

A map of Alabama with its watersheds delineated by blue lines and colored in various shades of green, yellow, orange, and purple. The map is the background for the entire page.

# **Auburn University Watershed Center of Excellence Report**

**2008 – 2012**

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ALABAMA AGRICULTURAL  
EXPERIMENT STATION

WATER RESOURCES CENTER

## Introduction

The President of Auburn University, Director of the Alabama Department of Environmental Management, and the Region IV EPA Director along with the Directors of the Alabama Agricultural Experiment Station, the Alabama Cooperative Extension System, and the AU Natural Resource Management and Development Institute, and the Deans of the Colleges of Agriculture and Forestry and Wildlife Sciences all signed a MOU in October 2008 establishing Auburn University as a Center of Excellence for Watershed Management.

AU Center of Excellence for Watershed Management includes affiliations with AU academic units, AU Water Resources Center, Alabama Water Resources Research Institute, Alabama Cooperative Extension System, Alabama Agricultural Experiment Station, Alabama Water Watch, and other interested parties



associated with AU. The Alabama Clean Water Partnership (ACWP) is also an integral part of the Auburn University agreement.

As part of the MOU, the AU Center of Excellence agreed to make a good faith effort to provide assistance to at least ten (10) local stakeholders during the 5-year term of this MOU, and to assist in the development of at least five (5) Watershed-Based Plans that meet EPA's and ADEM's Guide lines for the Clean Water Act 319 Program. The AU Center of Excellence also agreed to assist in the implementation of at least one (1) Watershed-Based Plan (that meets EPA's and ADEM's Guidelines for the Clean Water Act 319 program) such that the actions in the Plan are completed or substantially underway.

The purpose of this report is to provide an update of activities related to the agreement involving the following specific projects:

1. Parkerson Mill Watershed Management Plan- 319(h) NPS Grant (page 2)
2. Rock Creek Watershed Management Plan- 319(h) NPS Grant (page 5)
3. Mill Creek Watershed Management Plan- 319(h) NPS Grant (page 10)
4. Saugahatchee Creek Watershed Management Plan- 319(h) NPS Grant (page 13)
5. EPA STAR Proposal for Center of Excellence for Nutrient Management Practices (page 17)
6. EPA-funded Alabama Wetlands Project (page 21)
7. Tallapoosa Nutrient Numerical Criteria for Wadeable Streams Project NPS Grant (page 30)
8. Alabama Water Watch (page 36)
9. Global Water Watch (page 38)

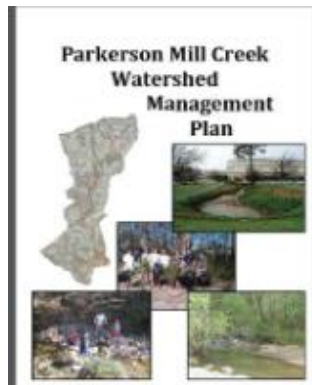
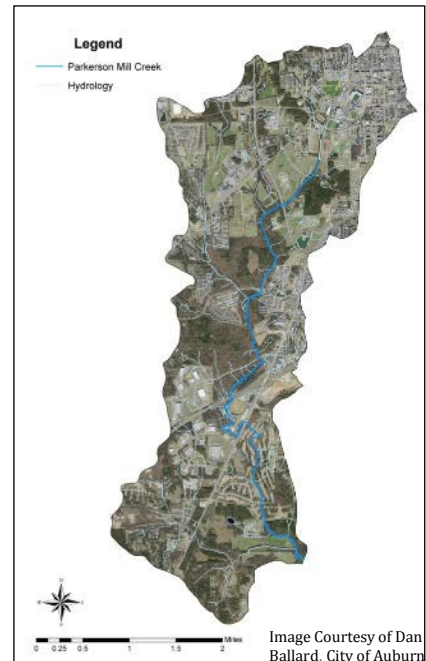


## Parkerson Mill Creek Watershed Project

Parkerson Mill Creek, which flows through a large portion of the Auburn University campus, was first listed on the State's impaired list in 2008 for not meeting minimum water quality standards for its designated Fish and Wildlife use classification. The cause of impairment was identified as pathogens from urban stormwater runoff and storm sewer sources. A pathogen Total Daily Maximum Load (TMDL) was developed by ADEM and approved by EPA in 2011.

The Parkerson Mill Creek Project (PMCP) is a cooperative effort between ADEM, Auburn University, the City of Auburn, the Alabama Cooperative Extension System at Auburn University, the Auburn University Water Resources Center, and other local stakeholders. The project will provide \$179,810 in federal funding, to be matched by \$120,558 in local and in-kind funding. The funding will support the implementation of best management practices targeting pathogens and improving water quality and habitat for aquatic organisms in the Parkerson Mill Creek Watershed. The project will also provide education/outreach opportunities for local citizens and Auburn University students with opportunities to learn about the importance of protecting water quality.

As a designated a Center of Excellence for Watershed Management by the U.S. Environmental Protection Agency (EPA), Auburn University's role in the Parkerson Mill Creek Project will also serve to support a Memorandum of Understanding between the Center, U.S. EPA Region-4, and the Alabama Department of Environmental Management. The EPA program works with colleges and universities to provide communities with hands-on, practical products and services to solve watershed problems, such as pollution control and water availability.



## Parkerson Mill Creek Watershed Management Plan

In 2010, the Parkerson Mill Creek watershed management plan was developed through funding provided by a Section 319(h) Nonpoint Source grant through the Alabama Department of Environmental Management (ADEM). The plan identifies sources of water quality concerns as well as practices that will serve to reduce pollutant loadings to the stream. It also provides focus and direction for stakeholders to effectively and efficiently mitigate pollution from stormwater runoff and protect water quality using a dynamic watershed management approach. Implementation of the plan will coincide with the Parkerson Mill Creek Watershed Project and serve as a source of information. The Watershed Project is a cooperative effort between ADEM, Alabama Cooperative Extension System (ACES), Auburn University, the City of Auburn, and Lee County, along with other local stakeholders. This project will install best management practices (BMP) to protect water quality, provide education to watershed community members that will focus on water quality protection, and provide outreach to local citizens, students, municipal officials, and city employees throughout the watershed. Site selection for BMP implementation will primarily target public properties, such as local government and school properties in the Mill Creek drainage area of Lee and Russell counties.

## Project Funding

The project is being funded in part by the Alabama Department of Environmental Management through a Clean Water Act Section 319(h) nonpoint source grant provided by the U.S. Environmental Protection Agency - Region IV. Auburn University will be administering the grant, which will provide 60% of the overall project cost. The remaining

40% of project cost will be supplied by “in-kind” matching services from local government, volunteers, and Auburn University. The Section 319(h) Program is a non-regulatory program that relies on local project partners to address impaired streams, with the ultimate goal of improving water quality.

### **Parkerson Mill Creek Website**

The Parkerson Mill Creek website provides links to the Watershed Management Plan, as well as a Request for Proposals to submit ideas for projects to be installed in the watershed. You can find photos of on-going work on the creek along with opportunities for you to get involved and be a proactive part of the solution. Workshops will be posted as they are announced with details and sign-up information. The website also contains links to other organizations and activities going on in the state and the nation. Please visit the Parkerson Mill Creek website and be sure to check frequently for news and updates - [www.aces.edu/pmc](http://www.aces.edu/pmc).

### **Parkerson Mill Creek Activities**

- IMPACT, a student volunteer organization, works at Parkerson Mill Creek to kick off each semester with a stream clean up.
- Engineers Without Borders conducts monthly monitoring and sampling through Alabama Water Watch on campus.
- Alabama Water Watch and Save Our Saugahatchee also conduct quarterly monitoring and sampling throughout the watershed.
- Many volunteer groups work on the creek for community service hours.
- University classes research the creek, spend time working at the creek and present findings to other classmates.
- Biosystems Engineering students will design and install Low Impact Development practices as part of a senior design project and renovation of the Corley Hall and Corley Hall Annex Buildings, as well as a constructed stormwater wetland as a part of Ag Heritage Park. The wetland will feature native plants, walking trails and bridges, and educational signage.
- The Parkerson Mill Creek Showdown is planned and will include partners such as the Davis Arboretum, Alabama Invasive Plant Council, Facilities, Athletics, Office of Sustainability, plus many others. The Showdown will be a morning of invasive plant removal along a section of the creek on campus and will end with a chili lunch for all volunteers. Participants will come from many departments on campus and in the community.
- The PMCP partnered with the Center for Forest Sustainability to host a Water Fun Day where many elementary school students spent the day learning about water and the environment.
- Parkerson Mill Creek hosted a pet waste campaign with the Environmental Awareness Organization, a student group to pass out informational flyers, pet waste pickup bags, and doggie bones on home football gamedays to pet owners and their dogs.



### **Parkerson Mill Creek On The Ground Projects**

- The Plant Science Research Center (PSRC) partnered with the PMCP to host an Open House and Rain Garden Workshop. Interested participants took part in a guided tour of the PSRC with highlights of some of the projects and research taking place, a demonstration of herb infused vinegars, and ended with the workshop and planting of the two rain water harvest beds at the entrance to the building.
- Two swales, a rain garden, and a rain water harvesting component were installed at the Auburn University Raptor Center to complement the grey water reuse at the restroom facilities. Another possible rain garden is proposed for the same location.
- The Dudley Hall Shop building was outfitted with a rain water collection system that will drain into a newly installed rain garden on campus. The 1,500 sq ft rain garden features a variety of native plants while providing an attractive and



functional means to capture stormwater runoff.

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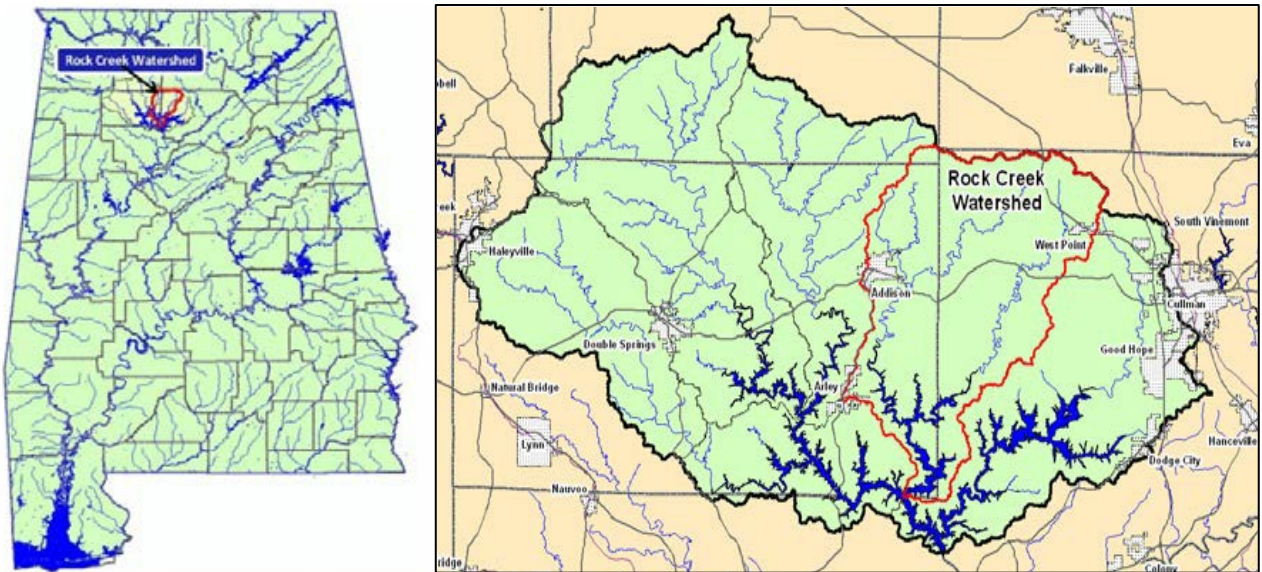
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## The Rock Creek Watershed Management Project

The Rock Creek Watershed Management Project (RCWMP) addresses impairments to the Rock Creek watershed and encourages watershed stewardship awareness. It is funded, in part, by the U.S. Environmental Protection Agency, Region 4, and the Alabama Department of Environmental Management (ADEM), and is coordinated by the Alabama Water Watch Program (AWW) in the Department of Fisheries and Allied Aquacultures of Auburn University (AU).



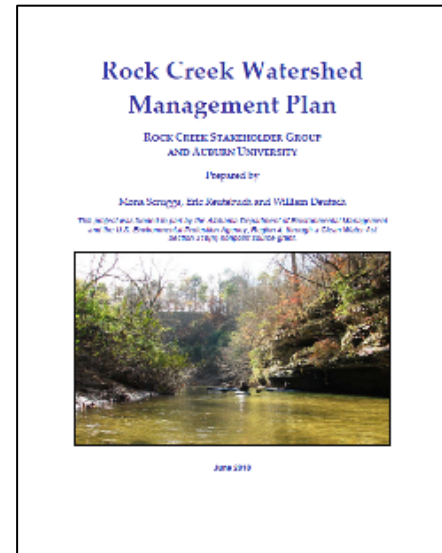
*The Rock Creek Watershed is located in the Northern Region of Alabama in the Black Warrior River Basin. Rock and Crooked Creeks, the main waterbodies in the watershed, flow into Lewis Smith Lake.*

The Rock Creek Watershed is located in north Alabama and is contained in parts Winston, Cullman, and Lawrence counties. The approximate watershed area is 207 square miles, and agriculture is the major economic activity. The watershed drains into Lewis Smith Lake, which is ranked as the cleanest reservoir in the state. Two streams in the watershed, Rock Creek and Crooked Creek have been placed on the 303 (d) list due to excessive organic enrichment/low dissolved oxygen, pathogens, and excessive ammonia. TMDLs have been completed for both streams.

Alabama Water Watch, the statewide citizen monitor program, has been involved in the watershed for over 16 years. In 2009, a watershed group requested assistance from AWW with local water quality restoration efforts. With guidance from AWW the group began the watershed planning process which was supported by the Auburn University Water Resources Center and a \$22,773 grant from ADEM. Stakeholders and project partners including local government officials, state and federal agencies, members of the agricultural community, business leaders, homeowners, and other concerned citizens worked together to develop the Rock Creek Watershed Management Plan, which was completed in June 2010. Funding totaling \$342,100 was awarded to AU in March 2011, to implement the Plan.

Stakeholders and partners have continued their collaboration, and Alabama Water Watch has worked intensively with the Natural Resource Conservation Service (NRCS) and the Alabama Cooperative Extension System (ACES) to achieve a number of project milestones.





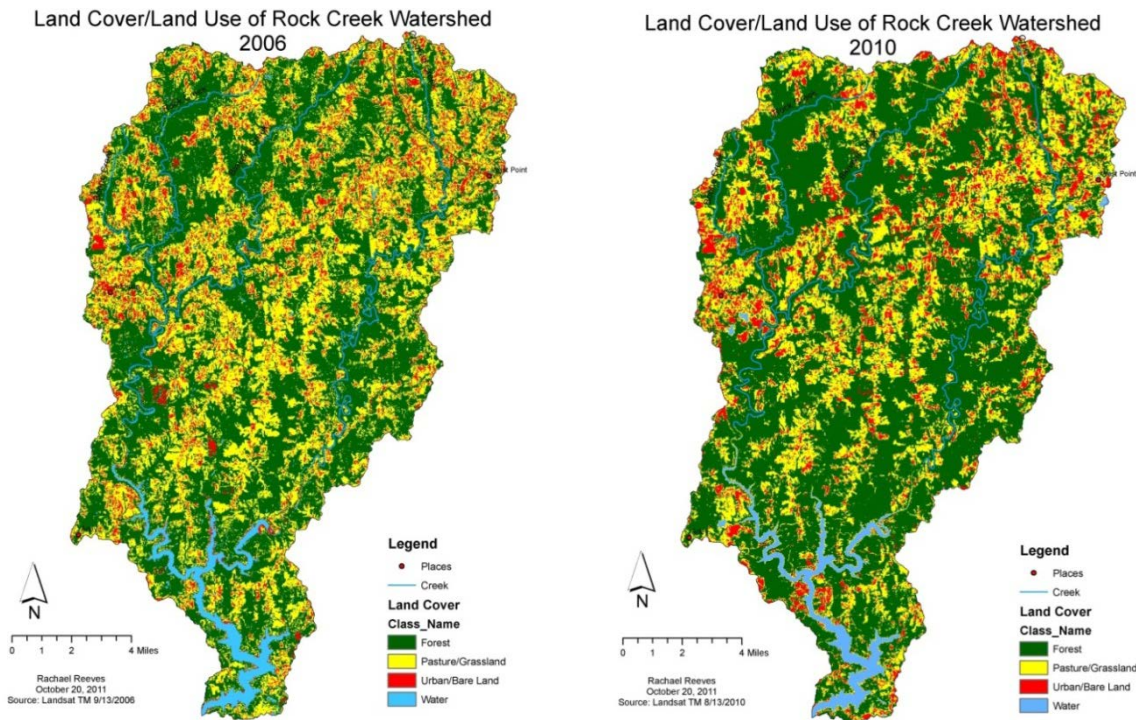
*Project partners prepare to tour the watershed during the planning phase (left), the Rock Creek Watershed Management Plan (right) was completed in June 2010.*

ADEM identified agriculture as the primary cause for water quality impairments in the Rock Creek Watershed; therefore \$150,000 was budgeted as cost-share (60%-40%) for agricultural on-the-ground BMPs. Fifteen applications with landowners for BMP installation in the Rock Creek Watershed have been approved by NRCS that include approximately 52 individual BMPs such as fencing, waste storage structures, pasture improvements, tree planting, and heavy use areas. Contracts have been established, on-the-ground BMP installation has begun for most projects, and many of the practices have been installed, certified according to NRCS standards, and landowners have been reimbursed for their expenses.



*W. Hill of NRCS explains how the heavy use area prepared by the RCWMP benefits water quality (left). This dry stack was recently completed and will prevent several tons of chicken litter from being washed into Rock Creek (right).*

In order to analyze BMP placement, an updated Land-Cover/Land-Use Analysis using Landsat 5 TM satellite images acquired through NASA and USGS by project partners in the AU Geography Department. The resulting maps are also being used in outreach and educational activities.



*By comparing land-cover maps from 2006 and 2010, it can be seen that forested lands and urban/bare lands have increased during the four year period.*

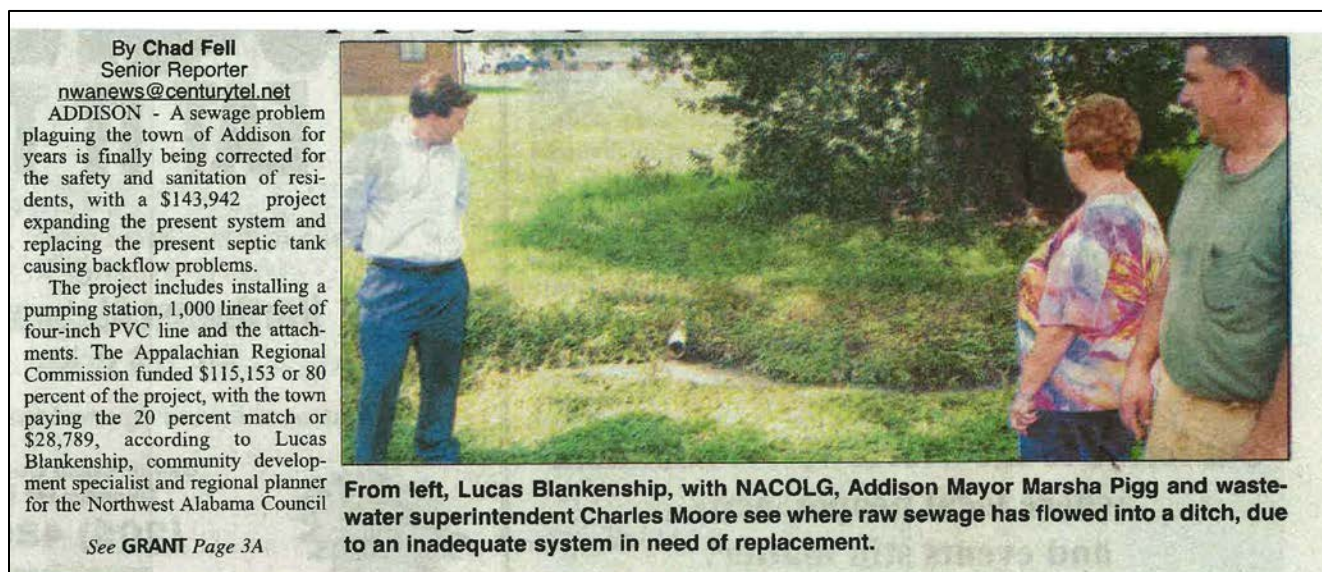
Citizen water monitors have participated regularly in Bacteria Blitzes, which help to identify bacteria hotspots and evaluate project progress. Since February of 2010, RCWMP project personnel have worked with stakeholders and municipal leaders to address high levels of bacteria (*E. coli*) that found in Addison, a small municipality in the watershed. Multiple meetings focused on this environmental and health threat, a result of failed septic systems. Municipal leaders used water data collected by RCWMP stakeholders to demonstrate the severity of the issue to the North Alabama Council of Local Governments (NACOLG).



*Citizens collect, plate, and incubate water samples to determine whether or not *E.coli* is present in local waters.*



With assistance from NACOLG, Addison applied for federal assistance to address the issue. In July 2012, nearly \$144,000 was awarded to expand the sewage system to this area of town and replace broken septic tanks. Stakeholders continue to pursue improved methods of detection, policies, and enforcement of policies regarding pathogen pollution on a state-wide basis.



*An article from the Northwestern Alabamian highlights the Addison wastewater problem and project.*

The RCWMP has worked closely with ACES to teach citizens about the land- water connection and how residential lawn care practices impact water quality by applying the Alabama Smart Yards program. One full-day workshop took place in May 2012, a "Smart Yards Landscaping in the Rock Creek Watershed" which provided area citizens an overview of the Smart Yards concepts. In fall 2012, a series of "Smart Yards" sessions took place one evening each month. Each session addressed a specific landscaping issue. RCWMP personnel are partnering with ACES to distribute a series of "Alabama Smart Yards" (residential lawn care publication by ACES) flyers to watershed citizens in coming months.



*Participants and facilitators of first Smart Yard Workshop (left, photo taken from article in Smith Lake Living magazine, (right) M. Henshaw (ACES) teaches students about septic tanks and water quality for Earth Day.*

Project partners have represented the RCWMP by participating in and sponsoring various outreach and education events including the GPS 101: Technology for Better Land and Water Management Workshop, Professional Logging Management Program, the North Region Forestry

Field Day, and a Rain Barrel Workshop. Project publications including brochures, flyers, and a poster have been used during such events to convey project goals to participants. A RCWMP website, [www.alabamawaterwatch.org/rockcreek](http://www.alabamawaterwatch.org/rockcreek), has been developed and is updated.

In Spring 2012, water-themed Earth Day Events were facilitated by project personnel, stakeholder volunteers, and ACES personnel in four elementary schools in the watershed. Approximately 400 fourth and fifth graders were reached. (Add photos) In 2013, the RCWMP plans to offer additional opportunities for students in the watershed including special school events, and professional development for educators that is focused on water quality.

The Watershed Coordinator has given presentations about the Rock Creek Watershed Management Project at several state conferences and meetings including the Black Warrior River Basin State of the Watershed Conference, the Smith Lake State of the Lake Address, and the Annual ADEM Nonpoint Source Pollution Conference. In addition, she also presented at the USDA National Water Conference in Portland, Oregon.

In 2013, the RCWMP will highlight completed project components such as the agricultural BMP's with project publications (web-based and printed) as well as through a project Study Tour. A variety of workshops will be facilitated in the watershed that will focus on septic maintenance, additional residential landscaping topics, and community-based watershed stewardship. Educational watershed signage will be pursued. The Rock Creek Watershed Management Plan is intended to be implemented during a six-year period. At this time, Section 319 funding is available for a three-year phase of the implementation. Project personnel will consider the pursuit of additional funding to continue the implementation into a second phase.

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## Mill Creek Watershed Project

Mill Creek, a major tributary to the Chattahoochee River, flows through the Cities of Smiths Station and Phenix City within Lee and Russell Counties of Alabama. The Mill Creek Watershed, with a drainage area of approximately 24.8 square miles, is an increasingly urbanized watershed. Development throughout the watershed has resulted in increased volumes of stormwater runoff from impermeable surfaces, which has led to flashy hydrology, loss of natural wetlands and riparian areas, inadequate natural floodplains, and threats to aquatic habitat. Intense stormwater runoff volumes and velocities continue to degrade streambanks, exacerbate erosion and sedimentation, and contribute to other water quality impairments. In 2008, Mill Creek was first identified on the State of Alabama's 303(d) List of Impaired Waters for organic enrichment resulting from this increased urban stormwater runoff. A Total Maximum Daily Load (TMDL) is currently scheduled for completion in 2018.



### *Developing the Plan*

In 2010, a watershed management plan was developed for Mill Creek through funding provided by a Section 319(h) Nonpoint Source grant through the Alabama Department of Environmental Management (ADEM). The Plan identifies sources of water quality concerns as well as practices that will serve to reduce pollutant loadings to the stream. It also provides focus and direction for stakeholders to effectively and efficiently mitigate pollution from stormwater runoff and protect water quality using a dynamic watershed management approach.



### *Implementing the Plan*

The Mill Creek Watershed Project will serve to implement components of the Mill Creek Watershed Management Plan through a cooperative effort between ADEM, Auburn University, the Alabama Cooperative Extension System (ACES), and other local stakeholders. This project will install best management practices to protect water quality, provide education to watershed community members that focus on water quality protection, and provide outreach to local citizens, students, municipal officials, and city employees throughout the watershed. Site selection for BMP implementation will primarily target public properties, such as local government and school properties in the Mill Creek drainage area of Lee and Russell counties. Local partners of the Mill Creek project currently include the City of Phenix City, the City of Smiths Station, the Lee and Russell County Commissions, Smiths Water and Sewer Authority, Chattahoochee-Chipola Clean Water Partnership, Keep Phenix City Beautiful, Consolidated Resources, Help the Hooch, Alabama Water Watch, and Central High School.

## Project Funding

The project is being funded in part by the Alabama Department of Environmental Management through a Clean Water Act Section 319(h) nonpoint source grant provided by the U.S. Environmental Protection Agency - Region IV. Auburn University will be administering the grant, which will provide 60% of the overall project cost. The remaining 40% of project cost will be supplied by “in-kind” matching services from local government, volunteers, ACES, and Auburn University. The project will provide \$239,597 in federal funding, to be matched by \$165,385 in local and in-kind funding. The Section 319(h) Program is a non-regulatory program that relies on local project partners to address impaired streams, with the ultimate goal of improving water quality.

## Project Web Site

The Mill Creek Project web site provides Section 319(h) and other nonpoint source pollution related information pertaining to the watershed. Upcoming workshops, tours, trainings, trash cleanups, and many other activities will be posted to this web site as they are planned. Additionally, the web site provides up to date photos of the watershed, watershed boundary maps, water quality data through Alabama Water Watch, and a copy of the watershed management plan. The web site features an interactive watershed boundary map showing best management practice (BMP) locations and volunteer water monitoring sample locations. Please visit our web site at: [www.aces.edu/millcreek](http://www.aces.edu/millcreek).



## Activities

The Mill Creek Project coordinated with the City of Phenix City and Consolidated Resources, LLC to hold a trash clean up that targeted an illegal dump site in Phenix City. The City provided Public Works employees as well as equipment including dump trucks, a backhoe, and a truck with a grab arm. It was estimated that the clean up removed 50 tons of trash from the site.

Nonpoint source pollution education was brought to local elementary and junior high schools in the Smiths Station area. Accelerated learning students learned about water quality data collection, their watershed, BMPs to manage stormwater, and how they could help improve water quality in their own back yards. To help spread the word, a video series was created for teachers on topics that include basic water quality concepts, bioretention and rain gardens, native plants, the Clean Water Act, and all about the Mill Creek Project.

The first of several rain barrel workshops was offered in Phenix City. Participants learned about nonpoint source pollution and how they





can help manage stormwater in their degraded watershed to improve water quality.

Education opportunities were also offered to Phenix City Public Works employees. We partnered with Georgia Cooperative Extension to offer a short workshop on environmentally friendly landscape management.

A Septic Tank Pumpout Workshop was offered to residents of Smiths Station. Attendees each received a pumpout voucher worth \$200 toward septic tank maintenance. The City of Phenix City Utilities waived waste hauling fees for these vouchers to bring pumpout costs down.

### ***On-the-Ground Project Installation***

A swale was installed at the Lee County Solid Waste site in Smiths Station. This solid waste site accepts household trash and yard waste from community members outside of the City limits. The water quality swale captures and treats leachate from large trash bins. Lee County provided labor and some materials for construction of the swale. The swale was hydroseeded and coconut fiber erosion control blankets were used to stabilize the swale until grass can get established.



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## Saugahatchee Watershed Management Plan

Phase 1 Implementation of the Saugahatchee Watershed Management Plan (SWaMP; ADEM Cooperative Agreement C70591009 - FY04 CWA Section 319(h) Nonpoint Source Grant Workplan Project #20), funded, in part, by the Alabama Department of Environmental Management (ADEM) and the U.S. Environmental Protection Agency (EPA), Region 4 (\$504,909 Section 319 funds and \$386,957 non-federal funds), began in January 2007 and ended on January, 2010. SWaMP was coordinated through the Auburn University Department of Fisheries and Allied Aquacultures (AUFAA)

Phase 2 Implementation of SWaMP (ongoing under a 6-month no-cost extension); ADEM Cooperative Agreement C10595050 – FY2009 CWA Section 319(h) Nonpoint Source Grant Workplan Project #18) involves the fourth and fifth years of implementation of the nine-year, stakeholder-driven watershed management plan for the Saugahatchee Creek Watershed. It is funded, in part, by the Alabama Department of Environmental Management (ADEM) and the U.S. Environmental Protection Agency (EPA), Region 4 (\$334,373 Section 319 funds and \$236,665 non-federal funds), and is coordinated through AUFAA. SWaMP Phase 2 began in December 2010.

Goals of SWaMP include the following:

- a) Address water quality problems identified in the Saugahatchee Creek Watershed TMDL by reducing nitrogen (364 lb/yr), phosphorus (58 lb/yr), sediment (8.4 tons/yr), and BOD (1,346 lb/yr) pollutant loading to Saugahatchee Creek each year of the project.
- b) Assist in identification and reduction of nonpoint sources of pathogens to Pepperell Branch, a 303(d)-listed tributary to Saugahatchee Creek.
- c) Develop a Low Impact Development Manual for Alabama.
- d) Increase citizen awareness about how land management and behavioral choices affect the Saugahatchee Creek watershed and its water quality.

Primary activities of SWaMP have included conducting stakeholder meetings, various forms of outreach, and installation of on-the-ground best management practices (BMPs). Additional activities during Phase 2 include development of a Low Impact Development manual for Alabama and working on watershed management policy that would reduce nonpoint source pollution in stormwater runoff.

SWaMP personnel have conducted a series of stakeholder meetings and presentations to communicate the goals and objectives of SWaMP and to build partnerships with local community groups, government and businesses. Many relationships and partnerships have been formed and strengthened during these gatherings.

Outreach activities have included presentations to numerous community and civic groups, outreach booths at area festivals, conducting various workshops, installing watershed signage, posting regular articles on the project website, and coverage on project events in the newspaper.

Workshops have focused on land management strategies and installation of BMPs to intercept nonpoint source pollution in stormwater runoff. SWaMP workshops have included the following:

- *Smart Yards* Lawn Care and Landscape Management workshops,
- Streamside Repair workshops,
- Community Rain Barrel workshops,
- Forest Land Best Management Practices workshops,



- Innovative Low-Impact Site Design workshop,
- Unpaved Road workshop, and,
- Rain Garden Construction workshops.

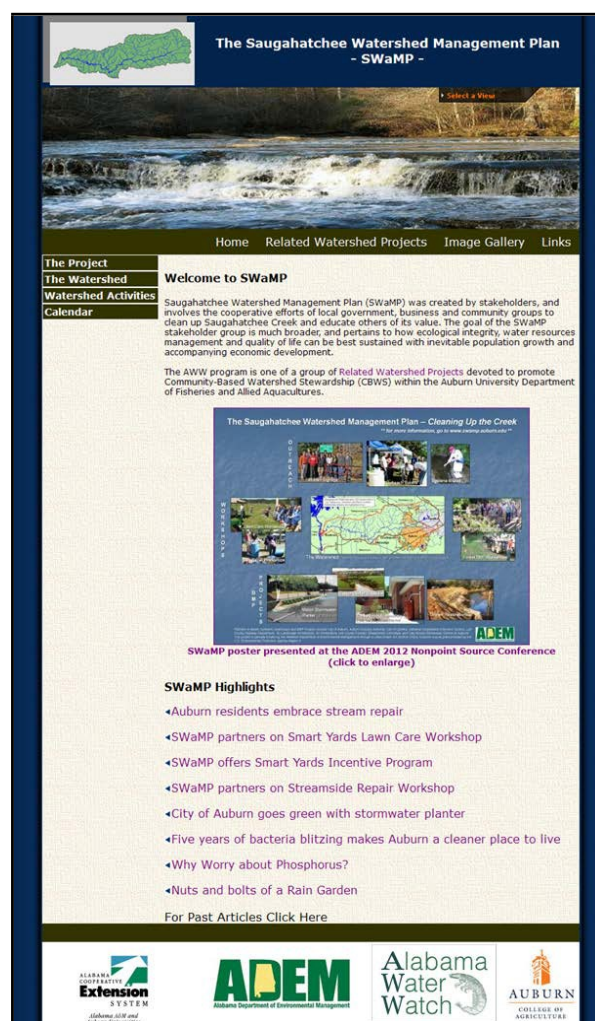
Installation of on-the-ground BMPs during SWaMP Phase One are documented in the project final report (available at [www.aces.edu/dept/fisheries/aww/swamp/project/reports.php](http://www.aces.edu/dept/fisheries/aww/swamp/project/reports.php)). SWaMP funded 18 projects during Phase 1 Implementation in collaboration with community groups, business/industry, government and academia. Projects involved installing low-impact-development BMPs (rain gardens, swales, constructed wetland), stormwater management, stream riparian zone restoration, stream channel and floodplain restoration and rainwater harvest. Pollution load reductions into Saugahatchee Creek during SWaMP Phase 1 implementation resulted from BMP installation, point source load reduction, and modification of human behavior resulting from SWaMP outreach. STEPL nonpoint source load reduction estimates for all SWaMP-funded BMPs were: approximately 1,300 lb/yr of nitrogen (N), 450 lb/yr of phosphorus (P), 4,800 lb/yr of biochemical oxygen demand (BOD), and 550 tons/yr of sediment.



SWaMP watershed signage at newly-named Swingle Creek



SWaMP Smart Yards Lawn Care Workshop held in 2011



SWaMP Project website at [www.swamp.auburn.edu](http://www.swamp.auburn.edu)



On-the-ground BMPs during Phase 2 include stormwater management BMPs in residential neighborhoods (eight completed and five in progress) promoted through a '*Smart Yards Incentive Program*' in collaboration with the City of Auburn's municipal water resources department, as well as a stream channel restoration project and installation of Auburn's first stormwater planter (see picture below).



Stormwater planter (above left, under construction) will be Auburn's first. Streamside repair workshop (above right, SOURCE: Opelika-Auburn News), in February 2012, was a big hit among Auburn-area residents.



Eric Reutebuch, SWaMP Coordinator, partnered with Eve Brantley, ACES, to conduct the first Rain Garden Certification Course offered in the state (above, left). SWaMP teamed up with Creative Habitats for a hands-on rain garden workshop and rain garden installation in north Auburn (above, right).

Compilation of a Draft Low Impact Development Handbook for Alabama is progressing. Eight BMP chapters for the handbook (Riparian Buffers, Level Spreaders and Vegetated Filter Strips, Swales, Bioretention, Constructed Stormwater Wetlands, Permeable Pavement, Green Roofs, and Rainwater Harvesting) have been reviewed by statewide experts whose comments are currently being incorporated. Three additional alternative practice chapters (Rain Gardens, Disconnected Downspouts, and Curb Cuts) have also been reviewed and are awaiting comment incorporation. Topics such as Site selection, Stormwater Hydrology, Vegetation, Maintenance, and Community Planning are being developed and will be included in the Draft LID Handbook for Alabama.



In the last year, the handbook has changed from a one column format to two columns for ease of reading and aesthetics. As such, each chapter must be put in the new format, which is a time consuming process as graphics, photos, and information shift. Sections and tables were combined, moved, or deleted based on review panel comments and the desire for a user friendly technical guidance handbook.

#### SWaMP Achievements and Recognition:

- Production of the publication *Saugahatchee Creek Watershed – Past, Present and Future* (see [www.swamp.auburn.edu](http://www.swamp.auburn.edu) and click *The Project -> Reports*).
- Posting of 40 articles to the SWaMP blog, showcasing SWaMP outreach and BMP activities, at [www.swamp.auburn.edu](http://www.swamp.auburn.edu) under **SWaMP Highlights**
- 2011 BEEP Award (Alabama's Best Environmental Education Program) for Cary Woods Elementary School's project, *Respect, Replace and Restore- the 3 R's of Cary Woods Elementary Outdoor Environment Project* (SWaMP-funded project)
- Official naming of local stream, Swingle Creek, via application to the U.S. Board on Geographic Names (USGS)
- State and national recognition for the Auburn *Green for Life* project (SWaMP-funded project)
  - 1) Alabama Chapter of the American Society of Landscape Architecture 2011 Best Community Design Award (Birmingham, AL, March 26, 2011),
  - 2) Alabama Chapter of American Planning Association 2011 Outstanding Team Project Award (Eufaula, AL April 1, 2011)
  - 3) Featured as a *Case Study for Green Infrastructure and Stormwater Management* on the National the American Society of Landscape Architecture website.

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## Center for Excellence in Nutrient Management Practices (CENMP)

The AU Water Resources Center lead the compilation and submission of a proposal titled 'Center for Excellence in Nutrient Management Practices (CENMP)' in response to the EPA funding opportunity, *Centers for Water Research on National Priorities Related to a Systems View of Nutrient Management* (EPA-G2012-STAR-H1). The proposal outlined the formation of a Center based at AU that would support research focused on the exploration of and development of nutrient management practices to be implemented in the southeastern United States and adjacent Gulf of Mexico drainages. The proposal brings together the expertise of five institutions – AU, University of Alabama, Jacksonville State University, Universidad Veracruzana and Institute of Ecology (both in the State of Veracruz, Mexico), as well as numerous regional, national and international partners.

The proposal describes how AU is well-positioned to establish the CENMP to develop, demonstrate, and evaluate novel approaches to water management through innovative and sustainable nutrient management practices and technologies. This is based on the university's history as a Land Grant Institution, its leadership in watershed management, its many strong research programs in areas related to nutrient management, and its strong commitment to demonstrating and implementing advancements from research to the public arena via robust outreach efforts.

The primary goals of the CENMP are:

1. Improvement of nutrient management practices in the Southeast, and beyond, through support of innovative, multidisciplinary research in nutrient management systems.
2. Decrease in nutrient loading into waters of the Southeast, and adjacent Gulf of Mexico.

Objectives to meet these goals include:

1. Address nutrient management challenges in the southeastern United States by supporting fourteen research projects (initially) that explore improvements in nutrient management via advancements in nutrient management knowledge base and via effective demonstration/ outreach efforts.
2. Promote dissemination of advancements in nutrient management regionally, nationally, and internationally (particularly in Mexico) through multiple media outlets, including scientific and non-scientific publications, presentations at professional conferences, and via the internet (web pages, web blog).

The CENMP plan to perform the proposed research is based on collaboration established with our partnering institutions, our researchers, and the establishment of a strong CENMP administrative unit. Throughout the development of the proposal, we have strengthened ties and collaboration among our administrative and research team. The research team is composed of experienced scientists from three research institutions in the Southeast: Auburn University (AU), the University of Alabama (UA) and Jacksonville State University (JSU); as well as a partners in Mexico, INECOL, A.C., Institute of Ecology, and Universidad Veracruzana (the University of the State of Veracruz).

The CENMP administrative and research teams encompass the following 14 academic departments and areas of expertise: Civil Engineering, Agricultural Economics, Forestry and Wildlife Sciences, Materials Engineering, Chemistry, Horticulture, Animal Sciences, Biological Sciences, Biosystems Engineering, Fisheries and Allied Aquacultures, Agronomy and Soils, Aquatic Ecology, Horticulture and Sociology. A multidisciplinary approach among the research team members will be fostered through multiple channels of collaboration and communication.



Establishment of a Science Advisory Committee (SAC) early-on will provide multiple benefits to the CENMP. The main function of the SAC will be to evaluate the scientific merit of proposed research in meeting the goals and objectives of the CENMP. The SAC will also provide insights, comments and suggestions on improvements in interdisciplinary integration of research and outreach efforts.

The CENMP's thematic approach to the development of a systems view of nutrient management is based on the integration of improved management practices developed across various geographic scales, across an array of geopolitical land use types, and covering a range of innovative, sustainable management practices. Proposed research includes a range of nutrient systems from small catchments to large river basins; across land use types ranging from rural agricultural farms to suburban residential landscapes to highly urbanized population centers. Sustainable management practices range from improved and innovative environmental monitoring strategies, to mitigation/treatment of pollutants, to cost effective nutrient capture and reuse, to advancements in water management and policy.

Research will be implemented based on interactions with stakeholder communities as well as thorough review of the scientific literature. Interactions with stakeholders during the implementation of research will have multiple benefits, including 1) fostering participation from communities that will be targeted for implementation of improved nutrient management practices, 2) obtaining information from stakeholders that help refine the research, and, 3) assisting in organizing outreach efforts to disseminate research results and improved nutrient management practices. The CENMP is well-positioned to engage community-based stakeholders through its strong collaborations with state and national Extension programs, and the Alabama Water Watch (AWW) and Global Water Watch (GWW) programs. These programs have strong ties to communities and are continually developing innovative approaches in implementing improvements in land and water management and policy (for examples, see AWW Success Stories at [www.alabamawaterwatch.org/successstor.html](http://www.alabamawaterwatch.org/successstor.html)). Collaboration with these programs also provides avenues for effective demonstration and innovative outreach. Examples include:

1. development of the *Alabama Smart Yards* manual and *Smart Yards* workshops,
2. publishing interactive web-based blogs on water monitoring, water policy and watershed management, and,
3. establishment of a watershed-based outreach forum through the AU Water Resources Center (see [www.aces.edu/dept/fisheries/aww/twp](http://www.aces.edu/dept/fisheries/aww/twp)).

Through these various outreach venues, the CENMP can efficiently and effectively engage community-based stakeholders in implementing improved nutrient management practices by highlighting research findings and showcasing effective real-world demonstrations of research-based management innovations.

Cutting edge approaches in research, demonstration and outreach are part and parcel of each of the 14 research proposals and will be supported through the CENMP's Administrative Unit. Cutting edge approaches include nanoparticle research, environmentally-friendly ion removal, development of water quality and hydrologic modeling frameworks, nutrient mitigation through bioretention, nutrient management practices in poultry production, nutrient recovery and re-use in aquaculture, and developing expert systems for nutrient best management practices. The CENMP is well-positioned to extending research advancements through the channels of higher education as well as through outreach. CENMP staff will coordinate the integration of research project activity and findings into university classrooms. The CENMP's real-world research and demonstrations will provide unique opportunities to educate our next generation of scientist, resource managers and policy makers. The CENMP will focus particular attention on

researchers presenting holistic approaches and predictive tools for advancing the principles of sustainability in nutrient management practices to their students.

#### Role of the CENMP's Members and Partners:

As described earlier, and in detail in the Administrative Unit Description section, the CENMP Director and staff will oversee the coordination of all research projects, establishment of the Science Advisory Committee and coordination of their advisory role, collaboration and communication among researchers, implementation of the CENMP Quality Management Plan, management of data generated through the CENMP research program, compilation of required annual and final reports, and facilitation of outreach efforts in multiple formats.

The AU College of Agriculture, under the leadership of Dean William Batchelor, will provide facilities to house the CENMP, including office and laboratory space in the new CASIC.



The new CASIC Building will be available for occupancy in September 2013 and will include two labs dedicated solely for water-related research and office space for the CENMP core staff.

Alabama Water Watch and Global Water Watch, both directed by Dr. William Deutsch, will serve as liaisons to community members and community-based groups to promote community engagement and involvement in research projects and dissemination of research results throughout the Gulf of Mexico region. AWW and GWW program personnel have extensive experience and contacts throughout the region from their two decades of promotion of community-based watershed stewardship in the Southeast and in many of the gulf states of Mexico.

The Alabama Department of Environmental Management will collaborate with the CENMP through data sharing and dissemination of research results at state and regional meetings and conference.

Partners in Mexico, INECOL, A.C., Institute of Ecology, and Universidad Veracruzana will assist in coordination of project activities in Mexico including evaluation of low-tech nutrient analysis techniques, training citizens in water monitoring, biological treatment of the wastewater from fish farming, conducting the analysis of the social aspects of the aquacultural waste management integrated with horticulture systems, and examination of nutrient enrichment of surface waters impacted by fish farming activities.



All CENMP research projects are directed by highly qualified PIs who have doctorate degrees in their areas of research, and have published peer-reviewed articles on their innovative research in the scientific literature. PIs also have extensive experience in community outreach and interactions with stakeholders, especially those that are part of, or have collaborated with Alabama Water Watch, the Alabama Cooperative Extension System and Global Water Watch.

#### **ABSTRACT:**

**a. Project Title:** Center of Excellence for Nutrient Management Practices (CENMP)

**b. Investigators:** Lead PI: Samuel Fowler, [fowlesr@auburn.edu](mailto:fowlesr@auburn.edu);

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**c. Institution(s):** Lead Institution – Auburn University, Auburn Alabama (Fowler, Anderson, Cheng, Deutsch, Dougherty, Fang, Guertal, Sibley, Wilson, Wright, Zhang, and Zhao); University of Alabama, Tuscaloosa, Alabama (Edmonds and Ernest); Jacksonville State University, Jacksonville, Alabama (Meade), Institute of Ecology, and Universidad Veracruzana, State of Veracruz, MX (Escobedo)

**d. Project Period and Location:** Beginning Date – January 2014; Ending Date – December 2017; Locations – Three universities and various Alabama field locations statewide.

<b>e. Project Cost:</b>	2014	2015	2016	2017
EPA-funded direct costs	539,864	540,528	543,752	411,507
EPA-funded IDC	116,087	116,087	116,087	116,087
Non-federal cost share	62,697	62,697	62,697	62,697

**f. Project Summary:** (1) the objectives of the study are: a) Improvement of nutrient management practices in the Southeast, and beyond, and b) decrease in nutrient loading into waters of the Southeast, and Gulf of Mexico Basin. (2) This will be done through 14 interdisciplinary/transdisciplinary research projects involving over 20 faculty and students at 3 US and two international partnering institutions. (3) The expected outputs are science-based tools and models which can be used by policy/regulatory agencies and by local communities to achieve sustainable and cost effective nutrient management. The expected outcomes are restoration of nutrient impaired watersheds so water quality meets standards for designated uses and reduction in the hypoxic zone in the Gulf of Mexico.

**g. Supplemental Keywords:** Nutrients, nutrient management, eutrophication, water quality, nutrient loading, nutrient recycling, sustainable, environmental assets, integrated assessment, biomonitoring, aquaponics, bioremediation, environmental chemistry, nanotechnology.

# Alabama Wetlands Project

## Introduction

Alabama's Wetland Program Plan (WPP) identified a need to gather and compile existing wetland inventory maps and location information. One of the more commonly used sources of digital wetlands data is the U.S. Fish & Wildlife Service's National Wetlands Inventory (NWI). However, NWI digital vector data for Alabama is incomplete; digital data are available for most of the state but the NWI data are only available as scanned images for some parts of the state. Moreover, this data is dated. The source material for NWI data is more than 20 years old, with data for the majority of the state generated from 1980's imagery. The average date of imagery used in the production of NWI data for the state is 1981 (U.S. Fish & Wildlife Service 2002) with only the coastal area having wetland data based on 2000's imagery (Tiner 2009). With rapid development in many areas, the existing NWI data are becoming increasingly less useful in representing a current account of wetlands, and the U.S. Fish and Wildlife Service has recognized that NWI data in the southeast are in dire need of updating (Tiner 2009).

Geographically isolated wetlands represent a unique and significant portion of the nation's wetlands, and in many areas, such as karst regions, are the predominant wetland type (Tiner 2003). Although typically smaller than nonisolated wetlands, isolated wetlands can be locally abundant or numerous (Tiner 2003, Lane et al. 2012). In a recent study, Comer et al (2005) reported that 29% of all wetland types in the United States are partially or wholly geographically isolated from navigable waters. The U.S. Fish and Wildlife Service reported similar findings for the percentage of wetland area comprised of isolated wetlands calculated from landscape analysis of 72 sites across the nation, including 1 site in Alabama (Tiner et al. 2002., Tiner 2003). However, isolated wetlands represented a greater percentage of the total number of wetlands than percent of wetland area with all sites in the southeast having >40% of their total number of wetlands considered to be isolated (Tiner et al. 2002). This was attributed to isolated wetlands generally being smaller in size than non-isolated wetlands. Lane et al. (2012) evaluated the abundance and expected condition of isolated wetlands in the southeastern United States and reported potentially isolated wetlands (PIW) covered 45,500.4 ha, with the size of PIWs ranging from 0.007 – 115.9 ha. PIWs represented 3.6% of total freshwater habitat (the lowest percentage for the 9 states included in their analysis) and 2.1% of total wetland habitat in Alabama. However, their analysis was based on NWI data, and digital NWI was not available for 29.8% of the state. Isolated wetlands of numerous types may be found throughout Alabama, with somewhat higher densities in the Interior Plateau and Southeastern Plains regions (Alabama Department of Conservation and Natural Resources 2005).

Many wetlands "isolated" from navigable waters are no longer protected under the provisions of the Clean Water Act (CWA). In the Supreme Court's 2001 decision in *Solid Waste Agency of Northern Cook County [SWANCC] vs. U.S. Army Corps of Engineers*, 531 U.S. 159 (2001), a split court ruled that CWA jurisdiction depended on a "significant nexus" being shown between the wetland and waters of the United States, and isolated wetlands did not fall within the scope of the CWA merely because they were used by migratory birds. In June 2006, the Supreme Court handed down a divided decision in the *Rapanos vs. U.S.* and *Carabell vs. Army Corps of Engineers* cases, referred to as *Rapanos*, which dealt with the meaning of navigable waters in the context of wetlands adjacent to tributaries of those waters. The court remanded the cases to the Sixth Circuit Court of Appeals for reconsideration in a "plurality opinion" which lacks authority as a precedent. Since this ruling, several lower courts have held that the



relevant test should be the “significant nexus” test. Despite the guidance provided by the Army Corps of Engineers and EPA for interpreting the *Rapanos* decision in a manner that allows for broad application of the Clean Water Act if a “significant nexus” can be established, neither the guidance nor recent court decisions have retreated from the position taken in *SWANCC*, so that most geographically isolated wetlands are still outside Clean Water Act jurisdiction.

The loss of regulatory jurisdiction over these isolated wetlands has significant implications. In addition to the many ecosystem functions provided by wetlands that benefit ecosystems as well as society (Patrick 1994, Reddy and Gale 1994, Mitsch and Gosselink 2000, Leibowitz 2003, Whigham and Jordan 2003), isolated wetland systems support high levels of biodiversity, including significant numbers of species and ecological communities of conservation concern (Moler and Franz 1988, Folkerts 1997, Semlitsch and Bodie 1998, Comer et al. 2005), with 43% of isolated wetland types supporting at least one species listed under the Endangered Species Act (Comer et al. 2005). Nationwide, 274 at-risk plant and animal species are supported by geographically isolated wetland types with more than a third of these species appearing to be restricted to such wetlands (Comer et al. 2005). Comer et al.’s report (2005) was limited to wetland types that are characteristically isolated, but typically non-isolated wetland types may also occur in isolation, adding to the number of wetland values and habitats at risk.

Because of their position on the landscape (i.e., geographically isolated), isolated wetlands have always been vulnerable to adverse impacts from human development and land use changes, especially in agricultural and developed areas. They have been greatly impacted by landscape changes throughout the state, with many isolated wetlands having been ditched, filled, deepened, otherwise altered and impacted, or degraded by mechanisms such as contamination from agricultural or urban runoff. Landscape changes in the area surrounding isolated wetlands often significantly impact the wetlands and their biota. Many animals that are an integral component of isolated wetland communities spend more time in contiguous terrestrial habitats than in the aquatic wetland habitat. Although some land use practices may include the use of buffers around isolated wetlands as a part of Best Management Practices, the buffer rarely provides sufficient upland habitat for the amphibians, reptiles, and other wildlife using the wetland. The result often is a loss of biodiversity as the populations decline and are extirpated. The ephemeral nature of some isolated wetlands leaves them vulnerable because they may not be recognized as wetlands when dry and are therefore subject to disturbance and destruction. The loss or degradation of these wetlands negatively impacts Alabama’s native fauna, flora, soils, and water quality.

The extent of isolated wetlands in Alabama is currently unknown, and their overall status and condition is poorly known. There also is a lack of current digital data regarding wetlands in Alabama. There is a clear need for a full inventory, classification, and mapping of Alabama’s isolated wetlands.

### **Isolated Wetland Definition**

Isolated wetland is a relative term that can be defined based on different perspectives (geographic, hydrologic, and ecologic) and using different spatial or temporal scales. Because geographic isolation is determined based on the position of a wetland relative to the surrounding landscape and is more readily observed than hydrologic isolation, it is the easiest to determine and lends itself to use in geographic information systems (GIS) analysis. Hydrologic and ecologic definitions of isolated wetland require a more detailed examination of hydrologic interactions (surface and subsurface) and ecological relationships (Tiner et al. 2002), and thus require data that is generally not readily available for GIS analysis. For use on this project, we follow the geographic definition used by Tiner (2003), and define a

geographically isolated wetland as one surrounded by upland with no apparent surface-water connection to perennial rivers and streams, estuaries, or the ocean. It is important to note that this is distinct from a regulatory or jurisdictional definition, which refers to waters or wetlands that are subject to federal regulation under the Clean Water Act.

## **Methods**

### Isolated Wetlands Criteria

Expanding the methodology introduced by Tiner (2003), we created a GIS model that identifies geographically isolated wetlands based on the USGS National Hydrography Dataset (NHD) high resolution line and polygon data (<http://nhd.usgs.gov/index.html>) and Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL) database (<http://www.msc.fema.gov>). Buffering line stream data prevents riparian or headwater wetland polygons from being disconnected from their associated drainages during GIS analysis (Tiner 2003). Previous studies have used buffer widths on stream line data ranging from 10 m to 40 m (Frohn et al. 2009, Martin et al. 2012, Tiner 2003). We selected two interpretations of geographic isolation using the 20-m and 40-m stream buffers used by Tiner. Some Army Corps of Engineers consider wetlands within the 100-year floodplain to be non-isolated (Kramer and Carpendedo 2009). Excluding wetlands located in the 100-year floodplain from the criteria for isolation also reduces the possibility of including wetlands with intermittent connections to non-isolated streams. Our two scenarios for interpreting wetlands as isolated were:

1. narrow interpretation – wetlands >40 m from non-isolated water body and not within the 100-year floodplain, and
2. broad interpretation - wetlands >20 m from non-isolated water body and not within the 100-year floodplain

We identified non-isolated water bodies using the NHD Hydro-net (geometric network line data) and Utility Network Analyst trace commands in ArcMap 10.0. Flags define the starting point for traces on geometric networks. Flags were placed at major river outflows to the Gulf of Mexico (Mobile, Conecuh, Chattahoochee, Choctawhatchee, and Pea rivers) and the Tennessee River flowing out of Alabama, and the trace task of find connected or find disconnected was run. Because the NHD line data is missing some connections around reservoirs, streams identified as disconnected by the trace command were examined manually on National Agriculture Imagery Program 2011 aerial imagery for Alabama. If the stream was connected to other water bodies, a flag was added and the trace rerun. The connected water bodies identified by the final trace, were buffered to 40 m to create a non-isolated mask for analysis. The goal of the project was to identify isolated wetlands, and features attributed in the NHD polygon data as swamp or marsh could themselves be isolated wetlands. Additionally, many of the features attributed in the NHD as swamp or marsh also could not be identified as such on the aerial imagery. Therefore, only features identified as reservoir or pond/lake were selected to possibly add to the buffer mask. Evaluation of the NHD polygon data revealed that many of the small lake and pond features could not be identified on the NAIP aerial imagery, so only those polygons which intersected the line buffer were merged with the 40-m buffer to create a buffer mask to identify non-isolated wetlands. We are currently in the process of creating the 20-m buffer. The 100-year floodplain was extracted from the FEMA NFHL database and merged with the 40-m buffer to create the narrow interpretation non-isolated layer.



## Hydric Soils Model

Hydric soils are defined by the National Technical Committee for Hydric Soils (2007) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation. Hydric soils were identified using Soil Survey Geographic (SSURGO) data (Soil Survey Staff 2012). SSURGO data consists of a tabular component of linked tables and a spatial component that links to the tables based on map unit. The tabular attribute database gives the proportionate extent of the component soils and their properties for each map unit. SSURGO digital soil maps are created from field surveys and aerial photograph interpretation, with maps made at scales ranging from 1:12,000 to 1:63,360 (National Soil Survey Center 1995). SSURGO data was downloaded for each county, but spatial data is not yet available for Washington County. The hydric rating (Table 1) for each map unit was added as an attribute in the spatial file using the soil data viewer (Natural Resources Conservation Service 2011). For the hydric soils model (HSM), we selected map units that were rated all hydric (consisting entirely of hydric soils) or were identified as water, swamp, or tidal marsh by map unit name. A potential hydric soils data layer was created by adding map units rated as partially hydric (soils with hydric inclusions) to the HSM. SSURGO linear and point data were not used.

Table 1. Soil Survey Geographic (SSURGO) Database hydric soil rating classifications indicating the proportion of map units that meet the criteria for hydric soils (National Technical Committee for Hydric Soils 2007).

Hydric Rating	Definition
all hydric	All components listed for the map unit are rated as being hydric.
partially hydric	At least one component of the map unit is rated as hydric and at least one component is rated as not hydric.
not hydric	All components listed for the map unit are rated as not hydric.
unknown hydric	At least one component for the map unit is not rated so a definitive rating for the map unit cannot be made.
not rated or not available	All components for the map unit are not rated.

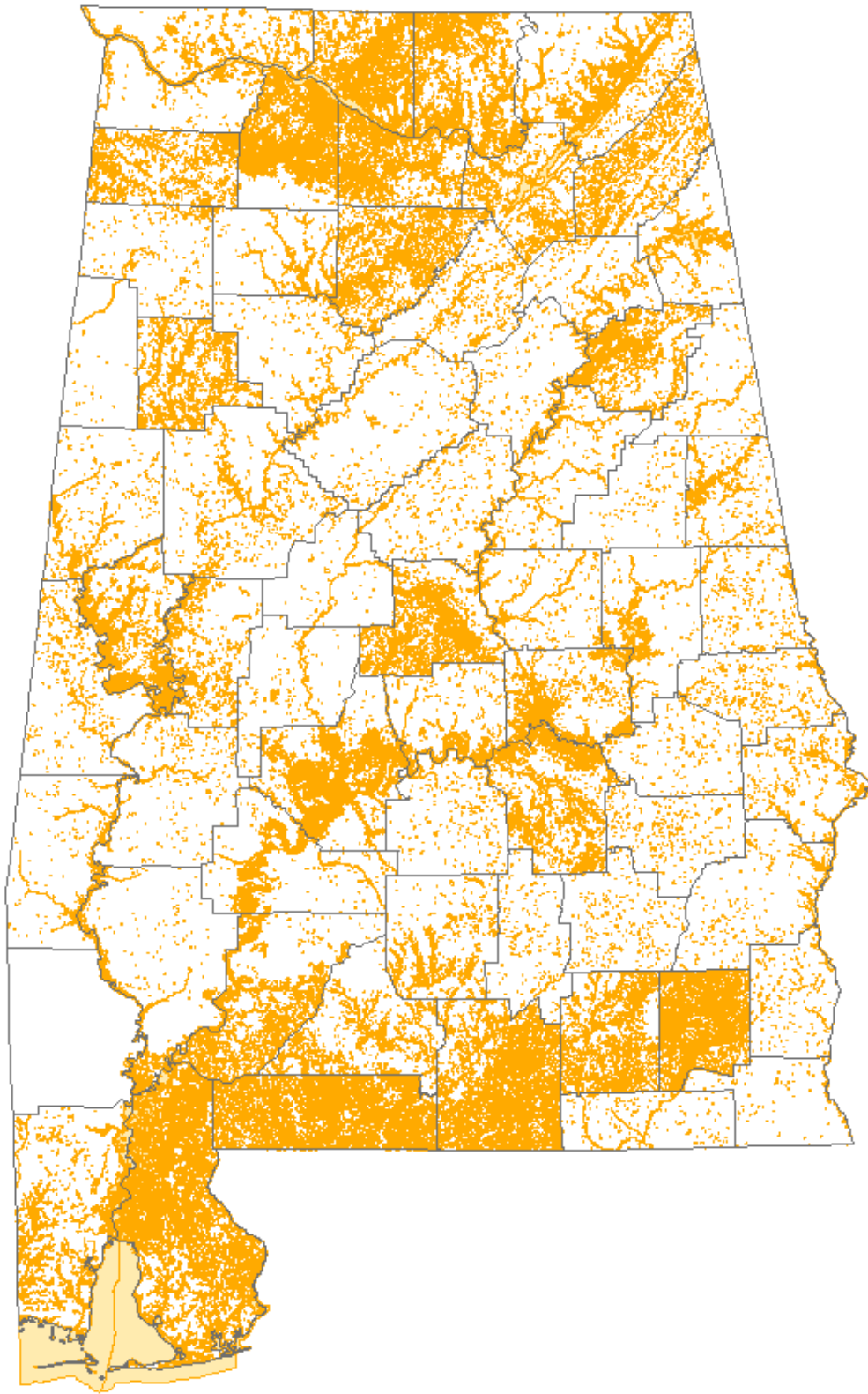


Figure 1. SSURGO hydric soils model for Alabama.



## National Wetlands Inventory

NWI data for Alabama was downloaded from the seamless wetlands data by state on the NWI website (U.S. Fish and Wildlife Service 2011) as a geodatabase. All of the wetland polygons within the NWI dataset were imported, regardless of the NWI classification of wetland type (Fig. 2).

## Object Based Image Analysis

Object Based Image Analysis (OBIA) is a sub-discipline of remote sensing that analyzes imagery and creates image objects using many different attributes other than spectral reflectance. Delineation of isolated wetlands will be performed using Definiens eCognition software which will allow for statewide analysis of open water sources based on the recent 2011 National Agriculture Imagery Program (NAIP) imagery. This object based image analysis software allows for automation of wetland delineation via several different segmentation and classification algorithms. This software classifies image objects based on color, shape, and size that we have defined to best represent isolated waters. Furthermore, the software supports batch processing of thousands of images across multiple processing cores which increases project efficiency.

Algorithms that delineate isolated wetlands have been constructed using eCognition Developer that identify open waters using 2011 NAIP imagery. These algorithms first break all the imagery into image objects through a multistep segmentation process allowing each isolated water body to be represented as a single object. Next, water bodies are classified based first on their spectral reflectance and shape. Image objects with high reflectivity in the near infrared band are selected then they are further classified based on their asymmetry. All of these candidate objects are then classified according to their size with any falling below a spatial extent of 500m<sup>2</sup> being removed from consideration. Finally, these objects are exported into georeferenced shapefiles to be analyzed according to the criteria for isolated wetlands.

## **Milestones Completed**

- Completed Quality Assurance Project Plan with final approval in June 2012
- Conference call with Lisa Huff and other Alabama Department of Environmental Management wetland staff on 14 March 2012 to discuss project
- Completed GIS model, and buffer mask, for narrow interpretation of isolated wetland (40-m NHD buffer and 100-yr floodplain)
- Completed hydric soils wetland model
- Constructed an eCognition algorithm to identify open waters from 2011 NAIP imagery
- Ran eCognition algorithm on NAIP imagery for northern third of state (above 34° N latitude)

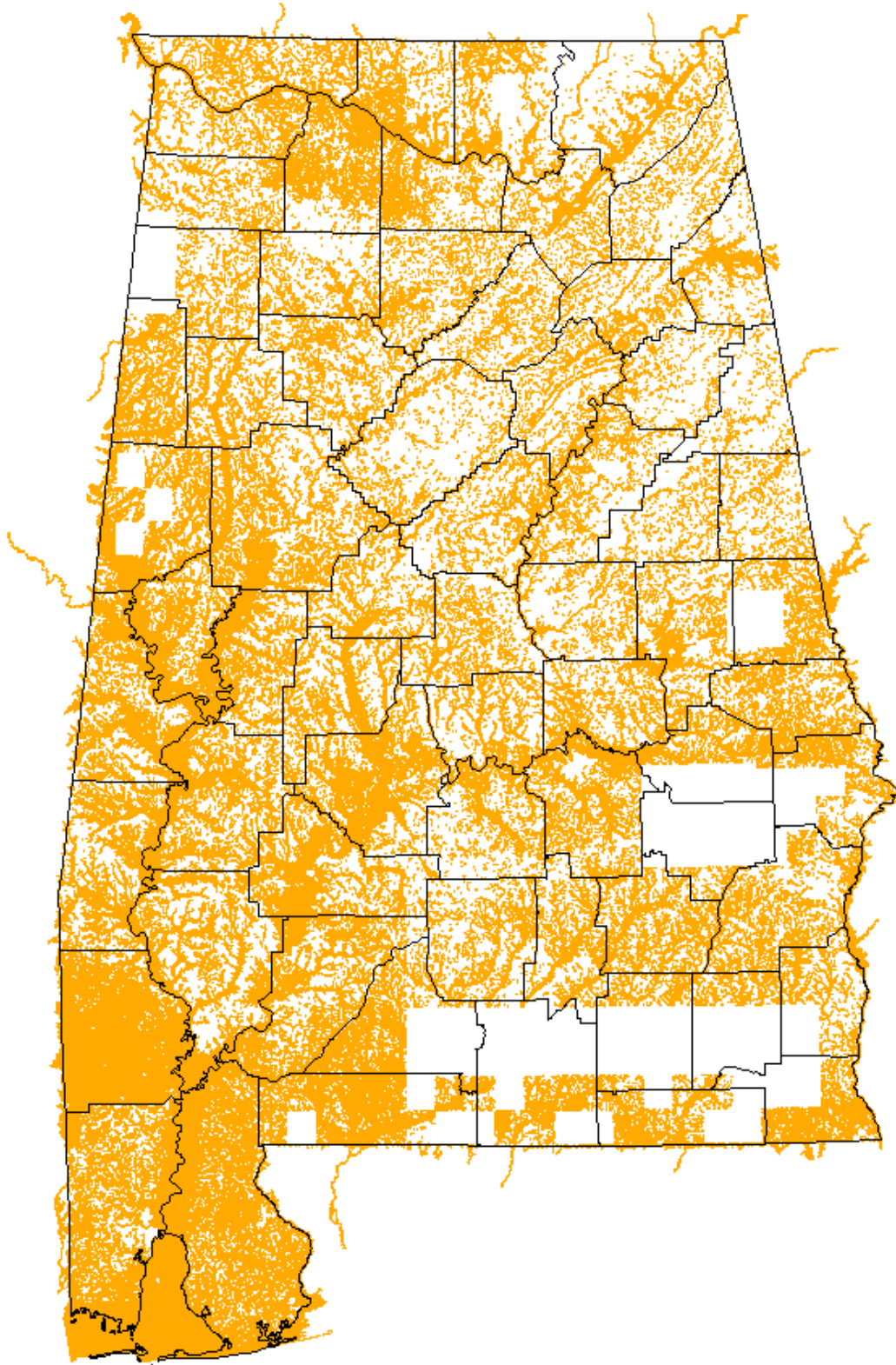


Figure 2. Wetlands as identified in National Wetlands Inventory data for Alabama.

## Problems Encountered

One problem encountered when compiling existing data to create the wetland models was incomplete digital data for the state. At the time the project began, digital SSURGO spatial data was not available for Washington and Winston counties. Winston County SSURGo spatial data has subsequently become available, but the spatial data still does not exist for Washington County. State Soil Geographic (STATSGO) database data is available, but this is much less detailed and more generalized. Hopefully, Washington County data will become available and can be incorporated before the end of the project. FEMA NHFL data was not available for Sumter and St. Clair counties, and data was also missing for portions of Conecuh and Escambia counties.

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## **Tallapoosa River Basin Numerical Nutrient Criteria For Wadeable Streams**

The *Tallapoosa River Basin Numerical Nutrient Criteria For Wadeable Streams* Project (Agreement ADEM-C00594051) funded, in part, by the Alabama Department of Environmental Management (ADEM) and the U.S. Environmental Protection Agency (EPA), Region 4 (\$37,997 federal and \$45,857 nonfederal), began in January 2010 and ends June 2012. This project is coordinated through the Auburn University Water Resources Center. The project is directed by Sam Fowler, PhD., who also directs the Auburn University Water Resources Center

Goal: The ultimate goal of this project is to assist ADEM in the development of numerical nutrient criteria (phosphorus and nitrogen; P and N) for wadeable streams in Alabama.

Project objectives include the following:

- 1) Analyze and quantify statistical or probability relationships between water chemistry and physical data, selected biota data, environmental data (light, vegetative cover, geological features, etc.) based on specific stream monitoring data collected or approved by ADEM.
- 2) Conduct analyses of data provided by ADEM and other approved sources to determine what levels of nutrients (P and N) become detrimental to aquatic biota and designated stream use in the Tallapoosa River Basin
- 3) Recommend alternative methods that may be used if numeric nutrient values cannot be determined from available data analysis.

Project Facilitation: On April 12, 2010, the project director and other AU researchers met with ADEM representatives in Montgomery to discuss the sampling to be performed and the creation of a scientific advisory committee (SAC). In April and May 2010, a SAC consisting of 14 people from different Alabama universities and state agencies was created and an initial meeting of the SAC was held on May 25, 2010 in Alexander City. The project was explained to the SAC and initial input was provided from the SAC members. During the next quarter, follow-up e-mails were sent to all of the SAC members to provide a more detailed explanation of the project and to solicit input on any suggested changes in the sampling methods and data to be collected.

Data consolidation and Assimilation:

Data Sources: The primary sources of data for this project were collected in 2010 by ADEM and the Geologic Survey of Alabama (GSA). Other data were compiled from 2005. ADEM conducted field data collection in 2010 in the Tallapoosa River Basin specifically for preliminary analyses of the relationships between nutrient levels in streams and the health of the aquatic ecosystem. Data were collected at 34 sites, including 18 stream sites, 6 river sites, 9 embayment sites and one tailrace site (see Figure 1).

ADEM 2010 datasets included water quality (field and laboratory parameters), stream habitat assessment, stream macroinvertebrate community assessment and algal growth potential data. GSA data included fish community assessment, stream habitat assessment, and human disturbance data. ADEM and GSA data were cross-referenced to maximize the number of streams in the analyses that had both water quality and stream biota data. Two additional streams were identified, Emuckfaw Creek (ADEM site EMUT-2; ADEM and GSA data from 2005) and Pepperell Branch (ADEM site PPLL-2; ADEM & GSA data from 2010) (see Table 1).

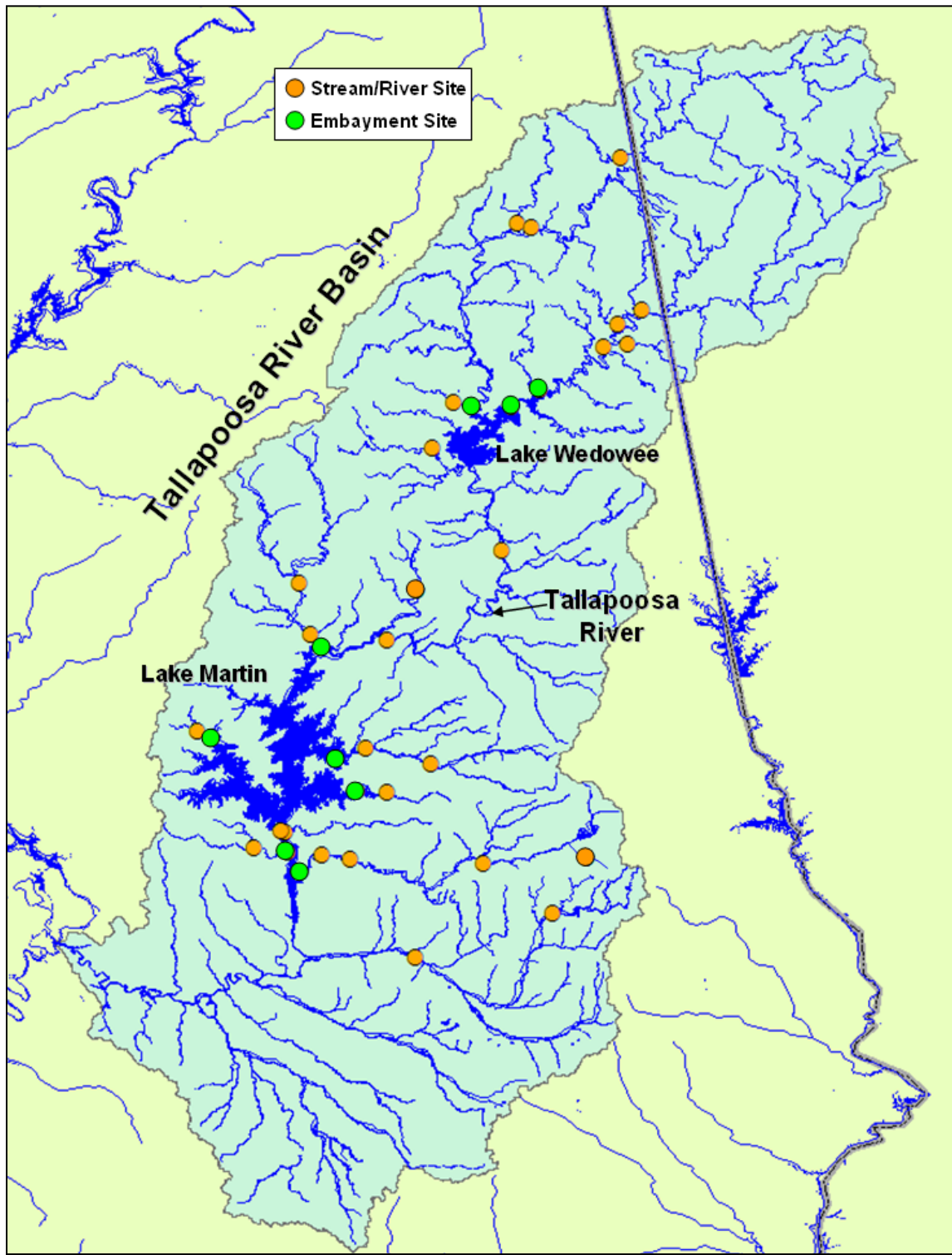


Figure 1. Stream, river and lake embayment sample sites. All sites were in the Tallapoosa River Basin.



Table 1. Sample sites and data sets included in analysis for development of nutrient criteria for Wadeable streams. Water quality and macroinvertebrate data were collected by ADEM, fish community structure data were collected by Geological Survey of Alabama (GSA). All data were collected during 2010 except for data from Emuckfaw Creek (EMUT-2), which were collected in 2005.

ADEM Code	Waterbody	Type	Diurnal DO	AGPT	Conventional Lab Parameters	Field Params	Flow	Macroinvertebrate Assessment	Water-column Chlorophyll	Fish GSA
BLCT-1	Blue Ck	Stream	X		X	X	X	X	X	X
CHNE-18	Channahatchee Ck	Stream		X	X	X	X	X	X	X
CHWL-4	Chewacla Ck	Stream			X	X	X		X	X
CNCL-1	Cane Ck	Stream	X	X	X	X	X	X	X	X
CRCC-5	Crooked Ck	Stream	X	X	X	X	X	X	X	
HILT-1	Hillabee Ck	Stream		X	X	X	X		X	X
HILT-2	Hillabee Ck	Stream			X	X	X	X	X	
KNSR-9	Knokes Ck	Stream	X	X	X	X	X	X	X	
NDNR-1	Mad Indian Ck	Stream			X	X	X	X	X	
OAKC-1	Oakachoy Ck	Stream		X	X	X	X	X	X	
SCC-4	Sandy Ck	Stream			X	X	X		X	
SCC-5	Sandy Ck	Stream	X	X	X	X	X	X	X	X
SHLR-5	Shoal Ck	Stream	X	X	X	X	X	X	X	X
SOGL-1	Sougahatchee Ck	Stream		X	X	X	X		X	X
SOGL-5	Sougahatchee Ck	Stream	X		X	X	X	X	X	X
SOGL-6	Sougahatchee Ck	Stream	X	X	X	X	X	X	X	
UPHM-3	Uphapee Ck	Stream	X	X	X	X	X	X	X	X
WINDT-1	Wind Ck	Stream	X	X	X	X	X		X	
EMUT-2	Emuckfaw Ck	Stream			X*					X*
PPLL-2	Pepperell Br	Stream			X					X
LTPR-1	Little Tallapoosa R	River		X	X	X	X		X	
LTRR-1	Little Tallapoosa R	River	X	X	X	X	X	X	X	X
TA-1	Tallapoosa R	River	X		X	X	X	X	X	
TA-2	Tallapoosa R	River			X	X	X		X	
TART-1	Tallapoosa R	River	X	X	X	X	X	X	X	X
TLRC-1	Tallapoosa R	River	X		X	X	X	X	X	X
MARE-16	Blue Ck	Reservoir Embayment	X	X	X	X			X	
YATE-3	Channahatchee Ck	Reservoir Embayment	X	X	X	X			X	
MARE-6	Hillabee Ck	Reservoir Embayment	X	X	X	X			X	
RLHR-4	Little Tallapoosa R	Reservoir Embayment			X	X			X	
RLHR-7	Little Tallapoosa R	Reservoir Embayment	X	X	X	X			X	
RLHR-6	Mad Indian Ck	Reservoir Embayment		X	X	X			X	
MARE-15	Oakachoy Ck	Reservoir Embayment	X	X	X	X			X	
MARE-14	Sandy Ck	Reservoir Embayment	X	X	X	X			X	
YATE-2	Sougahatchee Ck	Reservoir Embayment	X	X	X	X			X	
YATE-4	Yates Res	Tailrace	X	X	X	X			X	

\*Data collected during 2005 (all other data were collected during 2010).

### Data Manipulations:

- 1) Water quality data were flagged with a variety of qualifiers when sampling and/or water quality analyses did not conform to quality assurance protocols. A list of data qualifiers can be found in ADEM Standard Operating Procedure (SOP) #4910 Revision 3 – *LABORATORY DATA QUALIFICATION*. Data values marked with the following qualifiers were excluded from the data analysis:
  - F (for all parameters except chlorophyll a)
  - ALL R\*'s except RH and RI: RB-RG and RM-RS2
  - X, Y, YJI
- 2) Some water quality data values were flagged with MDL, meaning that the recorded value was the Method Detection Limit. All such flagged values were divided by 2 (one-half the MDL value) prior to analysis.

### Data analysis:

Descriptive statistics were derived for the data. Figures 2 and 3 below show means and ranges of TP concentrations of Embayment and Stream sites respectively.

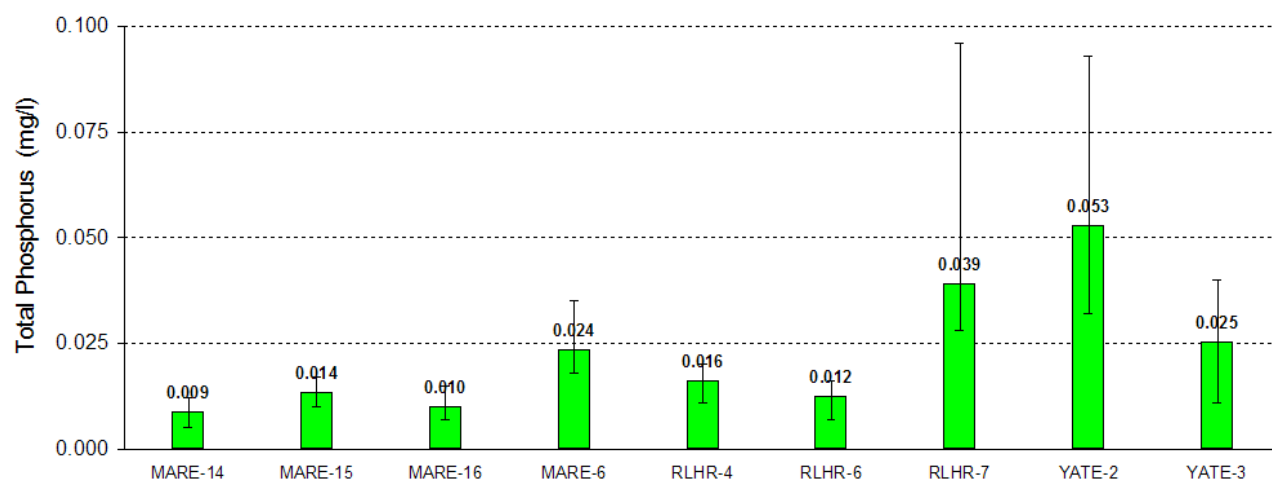


Figure 2. Mean and range of TP for Embayment sites sampled in the Tallapoosa Basin.

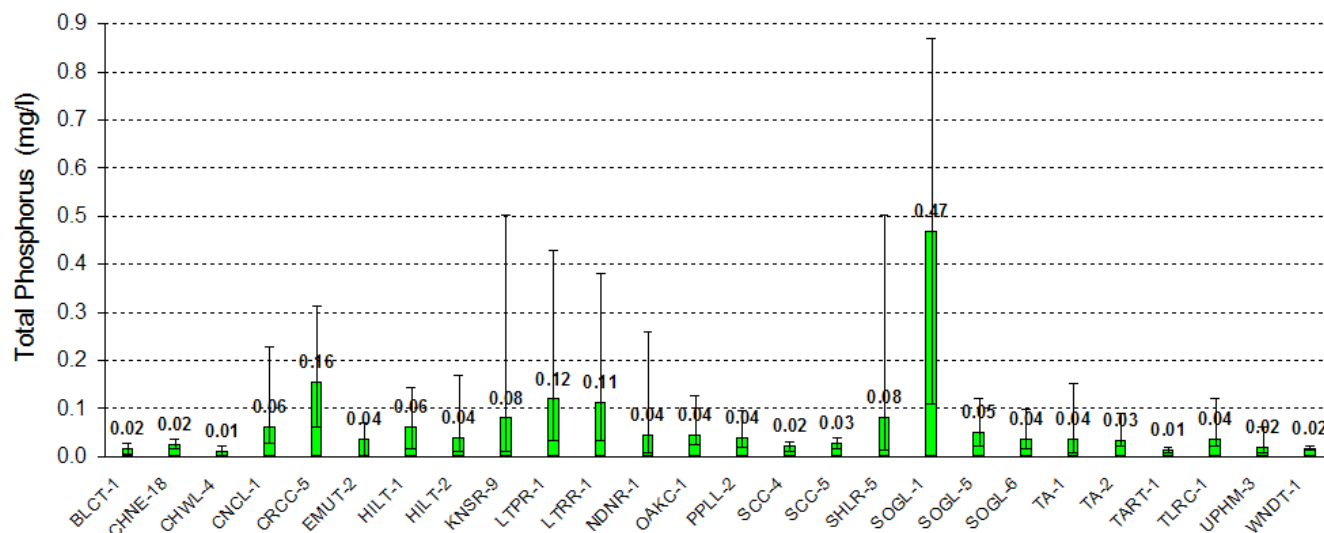


Figure 3. Mean and range of TP for Stream sites sampled in the Tallapoosa Basin.

Data were statistically analyzed using Classification and Regression Tree (CART) analysis. CART analysis recursively partitions observations in matched data sets, consisting of a categorical (for classification trees) or continuous (for regression trees) dependent (response) variable and one or more independent (explanatory) variables, into progressively smaller groups that most minimize intra-grouping variance. Each partition is a binary split based on a single independent variable. CART analysis constructs a set of decision rules that identify homogeneous groups of the response variable as a function of a set of explanatory variables (SOURCE: [www.epa.gov/caddis/da\\_basic\\_4.html](http://www.epa.gov/caddis/da_basic_4.html)).

CART analysis of the ADEM/GSA data was conducted as follows:

- Total Phosphorus (TP) and Total Nitrogen (TN) were input as causal variables.
- Water quality data were taken from the date closest to date of biotic (macroinvertebrate or fish) sampling
- The following variables were input as response variables:
  - chlorophyll a
  - periphyton coverage/density
  - percent nutrient tolerant macroinvertebrates
  - Secchi depth (for reservoir embayment data)
  - diurnal dissolved oxygen range (DOmax - DOmin)
  - pH range (mostly in reservoirs or tributary embayments)
- Stream data were analyzed separately from Reservoir Embayment data.

#### CART Analysis Results:

CART results are presented in Table 2 (below). The CART analysis identified breakpoints based on either TP concentration or TN concentration, whichever was the primary driver in determining the magnitude of the response variable. Analyses were done separately for Streams and for Embayments. In analysis of Embayment data, TP was the primary causal variable for all response variables. In analysis of Stream data, TP was the primary causal variable for some response variables, TN for others. CART analyses results suggest fairly robust nutrient criteria thresholds for the set of diverse response variables examined.

Table 2. Results from CART analyses of Tallapoosa Basin data.

Response Variable	CART Breakpoints	
	STREAM	EMBAYMENT
1. Photic zone depth	N/A	TP 0.021
2. Secchi depth	N/A	TP 0.020
3. Chlorophyll <u>a</u>	TP 0.071	TP 0.029
4. DO range (diurnal, 72 hr)	TP 0.016	TP 0.038
5. pH range	TP 0.016	TP 0.015
6. % Nutrient Tolerant Individuals	TN 0.531	N/A
7. % Taxa as Tolerant	TP 0.014	N/A
8. % Tolerant Individuals	TN 0.205	N/A
9. % Attached Algae	TN 0.773	N/A



#### Stream Results:

1. [Nutrient] relationship to Photic zone depth – not applicable
2. [Nutrient] relationship to Secchi depth – not applicable
3. [TP] less than 0.071 mg/L is related to lower chlorophyll a measurements
4. [TP] less than 0.016 mg/L is related to smaller DO fluctuations
5. [TP] less than 0.016 mg/L is related to smaller pH fluctuations
6. [TN] less than 0.531 mg/L is related to lower % Nutrient tolerant individuals (macroinvertebrates)
7. [TP] less than 0.014 mg/L is related to lower % Taxa as tolerant (macroinvertebrates)
8. [TN] less than 0.205 mg/L is related to lower % Tolerant individuals (macroinvertebrates)
9. [TN] less than 0.0773 mg/L is related to lower % Attached Algae

#### Embayment Results:

1. [TP] less than 0.021 mg/L is related to deeper photic zone measurements
2. [TP] less than 0.020 mg/L is related to deeper Secchi depth measurements
3. [TP] less than 0.029 mg/L is related to lower chlorophyll a measurements
4. [TP] less than 0.038 mg/L is related to smaller DO fluctuations
5. [TP] less than 0.015 mg/L is related to smaller pH fluctuations

#### Data gap Identification and Sampling Recommendations:

A major consideration for future sampling efforts would be to coordinate closely with GSA, and where possible, to collect water quality, macroinvertebrate and other data at stream sample sites where GSA is conducting fish community sampling to maximize the number of streams with coincident datasets.