Soil washing proves innovation in remediation

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U.S. Army Photo

Philadelphia District's Steve Creighton (l) and Jon Dougherty (r) with Carl Seward of ART Engineering at the leach tanks where the iron/arsenic coatings are "washed" off the sand particles using a high temperature water and sodium carbonate.

From 1949 until the early 1990s, the Vineland Chemical Company produced herbicides at a manufacturing facility in Vineland, N.J. The arsenic-based weed killers were commonly applied to fields of cotton, sugar cane, soybeans and other crops.

The manufacturing process generated arsenic-containing salts as a waste by-product. With no means to treat or dispose of these salts, they were stored in uncontrolled piles and lagoons across the approximately 35-acre site.

This practice led to contamination of the underlying soil and groundwater—and eventually of a low-lying nearby marsh, the adjoining creek, the Maurice River (a National Wild and Scenic River), and Union Lake. Arsenic originating from Vineland Chemical has been found as far as 36 miles downstream, near where the Maurice empties into the Delaware Bay.

After some limited attempts to treat wastes on-site, plant operations ceased in 1994—and with the company no longer in business, the site was added to the National Priorities List for cleanup under the EPA Superfund Program.

And as it has so many other times over the past two decades, EPA (specifically, Region 2) turned to the Corps (specifically, Philadelphia District) to plan, design and execute the selected remediation of this site.

As the project evolved, it was subdivided into four phases, or operable units (OU's):

■ OU1 (Plant Site Source Control): Excavation and onsite treatment of contaminated site soils.

■ OU2 (Groundwater Remediation): Pumpout and onsite treatment of the contaminated groundwater directly under and surrounding the site.

■ OU3 (River Areas): Cleanup of contaminated sediments in the nearby stream, marsh and floodplain.

■ OU4 (Union Lake): Cleanup or environmental management of Union Lake downstream.

It was for OU1 that soil washing was selected as the means of remediation, to handle an estimated 268,000 tons of arsenic-contaminated soils.

Just as EPA looks to the Corps for most of the project management, we look to our own contracting community to augment our technical expertise.

Enter Sevenson Environmental Services of Niagara Falls, N.Y., the Corps' prime contractor for Vineland remediation, and its subcontractor, ART Engineering of Tampa, Fla., developer and lead designer of the innovative soil washing treatment system for OU1.

Much of ART's previous experience is in the mining industry, where many of the earthen materials refining and volume reduction processes have proven applicable to this environmental remediation.

In fact, they had already designed and operated other successful soil washing plants on a smaller scale, including one for the removal of chromium, copper and nickel at a Superfund project in nearby Winslow Township, N.J. (In contrast, the Vineland plant is now the largest of its kind in the world.)

For the Vineland design, ART conducted a bench-scale treatability study and process optimization study at the Buffalo, N.Y., laboratory of Sevenson Environmental Services to confirm process design parameters.

Based on these study results, they prepared the process design including specifications for each piece of process equipment. They also prepared an excavation, staging and blending plan to describe how contaminated feed material would be mixed to achieve the desired feed concentration of arsenic (60 to 90 parts per million).

Design of the soil washing treatment plant was completed in December 2002. Sevenson constructed the plant in less than a year and it was up and running in October 2003—the world's first full-scale application of this innovative technology for environmental remediation.

How does it work?

In short, the soil washing treatment plant combines particle size separation processes with a chemical leaching and washing step to effectively remove arsenic contamination from site soils.

The site soils are sandy and contain arsenic in concentrations ranging from less than 20 to greater than 5,000 parts per million. The initial process step uses trommel screeners and vibrating wet screens to remove oversize materials (more than 2 millimeters) from the feed, then hydrocyclones to remove the fine particles ("fines," defined as soils with particle sizes less than 0.1 millimeters). In these soils being treated, oversize materials make up about 2 percent and fines approximately 4 percent by weight.

After removal of the oversize and fines, water is added to the remaining sand particles and the resulting sand slurry is sent through for washing. After being heated to 130 degrees Fahrenheit, the slurry passes through four in-series leaching tanks that mix in several process chemicals, including sodium carbonate, which is the primary washing and leaching agent.

The combination of high-temperature sodium carbonate slurry and the aggressive mixing dissolves the iron and arsenic coatings from the sand particles.

The resulting product is clean sand, with contaminated water as a byproduct that is further processed using pH adjustment and flocculation to precipitate (settle) the dissolved arsenic into

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highly contaminated sludge.

The sludge generated by this process, as well as fines initially removed by the hydrocyclones, is consolidated into a highly concentrated sludge that contains high levels of arsenic. The sludge is then shipped to an approved offsite hazardous waste landfill for disposal, as are the oversize materials.

Some 94 percent of the site's soils are treated and returned to the site as clean backfill, with the remaining 6 percent shipped to an approved offsite landfill in the form of oversize materials (gravel, roots and twigs, miscellaneous debris) and sludge. The treated sand is returned to the excavation. Some clean topsoil from an approved offsite source will be used to restore the site to its original grade and support revegetation.

How well does it work?

Since the soil washing plant began operation in October 2003, a rigorous sampling and analysis program has confirmed that arsenic concentrations are below the 20 part-per-million cleanup level for backfill. To date, only 1,300 tons (less than 2 percent) of the 100,000 tons of soil processed have exceeded that threshold and required retreatment.

As for innovation, this project boasts several "firsts":

■ Use of soil washing technology to remediate an arsenic-contaminated Superfund Site.

■ Use of the traditional mining processes of wet screening and hydrocyclones to remove those soil fractions which are not amenable to soil washing (fines and oversize materials).

■ Use of chemical leaching to remove the iron and arsenic coatings.

■ Incorporation into the soil treatment process of a rotating ball mill, which will use physical grinding with 1-inch diameter ceramic balls to remove arsenic coatings from higher-concentration, or "hot," feed materials (greater than 500 parts per million arsenic).

■ Implementation of an extensive coring and sampling program for the old Vineland Chemical Plant's foundations, with the result that concrete and asphalt areas previously assumed to require disposal as hazardous materials have been reclassified as contaminated but "nonhazardous," resulting in savings to the project of approximately $1.5 million.

Also, while not a "first," chemical stabilization of contaminated oversize material to render it "nonhazardous" for disposal will save the project approximately $350,000.

As of December 2004 the ball mill has not been used; instead the contractor has been able to successfully blend these "hot" materials with lower grade feed material (20 to 40 parts per million) to produce a combined feed stream with a concentration of approximately 80 parts per million. This combined feed has been successfully treated without the grinding step.

By the end of November 2004, approximately 25 percent of an estimated 268,000 tons of contaminated soils onsite had been successfully treated and returned to the ground as backfill.

Project completion date is currently projected as September 2006, six months ahead of schedule—thanks to process improvements by Sevenson and ART that increased the plant's treatment rate from 52 to 70 tons per hour and will end up trimming about $1 million from the project's $23.5 million budget.

Working with its contractors and EPA, the Corps will continue plant optimization efforts with the goal of additional project savings.

"This soil washing treatment plant has played an invaluable role in expediting and enhancing the cleanup of one of New Jersey's most complex and challenging Superfund sites," says EPA Region 2's Ron Naman, Remedial Project Manager for the Vineland Chemical Company Superfund Site.

"Its success offers great promise for use on other site operable units or for similar efforts within the Superfund program."

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