Research aims to cool runoff to protect coldwater streams

September 10 2009, by Bob Mitchell

(PhysOrg.com) -- The ocean of stormwater that flows off of the sun-baked urban landscape is packing heat, and trout are starting to feel it.

"When it rains, heat energy from rooftops and streets gets transferred to the runoff and is carried directly to storm sewers and to coldwater streams, raising the temperature," explains Anita Thompson, a University of Wisconsin-Madison associate professor of biological systems engineering who works to mitigate stormwater problems.

"Species like trout have very specific temperature preferences, so increases in stream temperatures can be lethal," she adds.

Groundwater comes to the surface at about 51 degrees, and the area's trout species have acclimated to that, explains Scott Stewart, a wildlife biologist with the Wisconsin Department of Natural Resources.

"Runoff from the first part of a rainstorm could be 100 degrees, much warmer than what those fish have adapted to," says Stewart, who notes that brook trout, the most temperature-sensitive, can tolerate temperatures into the upper 60s.

The problem isn't just water temperature, but also volume, adds Jeremy Balousek, an engineer with Dane County's land and water conservation department.

"Many of these streams have a very low base flow — as little as 2 cubic feet per second. During a large storm, the runoff from an urban area might flow at 30 cubic feet per second," Balousek says. "If the runoff water is hot, it's going to raise the temperature of the stream."

About a third of Dane County lies in the watersheds of thermally sensitive streams. A developer who wants to build in one of those areas must first determine if there will be a thermal impact, and if so, have an approved plan to mitigate the problem, Balousek explains.

About 10 years ago, UW-Madison researchers began work on a computer model to help with such an evaluation. Thompson is now refining that model, making it more user-friendly, incorporating new data about runoff rates and volumes, and developing uniform criteria for using the model to ensure consistent results.

To collect data, she set up plots of asphalt and sod at the university's West Madison Agricultural Research Station, with sprinklers to simulate rainfall and probes to record runoff, temperatures of surface, runoff and rainwater, solar radiation and other information.

"The goal was to understand how much asphalt and sod heat up during the summer and how both of those surfaces transfer the heat to runoff," she explains.

She found that the asphalt surface in her plots got up to 133 degrees, while the runoff from that asphalt reached temperatures of about 108 degrees.

Thompson also collected data on a common mitigation practice, an underground rock-filled chamber, or crib, used to cool down stormwater. She built a miniature stone crib in her lab so that she could control water temperatures and flow rate.

She incorporated data from both experiments into the computer model, which builders can use both to predict temperatures of runoff and, if need be, determine the size of rock crib needed to cool it down. Thompson is now evaluating the model at a 30-acre development in Sun Prairie.

If she needs a reminder of why the work is needed, she can follow the runoff from that development to where it flows into Token Creek, one of the county's most threatened coldwater streams.

"Right now less than 10 percent of the surface in the Token Creek watershed is impermeable," says Balousek. "Projections show that by 2020, that could be up to 30 percent. Once you get over 10 percent impermeable surface you start to see degradation (of the streams). Our job is to mitigate those impacts."

Provided by University of Wisconsin-Madison (news : web)