Mitigating Heat Transfer From Impervious Surfaces To Stormwater Discharge

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BACKGROUND

Mobile Bay (Fig.1) is home to Alabama's seafood industry and provides estuary service for many fish, crustaceans and wildlife. The main stormwater outfall for downtown Mobile flows directly into Mobile Bay. Little is known about thermal pollution attributed to stormwater flow at outfalls to urban receiving waters. The temperature of stormwater runoff (1st inch of flow) moving over impervious surfaces in downtown Mobile, AL has been recorded as high as 48º C during the month of July. (LeBleu, 2011) Many dead juvenile fish and crustaceans have been observed at Mobile's downtown stormwater outfall (Fig.2) due to this thermal pollution.

Stormwater temperature is an essential but overlooked aspect of the urban stormwater condition. As urbanization and build-out occurs, the thermal regime (surface, air, and water) of the surrounding environment is altered. Heated stormwater runoff flows into receiving waters where it mixes and potentially increases the base temperature of the surface water in lakes, streams, bays and estuaries. The amount of heat transferred, and the degree of thermal pollution is of great importance for fisheries management and the ecological integrity of receiving waters. Fish and other aquatic life in particular are most sensitive to thermal pollution. (Galli, 1990)

Figure 1: Aerial view of Mobile, Alabama bay area (al.com)

Figure 2: Downtown storm outflow to Mobile Bay (LeBleu)

Research Aims

Aim 1: Establish benefits of pervious pavements in mitigating thermal heat removal.

Aim 2: Establish a baseline measurement of heat removal effectiveness of pervious material when used as a solitary stormwater control measure.

Aim 3: Establish pervious material role mitigating thermal heat removal when used in combination with other stormwater control measures.

HYPOTHESIS

This project hypothesizes that pervious surfaces and rain gardens can be used to mitigate ground level thermal loads in stormwater runoff.

PURPOSE

Very little has been published on the mitigation of thermal pollution using low impact development (LID) strategies. The LID approach is referred to as creating a hydrologically functional landscape and has been recommended as an alternative to traditional stormwater design. Common LID practices include bioretention areas such as green roofs, rain gardens, grassed swales, and pervious pavements. (Dietz, 2007) Low impact development is the driving force behind the use of bioretention in many parts of the country. (Davis et al., 2009)

Results from this project will be used to establish a baseline measurement of heat removal effectiveness of pervious material when used as a solitary stormwater control measure and when used in combination with other stormwater control measures. This research is significant and unprecedented.

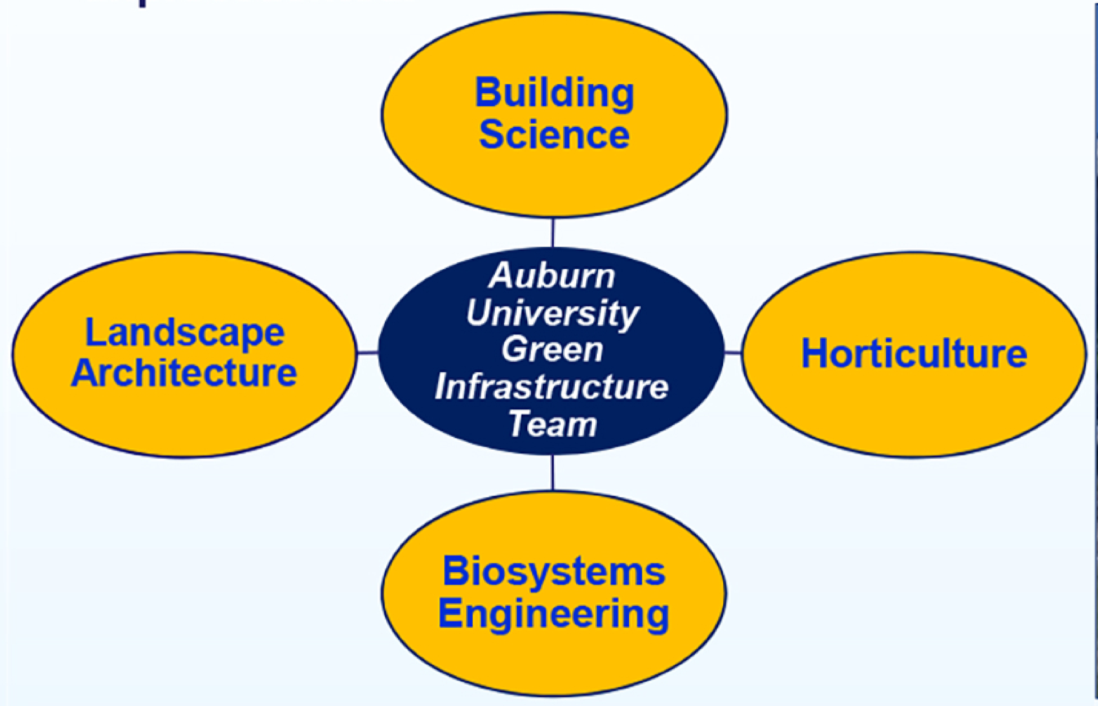

Figure 3: Green Infrastructure Team Diagram

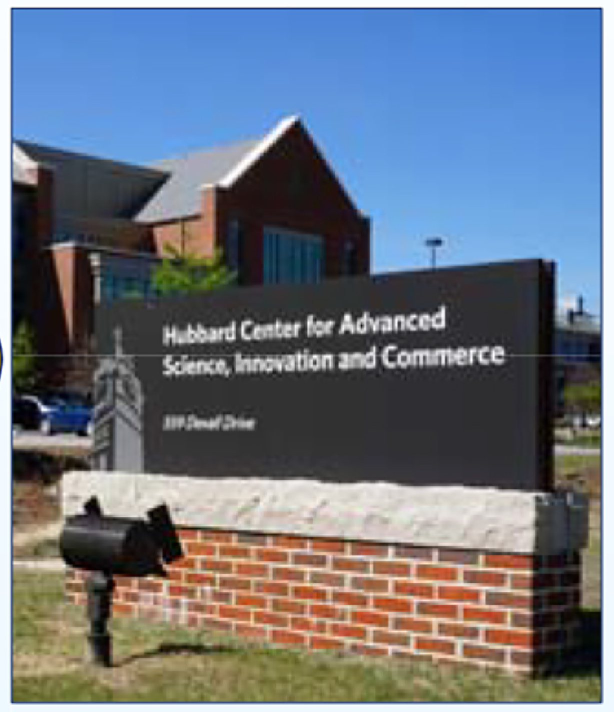

Figure 4: CASIC Building (Rahn)

METHODS

Research will be conducted in the Green Infrastructure Laboratory at the Mike Hubbard Center for Advanced Science, Innovation and Commerce (CASIC) Building at Auburn University (Fig.4). The laboratory provides a controlled environment, and is designed for both wet and dry research. All PI's are members of the AU Green Infrastructure Lab Team (Fig.3).

Test cells are constructed from concrete paving material of the type and thickness typically used in urban areas. Infrared heat lamps are used to heat each cell (Fig.5). A simulated rainfall system with irrigation spray heads were installed in each corner of the testing area (Fig.6). The cells are designed to simulate the appropriate installation method, including fill (impervious) or retention (pervious) subbase and soil below the 10 cm thick slabs. They are also designed to capture the simulated stormwater (Fig.7) runoff for impervious materials or allow infiltration for the pervious materials. Unique to this project is using a data logging system (Fig.10a-b) and thermistors located in various locations (Fig.8) within the cells in conjunction with surface thermal imaging using an infrared camera (Fig.11a-b)

Figure 5: Infrared Heaters – Solaira Alpha HI- SALPHA15120 (Rahn)

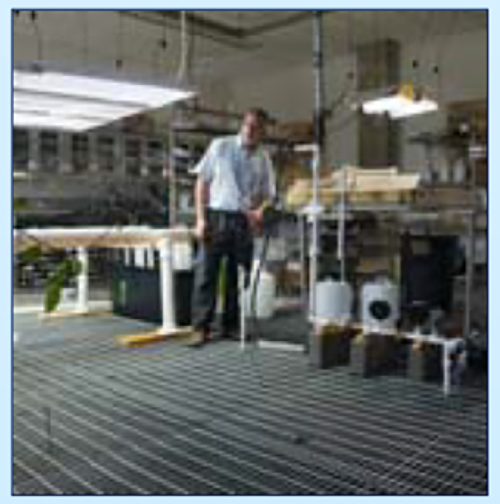

Figure 6: Adjusting Irrigation Spray (Rahn)

Figure 7: Runoff or Leachate Collection Pan w/ Sensor (Rahn)

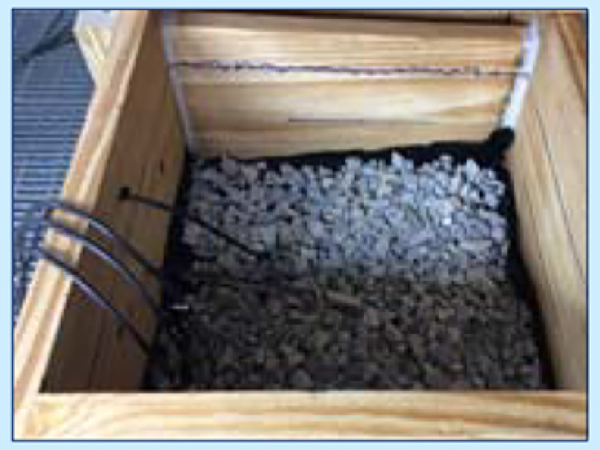

Figure 8: RockTest Thermistors – TH-T (Rahn)

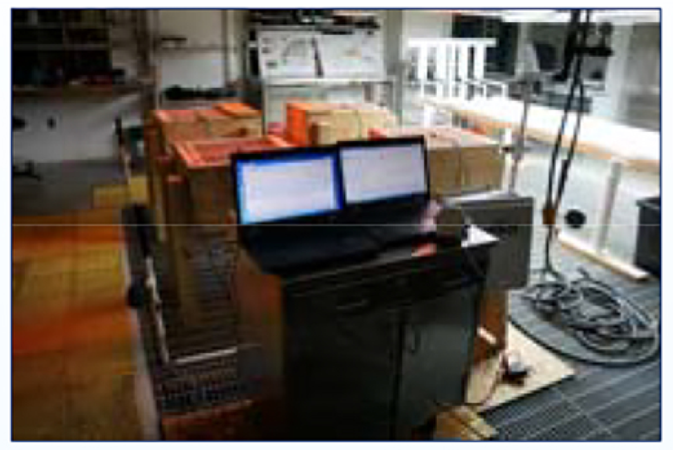

Figure 10a: RockTest™ Automated Data Acquisition System - FR-1137050100 (Rahn)

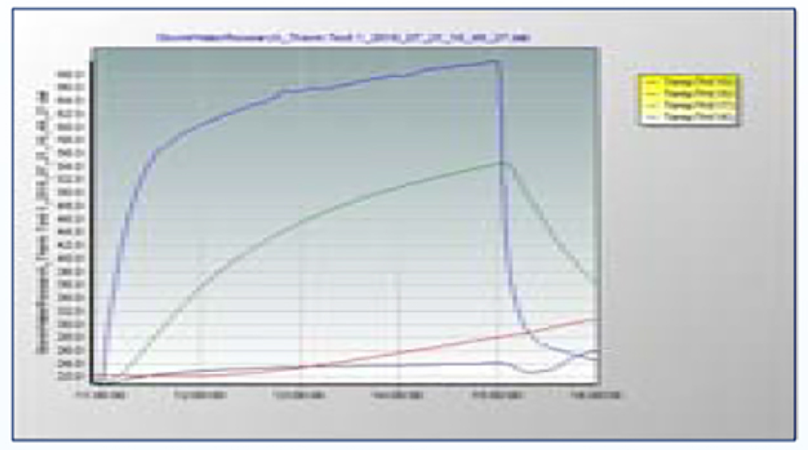

Figure 10b: Test Cell D – Pervious Concrete Results 7/21/16 (Campbell Scientific LoggerNet® 4.4.0.2)

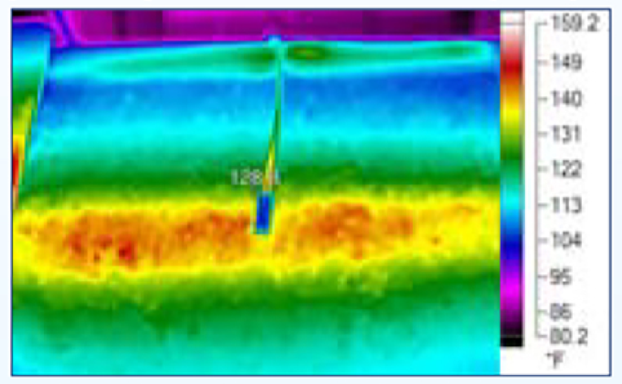

Figure 11a: Thermal Image (Fluke™ Ti32 Camera)

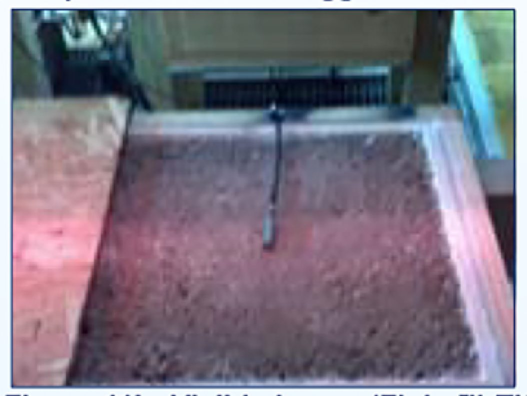

Figure 11b: Visible Image (Fluke™ Ti32 Camera)

CURRENT FUNDING SOURCES

Internal:

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External:

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