Trying out carbon to treat toxic sediment

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On the surface, Canal Creek looks like a postcard Chesapeake Bay tributary, with red-winged blackbirds swooping over the tidal marsh lining its banks.

But the creek flows through Aberdeen Proving Ground in Harford County, where for decades the Army produced and tested chemical weapons, and dumped its wastes indiscriminately. The creek's bottom and the marsh muck are riddled with toxic chemicals like PCBs, pesticides like DDT and metals including lead and mercury. Fish and turtles in the creek are tainted as well.

Now, researchers are working in the creek to test a new use for a familiar substance, activated carbon, to see if it can "lock up" the contaminants left in the sediments by long-gone practices. Scientists and the military hope a pelletlike form of the material, which is commonly used in water filters, may one day help rid the Chesapeake and other polluted water bodies of troublesome toxic hot spots that pose a threat to fish, wildlife and people.

It is one potential approach the Army is studying to help with many of its contaminated sites. It may be years yet before the Pentagon settles on how to proceed on all of the hot spots.

Ben Amos and Ken Cerreto, senior scientists with Exponent, a California-based consulting firm, slogged through knee-deep muck in the marsh one steamy day last week to check on the SediMite pellets they had spread at selected points along Canal Creek in frozen

December. They shoved clear plastic tubes into the water and mud, capped them and tugged them out, filled with a foot or more of dark gunk.

"We think we see some changes in the color here that say there's still some carbon here," said Amos, holding one tube up. A good sign, he explained, that the pellets persisted through winter and spring.

Amos then drove the samples to the University of Maryland, Baltimore County for a scientific analysis of how the pellets are working. There, Upal Ghosh, associate professor of civil and environmental engineering and SediMite's co-developer, will test to see whether contaminants in the muck have been reduced from levels before the field trial began. He'll also assess whether worms exposed to the mud are picking up as many toxic chemicals.

Activated carbon is widely used to treat drinking water and to keep aquariums free of impurities. Although it can bind itself to certain chemicals and effectively remove them from water, getting contaminants out of sediments is far more challenging. Carbon in its raw form is a powdery substance that would easily wash away if put in open, flowing water, Ghosh explained.

So, in collaboration with Charles Menzie, a principal scientist with Exponent, Ghosh came up with a way to form pellets made of activated carbon mixed with clay and sand. The pellets sink to the bottom and work their way into the sediments - where the contaminants are - before eventually breaking up.

After a series of promising lab tests, the collaborators have been trying the pellets out in real-world conditions, including two contaminated sites in the bay, both military installations. The other is at Fort Eustis near Newport News, Va.

Aberdeen Proving Ground was selected for a field trial in part because, with its history of chemical weapons production and of testing explosives, the 72,000-acre base has multiple contaminants in sediments. The 13,000-acre Edgewood area bordering the bay and the Bush and Gunpowder rivers has so many hot spots, the entire peninsula is classified as a federal Superfund toxic waste cleanup priority.

SediMite is being tested in two spots along Canal Creek. One is the tidal marsh, which has elevated levels of PCBs, or polychlorinated biphenyls, at one time a widely used electrical insulating material that's since been shown to cause cancer in lab animals, as well as other serious health effects. At the other site further downstream, mercury, a potent neurotoxin, lurks in the sediments.

Fish and turtles from Canal Creek had elevated levels of both contaminants in them, according to a 2008 public health assessment of the proving ground by the federal Agency for Toxic Substances and Disease Registry.

Fish get toxic chemicals in their bodies by eating worms and clams that have lived and fed in the contaminated sediments. There's a risk to humans as well from eating fish and wildlife that's been in the area. Even when contaminant levels are relatively low in the wild, they tend to increase as more of the tainted food is consumed.

In lower Canal Creek, red-winged blackbirds and other marsh-frequenting birds are at risk of picking up mercury from the bugs they feed on, said Cindy Gilmour, a senior scientist with the Smithsonian Environmental Research Center in Edgewater, who is handling that portion of the field trial.

Lab tests have shown that the activated carbon in the SediMite pellets binds with the mercury, she said, and keeps it from getting into the water

saturating the sediments.

"This is hopefully a technique to fix sites that are contaminated but not massively contaminated," Gilmour said.

Until now, authorities responsible for cleaning up toxic contaminants on stream or river bottoms had few options. They could dredge them up, a costly and messy remedy that damages and even destroys natural habitat for fish and wildlife.

"Experts cannot agree on whether it's going to make things better or worse," Ghosh pointed out.

Other times, tainted sediments can be "capped" with a layer of clean clay or sand. It's a practice similar to what the Maryland Port Administration is doing to an upper portion of the Masonville Cove area in Baltimore. But that also can alter the ecosystem and may still release contaminants into the water if disturbed by a storm or some subsequent human activity.

All too often, though, fouled areas just sit, closed to fishing and swimming while they await a remedy and money to pay for it.

"The beauty of the work that Ben and company are doing is it's an application that's noninvasive and won't destroy the ecosystem that is there," said Allison O'Brien, an environmental protection specialist at the proving ground. Plus, she added, it can be applied in areas that are hard to get to, like a marsh. They're applied to a contaminated marsh or stretch of water by spraying them out of a commercial fertilizer spreader.

Two months after putting SediMite on a patch of wetland at Fort Eustis in 2009, Ghosh said, the researchers measured an 80 percent decline in

PCBs in the worms and clams exposed to treated muck. The trial under way at Aberdeen will help test how long the carbon keeps working, the UMBC engineer said, and a parallel study will look to see if the carbon itself has any untoward effects on the bottom-dwelling clams and worms, or on aquatic vegetation.

Activated carbon treatment probably won't be suitable for all contaminated sediments, particularly if there is continuing pollution or some likelihood of disturbance, Ghosh cautioned. Dredging may still be the only way to deal with badly fouled spots. But for less severely tainted sediments, as are more widely found in Maryland waters, he said, treating them with a layer of activated carbon - perhaps in combination with some kind of a clay or sand cap - may be an effective cleanup remedy.

Meanwhile, signs posted along Canal Creek warn anglers who may fish there not to keep what they catch.

Amos, 31, said he hopes to live long enough to see those signs come down.

"If the right remedies or group of remedies are selected for cleaning up Canal Creek," he suggested, "in a few, 10 or maybe 15 years, you could come back here and catch fish free of contamination."