By Mike Larson

Just-in-Time Dredging Pulls Out Toxins

A nine-year, $600-million riverbed remediation in northeastern Wisconsin—the world's largest river cleanup of its kind—is proving that dredging doesn't have to be drudgery. Operating in a mode more akin to just-in-time manufacturing and with laser-like precision, contractors there are using a very efficient system of mapping, dredging and filtering river sediment as they clean up 13.3 miles of the lower Fox River near Green Bay, home to the largest concentration of pulp and paper mills in the world.

Over the course of the nearly decade-long project, the massive cleanup will dredge and process 3.8 million cu yd of sediment contaminated with polychlorinated biphenyls (PCBs) to levels reaching 3,000 parts per million. PCBs cause severe health problems for wildlife and are considered a probable human carcinogen. The U.S. Environmental Protection Agency and Wisconsin Dept. of Natural Resources (DNR) mandated the cleanup after identifying eight companies that had flushed 700,000 lb of PCBs into the river from the 1950s to the 1970s, mostly while making and recycling carbonless duplicating paper.

Three of the companies—Appleton Papers Inc., Georgia-Pacific and NCR—have formed the Fox River Cleanup Group and are entirely funding the $600-million effort. The site is on the federal Superfund program's National Priorities List.

In March 2008, the group named Tetra Tech EC Inc. prime contractor. The contract required full-scale sediment processing to begin by EPA's and DNR's deadline of May 1, 2009. That meant the company had to select its team and design, build, equip and commission a processing plant in about a year. Tetra Tech EC, Morris Plains, N.J., is the environmental division of Tetra Tech Inc., Pasadena, Calif.

To fix 600 acres of contaminated riverbed that can't be dredged effectively, the Tetra Tech team will contain silt with contamination levels up to 50 ppm in place by capping it with combinations of sand, gravel, and rock ranging from 6 in. to 33 in. thick. Dredged slurry now is pumped directly to a custom-designed, computer-controlled processing plant that removes debris and sand before squeezing the water out of the contaminated silt to make a dry filter cake that is landfilled.

Sand removed during processing is washed and tested to be sure it meets cleanliness standards, then reused as fill or sold for other beneficial reuse, such as making concrete. The water removed from the slurry during processing is highly filtered, then used in the processing plant or returned to the river.

The project's objective is to cut costs by capturing only the contaminated silt. "The PCBs adhere to the organic silt in the river, so that's what you need to landfill. There's no use in excavating and processing more silt than necessary, and there's no sense in incurring the expense to landfill any more sediment than you need to," says Ray Mangrum, Tetra Tech's vice president of remediation and project manager. "We are dredging and processing only the amount of sediment necessary."

Tetra Tech's plan has resulted in a total cost of about $160 per cu yd, including landfilling. Overall, it will cost $50 million to $100 million less than other cleanup methods, the company claims. The cleanup will take nine years to complete, with crews dredging 24 hours a day, five days a week, from April to November, depending on the length of Wisconsin winters. Covering and capping will run 10 hours a day, five days a week.

"This is the largest cleanup of its kind in the world," says Bruce Baker, a Wisconsin DNR administrator who oversees the project. "For a U.S. river with contaminated sediment, nothing before has even come close in volume moved and processed."

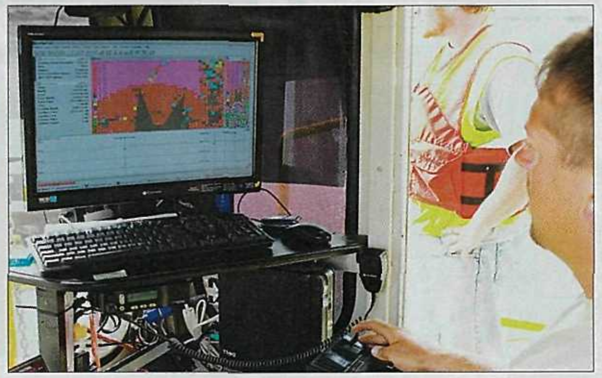
Keeping Material Moving

Work begins with three hydraulic-suction dredges that excavate contaminated sediment from the riverbed. A 12-in. dredge works areas that need high production, and two 8-in. dredges work smaller areas and finish-cut behind the larger machine. Continuous runs of high-density polyethylene pipe carry the slurry directly from the dredges to the processing facility up to 10 miles away. Barge-mounted booster pumps positioned at every mile keep the flow at up to 6,000 gallons per minute, or about 150 cu yd of sediment per hour.

The pipelines from the dredges connect directly into the processing plant without a buffer pond, an unusual method that requires precise coordination between the dredges and processing plant to keep the slurry flowing smoothly. Computerized controls, expert operators, and good communication are needed to make the system work efficiently.

"Although hooking the dredges directly into the processing plant requires precise flow control, it is faster and cheaper than using a buffer pond," says Steve McGee, another Tetra Tech vice president. "In this case, it also eliminates the problem of having an open pond hold contaminated material near stakeholders and the public."

The cleanup is making extensive use of computerized mapping and project controls to define areas that need remediation, guide precision contour dredging, and verify the results. Before dredging started, engineers and scientists used a combination of GPS, multibeam sonar, laser scanners and aerial orthophotography to map every inch of the river, shoreline and re-



▲ **Cleanup Crew.** Clockwise from top, Tetra Tech's Ray Mangrum, left, and Steve McGee; an operator dredges by computer; HDPE pipe delivers slurry directly from dredge to processing plant.

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