bricks, and portland cement as well as zinc.

The American Metals plant in La Harpe.

The Altoona smelter operated between 1903 and 1917.

The same smelter in 2005-- acres of smelter waste with little or no vegetation.

The Return to Coal

Gas was so cheap that nobody saw any reason to conserve it, and the furnaces had very inefficient designs. Eventually there was a decline in gas production. Factories and towns began drilling for gas further from their industrial centers. Within a few years, the gas pressure was so poor the pipeline companies had to install pumps, and on very cold days the pressure would drop to the point where a smelter could not fire their furnaces until the weather warmed up.

On the other hand, market prices for zinc were good enough from 1904-1907 that many of the coal-fired smelters were reopened. The original Robert Lanyon plant in Pittsburg had been torn down, but the East and North works were reopened by Lanyon Zinc Co. and Cockerill Zinc Co. Cockerill Zinc Co. also operated smelters in Altoona, Bruce (just west of Cherokee), Gas, Iola, and La Harpe, making Cockerill Zinc Co. one of the largest producers. New smelters were built in Dearing and Caney.

In order to compensate for the higher price and lower availability of gas, some smelters began shipping more and more of their ore by rail from Colorado. Most of the Colorado ore was blende, the same as found in the Tri-State Mining District, but an increasing amount was in the form of calamine. Calamine contains relatively little elemental zinc, compared to blende, but the zinc is already in the form of zinc oxide and

Cockerill Zinc Co. operated Pittsburg's North smelters in 1905.
Photograph courtesy Kansas State Historical Society.

thus does not require roasting before distilling. Ore in the form of zinc oxide would save smelter operations a great deal of fuel. The Cherryvale smelter turned to petroleum to fire its roasting kilns.

Smelter foundations in La Harpe.

Syndicates Collapse

The year 1910 saw a great many of the Kansas smelters close. Cockerill Zinc Co. went bankrupt, its assets seized and sold to pay its debts. Lanyon Zinc Co., with three smelters in Allen County and one at Pittsburg, went into receivership and closed its plants. Even the Cherokee-Lanyon Spelter Co., the first of the syndicates, was gone, having sold or leased its properties to other operators. On the other hand, smelters were being built in Oklahoma, where sufficient gas was easily found. Faced with competition from smelters in Oklahoma, Colorado, Illinois, and West Virginia, the Kansas zinc industry did poorly for the next few years.

The War Years

The zinc smelting industry in Kansas did not do well between 1911 and 1914. The war years sparked the last great smelting boom in Kansas. Supplies of spelter from Europe were cut off at a time when more zinc was needed for domestic use and for building munitions. Even so, the vast increase in demand took the industry by surprise.

In Pittsburg, the old East and North works were repaired and reopened, the East works by Pittsburg Zinc Co. and the North works by the Joplin Ore and Spelter Co., a consortium formed by zinc mining companies in the Tri-State Mining District. When spelter prices shot up, both companies rushed to get their plants into production. Pittsburg Zinc Co. even considered repairing and reopening the old W & J Lanyon works, but residents in the neighborhood, concerned about pollution, persuaded them not to. Many of the older smelters in Iola, Altoona, Gas, La Harpe, Neodesha, Cherryvale, Bruce, Chanute, Caney, and Dearing suddenly had all the business they wanted and operated at full capacity. The American Spelter Co. built a new plant at Pittsburg, and the Iola Zinc Co. temporarily converted an abandoned portland cement factory into a smelter at Concreto, just north of Gas.

The ruins of the Iola Zinc Company smelter at Concreto, once a portland cement plant.

As the war was drawing to a close, prices of zinc dropped back to their pre-war levels. Profits also plummeted, and most of the Kansas plants closed. By

1921, only two smelters remained in operation: Edgar Zinc Co. in Cherryvale and Weir Smelting Co. in Caney. These two plants managed to hang on for another ten years, until competition from the new electrolytic smelting methods and the Depression closed the Caney plant for good in 1931. The Cherryvale plant continued operating on a small scale, reprocessing smelter wastes, until 1976.

The Smelters Today

Little is left to be seen of the zinc industry in Kansas today. A visit to a former smelter site may show a quiet lot or empty field, a few foundations peeking through the underbrush, piles of broken bricks or ceramic retorts and acres of contaminated smelter waste (slag), soil, sediments and surface water.

KDHE is working with the EPA, local communities, landowners, residents, and developers to locate these former smelter sites, assess the environmental damage and risk to human health, and clean them up. Looking at the historical records, such as historical monographs, newspaper stories, land title records, aerial photographs, and historical deeds can identify these former smelter operations. KDHE staff also interviews people living in the area in order to gather valuable information. To date, KDHE has identified a total of 33 former smelter operations in Kansas.

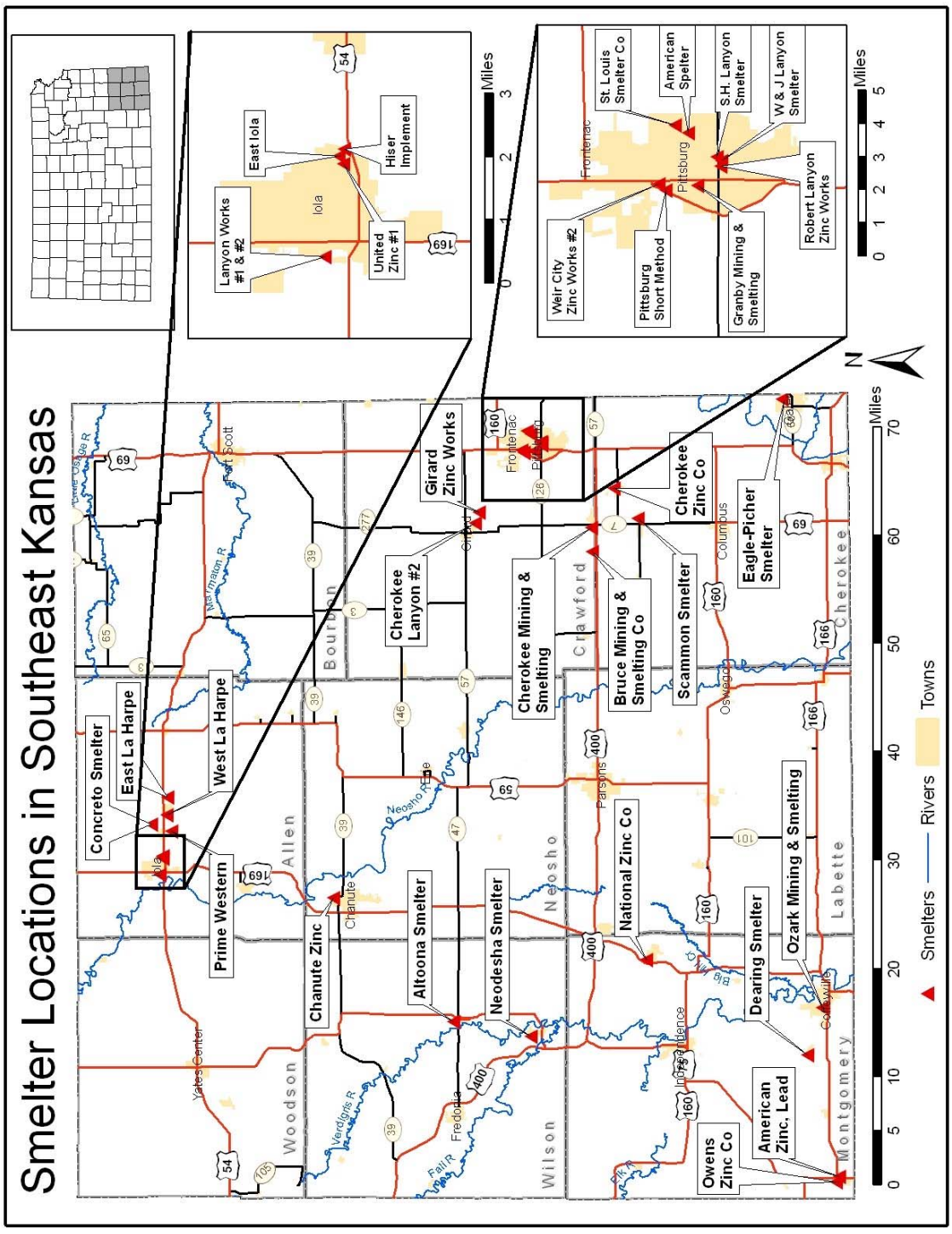
Ruins of a kiln at the North smelter in Pittsburg.

A majority of the smelters operated in the southeast part of the state with the exception of the Argentine smelter located in Kansas City. Almost all of the former smelter properties are abandoned and are not in productive use. Most still have remnants of the smelter and acres of barren, non-vegetated land.

An XRF analyzer used for field screening.

Restoring the Environment and Promoting Property Redevelopment

Addressing environmental contamination caused by former smelter operations can be very expensive and time consuming. Once a site is identified, KDHE contacts the landowner and gets permission to begin an initial assessment of the identified property. The assessment includes a visit to the site to evaluate environmental conditions, photograph the site, review the site's history, and identify potential human and environmental receptors and population demographics for that area. This information is used by KDHE to develop a sampling plan.


Smelter Locations in Southeast Kansas
Concreto Smelter
East La Harpe
West La Harpe
Prime Western
Chanute Zinc
Altoona Smelter
Neodesha Smelter
Girard Zinc Works
Cherokee Lanyon #2
Cherokee Mining & Smelting
Bruce Mining & Smelting Co
National Zinc Co
Scammon Smelter
Cherokee Zinc Co
Eagle-Picher Smelter
Dearing Smelter
Ozark Mining & Smelting
Owens Zinc Co
American Zinc, Lead
Lanyon Works #1 & #2
East Iola
Hiser Implement
United Zinc #1
Weir City Zinc Works #2
Pittsburg Short Method
Granby Mining & Smelting
Robert Lanyon Zinc Works
St. Louis Smelter Co
American Spelter
S.H. Lanyon Smelter
W & J Lanyon Smelter
Allen
Bourbon
Crawford
Cherokee
Labette
Montgomery
Wilson
Neosho
Woodson
Miles
Smelters
Rivers
Towns
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Before and after pictures of a successful cleanup and redevelopment project in east Iola. The smelter waste, lead, and contaminated soil was consolidated into one small area and capped, and now lies underneath this parking lot. Consolidation and capping is an effective and relatively inexpensive remedial method, and land use restrictions prevent digging on the property or its use as a residence.

Fish and sediment sampling downstream of the Cherryvale smelter in order to identify the impact of contamination on surface waters.

A sampling assessment includes collecting environmental samples from soil, sediment, surface water, and ground water in order to determine the presence, source, and movement of environmental contamination. The assessment also identifies various human health receptors such as schools, residential yards, and domestic wells, and environmental receptors such as streams, wetlands, parks, and ponds. Test results for substances such as lead, zinc, cadmium, and arsenic are compared to the health standards outlined in KDHE's Risk-based Standards for Kansas (RSK) manual. KDHE uses this information to assign a priority to the project and determine how to proceed with further analysis.

At the same time as the sampling assessment, KDHE investigates the business history of the facility in order to determine if any of the corporations that operated at the smelter have successors that still exist today and are legally liable for the costs associated with cleanup of the facility. If a financially viable corporation is found, KDHE contacts them and brings them into the cleanup planning and execution process through an agreement with a state response program. If there is no successor corporation, the site is declared an orphan and funds for cleanup come from a state or federal program. Generally state orphan site money is very limited.

Cleanup activities are determined by a variety of factors including the type of contamination, the volume and extent of

Removal of contaminated soil from a school yard in Iola.

contamination present, the number of human health and environmental receptors impacted, the cost of various cleanup options, and the future land use for the property following cleanup. A common cleanup alternative for contaminated smelter sites is to consolidate the waste into a small area and encapsulate the waste by constructing an engineered cap over the waste. Engineered caps can consist of asphalt, clay, concrete or some other impermeable material.

The capped area may be redeveloped into commercial or industrial parking lots, streets, and building foundations. The advantages of consolidation and capping are that it is relatively inexpensive, is effective as the contaminated material is controlled through engineering and environmental use controls, and the contamination can be monitored. This solution also means the contamination does not have to be transported off-site to a landfill or other area. Areas that have been capped can be redeveloped into commercial or industrial properties.

The fifty years of zinc smelting in Kansas brought opportunity to thousands of workers and encouraged the development of new communities. The prosperity of the era also left behind a legacy of contaminated land that has resulted in millions of dollars of private and public funding to complete environmental cleanup ensuring the protection of human health and the environment.

Abandoned smelter waste and contaminated soil at Former Weir City Zinc Smelter.

Above: Remediation activities at the Weir City Zinc Smelter site.

Below: Cleanup of the Weir City Zinc Smelter site is completed. Following cleanup, the once contaminated property is successfully redeveloped into a viable commercial business and the community's economy is revitalized.