UNIVERSITY OF MISSOURI

2015 STORMWATER MASTER PLAN

AUGUST 2015

MU Projects Address Stormwater

As water flows downhill off campus, it collects in Flat Branch and Hinkson Creek. Greater quantities of water gather and flow to those streams when traveling over impervious surfaces such as asphalt or rooftops than it does if soil absorbs the rain. Because of this effect in urban environments, heavy storms cause flash flooding in local waterways. MU implemented the Stormwater Master Plan in 2012 to set goals and provide guidance for future development on campus.

Flooding is not the only problem. “The faster stormwater moves, the more pollutants it picks up and the opportunity for infiltration is reduced,” says Jennifer Sullivan, facilities project manager. Soil on campus might erode away, as might creek beds downstream. Extra sediment and water heated by pavement may change stream habitats. ***CONTINUED ON PAGE 8***

A collaborative adaptive management agreement with the University of Missouri, the City of Columbia and Boone County works to improve the health of Hinkson Creek.

Goals

The University of Missouri Stormwater Master Plan provides an adaptable framework that enables the campus community to improve stormwater quality, maintain regulatory compliance and sustain water resource stewardship. This overall goal is energized by Mizzou’s leading research and innovation engine, a key asset in developing solutions to evolving stormwater challenges.

Objectives

- Identify an optimal set of site-level stormwater controls and guidelines for new and redevelopment projects.
- Pursue a watershed-scale management approach to effectively place stormwater controls, assess contributions and evaluate improvements.
- Provide an adaptable framework that enables MU to address evolving regulations and the needs of local waterways.
- Sustain innovation by integrating Mizzou’s education, research and outreach programs into the stormwater planning process.

BMP Research Grant

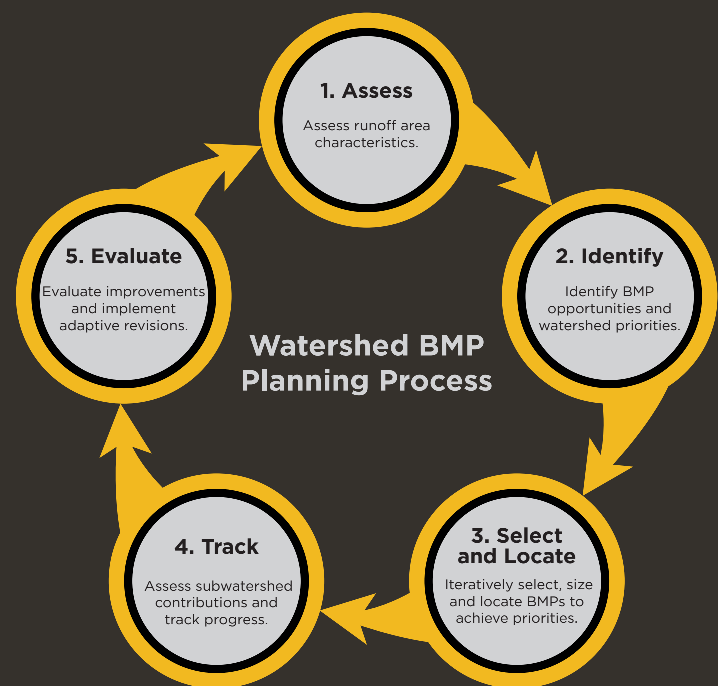
A grant from the Missouri Department of Natural Resources allows MU researchers to study the effectiveness of best management practices (BMPs) on preventing water pollution. MU environmental and bioengineering faculty and students collect and sample water as it enters a bioretention cell near the Animal Research Center, then resample water once it runs through the bioretention to identify what pollutants have been removed.

Students tested different soils and plant material combinations in a laboratory to determine the best mix for the area and extrapolated how other mixtures might perform in different environments. The grant was extended through June 2015 to allow for further data collection from the sites being monitored. Enos Inniss, civil & environmental engineering professor, and Allen Thompson, bioengineering professor, and their student team have found that soil components selection has a strong influence on the effectiveness of treatment and the retention of water on site.

Testing of the soil components required that students construct several soil columns to test different soil mixes, both with and without vegetation present. In addition to collecting and analyzing soil and water samples from the field sites, the student team is researching the effects of different soil mixes on nutrient fate as well as water retention. This research helps MU meet its MS4 permit reporting requirements.

What is a Watershed?

A watershed is the area of land that is drained by a common river, stream or flow path. Small watersheds feed larger ones where two or more streams come together. Locally, the Grindstone Creek watershed feeds Hinkson Creek, eventually reaching Perche Creek, which drains into the Missouri River. An approach that recognizes the importance of managing stormwater according to watershed boundaries is termed the watershed-based BMP planning process.



3-Tiered Approach to Sizing BMPs

Achieving water quality improvements, natural resource enhancements and flood control in urban areas requires a thoughtful balance between controlling sources and treating pollution already mobilized by runoff. Construction of structural BMPs such as rain gardens and vegetated swales helps catch and treat stormwater.

1 Stormwater Treatment

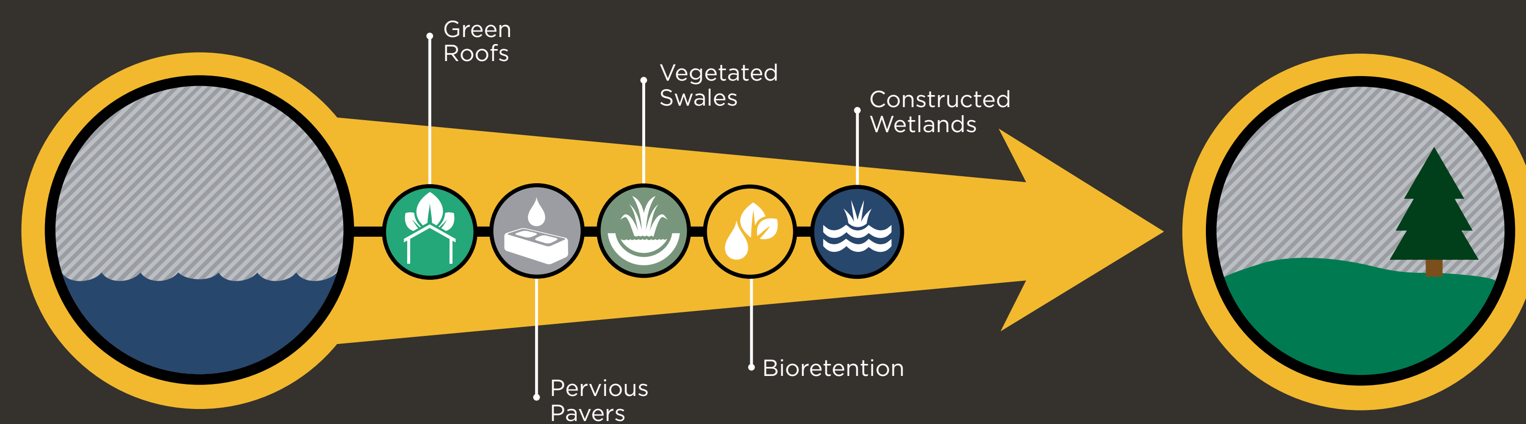
Improving stormwater quality with structural controls requires that runoff be routed through BMPs. Sizing BMPs to effectively capture runoff will reduce pollutants through filtration, uptake and settling processes. An initial BMP-sizing goal is to capture or treat 80 percent of post-construction runoff.

2 Volume Reduction

For sites not constrained by existing infrastructure or environmental conditions, a 10 percent reduction in runoff volume serves as a guideline for new and redevelopment projects.

3 Rate Control

Natural resource agencies are concerned that the frequency of high flow rates in Hinkson Creek are increasing. Preliminary watershed flow-rate reductions could prevent deterioration of aquatic habitat and reduce flooding risks.



Mizzou BMP Model

The University of Missouri uses a variety of BMPs to control stormwater runoff throughout the campus. Pervious pavers, swales, green roofs and bioretentions are among the stormwater practices used to help turn affected areas into environmentally sustainable spaces.

Recent BMPs

Green Roof at Patient Care Tower.
Reduces and slows stormwater runoff.

Pervious Pavement at Traditions Plaza.
Filters pollutants and reduces runoff.

Bioretention at Animal Resource Center.
Reduces runoff by pooling and filtering excess water.

East Campus Stormwater Modeling Case Study

MU engineers are using sophisticated computer models to guide stormwater planning for new and redevelopment projects. A 150-acre watershed located in east campus was selected as a case study area. The goal of the case study was to assess stormwater improvements possible through installation of BMPs.

BMP Planning Options

University engineers modeled three typical situations on campus according to the footprint available for BMP construction. These results are supporting ongoing watershed-based planning and goal-setting efforts.

1 Constrained Situations

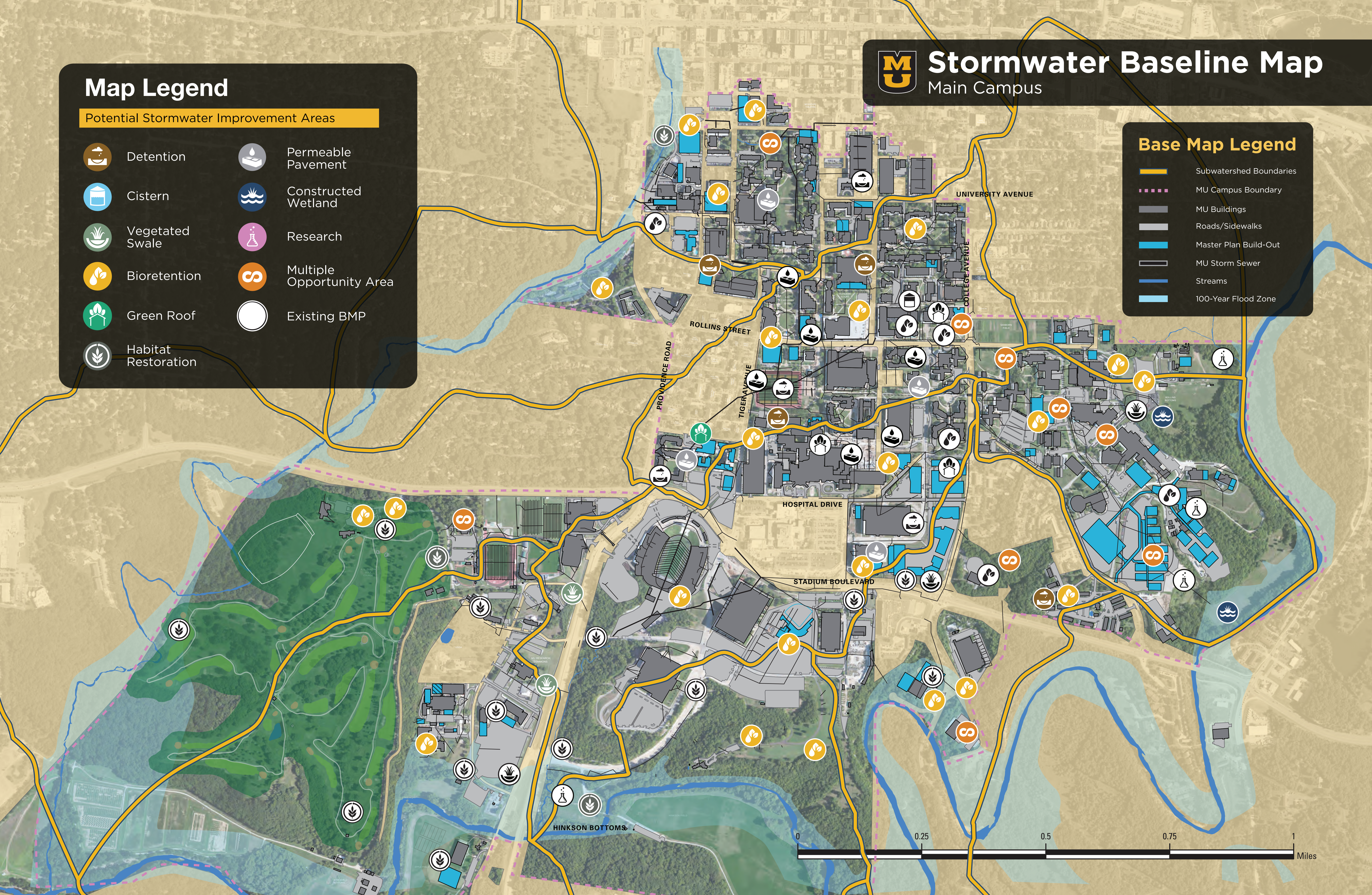
Areas that are highly developed have fewer opportunities for BMPs than open areas. A limited footprint of distributed BMPs for stormwater control is achievable in constrained settings.

2 Moderate Scenarios

Watersheds having moderate open-space but without regional control opportunities. Significant improvements can be achieved with investments in widespread installation of site-level BMPs.

3 Optimized Situations

The addition of a centralized detention basin (regional control) along with distributed BMPs increase watershed-level stormwater control.


Stormwater Baseline Map
Main Campus
Map Legend
Potential Stormwater Improvement Areas
Detention
Cistern
Vegetated Swale
Bioretention
Green Roof
Habitat Restoration
Permeable Pavement
Constructed Wetland
Research
Multiple Opportunity Area
Existing BMP
Base Map Legend
Subwatershed Boundaries
MU Campus Boundary
MU Buildings
Roads/Sidewalks
Master Plan Build-Out
MU Storm Sewer
Streams
100-Year Flood Zone
UNIVERSITY AVENUE
COLLEGE AVENUE
ROLLINS STREET
PROVIDENCE ROAD
TIGER AVENUE
HOSPITAL DRIVE
STADIUM BOULEVARD
HINKSON BOTTOMS
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0.25
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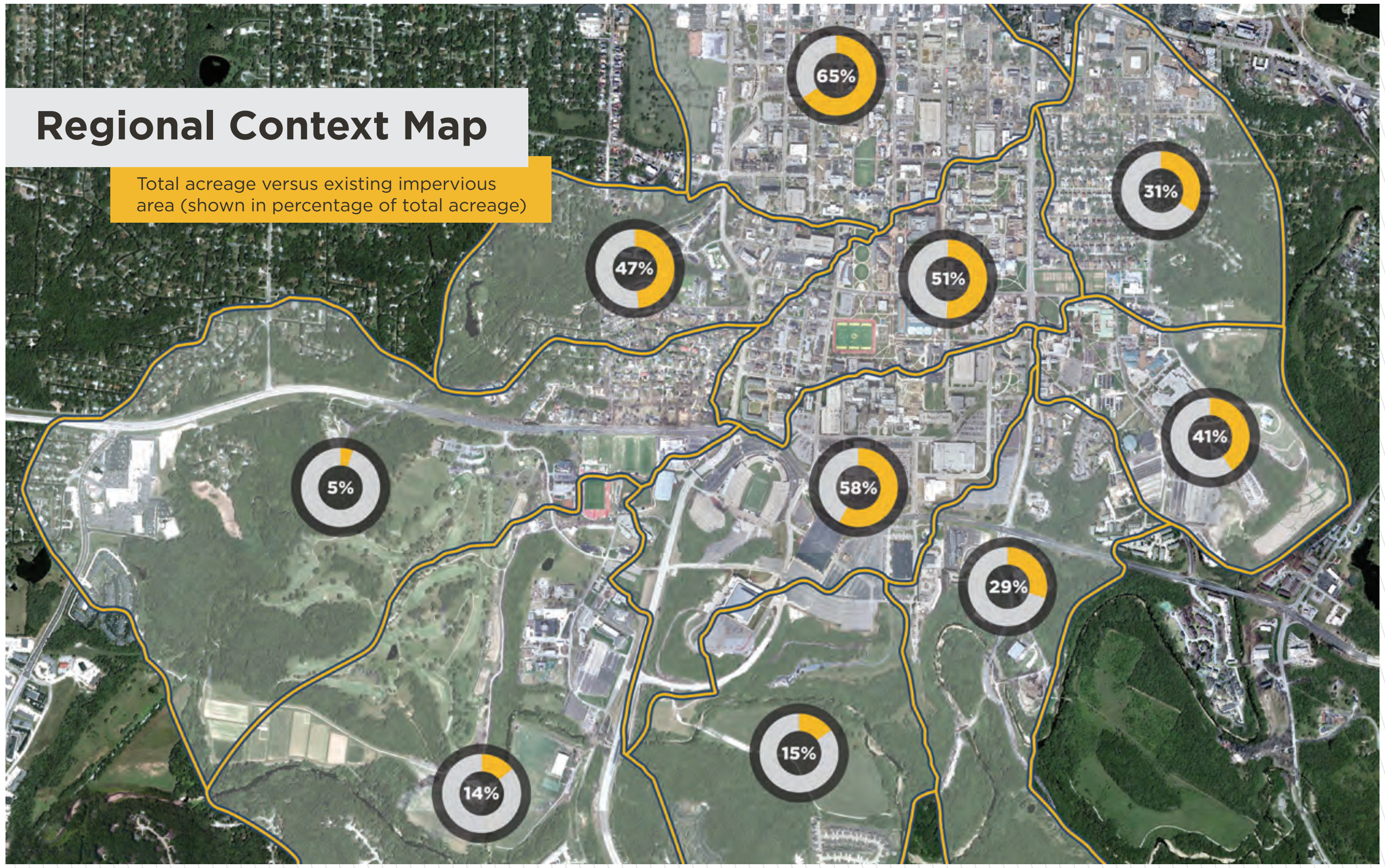
1
Miles



Floodplain Research

Hinkson Creek, which runs through the heart of Columbia, did not meet the standards for a warm water aquatic community, based on the numbers and diversity of invertebrates. Because no single pollutant was discovered for creating the problem, the concept of collaborative adaptive management (CAM) was adopted by the joint stakeholders of the University of Missouri, City of Columbia and Boone County.

CAM is a science-driven, stakeholder-based process for decision-making that allows for a wide range of actions to be investigated, including reducing peak stormwater run-off and reducing the pollution in the run-off, which can contribute to better decision-making over time, thus improving the water quality and biological community.

One of the first steps MU's Gary Ward, vice chancellor for operations and chief operations officer, proposed was to meet with Jason Hubbart, associate professor of hydrology and water quality at Mizzou.

MU Campus Facilities helped to fund Hubbart's research to investigate the impacts of land use/cover changes on hydroclimate, water quality, biogeochemistry and physical-biological interactions in forested, agricultural, and urban ecosystems within the Hinkson Creek Watershed.

Monitoring equipment was installed along two sites adjacent to Hinkson creek, one a remnant bottomland hardwood forest and the other a historical agriculture field. Groundwater samples were collected each month (June 2011-June 2013) to determine chemical composition along the floodplain.

The study, among the first to comprehensively characterize and compare shallow groundwater chemical composition at sites with contrasting land-use histories, showed that the bottomland forest had significantly higher concentrations of nutrients while the ag groundwater had significantly higher concentrations of trace elements. Comparing these samples with those of Hinkson Creek suggests potential (positive) impacts of surface vegetation alteration on soil chemistry and groundwater quality.

Ultimately, Hubbart's research supports the use of floodplain and riparian forests for the conservation of groundwater and surface water resource quality.

MU's Financial Commitment to Stormwater Improvements

2012: **$11,030,167**

- Campus Floor Drain Investigation*
- Stormwater Masterplan & East Campus Water
- South Campus Storm Sewer
- South Campus Storm Sewer Interest on Bond
- Storm Sewer Mapping*
- Repair, Maintenance & Improvement of Storm & Sanitary Sewer Infrastructure*
- Storm & Sanitary Sewer Discharge Corrections*
- Storm Water Management*
- Street and Sidewalk Sweeping*
- Hospital Drive Storm Sewer

2013: **$466,381**

- Stewart and Providence Road Bioretention
- Patient Care Tower Green Roof
- Campus Long Term Water Quality Monitoring*
- Animal Resource Center Rain Gardens and Monitoring

2014: **$201,196**

- Traditions Plaza Permeable Pavement
- Habitat Assessment
- Memorial Union Floor Drain Re-routing to Sanitary Sewer

2015: **$357,654**

- Gateway Hall Bio-Retention
- Wolpers and Johnston Permeable Pavers
- Francis Quadrangle Storm Inlets
- Campus Floor Drain Investigation
- Flow and Sediment Monitoring

*Project began but maintenance continues annually.

Student Research Helps with Mitigation

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To address this problem, stormwater planners at Mizzou now aim to ensure that runoff is not increased and look for ways to improve water quality with each new construction project. Some standalone mitigation projects also have recently been implemented.

A new bioretention basin below the southeast parking lot at Stewart and Providence roads is one example. "Vehicles can leak transmission fluid, brake fluid or oil, and in that leakage there may be things that are harmful," says Pete Millier, director, Campus Facilities – Landscape Services and Mizzou Botanic Garden. A depression in the ground sequesters pollutants, and a portion of the water is kept from washing to Flat Branch. "For us, a few thousand gallons here and there makes a big difference," Millier says. As a bonus, it demonstrates good stormwater practice to the community.

Both Millier and Sullivan say this is not so much innovative as common sense, and a way to further the university's academic mission. A large-scale, collaborative effort among Campus Facilities, the civil engineering department, MU Sustainability and researchers in the forestry department is shining new light on both stormwater monitoring and BMP performance in mid-Missouri. "We are looking at opportunities for stormwater improvement with every project," Sullivan says.

Bioretention basin at Providence and Stewart Roads.

A group of Mizzou students gathered to plant pecan trees near Hinkson Creek on Arbor Day.

Links and resources

1. **MU Environmental Health and Safety**
   ehs.missouri.edu/env/stormwater
2. **Hinkson Creek CAM**
   helpthehinkson.org
3. **Missouri Department of Natural Resources**
   dnr.mo.gov/env/wpp/stormwater
4. **U.S. Environmental Protection Agency**
   epa.gov/greeningepa/stormwater
5. **Stormwater BMP Performance Database**
   bmpdatabase.org

ENVIRONMENTAL STATEMENT

The University of Missouri saved these valuable resources by using 80% recycled paper containing 60% post-consumer waste, processed chlorine free and manufactured with electricity that is offset with Green-e certified renewable energy:

TREES	WATER	ENERGY	SOLID WASTE	GREENHOUSE GASES
1 fully grown	570 gallons	0.5 million BTU	38 pounds	105 pounds of CO_2

Calculations based on research by Environmental Defense and other members of the Paper Task Force

University of Missouri