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## LIFESTYLE

# Low-Head Dams: Danger Below

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On July 18, with the Saturday afternoon heat index broiling just shy of 100 degrees, half-brothers Anthony Martin and JoJo Welch went down to the Olentangy River with a couple of friends to find respite in the water. They took a trail on the east side of the river, emptied their pockets and left their bikes and Welch's skateboard in a nearby tunnel before wading into the cool currents. It was a group of young guys, horsing around, having fun. They might have missed the red warning signs near the dam, readable from both directions, which read, "Danger Dam Restricted Area, Drown Hazard."

Not long after he got in the water, Martin, 20, went over the Dodridge Street low-head dam. Welch, 18, reacted almost immediately, his sandy hair disappearing in the churning waters as he dove after his trapped brother, who could not swim. Neither brother resurfaced.

"When we first found out, we didn't think it could be them," says their uncle, Brian Sailor. "I was in shock. It broke my heart."

Around 7:30 p.m., Columbus firefighters dispatched two boats to begin what would become a days-long search for Martin and Welch. A police helicopter found Martin's body first, about three miles downstream next to a small river island south of the West Goodale Street overpass. The dive team found Welch around noon the next day near the Third Avenue bridge.

Relatives thought of Martin and Welch as brothers-not half-brothers-because they were so close. Martin worked as a car detailer and helped an elderly family friend with errands. Welch, who'd dropped out of high school, seemed to be turning his life around, working on his GED and spending time with his girlfriend.

"He was always my best friend, my go-to person," says cousin Christina Jarvis, 27, of Martin. "He had a lot of friends who cared for and adored him."

Following Martin and Welch's funerals, as well as a candlelight vigil near the river, their aunt Barbara Sailor began collecting paperwork to petition for a bill that would close off the tunnel and mandate buoys or safety lines on all Ohio waterways. "To me, he's a hero because he jumped in after his brother," Sailor says of Welch. She wants to name the proposed legislation the A.J. Law, in honor of her nephews and in hopes it will put an end to future injuries and deaths at low-head dams.

Though their usefulness faded decades ago, low-head dams are a lingering threat to people and wildlife. Since the 1950s, at least 441 people have died at 235 submerged dams in 38 states. About half of those deaths occurred in the past 15 years—a period in which many cities have sought to repurpose their rivers into picturesque attractions that would draw tourists and shoppers to business districts. With 14 fatalities, Ohio ranks high among states with the most recorded deaths from low-head dams, according to data compiled by Brigham Young University.

Ohio is estimated to have between 200 and 1,000 of these dams, a range that speaks to their oddball, often remote locations on a mix of public and private properties.

It's expensive to mitigate or remove low-head dams; they often conceal utility lines that would be expensive to relocate. Yet they are also minimally regulated in Ohio, where environmentalist organizations are often the voices agitating for their removal. On private property, owners are encouraged but not required to post warning signs or buoys.

Sixteen low-head dams remain in Franklin County, according to the Ohio Department of Natural Resources. Since 2002, the number of low-head dams on the Olentangy River has been reduced from 11 to five, but activists say more needs to be done to make rivers safer for people and less destructive to the environment.

The dams, dubbed "killer dams" and "drowning machines" by critics, can be dangerously misleading. Most onlookers observe a scenic, harmless-looking waterfall, but a submerged hydraulic jump forms deadly whirlpool-like currents.

"As water goes over the dam, it may carry velocities even higher than Olympic swimmers [can] swim out [of]," says Bruce Tschantz, a leading researcher on low-head dams and a professor emeritus of engineering at the University of Tennessee-Knoxville.

Tschantz says the foamy bubbles generated by the dam means the water is highly aerated, creating very low buoyancy. "You're using your hands, but you're only kicking foam," Tschantz says. "You're in an environment where you can't swim out and you can't stay up."

Those who fall into low-head dams experience what feels like 200 to 300 pounds of water dumped on their head and shoulders. Even for the few who manage to break free, the powerfully rotating undertow currents pull victims back in, Tschantz says.

The hazardous hydraulic conditions vary depending on the depth of the water and speed of the flow-has it been raining for days, or did a soaking thunderstorm move through earlier in the day? A dam may be less dangerous in the morning but deadly by afternoon, Tschantz says. The dam's circulation also erodes sediment at the base, increasing rotation while deepening the riverbed. Victims can also be injured when they strike rocks, logs and other debris that become caught in the dam.

"Most people underestimate the power of the water and overestimate their power to escape," Tschantz says. "It looks smooth, it looks inviting, and it doesn't look dangerous."

Typically built in the 19th and 20th centuries, submerged dams used America's waterways to power gristmills and sawmills, generate electricity and store water for agricultural irrigation.

As those industries shrank or technology advanced and demand for low-lying dams diminished, thousands of these masonry structures were abandoned across the country.

"They were built a long time ago, and no one has taken the initiative to remove them," Tschantz says. "Often there's no clear ownership for someone to take responsibility."

Though state Department of Natural Resources engineers conduct more than 350 inspections of dams each year (dams are inspected on a five-year cycle), inspections are not required for most low-head dams because they typically don't meet the minimum size requirements set by the state. Neither the state Environmental Protection Agency nor the Department of Natural Resources is actively working to remove dams. Many low-head dams are located on private property, in which case property owners are encouraged to post warning signs, apply for grants to pay for warning buoys and work with nonprofit organizations to secure funding for dam remediation or removal.

Only a few states-Pennsylvania, Illinois and Virginia-regulate public safety at and around low-head dams, according to a 2014 survey sponsored by the Association of State Dam Safety Officials and conducted by Tschantz.

Aside from their threat to human safety, low-head dams have been causing a deluge of ecological problems for decades, conservationists say. They stifle fish migration up and downstream, degrade the river's chemical quality, increase the water temperature and starve fish of oxygen. Dams also blockade the dispersal of freshwater mussel larvae, called

glochidia, which depend on fish. The young mussels hitch a ride on the fish's gills in a parasite-host relationship for six to eight weeks, before dropping off and forming a new mussel bed far from their starting point. The presence of mussels-considered a pollutant-intolerant species-can be a strong indicator of healthy water quality conditions. But a freshwater mussel survey taken in 2005 indicated the Dodridge Street dam had the least diverse mussel community, with just six species collected.

"The environmental impact is really huge, all the time," says Laura Fay, who chairs the science committee for local group Friends of the Lower Olentangy Watershed (FLOW), which has raised money for dam removal and modification. In 2012, the group worked with the City of Columbus, Ohio State University and the Ohio Environmental Protection Agency to complete the removal and begin restoration of the Fifth Avenue dam, built in 1935 to cool Ohio State's power plant water.

Removal of a dam can bring nutrients and lush vegetation back to the flood plain, but experts say a lot of variables should be taken into account. "You can't just knock a dam down, because the sediment might contain PCBs (polychlorinated biphenyls), metals, maybe even arsenic, like in the mill towns in New England," Tschantz says.

One example of a dam removal gone wrong occurred in the 1970s. For decades, two General Electric plants in upstate New York had discharged an estimated 1.3 million pounds of PCBs, into the Hudson River from its capacitor manufacturing plants at Hudson Falls and Fort Edward above the Federal Dam at Troy.

By the time the Fort Edward Dam was taken out, flooding transported the accumulated PCB-contaminated sediment downstream. It was an environmental catastrophe, and by 1984, a 200-mile stretch of the river had been placed on the federal EPA's National Priorities List of the country's most contaminated hazardous waste sites.

As for FLOW, the group conducted water-quality studies to look at the physical, chemical and biological attributes of the Olentangy River near and around the 8-foot high concrete dam at Fifth Avenue, and found the river did not meet quality standards. FLOW, which developed the Lower Olentangy Watershed Action Plan in 2003, recommended the dam be removed. Doing so would increase dissolved oxygen levels (making it easier and better for fish to breathe), unblock sediment flow backed up by the dam and increase fish migration, they reported.

When the Fifth Avenue dam was dismantled in 2012, it joined the list of more than 50 dams removed in Ohio since 1973. In total, the project cost about \$6.9 million; it took \$200,000 to remove the dam. Some of the funds were allocated to create four large wetlands, establish native vegetation, and reconstruct river features and infrastructure such as storm-water outfalls. The cost was shared by Ohio EPA, Ohio State and the city.

During the 1980s, two teenage boys from Bexley drowned while body surfing over the Wolfe Park dam on Alum Creek in Bexley. "The drownings," says Jerry Holloway, vice president of watershed preservation group Friends of Alum Creek & Tributaries (FACT), "that seems to tug at people's heartstrings more than the water quality. How does one market taking out a dam that's been there for 60 or 70 years? What angle do you take?"

After a three-year effort, FACT in 2008 won \$250,000 in federal grants for removal of two low-head dams on Alum Creek near Wolfe Park and Nelson Park. Holloway criticizes the government for not taking a more direct role in the project. "If you're the EPA, I don't know why you don't just walk in there and take the dam out," Holloway says. "Instead, they dropped this grant on a nonprofit group, and we did all the due diligence."

In the last 10 to 15 years, there has been a swelling movement to remove low-heads dams, says Marcelo Garcia, an engineering professor at the University of Illinois at Urbana-Champaign and leader in the field of river mechanics.

Despite growing efforts to gut existing low-head dams, obstacles remain. For instance, city officials say the five low-head dams on the Olentangy River won't be removed any time in the near future because they contain sanitary sewer lines. A December 2005 report estimated the cost for the full removal of those dams would be \$44 million. The cost, plus an increased potential for sanitary lines to overflow, "make this option not feasible," according to the report.

When low-head dams act as utility conduits, the removal process is bogged down as urban planners and conservationists alike wait for new technologies that would ease the burden of realigning utility lines or retrofitting utility-laden dams more economically, Fay says.

In the meantime, alternative (and sometimes less expensive) repair methods are emerging that make low-head dams safer and more eco-friendly.

Rock ramps-also known as rock arches-eliminate the hydraulic vortex by creating a slope directly downstream of the dam crest and converting the water into rapids. Arranging rocks on the downstream side also allows fish to more easily swim up and over the dam. In Toledo,

a group called the Highland Park Dam Mitigation Project installed a rock ramp at the low-head dam on Swan Creek near the South Avenue bridge, at a cost of \$227,000—a fraction of the potential cost to remove the dam.

In Columbus, FLOW applied for a \$10,000 grant from the Create Columbus Commission to study the introduction of rock ramps to Central Ohio, Fay says. Although the group didn't receive the grant, Fay believes the city is further investigating the usage of rock ramps. She also says greater analysis for each dam will be necessary to determine the best retrofit option.

Some states have turned their low-head dams into communal attractions by constructing a series of small, gradual drops. This method, called step-pool remediation, dissipates the water energy and breaks up the churning, Garcia says.

Another approach: fish ladders or diversion channels. The structure's engineered design can improve fish migration by providing passage over or through the obstructions posed by the dam. Fish "climb" the ladder by jumping from pool to pool, but it is not always effective for species that don't tend to jump.

Garcia and his students designed canoe chutes or boat passages to allow kayakers to pass safely through the low-head dam and improve safety for waders and fishermen. "If for some reason you get to the dam and your canoe flips over, they should be able to walk out of the water," Garcia says.

While removal of all low-head dams doesn't seem like a possibility yet, two low-head dams were removed from the Olentangy in Delaware in August. Neither had warning signage.

"These two were the most challenging since they're on private property," says Kristin Piper, watershed coordinator for nonprofit organization Olentangy Watershed Alliance.

Because the dams were located on a designated state scenic river, extra steps, like conducting a historic, cultural and mussel survey, were required, Piper says. The entire removal process has taken five years to complete. A grant from the Ohio EPA helped pay for the \$70,000 dam-removal project. In the past decade, the City of Delaware has knocked down six low-head dams at a cost of about \$310,000.

So far, Delaware's waterways are reaping the environmental benefits. An abundance of fish and insects that tolerate pollution is an indicator of an unhealthy stream, but Piper has seen a growing number of pollutant-intolerant species in the river.

Communities working in partnership with nonprofit organizations and state and federal agencies removed 72 dams in 19 states in 2014, according to American Rivers, a national river conservation group. Five of those removals were in Ohio, adding to the 1,185 dams removed across the U.S. since 1912.

Finding a balance between public and environmental safety can get thorny when dam owners and community members don't want their dams removed. Garcia says residents in Yorkville, Illinois, felt a strong sense of nostalgia for a 1960s-era dam on the Fox River. The dam's spillway has since been modified with four concrete steps, a fish ladder and a bypass channel for kayakers and canoeists.

"Usually the people who want the dams removed don't live near them," Garcia says. "There is almost an emotional attachment."

But Garcia says there's one driving force behind all of this: liability. Tschantz agrees, questioning the legality of having low-head dams present on waterways as a hidden and concealed danger rather than an open and obvious hazard.

Tracy Smith, Columbus Fire Battalion Chief, didn't think the number of people falling in low-head dams is "as much as people think it is." Smith says in the last couple of years, she could recall only "one or two specific incidents" related to low-head dams.

"There are many inexperienced boaters that go out on higher water because they think it's going to be fun," says Eric Reed, a training coordinator with the Department of Natural Resources Division of Watercraft. By the time Reed and his team arrive onto a scene, it's often too late. He's never rescued a survivor.

Barbara Sailor knows it's unlikely Columbus' remaining low-head dams will be removed any time soon, but that's not stopping her from petitioning to mandate buoys or safety lines at all low-head dams for imperiled boaters or waders. Sailor says she will need about 187,000 signatures to present the issue to the Franklin County Board of Elections.

"It's just going to keep happening and keep happening until something changes," she says.

But Tschantz says most of the positives and negatives relating to dams can't be put into tangibles. It's based on emotional issues.

Says Tschantz: "What's the value of a life? Is it one million dollars? Is it infinite?"