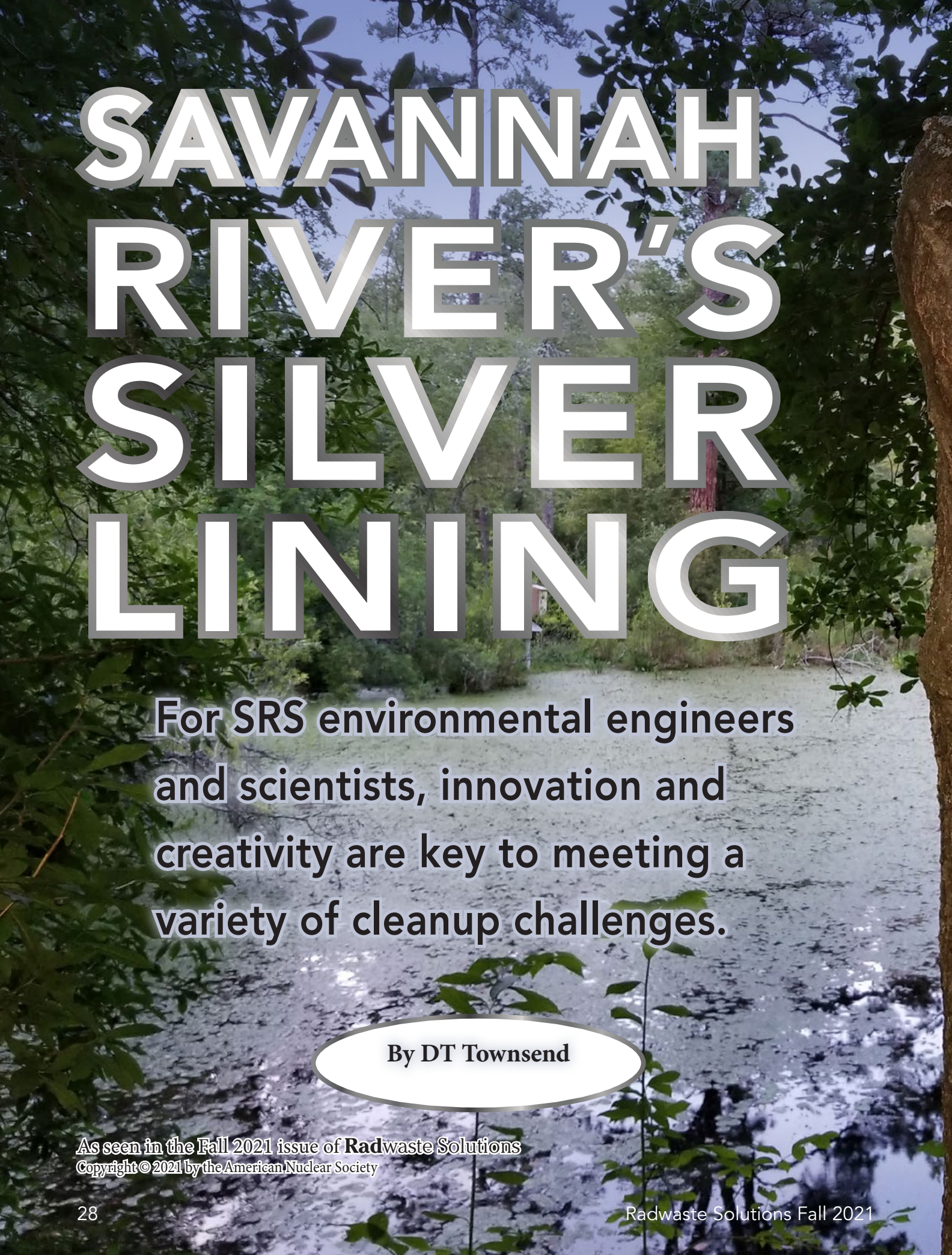

# SAVANNAH RIVER'S SILVER LINING

For SRS environmental engineers and scientists, innovation and creativity are key to meeting a variety of cleanup challenges.

By DT Townsend

As seen in the Fall 2021 issue of **Rad**waste Solutions


Nature reclaims a no trespassing sign along a walking trail at the Savannah River Ecology Laboratory. (Photo: DOE/Sean Poppy)

Since being awarded the operations and management contract at the Department of Energy's Savannah River Site in 2008, a primary goal for Savannah River Nuclear Solutions (SRNS) has been the safe cleanup and restoration of a landscape environmentally impacted by nuclear waste generated during the Cold War.

Though decades of nuclear weapons production at SRS helped defeat the Soviet Union and win freedom for several nations in Eastern Europe, there were some negative consequences. These include the accumulation of over 30 million gallons of highly radioactive liquid waste; areas across the DOE site with groundwater contaminated by chemicals; and, in some instances, radioactive materials left over from Cold War operations.

According to Chris Bergren, SRNS director of Environmental Compliance and Area Completion Projects, SRNS has a strong cleanup history based on close interaction with regulators and other stakeholders, utilizing a "core team" approach for decisions.

"The variety and number of cleanup challenges found across the 300-square-mile Savannah River Site has made our end goal that much more complex," said Bergren. "We've taken down more than 50 buildings; grouted several contaminated structures with a cement-like material, including two nuclear reactors; cleaned up earthen pits formerly holding contaminated items; remediated and closed pond-like basins containing hazardous materials; and found highly effective ways to remediate contaminated groundwater. The list goes on and so does our company's success with each task."

Bergren credits much of this success to the innovation, creativity, and dedication of those in his organization and the numerous contributions made by the Savannah River National Laboratory's engineers and scientists.

SRNL geologist Mark Amidon (left) and geochemist Hansell Gonzalez-Raymat discuss the progress of a project to immobilize iodine-129 in the groundwater and soil at the Savannah River Site while collecting soil samples. (Photos courtesy of DOE)

## A SILVER SOLUTION TO GROUNDWATER CONTAMINATION

Some of the world's best solutions are often simple in concept. The first light bulb, the assembly line, sticky notes and Velcro fasteners are classic examples. Some of SRNS' toughest environmental cleanup challenges were surprisingly simple to solve through employee ingenuity.

Using such creativity, SRNS workers found that, using wells, they could inject silver chloride below the earth's surface, thereby immobilizing much of the radioactive iodine-129 found in soil and groundwater near the center of SRS.

"Since 2019, silver chloride, a conventional industrial product, has been injected into soil and groundwater to capture and lock into place a high percentage of the iodine nuclides, significantly reducing the amount of contamination in the groundwater," SRNS Area Cleanup Projects Engineer Jeff Thibault said.

This pioneering environmental cleanup technology, developed by SRNS, avoids waste and requires no power. Moreover, post-treatment testing found levels to be much lower than regulatory limits.

Ultra-fine particles of silver chloride are specially milled by an off-site vendor to create highly irregular edges, which greatly increase the surface area of the particles. The material is mixed with water and injected into the water table 30 to 60 feet below the surface. To date, workers have injected a total of 240,000 gallons of water and 165 gallons of silver chloride.

Extensive studies confirm that injecting silver chloride beneath a portion of the site has reduced levels of I-129 found in SRS groundwater up to 50 percent during pilot program field tests.

At SRS, I-129 was created as a byproduct during Cold War–era production of plutonium and tritium. Working with SRNL scientists, SRNS strives to limit the remaining radioactive isotope from moving into nearby wetlands.

"The current treatment relies on silver chloride and soil to work together to bind the iodine to subsurface, mud-like sediment, prior to it reaching the wetlands," Thibault said. "Once this plume of contaminants fully enters the marsh, treatment—much less immobilization—of the iodine, becomes much more difficult. There's little or no sediment. We're now working mostly with organic material and the water of the marsh."

SRNL geochemist Hansell Gonzalez-Raymat said that workers have completed shallow drilling for soil samples in the affected wetlands.

"The data collected from the samples will help us to determine how the iodine will interact with the organic matter and surface water found within SRS wetlands. This research will lead to future improvements to existing treatment technologies that can be submitted to the South Carolina Department of Health and Environmental Control [SCDHEC] for approval," Gonzalez-Raymat said. "This is part of a larger project within the site's F Area that is partially funded by the Department of Energy's Environmental Management Office of Technology Development."

Thibault said SRNS is working to make this project passive, requiring minimal maintenance and use of little to no electrical energy.

"We are looking at the possible use of silver chloride, along with other cleanup technologies, to continue the level of success we've experienced in the past. We are confident we'll protect our wetlands," he said.

SRNS mechanic Curtis Williford helps remove the cover of an industrial wastewater tank within a containment pit at the Savannah River Site. Employees test the area for potential health hazards prior to pumping silver-bearing sludge from the tank.


**FACTOID: From 1954 to 1984, the Savannah River Site's P Reactor produced tritium and plutonium in support of the nation's Cold War nuclear deterrent.**

**Solvents used at that reactor and other waste sites across SRS seeped into the subsurface over time, contaminating the aquifer.**

(Photo: DOE-SR)


**FACTOID: German chemist Johann Schulze (1687–1744) is credited with laying the foundation for photography.**

**He found that mixing silver, chalk, and nitric acid would form a solution that becomes black in color when exposed to light.**

*(Image: Wikimedia Commons)*

# SLUDGE AT SRS YIELDS PRECIOUS METAL

SRNS also played an essential role in the successful removal of sludge containing silver from an industrial wastewater tank at SRS.

The silver-bearing sludge from SRS was shipped to the DOE Business Center for Precious Metals Sales and Recovery to be reclaimed, with proceeds going to the U.S. Treasury. Precious metals reclamation is the recycling and recovery of elements such as gold, silver, platinum, and palladium from hazardous waste.

For many years, workers at SRS developed photo film using a process that generated industrial wastewater containing silver nitrate. The wastewater passed through ion-exchange equipment to remove the silver before being discharged into a long-term storage vessel.

"Some of the precious metal still made it to the tank and, over the years, had accumulated to a significant amount," said Ted Millings, with the Environmental Compliance Division at SRNS. "Fast-forward to the age of digital photography. Now this tank that's regulated through the South Carolina Department of Health and Environmental Control no longer serves a purpose."

Millings said appropriate safety measures were followed during removal of the tank sludge. After workers emptied the contents of the tank and cleaned it, a camera was lowered into the vessel to verify that no sludge remained and that the floor and walls of the tank remained intact.

"It was at this point that we filled the tank with grout," said Andrew MacMillan, project lead for SRNS Area Completion Projects. MacMillan noted that the sludge removal project allowed SRS to avoid the cost of managing and disposing of the sludge as hazardous waste.

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A special vacuum-equipped truck removes water from an SRS waste tank, exposing a layer of sludge containing silver to be processed and delivered to the U.S. Precious Metals Repository.

"Helping to ensure the proceeds from the reclaimed precious metal goes to the U.S. Treasury is important; however, protecting our environment from this waste is invaluable," MacMillan said.

The DOE Savannah River Operations Office (DOE-SR) and SRNS worked closely with SCDHEC officials to ensure all state environmental regulations were followed during the project.

"Although it's the end of an era at SRS for developing photographic film, the successful completion of this project validates the continued value of teamwork and shared resources for a common cause," said Travis Shaw, SRNS environmental compliance authority for Asset Management and Distribution operations.

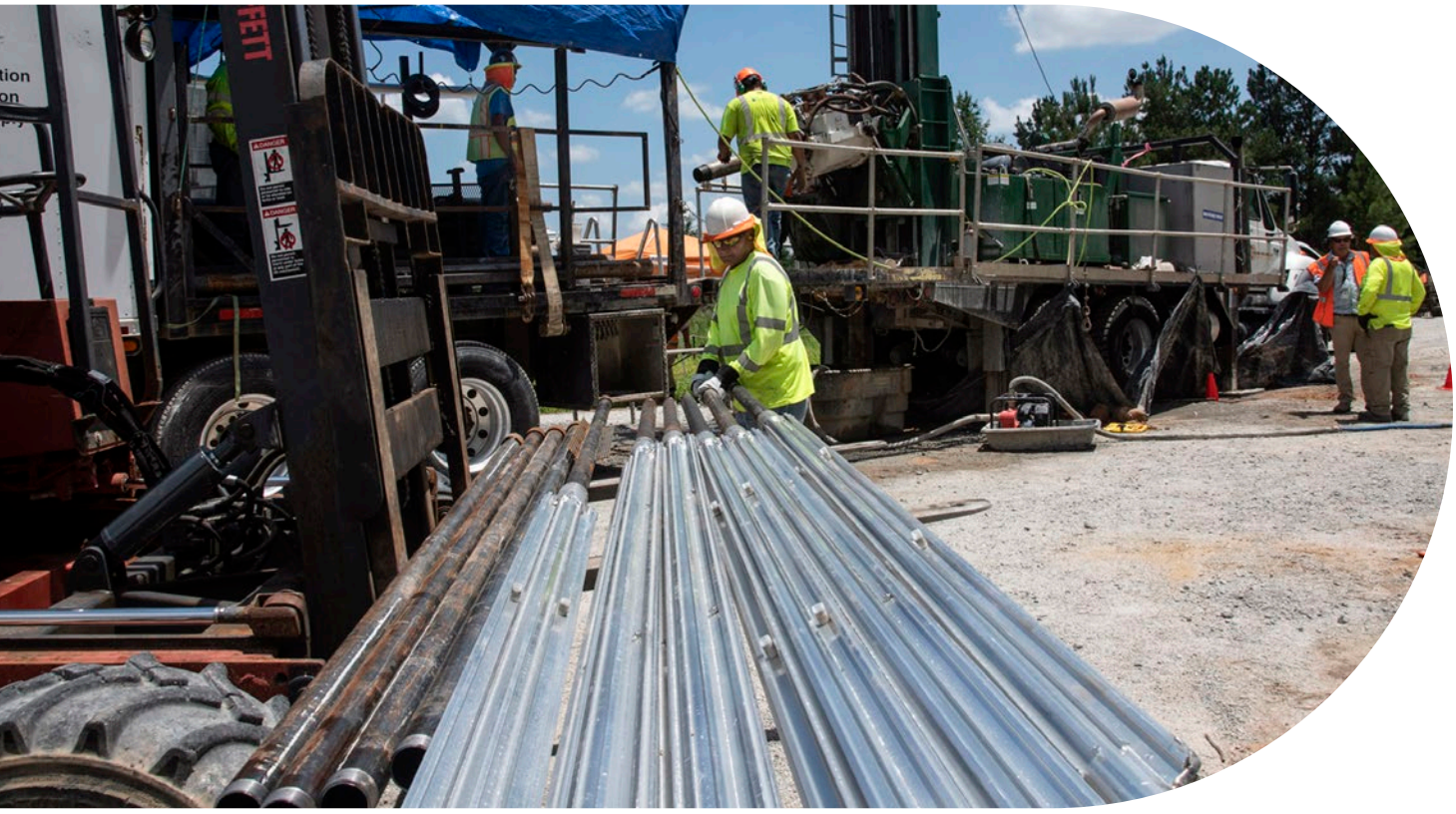
# IRONING OUT CHEMICAL CONTAMINATION

SRNS recently used recycled iron filings to construct a large underground, water-permeable wall. Though not a precious metal, the filings naturally neutralize Cold War–era chemical solvents found in the aquifer beneath SRS. The solvents are much like those used in dry cleaning.

Three basketball courts in length and, on average, about four inches thick, the wall extends 135 feet below the earth's surface at its deepest point and acts like an enormous water filter.

"The contaminated water cascades down through the filings, significantly increasing the amount of contact with the iron. The interaction with the iron breaks down the structure of the contaminants, becoming harmless," said Philip Prater, senior physical scientist with DOE-SR. "This system is designed to work for decades with little maintenance, as it has in other parts of the country."

According to Prater, the remedial technology being deployed is innovative because it does not involve the use of a trench, and it can be installed at greater depths than permeable reactive barriers built at the site in the past. This technology also allows for precision placement, enabling SRS to intercept the contaminated groundwater plume in a narrow zone as it travels along an old subsurface streambed.



Injecting material containing iron filings into wells at Savannah River is a multistep process. Using 22 wells, workers created a wall three basketball courts in length, about four inches thick, and extending 135 feet below the earth's surface at its deepest point. The porous wall neutralized degreasing solvents, like those found at dry-cleaning stores, as groundwater passed through.

SRNS workers mixed more than 1.5 million pounds of iron filings with a food-grade, starch-like material, shown here.

To create the wall, SRNS subcontractors mixed large amounts of a food-grade, starch-like material with 1.5 million pounds of iron filings, which are ground-up iron parts from reclaimed automobile engines. The workers then injected the material into 22 wells, 12 feet apart, within the aquifer. The high-pressure injection creates fractures in the subsurface sediment, creating space to be filled by the mixture.

"Incredibly, the weight of this reactive permeable wall is equal to approximately 500 Toyota Prius vehicles," said Mark Amidon, a geologist with SRNL. "This environmental cleanup system is designed to work passively with only routine monitoring."

Prater noted that workers completed the iron injections safely and ahead of schedule.

"SRNS personnel were able to recognize early on and take advantage of cooler air temperatures. The cooler weather greatly improved the volume of iron injected each day," he said. "Further, they ensured excess iron was distributed where groundwater contaminant levels were the highest, which provided improved remedial effectiveness."

"This highly efficient environmental cleanup technology is another asset within the arsenal of environmental restoration tools assembled for use across SRS," said Amidon. "It's an 'environmental war' on hazardous waste, and we're winning it." ⊠