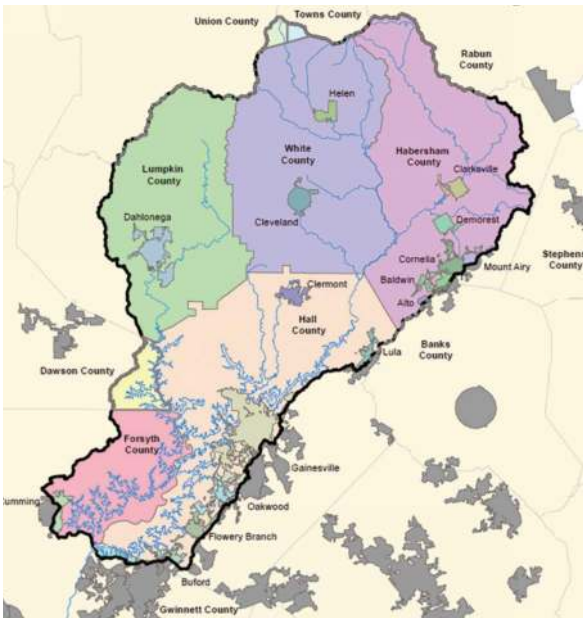
2021
LAKE LANIER WATERSHED
5-YEAR RESEARCH PLAN

THE WATER TOWER



Lake Lanier Watershed
5-Year Research Plan

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The Water Tower

2021

THE WATER TOWER

The Water Tower (TWT) is a 501(c)(3) nonprofit organization located in Buford, Georgia with a mission to develop and continue to grow a thriving ecosystem of water innovation fueled by imagination, informed by research, and powered by pioneers. TWT is building an ecosystem to reimagine the future of water - with the public and private sectors of the water industry - via applied research, technology innovation, workforce development, and community engagement. The integration of these four key areas of programming contribute to TWT's goal of water innovation and helping water and wastewater utilities become more progressive.

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The document was prepared by the following organizations:

- Carollo Engineers, Inc.
- Constantine Engineering, LLC

The Water Tower's Lake Lanier Watershed 5-Year Research Plan is a "living document" and for this reason we welcome your input on any aspect of the plan. To provide feedback, express interest in funding a project, or volunteer on a Project Advisory Committee, please enter the link below into your browser or scan the QR code with your smartphone camera.

www.surveymonkey.com/r/XNR8VLY

A Note from The Water Tower CEO:

On behalf of The Water Tower, I would like to sincerely thank the Gwinnett County Department of Water Resources, project team, stakeholders, and technical experts who contributed their time, talent, expertise, and ideas to this important project. The Lake Lanier Watershed 5-Year Research Plan project marks the inauguration of The Water Tower's research program focusing on applied research to provide direct benefits for utilities and communities. With support from the County and all of those involved in this effort, we are excited to start these efforts in our own backyard.

Lake Lanier is the major source of water supply for communities in the North Georgia region, as well as a critical recreational and quality of life component. While there have been research and planning efforts concerning the Lake in the past, there is a need for a coordinated plan that facilitates management, resourcing, and funding of applied water research projects. It is imperative that we break down the silos between water uses, disciplines, and professionals to utilize this precious resource safely and effectively for generations to come. Without collaboration, there is no innovation. Together we can innovate, engage, and pioneer to create a better water future for the Lake Lanier Watershed and beyond.

Melissa L. Meeker
Chief Executive Officer
The Water Tower

Acknowledgments

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The project team would like to thank Kristan VandenHeuvel, The Water Tower's Project Manager on this effort, for the guidance and support provided that ensured the success of the project. The project would not have been possible without the involvement of the stakeholders, which included water and wastewater agencies, local governments, regulators, environmental non-government organizations, and federal agencies. Their participation in the project and their input on critical issues facing Lake Lanier and the watershed was invaluable in establishing the research topics that needed to be addressed.

In addition, the project team owes a great deal of gratitude to the technical and scientific advisors that served on the Technical Advisory Committee (TAC). This dedicated and resourceful group of individuals representing utilities, academia, consulting firms, and federal agencies deserve the credit for developing the project concepts that serve as the foundation for the Lake Lanier Watershed 5-Year Research Plan. Their involvement was vital to the project. The members of the TAC were as follows:

- Doug Baughman, Hazen and Sawyer
- Brian Bledsoe, PhD, University of Georgia – Institute for Resilient Infrastructure Systems
- Dan Calhoun, United States Geological Survey
- Gail Cowie, PhD, Albany State University – Georgia Water Planning and Policy Center
- Dan Deocampo, PhD, Georgia State University
- Ashwin Dhanasekar, The Water Research Foundation
- Denise Funk, Brown and Caldwell
- Gary Hankins, USDA Natural Resources Conservation Service
- Brigette Haram, PhD, Gwinnett County DWR
- Laurie Hawks, Hawks Environmental
- Ching-Hua Huang, PhD, Georgia Institute of Technology
- John Joiner, United States Geological Survey
- Todd Rasmussen, PhD, University of Georgia - Warnell School of Forestry
- Erik Rosenfeldt, PhD, PE, Hazen and Sawyer
- Brian Skeens, Jacobs
- Dan Wallace, USDA Natural Resources Conservation Service
- Brian Watson, PE Tetra Tech
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Abstract

The Lake Lanier Watershed 5-Year Research Plan (Plan) was developed through a stakeholder driven process by The Water Tower (TWT), the new innovation campus in Gwinnett County. The Plan documents applied research project concepts that will support the protection of the water resources within the Lake Lanier watershed. The Plan also provides a framework to facilitate the implementation of collaborative studies, reflects the interests of stakeholders, and describes the research efforts needed to protect the Lake's beneficial uses.

Located in northern Georgia, Lake Lanier is a critical water resource asset for our region, providing a wide range of benefits, including flood protection, hydropower production, water supply, recreation, and habitat for fish and wildlife. However, Lake Lanier faces challenges from increasing urbanization, impacts from urban and agricultural runoff, droughts, and water quality issues such as algal blooms.

The Plan is a stakeholder-driven multi-year roadmap of applied research projects that will provide stakeholders with the scientific understanding and policy tools needed to help protect the Lake and improve water quality in the watershed. The Plan was developed with input from stakeholders, including regulators, environmental organizations, water and wastewater utilities, regional planning agencies, and representatives of the communities surrounding the Lake and located within the watershed.

The Plan consists of concept-level applied research projects. These projects will help focus and direct efforts to secure the resources and funding needed from public and private entities for implementing the research projects.

The process involved working with stakeholders on priority topics and with technical and scientific experts to address those issues. The stakeholders identified specific questions and challenges related to the protection of the Lake Lanier Watershed. The technical and scientific experts developed targeted research concepts to address those concerns. TWT coordinated the efforts of the stakeholders and the technical experts.

In summary, the Lake Lanier Watershed 5-Year Research Plan provides TWT with a framework to facilitate and encourage the sponsorship of studies that will address a consensus of stakeholder identified priorities identified within the watershed. Based on the Plan, TWT will conduct applied research that provides meaningful results for water and wastewater utilities and other stakeholders. The results of research will inform decisionmakers, guide regulatory decisions, assist with compliance, answer policy and engineering questions, enhance water resource management, and optimize treatment to maintain and protect the Lake's many uses and benefits.

Keywords: Lake Lanier, research plan, watershed, non-point source pollution, nutrients, water quality, monitoring, algal blooms, HABs, best management practices, stormwater, water reuse.

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Acronyms

BMP	best management practice
CECs	constituents of emerging concern
EDCs	endocrine disrupting compounds
EPD	Georgia Environmental Protection Division
FIB	fecal indicator bacteria
HAB	harmful algal blooms
NRCS	Natural Resources Conservation Service
U.S. EPA	U.S. Environmental Protection Agency
GAEPA	Georgia Environmental Protection Division
MDGWPD	Metropolitan North Georgia Water Planning District
MST	microbial source tracking
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PAC	Project Advisory Committee
PFAS	per- and polyfluoroalkyl substances
RAC	Research Advisory Committee
RCPP	Regional Conservation Partnership Program
SWAT	Surface Water Assessment Tool
TMDL	Total Maximum Daily Load
TAC	Technical Advisory Committee
TWT	The Water Tower
USACOE	US Army Corps of Engineers
USGS	U.S. Geological Survey
USDA	U.S. Department of Agriculture
WEF	Water Environment Federation
WRF	The Water Research Foundation

Executive Summary

ES.1 Purpose and Drivers

Lake Lanier, which is bordered by seven counties, is an asset for the region by providing a wide range of benefits, including flood protection, hydropower production, water supply, recreation, and habitat for fish and wildlife. Lake Lanier is a popular destination with 8 million annual visitors. However, Lake Lanier faces challenges from increasing urbanization, impacts from urban and agricultural runoff, droughts, and water quality issues such as algal blooms. In addition, more stringent environmental regulations must be met.

Satellite image of Lake Lanier and tributaries

The protection of the Lake's uses, including water supply, recreation, and habitat, will likely involve additional management strategies. The Water Tower (TWT), the new innovation campus in Gwinnett County, can help address these challenges by working with stakeholders to ensure that Lake Lanier can continue to meet the needs of the region.

The purpose of this project is to develop a stakeholder-driven **Lake Lanier Watershed 5-Year Research Plan** (Plan) to prioritize and spearhead research that will support the protection of the water resources within the Lake Lanier watershed. In addition to meeting the needs of stakeholders, the Plan is built on current efforts and provides a framework for collaborative studies. By engaging stakeholders, the Plan reflects the interests of stakeholders and describes the research efforts needed to protect the Lake's beneficial uses and improve the watershed.

ES.2 Goals and Objectives

The goal of the Plan is to document a **stakeholder-driven multi-year roadmap of applied research projects that will help protect and improve water quality in the Lake Lanier watershed**. The Plan reflects the views of stakeholders in the Lake Lanier Watershed including regulators, environmental nonprofit organizations, water and wastewater utilities, regional planning agencies, as well as the communities surrounding the Lake and within the watershed. The projects in the Plan also reflect the insights of independent technical and scientific experts.

Project Stakeholders
Local Governments and Regulated Entities ▪ Cities and counties ▪ Water and wastewater departments
Regional Planning Agencies ▪ Metropolitan North Georgia Water Planning District ▪ Georgia Mountains Regional Commission
Regulators ▪ Georgia Environmental Protection Division
Environmental Non-Profit Organizations ▪ Chattahoochee Riverkeeper ▪ Georgia River Network
Other Interested Parties ▪ Academia ▪ US ACOE - Lanier Management Office ▪ Associations and nonprofit organizations ▪ General public

The objectives of the Plan are as follows:

- Identify questions and challenges faced by Lake Lanier Watershed stakeholders that can be answered and addressed through applied research.
- Based on input from stakeholders and a review by technical experts, develop a set of near-term concept-level applied research projects as part of a 5-Year Research Plan, which would help protect and improve the water resources within the Lake Lanier Watershed.
- Focus and direct efforts to secure the resources and funding needed from public and private entities for implementing the research projects developed under the 5-Year Research Plan.

ES.3 Approach

TWT received input from stakeholders and technical and scientific experts in the development of the Plan. The stakeholders identified questions, issues, and concerns regarding the management of Lake Lanier and the watershed. These topics were reviewed by technical and scientific experts to develop research concepts to address the stakeholder concerns. TWT coordinated the efforts of the stakeholders and the technical experts and will be responsible for the implementation of the 5-Year Research Plan.

ES.4 Outcomes

The outcome of this project is a Plan that documents a stakeholder-driven multi-year roadmap of applied research projects that will support the protection of the Lake Lanier Watershed.

ES.4.1 List of Prioritized Projects

The project resulted in the development of 32 project concepts focused on relevant research categories, listed at left, in response to the priorities provided by the stakeholders. Each project description was developed to include specific information on research objectives, need and background, research approach, and expected outcomes.

The stakeholders were surveyed to review each of the 32 research projects. Specifically, the stakeholders were asked to provide their perspectives on how timely and compelling the individual projects were.

Research Categories
▪ Non-Point Sources
▪ Nutrients
▪ Water Quality and Monitoring
▪ Stormwater
▪ Land Use
▪ Outreach
▪ Policy
▪ Water Reclamation

The 32 proposed projects are listed in table ES-1 below and are organized by the stakeholder review of the project descriptions. Based on the results, 29 projects were viewed as “Very High” or “High” in terms of stakeholder interest.

Table ES-1 Results of Stakeholder Review of Project Descriptions

Project Number	Project Description	Stakeholder Review
N-003	Lake Lanier Watershed Nutrient-Algae-HABs Working Group	**Very High Interest**
N-007	Improved Information for EPD Base Nutrient Modeling Tool	
NPS-001a	Improved Modeling of Non-Point Sources in Lake Lanier Watershed (Phase 1)	
NPS-001b	Improved Modeling of Non-Point Sources in Lake Lanier Watershed (Phase 2)	
NPS-005	Analysis of Land/Locations for Suitability of BMPs	
O-001	Lake Lanier Water Quality Outreach Program (Phase 1)	
P-001	Innovative Solutions for Nutrient Management	
SW-001	Fecal Bacteria Source Tracking in the Watershed	
SW-002	Effectiveness of BMPs for First Flush Events (initial surface runoff of a rainstorm)	
WQ-001a	Watershed Monitoring Techniques – Current Assessment and Roadmap for the Future (Phase 1)	
WQ-001b	Watershed Monitoring Techniques – Implement Roadmap (Phase 2)	
WQ-003	Assess Lake Lanier Water Quality (and Eutrophication) based on Transparency Measurements (Secchi Disk Depths)	
WQ-007	Predictive Modeling of Harmful Algal Blooms (HABs)	
LU-001	Understand Benefits and Develop Incentives to Maintain Forests for Watershed Protection	**High Interest**

LU-002	Assess Issues Associated with Urbanization and Develop Best Practices for Managing Land Use	
N-001a	Nutrient Trading for the Lake Lanier Watershed (Phase 1)	
N-001b	Nutrient Trading for the Lake Lanier Watershed (Phase 2)	
N-006a	Water Quality Monitoring Dashboard/Indicators (Phase 1)	
N-006b	Water Quality Monitoring Dashboard/Indicators (Phase 2)	
NPS-004	Contribution of Nutrients and Non-Point Source Pollution from Septic Systems	
NPS-006	Capturing Sediment as a Resource	
NPS-008	Review of Efficacy of Agriculture and Urban BMPs for the Lake Lanier Watershed	
NPS-007a	Nutrient Management Practices for Chicken Litter (Phase 1)	
NPS-007b	Nutrient Management Practices for Chicken Litter (Phase 2)	
O-002	BMPs for Municipalities, Agriculture Community, and Businesses/Residences (Phase 2)	
WR-001	Assess Potential and Benefits for Expanded Recycled Water in the Region	
WQ-004	Non-Algae Water Quality Drivers for Drinking Water Taste and Odor Events and other Impacts	
WQ-005	Assess the impact of CECs in Lake Lanier and the Watershed (CECs Phase 1)	
WQ-006	Survey of Inputs and Control Measures of CECs to Lake Lanier and the Watershed (CECs Phase 2)	
NPS-002a	Assess Sediment Loading Over Time (Phase 1)	**Additional Review Needed**
NPS-002b	Assess Sediment Loading Over Time (Phase 2)	
NPS-003	Modeling Techniques for Surveys of Soils and Corings	

ES.4.2 Other Outcomes

In addition to the 32 research projects, the approach to develop the Plan provided other benefits, including the following:

- **Involvement of Stakeholders.** The stakeholders involved in the project representing local governments, planning districts, water and wastewater utilities, environmental groups, and regulators can be engaged to further advance the research efforts for the region.
- **Technical and Scientific Advisors.** These individuals that supported the development of project descriptions have strong interests in Lake Lanier watershed and can be engaged by TWT during the implementation phase as collaborators and research partners.

These partnerships with stakeholders and researchers will be a valuable resource in future research efforts.

ES.5 Next Steps

The Lake Lanier Watershed 5-Year Research Plan provides TWT with a framework to sponsor research through its formal research process. This research process provides TWT with a robust and credible approach to managing and conducting research that provides meaningful results for water and wastewater utilities and other stakeholders. The research results will be used to inform decisionmakers, guide regulatory decisions, assist with compliance, answer policy and engineering questions, enhance water resource management, and optimize treatment.

ES.5.1 Research Process

TWT's research process involves the use of the following:

- **Research Advisory Committee (RAC).** The RAC is comprised of experts who will review research concepts and provide recommendations to TWT's Board of Directors for funding consideration.

- **Board of Directors.** The Board provides overall direction for TWT's research program and provides final funding approvals.
- **Project Advisory Committees (PAC).** A PAC is assigned for each project approved by the Board of Directors and provides technical oversight throughout the life of the project.

The roles of each group are defined by TWT's research process and are summarized in the figure below.

TWT is ideally positioned to lead research collaborations for the Lake Lanier Watershed based on its nonprofit status, focus on applied research, its proximity to the Lake, and mission to create a thriving ecosystem of water innovation informed by research. As TWT manages the implementation of applied research projects through its formal research process, a key element of that process will be the identification of research and funding partners for each project.

ES.5.2 Partners and Collaborators

To maximize the effective use of available resources, TWT will seek to develop strong relationships with partnering organizations and research collaborators who maintain similar interests. Potential partners include the following:

- Water and wastewater agencies in the Lake Lanier Watershed
- Local and county governments in the Lake Lanier Watershed
- Planning districts
- Federal agencies with responsibilities in the region including the Army Corps of Engineers and the Natural Resources Conservation Service
- Universities (e.g., University of Georgia, University of North Georgia, Georgia Tech).
- Environmental organizations

TWT will partner with these organizations by seeking their support in co-sponsoring projects, serving on TWT committees, and providing additional resources on projects (including in-kind resources).

ES.5.3 Funding

Funding for projects will be secured from several sources, including the following:

- **Stakeholders.** TWT will continue to serve as a forum for stakeholders, including water and wastewater utilities and planning organizations to collaborate on research projects. The list of stakeholders can be expanded over time to include organizations representing other industries such as agriculture and forestry.
- **Research Partnerships.** TWT will collaborate with other research partners on projects, including government agencies, environmental organizations, universities, and other research institutes.
- **Grants.** TWT will work to secure grants from public, non-profit, and private sector organizations.
- **Crowdsourcing.** TWT will develop innovative and non-traditional approaches to funding, including organizing crowdsourcing approaches by enlisting the services of a large number of people or groups via social media and the internet.

ES.5.4 Project Management

After securing funding for projects, the applied research projects will be competitively bid. Each project will be managed by TWT and will include third party technical expert oversight. The results of research will be shared with stakeholders.

Chapter 1

Introduction and Background

Lake Sidney Lanier (Lake Lanier), which is located northeast of Atlanta, encompasses 59 square miles of lake surface and over 690 miles of shoreline. Lake Lanier, formed by Buford Dam, is a valuable resource for the region and provides a range of benefits including flood control, water supply, and recreation. However, Lake Lanier, which is bordered by seven counties, also has been impacted by droughts, development, and water quality issues such as algal blooms.

The Lake Lanier watershed includes 10 counties, covers over 1000 square miles (Figure 1), and receives most of its inflows from the Chattahoochee and Chestatee Rivers. Residents and visitors from throughout the region enjoy Lake Lanier for the abundant recreational opportunities it provides. The watershed also contains heavily forested areas and traverses 17 cities. In addition, agriculture is one of the primary activities in the watershed.

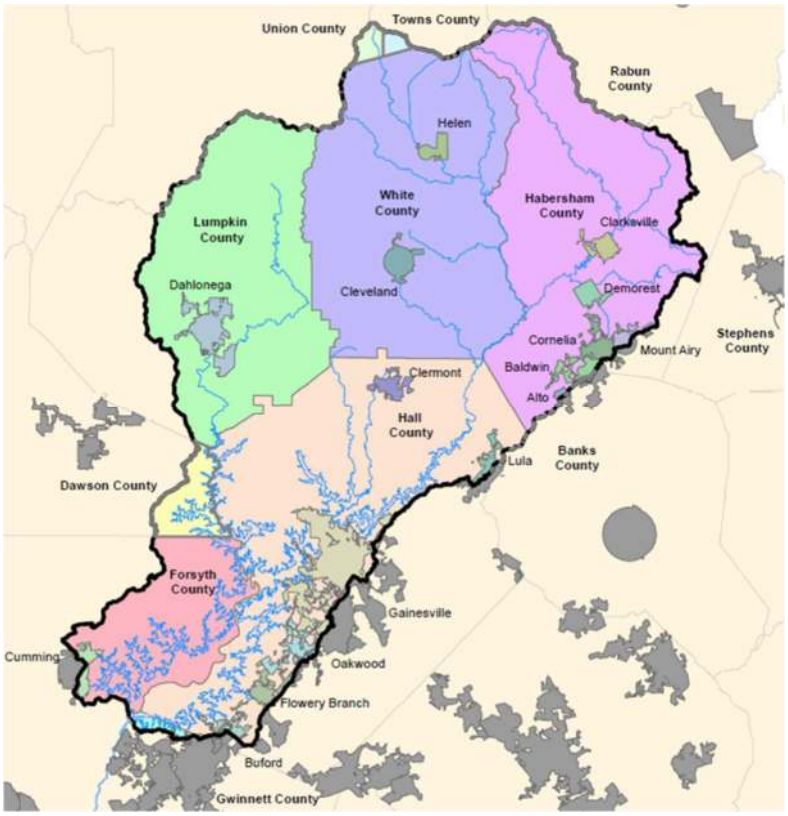


Figure 1. Local jurisdictions in the Lake Lanier Watershed.

As the region grows, the water supply and recreational uses of the Lake need to be protected. The protection of these uses will likely involve the development and adoption of additional environmental controls and management strategies. These measures will affect stakeholders in the watershed and the waterways that feed the lake. The Water Tower (TWT), the new innovation ecosystem campus in Gwinnett County, is positioned to help address these challenges by working with stakeholders to ensure that Lake Lanier can continue to meet the needs of the region. As an initial step, TWT sponsored the development of the **Lake Lanier Watershed 5-Year Research Plan** (Plan), which identifies and prioritizes research projects that will support the protection of the water resources within the Lake Lanier Watershed. The Plan was developed to benefit stakeholders who have an interest in the management of the Lake Lanier Watershed by providing a roadmap for collaborative studies.

I.I Vision and Purpose of Plan

A number of water research projects and planning efforts have been conducted throughout the Lake Lanier Watershed by regulators, planning groups, environmental organizations, water and wastewater utilities, and community groups. However, these efforts have not been coordinated around questions and challenges that can be addressed through an organized applied research program.

An informed research plan will help document, facilitate, and coordinate an approach to develop the ideation, planning, prioritization, management, resourcing, and funding of applied water research projects that meets the needs of the Lake and the watershed.

By engaging stakeholders and technical experts, TWT facilitated the development of the 5-Year Research Plan that reflects the interests of stakeholders and describes the research efforts needed to protect the Lake's beneficial uses and improve the watershed.

I.2 Plan Goal and Objectives

The goal of this Plan is to document a **stakeholder-driven multi-year roadmap of applied research projects that will help protect and improve water quality in the Lake Lanier watershed.**

> *"The Lake Lanier Watershed 5-Year Research Plan will reflect stakeholder needs, will be informed by expert scientists and researchers, and will serve the community by providing a research roadmap for addressing the most critical questions and research needs."*
>
> Kristan VandenHeuvel
> Research Plan Project Manager
> The Water Tower

The specific objectives for the Plan reflect the interests of a range of stakeholders in the Lake Lanier Watershed, including regulators, environmental NGOs, water and wastewater utilities, regional planning agencies, as well as the communities surrounding the Lake and within the watershed. The specific objectives of the Plan are as follows:

- Identify questions and challenges faced by Lake Lanier Watershed stakeholders that can be answered and addressed through applied research.
- Based on input from stakeholders and a review by technical experts, develop a set of near-term concept-level applied research projects as part of a 5-Year Research Plan, which would help protect and improve the water resources within the Lake Lanier Watershed.
- Focus and direct efforts to secure the resources and funding needed from public and private entities for implementing the research projects developed under the 5-Year Research Plan.

I.3 Collaborative Approach

To develop the 5-Year Research Plan, TWT used a collaborative approach to engage stakeholders as well as technical and scientific experts. These two groups had specific roles and responsibilities in the Plan development and were coordinated by TWT.

The stakeholders covered a range of perspectives in the watershed and were used to identify questions and issues regarding the management of Lake Lanier and the watershed. The technical and scientific experts were included in the process to help develop potential research concepts. Experts were selected with a wide range of backgrounds including water quality, engineering, and water resources.

Figure 2. The Water Tower engaged stakeholders and technical experts in the Plan development process.

I.4 Plan Assumptions

To meet the needs of a research program, specific assumptions regarding the Plan development were defined. It was determined that the Plan needed to reflect the needs of stakeholders, address issues specifically affecting the watershed, and focus on applied research that would provide the opportunity to develop practical results that would have the greatest impact on the watershed.

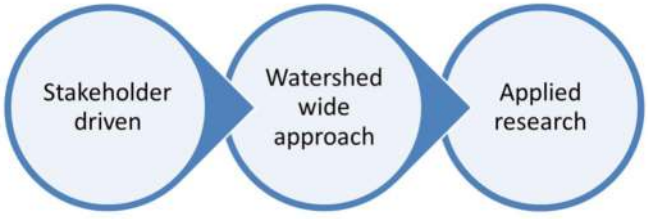


Figure 3. The Plan was developed based on specific assumptions.

1.5 Organization of the Plan

The remainder of the Plan is organized into the following sections:

- **Chapter 2: 5-Year Research Plan Approach.** Summarizes the approaches used to develop the Plan.
- **Chapter 3: Plan Results.** Summary of the results of the Stakeholder Committee and Technical Advisory Committee efforts, including the list of recommended project descriptions.
- **Chapter 4: Summary and Next Steps.** Provides a summary of the findings and a description of the next steps in the implementation of the projects.
- **Appendix A: Summary of Existing Research.** Provides an overview of existing research that may inform/complement the Plan.
- **Appendix B: Project Descriptions.** Provides descriptions of the recommended research project.

Chapter 2

5-Year Research Plan Approach

2.I Overview of Approach

To support the development of the 5-Year Research Plan, TWT created a forum to solicit stakeholder and technical expert input on the challenges facing the Lake Lanier Watershed and how to address them through applied research. This effort was designed to build on the work that is being conducted or has been done by other entities. It was recognized that for the Plan to be successful, the proposed research would need to reflect the interests of stakeholders in the watershed.

The specific approach to develop the Plan involved the use of a wide range of stakeholders and a Technical Advisory Committee. The stakeholders included regulated entities, regional planning agencies, environmental organizations, regulators, and organizations with operational interests in Lake Lanier. The Technical Advisory Committee was made up of scientific and technical experts with backgrounds related to the research needs for the watershed.

As shown in Figure 4, stakeholders were used to define research needs and the Technical Advisory Committee of experts reviewed high priority topics and developed research concepts to address those needs. TWT coordinated the efforts of stakeholders and the Technical Advisory Committee in Plan development and will continue to take a lead role in the ongoing development of the Plan and the coordination of its implementation.

Figure 4. Overview of the Lake Lanier 5-Year Research Plan Approach

2.2 Stakeholders

The input of stakeholders was identified as a critical element for the success of the project. The stakeholders were engaged and asked to identify the issues and questions that the research plan needed to address. The outcome of this outreach effort was the identification of a broad list of research needs that effectively represented the interests of the stakeholders.

Several sources were used to develop the list of stakeholders. GIS data was used to identify city and county governments and water and sewer authorities located within the Lake Lanier watershed. A list of individuals and organizations who participated as stakeholders in the development of the 2017 Lake Lanier TMDL was used to identify organizations with interests in water quality issues in the watershed. Based on this approach, the project team identified the stakeholder groups shown in the figure below.

Entities from each of these groups were involved in the needs assessment and issue identification efforts for the project. It is expected that these stakeholders will continue to play a role in the implementation of the Plan.

Project Stakeholders
Local Governments and Regulated Entities ▪ Cities and counties ▪ Water and wastewater departments
Regional Planning Agencies ▪ Metropolitan North Georgia Water Planning District ▪ Georgia Mountains Regional Commission
Regulators ▪ Georgia Environmental Protection Division
Environmental Non-Profit Organizations ▪ Chattahoochee Riverkeeper ▪ Georgia River Network
Other Interested Parties ▪ Academia ▪ US ACOE - Lanier Management Office ▪ Associations and nonprofit organizations ▪ General public

2.2.1 Stakeholder Committee

The entities that represented local governments, planning agencies, and other organizations with a specific interest in Lake Lanier, were invited to participate on the Stakeholder Committee. In addition to providing specific feedback on questions and desired research the stakeholders also helped prioritize the developed project descriptions.

Purpose and Role

The primary purpose of the Stakeholder Committee was to provide a collaborative forum for supporting a dialogue to identify research drivers and questions. This input reflected the most pressing issues for these stakeholders regarding the operations and management of Lake Lanier and the watershed. During the process, the questions and topics that were discussed and documented were those that resonated with the stakeholders.

During their deliberations and discussions, members of the Stakeholder Committee were asked to think broadly about their questions in context of a "One Water" approach to integrated water resource management. In addition, it was noted that the purpose of the Plan would be to conduct applied research that would benefit or provide a better understanding of water resource management within the lake and the watershed. The Stakeholder Committee was also asked to identify current and past research efforts that would be relevant for the project.

Stakeholder Research Areas for the Lake Lanier Watershed
Non-Point Sources
Nutrients
Water Quality and Monitoring
Stormwater
Other (Land Use, Outreach, Reuse)

The Stakeholder Committee developed a consensus on applied research that would provide benefits to stakeholders, including decision makers, regarding the management of Lake Lanier and the watershed.

Committee Selection Process

Stakeholder Committee members all have a direct interest in the management of the Lake Lanier watershed. Stakeholders included policy makers and representatives of agencies or utilities that are driven by mandates and or other drivers to manage water resources and deliver water management outcomes. It is anticipated that many of the stakeholder groups may also become potential funding partners of the applied research projects developed out of the planning process.

Stakeholder Committee Members

Representatives from the organizations, agencies, and associations listed in Table 1 participated as stakeholders in support of the planning process.

Table 1 List of Stakeholders

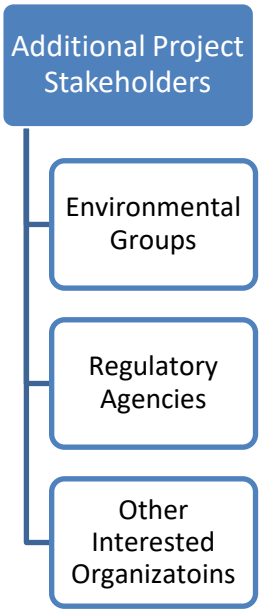
Planning Organizations	Local Government Cities
Metropolitan North Georgia Water Planning District	City of Alto
Georgia Mountains Regional Commission	City of Clarksville
	City of Cleveland
Local Government - Counties	City of Cornelia
Athens Clark County - Public Utilities	City of Dahlonega
Forsyth County - Water and Sewer	City of Gainesville
Forsyth County - Health Department	City of Oakwood
Gwinnett County - Water Resources	
Hall County - Public Works	**Other Organizations**
Lumpkin County W&S Authority	US ACOE - Lanier Management Office
White County Water Authority	Lake Lanier Association
	Georgia Forestry Foundation

2.2.2 Outreach to Additional Stakeholders

In addition to the Stakeholder Committee process, outreach to additional stakeholders was conducted. This approach ensured that a wide variety of stakeholders had the opportunity to provide input in the process.

Overview

To augment the Stakeholder Committee efforts, other specific groups were contacted for input and ideas. Additional entities included regulators, environmental NGOs, and other interested organizations.



Reaching out to these groups provided the opportunity to engage a wider audience. Input from these groups was used to inform the project effort and allowed a wider range of perspectives and additional ideas to be captured.

TWT will keep these groups informed of the findings of the project and other efforts by TWT to coordinate and implement the 5-Year Research Plan. These organizations could become partners in the future research projects. A working list of contacts at these organizations was developed to support future outreach by TWT on the research program.

These other stakeholders were initially selected based on groups with known interests in the Lake Lanier watershed and the project. During the Stakeholder Committee and Technical Advisory Committee efforts, suggestions were made for outreach to additional organizations, which were added to the working list of interested organizations.

Outreach Efforts

As part of the project, outreach to the regulatory and environmental groups was conducted. Conference calls were held with each group to received feedback on the project and suggestions on issues and research needs. Several representatives of the Georgia Environmental Protection Division participated on the regulatory group call and the Chattahoochee Riverkeeper and the Georgie River Network participated on the environmental group call. The input from both groups was captured as part of the project.

2.3 Technical Advisory Committee

The Technical Advisory Committee (TAC) was essential to the review water quality issues and questions identified by the stakeholders and in the development of proposed research to address those issues.

2.3.1 Purpose and Role

The primary purpose of the TAC was to engage a diverse group of experts who had backgrounds in a variety of scientific, technical, and water resources disciplines. The TAC members were tasked with reviewing the issues and questions raised by stakeholders and developing applied research projects focused on the needs of the stakeholders.

The technical experts were asked to develop the research projects based on their research experience and scientific and technical knowledge. By applying their diverse and extensive experience, the TAC was uniquely capable of working through the stakeholder issues and developing recommended applied research projects. The project descriptions that resulted from the TACs efforts formed the basis of the 5-Year Research Plan.

2.3.2 Selection Process

The technical experts were selected to ensure that the appropriate backgrounds to address the stakeholder needs were included on the TAC. In addition, the TAC was limited to 20 members to encourage a productive dialogue and so TAC members could be actively engaged in the process.

A list of required scientific disciplines such as hydrology, limnology, ecology, and others were initially developed to align with the questions raised by the stakeholders. The stakeholders were asked to provide recommendations for the TAC. Local and national experts from academia, consulting firms, and federal agencies were identified. A review was conducted of their credentials, published works, and references. Lastly, each potential TAC member was interviewed to confirm availability and interest.

TAC Member Disciplines

- Lake ecology and limnology
- Water resources and hydrology
- Watershed planning and modeling
- Water, wastewater, and recycled water treatment
- Best management practices
- Water quality (nutrients, CECs, etc.)
- Stormwater and nonpoint source water quality management
- Algal and harmful algal blooms
- Environmental and climate impacts
- Water policy and regulations

2.3.3 TAC Members

The members of the TAC represent a range of organizations, including universities, consultants, and agencies. The TAC members that supported the process are listed in Table 2.

Table 2 – List of Technical Advisory Committee Members

Name	Affiliation
Doug Baughman	Hazen and Sawyer
Brian Bledsoe, PhD, PE	University of Georgia – Institute for Resilient Infrastructure Systems
Dan Calhoun	United States Geological Survey
Gail Cowie, PhD	Albany State University – Georgia Water Planning and Policy Center
Dan Deocampo, PhD	Georgia State University
Ashwin Dhanasekar	Water Research Foundation
Denise Funk	Brown and Caldwell
Gary Hankins	USDA Natural Resources Conservation Service
Brigette Haram, PhD	Gwinnett County Department of Water Resources
Laurie Hawks	Hawks Environmental

Ching-Hua Huang, PhD	Georgia Institute of Technology
John Joiner	United States Geological Survey
Todd Rasmussen, PhD	University of Georgia - Warnell School of Forestry
Erik Rosenfeldt, PhD, PE	Hazen and Sawyer
Brian Skeens	Jacobs
Dan Wallace	USDA Natural Resources Conservation Service
Brian Watson	Tetra Tech
Alan Wilson, PhD	Auburn University - School of Fisheries, Aquaculture, and Aquatic Sciences

2.4 Information Sources

To support the process of developing the 5-Year Research Plan, information was collected by surveying stakeholders and identifying existing and ongoing research efforts.

2.4.1 Review of Existing Research

A review of existing research studies and projects by universities, water and wastewater agencies, consulting firms, USGS, and other local organizations was conducted. This prior research helped underscore important water quality issues in the Lake Lanier watershed and the types of information and data available. A summary of the research studies reviewed as part of this project is provided in Appendix A.

2.4.2 Use of Stakeholder Surveys

Online surveys were used to solicit information from the stakeholders. Initially, all stakeholders were surveyed for their suggested research questions and project ideas. A survey was also used to assess stakeholder priorities on the Project Descriptions. The results of the surveys are presented in Chapter 3.

2.5 Project Committees

To develop the Plan, the Stakeholder Committee and Technical Advisory Committee were engaged through a series of meetings (see Figure 5). The meetings were organized to achieve the following objectives:

- Develop research drivers, needs, and questions by stakeholders.
- Develop priority research concepts and project descriptions to address the research identified by the stakeholders.
- Review and prioritize the project descriptions for the Plan.

The meetings were sequenced as follows:

- **Stakeholder Committee Meeting #1 – Research Drivers and Needs.** An initial Stakeholder Committee meeting was held to solicit a range of questions or projects important to the stakeholders. Prior research efforts were also identified.

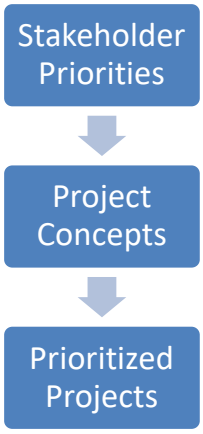
Figure 5. Stakeholder Committee and Technical Advisory Committee Meetings.

- **Technical Advisory Committee Meetings**
    - **TAC Meeting #1 – Review the Research Needs.** At the first meeting, the TAC reviewed the stakeholder research needs and developed project concepts to address those categories of needs.
    - **TAC Meeting #2 – Develop Research Concepts.** At the second meeting of the TAC, research concepts were reviewed, consolidated, and refined by area or category. These revised concepts formed the basis of specific Project Descriptions.
    - **TAC Meetings #3 and #4 – Develop Project Descriptions.** The TAC held two meetings to develop and review Project Descriptions. The final Project Descriptions were organized into several research areas.
- **Stakeholder Meeting #2 – Review and Prioritize Project Descriptions.** The second Stakeholder meeting was held to review the proposed Project Descriptions organized by category and to gain insights on research priorities.

Chapter 3

Plan Results

3.1 Introduction



As detailed in Chapter 2, the development of the 5-Year Research Plan involved three phases:

- Identify priorities based on a wide-ranging review of stakeholder perspectives and suggestions.
- Develop proposed research project concepts to address the stakeholder priorities.
- Prioritize the research project concepts based on stakeholder review.

In this Chapter, the results of each of these steps are summarized.

3.2 Initial Stakeholder Input

Compiling the initial stakeholder input involved the use of a web-based survey of the stakeholders and discussion of the results during meetings with the stakeholders.

The survey was designed to solicit critical topics of interest and identify potential research areas. The survey included 24 respondents representing water and wastewater utilities, planning agencies, non-profit organizations, and local, state, and federal government agencies. Specific questions addressed the following:

- Current challenges facing Lake Lanier
- Recommendations for experts to serve on the Technical Advisory Committee
- Sources of monitoring and other technical information
- Potential partners on research collaborations

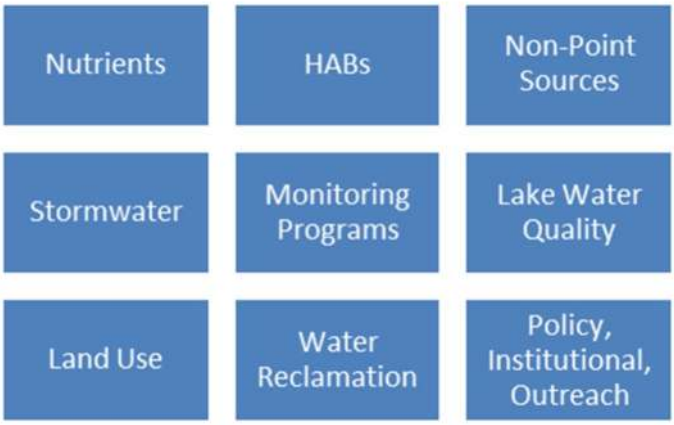


Figure 6. Categories of Lake Lanier watershed research priorities based on stakeholder input.

Based on the initial stakeholder survey results, the challenges facing Lake Lanier and the watershed were organized into the nine categories shown in Figure 6. These categories represented the major areas of interest by the stakeholders and each category included several subtopics of interest. In addition to the information captured in these categories, other feedback regarding alignment with existing planning efforts, the availability of funding sources, and other available informational resources was also offered by respondents.

3.2.1 Research Categories

Specific suggestions captured in the initial stakeholder survey for each of the major categories is provided below. Although, there is overlap between different categories, the information below reflects the specific stakeholder comments within these areas.

Nutrients
The impacts of nutrient levels in Lake Lanier was a common theme among many stakeholders. The topics raised address a range of topics including sources, impacts, and control. Specific areas of interest identified included:

- Assess sources, including non-point sources
- Assess control strategies, including the effectiveness or validation of BMPs
- Bioavailable nutrients in the Lake
- Nutrient ratios in the Lake and their impact on the formation of algal blooms and harmful algal blooms (HABs)
- Innovative approaches/strategies to control nutrients

Harmful Algal Blooms
Algal blooms and HABs were viewed as a visible impact of nutrients in Lake Lanier and have the potential for impacting drinking water, lake ecology, and potential recreational activities. Recommended topics included:

- Assess eutrophication causes and impacts
- Impacts on drinking water aesthetics (i.e., taste and odor)

Non-Point Sources
The impact of non-point sources of pollutants, including nutrients, pesticides, and other constituents, was viewed as an area of significant interest for the protection of Lake Lanier. Non-point sources are more diffuse and more difficult to control than point sources. Non-point sources of interest included residential land use, urban runoff, and agricultural activities. Specific topics included:

- Sources of non-point pollution, including agricultural, stormwater runoff, and residential pollution control practices
- Contribution of nutrients to the Lake
- Source of other pollutants (e.g., pesticides, bacteria, metals, etc.)
- Use and effectiveness of BMPs, including agricultural, urban, and construction

Stormwater
Because stormwater runoff enables non-point source pollution, stormwater was of high interest, particularly regarding its ability to carry nutrients and other pollutants in the watershed into Lake Lanier. In addition, the issue of increased sedimentation in Lake Lanier from rain events was an area of interest based on local erosion and impacts of nutrients in sediments. Recommended topics included:

- Beneficial use of stormwater as a water supply
- Assessing runoff as a source of pollutants
- Sedimentation:
    - Sources, including erosion and development/construction
    - Impacts to the Lake (source of nutrients, silting)
    - Shoreline erosion
- Types of effective BMPs

Monitoring Programs
A key activity in the assessment of water quality for Lake Lanier is the use of monitoring for a range of water quality parameters and constituents in the lake and the watershed. Although there are a number

of current monitoring programs, these efforts are not coordinated, and the information they produce may not be widely available. Areas of interest included:

- Coordination of current and future monitoring
- Review and document the purposes for monitoring
- Reviewing the drivers for monitoring, and reconsidering the parameters being monitored, the frequency of monitoring, and the distribution of monitoring locations

Lake Water Quality

The water quality in Lake Lanier is a primary driver for the Plan and a theme in all of the categories. Water quality in the Lake Lanier watershed is important for water supply and environmental protection. Specific issues such as TMDLs and constituents of emerging concern (CECs), including per- and polyfluoroalkyl substances (PFAS), were raised by stakeholders. Recommended areas of research interest included:

- Water supply, including source water protection
- Support of ecology and habitat
- CECs, including PFAS
- Regulations, including NPDES permits, more stringent effluent limits, and Lake Lanier watershed TMDLs for nutrients.

Land Use

Land use and development was widely recognized as an important factor to assessing the future trends in Lake Lanier's water quality. Areas of interest include assessing growth, land use practices, and the urbanization of the region. Specific topics identified included:

- Urbanization issues
- Impact of growth on land use practices
- Responsible development
- Benefits of forests (environmental, social, and economic)

Water Reclamation

Water reuse provides the opportunity to use treated wastewater effluent for beneficial uses that can provide important benefits to the region, including offsetting potable water demands and reducing nutrients discharges to the lake and watershed. Areas of interested included:

- Innovative treatments
- Decentralized treatments and applications
- Benefits of recycled water

Policy and Institutional

Stakeholders recognized that informed policies and institutional changes can provide significant advancements in how water is managed in the region. Changes in polices can reduce barriers to solutions. The use of integrated water management approaches can better recognize multiple benefits of projects and can involve regional approaches. Recommended topics included the identification of:

- Integrated approaches, including for water supply, wastewater, and stormwater.
- Regional solutions and collaboration between jurisdictions
- Projects with multi-benefits or co-benefits
- Barriers to implementation

Outreach

Public engagement and education were viewed as a cost-effective approach to raise awareness as well as a requirement for informing stakeholders and the public on new projects to gain support. In addition, outreach to crucial partners, such as the agricultural community and environmental organizations, will be needed to advance solutions. Specific topics of interest that were identified included:

- Identify effective methods of communication and public engagement to connect with homeowners and businesses
- Raise awareness (e.g., public information campaign)
- Engage stakeholders, including agricultural, NGOs, and others

3.2.2 Other Suggestions

The stakeholders had additional recommendations that addressed specific regional efforts or were more general. These included:

- Consider the action items in the Metropolitan North Georgia Water Planning District's (MNGWPD) Water Resources Management Plan (MNGWPD 2017) addressing:
  - Integrated Water Resource Management
  - Water Supply Planning and Water Conservation
  - Wastewater
  - Public Education
- Address all areas of water management across multiple jurisdictions and stakeholders
- National Resources Conservation Service (NRCS): Potential funding to address on-farm, watershed, and related topics through the Regional Conservation Partnership Program (RCPP)
- Other potential sources of information include:
  - Gwinnett County Septic System Assessment Project
  - Soque River Watershed Protection Plan
  - Anuran Monitoring Project
  - Lake Lanier TMDL
  - University of Georgia and University of North Georgia
  - Georgia Mountain Regional Council Studies
  - US Forestry Services Southern Research Center

3.3 Results of Outreach to Additional Organizations

Discussions were held with additional stakeholder organizations, including regulators and environmental groups, on their perspectives on protecting Lake Lanier and the watershed. These discussions were informal, and the input was used to inform the development of the Plan.

3.3.1 Input from Environmental Groups

The project team also held discussions with representatives of the environmental community. These representatives included the Chattahoochee Riverkeeper and the Georgia River Network. In addition to providing their perspectives on the Lake and the use of integrating planning, as mentioned in Figure 7, the environmental groups also provided the following suggestions on research priorities for Lake Lanier:

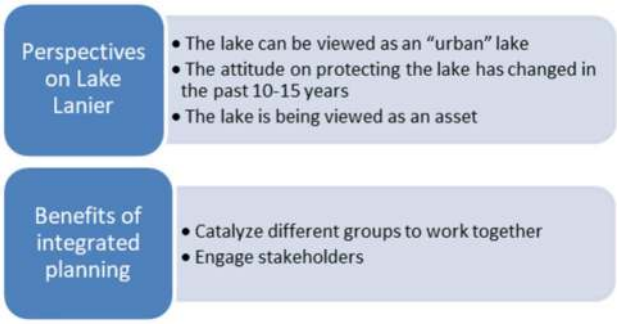


Figure 7. Suggestions for the Plan from environmental groups.

- Stormwater runoff, including control of nutrients, bacteria, and oil
- Sedimentation, including erosion control compliance

3.3.2 Input from Regulators

Several representatives of the State of Georgia's Environmental Protection Division (EPD) participated in a discussion with the project team on their topics of interest associated with Lake Lanier. In addition to the items mentioned in Figure 8, EPD also expressed an interest in the following issues:

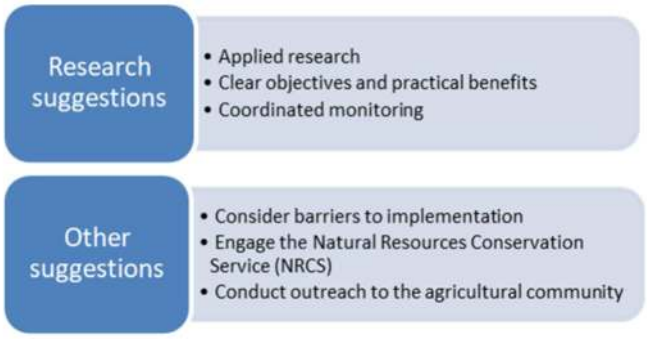


Figure 8. Regulator recommendations on the Plan process.

- Reduction of non-point sources
- Verification of BMP performance
- Harmful Algal Blooms (HABs)
- Nutrient ratios that contribute to HABs
- Identification of sediment sources and develop an enhanced understanding of their impacts on the Lake

3.4 Recommended TAC Research Projects

The TAC developed a list of 32 project concepts in response to the priorities provided by the stakeholders. In reviewing the suggested topics, the TAC refined the list of categories to reflect the proposed research projects developed by the TAC (see Figure 9).

TAC Research Categories (No. of Projects)
▪ Non-Point Sources (11)
▪ Nutrients (6)
▪ Water Quality and Monitoring (7)
▪ Stormwater (2)
▪ Land Use (2)
▪ Outreach (2)
▪ Policy (2)
▪ Water Reclamation (1)

Figure 9. List of TAC research categories.

The number of projects for each topic is provided in Figure 9. Several of the projects have multiple phases. That is, certain projects are sequenced by separating a project into two phases to allow for an initial exploratory project followed by a larger study. These projects are listed as Phase 1 and Phase 2 projects.

Full project descriptions for each of the 32 projects are provided in Appendix B. Each of the projects is summarized below by topic area.

3.4.1 Non-Point Sources

For non-point sources, as shown in Table 3, 11 project descriptions were developed. These proposed projects addressed sources of non-point source pollution, sedimentation, suitability of BMPs, and management practices.

Table 3: Projects on Non-Point Sources

PD No.	Title
NPS-001a	Improved Modeling of Non-Point Sources in the Lake Lanier Watershed (Phase 1)
NPS-001b	Improved Modeling of Non-Point Sources in the Lake Lanier Watershed (Phase 2)
NPS-002a	Assess Sediment Loading Over Time (Phase 1)
NPS-002b	Assess Sediment Loading Over Time (Phase 2)
NPS-003	Modeling Techniques for Surveys of Soils and Corings
NPS-004	Contribution of Nutrients and Non-Point Source Pollution from Septic Systems
NPS-005	Analysis of Land/Locations for Suitability of BMPs

NPS-006	Capturing Sediment as a Resource
NPS-007a	Nutrient Management Practices for Chicken Litter (Phase 1)
NPS-007b	Nutrient Management Practices for Chicken Litter (Phase 2)
NPS-008	Review of Efficacy of Agriculture and Urban BMPs for the Lake Lanier Watershed

NPS-001a: Improved Modeling of Non-Point Sources in the Lake Lanier Watershed (Phase 1)

Objective: In Phase 1, assess current non-point sources modeling work in the watershed, by various sources, and determine additional work that would assess loadings and identify knowledge and data gaps that would improve the models.

Need: NPS modeling has been done primarily for large categories like agriculture. However, the modeling would benefit from a better understanding of items such as: refining the partitioning of phosphorus loads from in-lake erosion; sedimentation in the upper reaches; impacts of septic systems; nutrient loading from poultry operations; tributary channel incision and gullying; and other sources.

NPS-001b: Improved Modeling of Non-Point Sources in the Lake Lanier Watershed (Phase 2)

Objective: In Phase 2, conduct a longer-term (over the next several decades) modeling effort that assesses the resilience of the lake due to changing land use and climate impacts by modeling in different time scales and conducting stress tests under different climate scenarios.

NPS-002a: Assess Sediment Loading Over Time (Phase 1)

Objective: In Phase 1, perform an initial assessment of sediment sources and deposition rates in key areas of Lake Lanier. Determine areas with the greatest impacts from sedimentation using water quality data to map and estimate sediment loadings over time and to estimate deposition patterns. Evaluate bank erosion and other sources that contribute to the total sediment deposition rates. Review water-quality characteristics and potential sources of constituents of concerns or other emerging contaminants.

Need: Increasing sedimentation in the Lake from runoff, shoreline erosion, and headwater bank erosion, can be a source of nutrients such as particulate-bound phosphorus.

NPS-002b: Assess Sediment Loading Over Time (Phase 2)

Objective: After the Phase 1 assessment of key locations linked to increased sedimentation, Phase 2 will focus on potential watershed mitigations on specific subbasins. Understanding the sediment dynamic will help with understanding the nutrient dynamic. In addition, it may be possible to conduct sediment fingerprinting for source tracking to determine where sediments originate.

NPS-003: Modeling Techniques for Surveys of Soils and Corings

Objective: To determine how much sediment is accumulating in creeks over time, develop an underwater soil map in Lake Lanier bays and inlets by assessing subaqueous soils. This assessment can be verified with corings (10-20 ft. deep). Examine modeling techniques for applicability to the Lake Lanier watershed.

Need: The underwater topo maps can identify different ecosystems, depths of sediment, and other information related to sedimentation in Lake Lanier. This information can assist in identifying the sources of sediments and areas for potential sediment removal.

NPS-004: Contribution of Nutrients and Non-Source Pollution from Septic Systems

Objective: Assess whether data from the 2020 Gwinnett County Water Resources septic study is sufficient and representative of the watershed. Develop a more robust data set on nutrient movement from septic systems to receiving waters in the Lake Lanier watershed to better inform current and future model load estimates.

Need: Estimating non-point source pollution contributions from septic systems is challenging. Various factors (system age, performance, water usage, distance, soil characteristics, etc.) can affect pollutant loads to receiving waters. Current estimates may not be accurate due to a lack of watershed specific data. It's likely, however, that some septic effluent makes its way to the water table and eventually the Lake via preferential flow, through cracks and pathways.

NPS-005: Analysis of Land/Locations for Suitability of BMPs

Objective: Conduct an analysis of the watershed to identify locations that are the most suitable for application of specific nutrient/sediment/erosion control BMPs. Use the Soil Water Assessment Tool (SWAT) to assess suitability of land for various BMPs and model the loading reductions by BMP to assess problem areas and locations where BMPs could be used to maximum benefit.

Need: Verification of BMP effectiveness for the region, including local validation of removal efficiencies provided in the literature for various pollutants. This is an important issue for nutrient management in the watershed. A review is also needed of both urban and agricultural BMPs used to control erosion and sedimentation.

NPS-006: Capturing Sediment as a Resource

Objective: Investigate the potential of capturing nutrient-laden sediment in the Lake Lanier watershed to develop marketable products and to reduce nutrients and sediments reaching Lake Lanier.

Need: A significant portion of the sediment contained in dredging spoils (i.e., unconsolidated, randomly mixed sediments composed of rock, soil, or shell materials) can be reused for beneficial purposes. Dredging also has sustainable benefits such as maintaining ecosystems, removing trash and debris, and reconfiguring waterways amongst others. Dredging is also a viable remediation option to reduce the potential for eutrophication by the removal of nutrients in the sediment. Another benefit from dredging can be habitat restoration. By applying dredged spoils to farmland, topsoil can be conserved and reclaimed, while also improving drainage and potential flooding.

NPS-007a: Nutrient Management Practices for Chicken Litter (Phase 1)

Objective: Under Phase 1, assess the current number of chicken farms and current and past chicken litter management strategies (including BMPs) at these farms to develop or supplement data for models and to assess the types and usefulness of current strategies. Enhance working relationships between stakeholders and develop a forum to facilitate a better understanding of chicken litter management practices and their effect on nutrient loads to the lake.

Need: The chlorophyll-a TMDL prepared by GAEPD in 2017 states that Georgia is consistently among the top three states in the U.S. in terms of poultry operations, and the majority of poultry farms are dry manure operations where the manure is stored for a time and then land applied. TMDL stakeholders determined that to meet the chlorophyll-a limit in the Lake at the various compliance points would, in part, require that the agricultural nutrient accumulation loading rates, including chicken litter application, be reduced. Better information is needed on the current number of active chicken farms, current and past poultry litter management strategies and practices, and current disposal practices and BMPs. This information would be used to update or validate current nutrient models and to refine load assessments. Better lake water quality outcomes will also be realized through the enhancement of working relationships with the chicken industry to partner on future nutrient management studies and activities.

NPS-007b: Nutrient Management Practices for Chicken Litter (Phase 2)

Objective: Under Phase 2, based on findings of Phase 1, identify opportunities to improve nutrient management on poultry farms, building on the relationships established with the poultry industry and farmers.

NPS-008: Review of Efficacy of Agriculture and Urban BMPs for the Lake Lanier Watershed

Objective: Conduct a literature review on the performance and effectiveness of nutrient and sediment control BMPs that would be applicable for the region, including the validation of removal efficiencies in the literature for various pollutants, for both urban and agricultural settings. Conduct an initial assessment of agricultural and urban BMPs that are targeted for the region, including for upland BMPs.

Need: To support BMP selection specific to the Lake Lanier watershed region, an assessment of the effectiveness and operations of current and innovative BMPs for nutrient and sediment control is needed. A review is needed for both urban and agricultural BMPs, including for multiple BMPs working together. Often BMP removal efficiencies are presented for "idealized" conditions. As a result, an assessment of BMPs for the region by effectiveness, performance, cost, operations, and current installations would inform the selection of solutions tailored for the region.

3.4.2 Nutrients

Six project descriptions were developed for nutrients as shown in Table 4. These proposed projects addressed the concept of nutrient trading in the region, improved modeling, the need for a regional working group, and the use of indicators to assess conditions and trends.

Table 4: Project Descriptions for Nutrients

PD No.	Title
N-001a	Nutrient Trading for the Lake Lanier Watershed (Phase 1)
N-001b	Nutrient Trading for the Lake Lanier Watershed (Phase 2)
N-003	Lake Lanier Watershed Nutrient-Algae-HABs Working Group
N-006a	Water Quality Monitoring Dashboard/Indicators (Phase 1)
N-006b	Water Quality Monitoring Dashboard/Indicators (Phase 2)
N-007	Improved Information for EPD Base Nutrient Modeling Tool

N-001a: Nutrient Trading for the Lake Lanier Watershed (Phase 1)

Objective: Evaluate the stakeholder interest and economic viability of nutrient trading in the Lake Lanier watershed to efficiently meet NPDES permit requirements for total phosphorus, implemented in response to the 2017 TMDL for Chlorophyll a. If interest and economic feasibility indicate the value of nutrient trading, additional research steps can be conducted to support implementation.

Need: Nutrient trading as an alternative nutrient management strategy may help improve water quality in the Lake Lanier watershed while helping communities meet permit requirements more cost-effectively. Nutrient trading is one type of water quality trading that is defined by USEPA as an option to comply with water-quality-based effluent limitations in an NPDES permit. In addition, GAEPD identified nutrient trading as a compliance tool in the 2017 Lake Lanier TMDL. Water quality trading can provide greater flexibility on the timing and level of technology a facility might install, reduce overall compliance costs, and encourage voluntary participation of nonpoint sources (NPS) within the watershed. Point to point source trading has been successfully implemented in several other states within TMDL watersheds. Nonpoint to point source trading programs and nutrient mitigation banks are more complicated but offer an opportunity to reach agriculture, residential, and urban land uses in the watershed.

N-001b: Nutrient Trading for the Lake Lanier Watershed (Phase 2)

Objective: Based on the results of Nutrient Trading for Lake Lanier Watershed Phase 1, Phase 2 of the project is designed to support implementation of nutrient trading by producing a Nutrient Trading Plan specifically designed for the Lake Lanier watershed. Phase 1 focused on determining if there is sufficient interest and economic feasibility for trading from the demand side – assumed to be wastewater permit holders interested in cost effectively meeting their total phosphorous load limit. Phase 2 will focus on how to meet that demand and the rules and procedures associated with setting up a trade(s). The research objectives are to complete a Nutrient Trading Plan, gather input from other point sources and nonpoint sources in the watershed interested in providing credits, exchange information with Georgia EPD, describe characteristics of the watershed and lake as related to trading ratios and delivery factors and provide information from successful programs in other watersheds tailored to the specifics of Lake Lanier.

N-003: Lake Lanier Watershed Nutrient-Algae-HABs Working Group

Objective: Organize and launch a "Lake Lanier Watershed Nutrient-Algae-HABs Working Group" comprised of a range of stakeholders in the region that would coordinate and plan activities and projects to reduce water quality impacts associated with nutrient-algae-HABs in the Lake Lanier watershed.

Need: The issues surrounding nutrients, algae blooms, and HABs in the Lake Lanier watershed are complex and wide-ranging. Coordination is required to address water quality issues associated with nutrients, including water quality monitoring, research studies, implementation of BMPs, and land use activities. There are several current activities in the watershed sponsored or conducted by regulatory agencies, water and wastewater utilities, NGOs, and universities. However, these monitoring and nutrient control efforts are conducted independently and without an overall vision or common objectives. A working group or coalition of interested entities and stakeholders would provide a forum for dialogue and sharing of information related to nutrient monitoring and control studies. In time, the group would coordinate planning and studies that could enhance nutrient control outcomes. By collaborating on monitoring programs, the working group could align purposes and share resources which would assist in the delivery of improved results and help inform better policy and decision making. This coordination and collaboration could optimize monitoring data collection, analysis, and evaluation. The working group could also collaborate on BMP evaluation and implementation in urban and rural areas.

N-006a: Water Quality Monitoring Dashboard/Indicators (Phase 1)

Objective: Assemble available water quality data sources in the Lake Lanier watershed and conduct an initial evaluation of the concept and approach for a GIS based database and dashboarding tool to consolidate and share data with researchers, utilities, and the public.

Need: Stakeholders have identified water quality (including nutrients, sediment, and organics) and resulting water quality issues such as promotion of HABs as critical challenges to understanding and managing future lake water quality. Although the watershed has been studied extensively, data from such monitoring efforts has been stored in a variety of locations with specific academic researchers, utilities, government agencies, and non-governmental advocacy organizations. Once assembled, a thorough analysis of the data should be performed, focusing on discerning seasonal variations, long-term trends, and identifying data gaps and future monitoring needs to fulfill water quality monitoring and management objectives. While researchers, utility managers, and regulatory agencies would benefit from access to the broad assemblage of Lake Lanier watershed data, an additional benefit of assembling the available data can be to foster communication with stakeholders and the public about the Lake's water quality. A GIS based, dashboard approach, could be effectively leveraged to provide both access and accessibility to the data, facilitate the public notification and explanation of important water quality data, and provide opportunities for citizen science and collaboration.

N-006b: Water Quality Monitoring Dashboard/Indicators (Phase 2)

Objective: Based on the results of Water Quality Monitoring Dashboard/Indicators compiled in Phase 1, Phase 2 of the project would support the design and implementation of a dashboard based on selected indicators. Specifically, building on the outcomes of Phase 1, the project would assemble data, develop a plan for updating water quality monitoring data, perform data analyses, evaluate seasonal and long-term fluctuations and trends, and develop a public-facing GIS/dashboard interface to provide researchers, utilities, and the public with access to the data.

N-007: Improved Information for EPD Base Nutrient Modeling Tool

Objective: To improve nutrient modeling of Lake Lanier using the Georgia EPD tool to predict lake response to nutrient loading, develop better data to inform the model and develop better caveats and assumptions for items such as active poultry houses, nutrient loading from specific land uses, and septic inputs. The improved model would produce better nutrient response estimations and would help to make more informed decisions.

Need: The Georgia Environmental Protection Division (GAEPD) used a coupled watershed model and lake model for Lake Lanier to develop Total Maximum Daily Loads (TMDLs) for nitrogen and phosphorus entering Lake Lanier. These models included inputs from both point and non-point sources. Non-point sources into the model include land use, septic systems, nutrient fluxes, and poultry operations, and are represented by information obtained from literature reviews, previous studies, as well as best professional judgement. An updated model would help assess the various assumptions input into the models and what the impact would be on critical locations in the Lake, such as GAEPD compliance points.

3.4.3 Water Quality and Monitoring

For water quality and monitoring, as shown in Table 5, seven project descriptions were developed. These proposed projects addressed the assessment of current monitoring practices and other water quality issues, including, CECs and HABs.

Table 5: Projects for Water Quality and Monitoring

PD No.	Title
WQ-001a	Watershed Monitoring Techniques – Current Assessment and Roadmap for the Future (Phase 1)
WQ-001b	Watershed Monitoring Techniques – Implement Roadmap (Phase 2)
WQ-003	Assess Lake Lanier Water Quality (and Eutrophication) based on Transparency Measurements (Secchi Disk Depths)
WQ-004	Non-Algae Water Quality Drivers for Drinking Water Taste and Odor Events and Other Impacts
WQ-005	Assess the Impact of CECs in Lake Lanier and the Watershed
WQ-006	Survey of Inputs and Control Measures of CECs to Lake Lanier and the Watershed
WQ-007	Predictive Modeling of HABs

WQ-001a: Watershed Monitoring Techniques – Current Assessment and Roadmap for the Future (Phase 1)

Objective: Compile and assess the parameters and methods used to sample and analyze water quality in Lake Lanier and the watershed. Under Phase 1, develop a plan to harmonize techniques and include additional or different parameters, locations, and collection frequencies to allow a more holistic approach.

Need: There are quite a few entities that conduct monitoring in the Lake and watershed, including EPD, University of North Georgia, Chattahoochee Riverkeeper, various utilities, Lake Lanier Association, and others. These monitoring plans are conducted for various reasons depending upon the agency and funding mechanism. Some monitoring is conducted for compliance with EPD permitting of discharges

and drinking water supplies. Some monitoring is done to assess lake health and general recreational quality. Each entity has their own list of parameters, sample collection frequency and procedures, analytical techniques, and laboratory. The data is used for various purposes, including as inputs for models. Chlorophyll-a data is used by regulators to classify water bodies as impaired. Assembling and analyzing this monitoring information (parameters, methods, frequency, locations, etc.) allows for a broad evaluation of the monitoring efforts and would inform future decisions and investments in monitoring. Evaluate the parameters being measured, comparability of data, locations that should be investigated, and use of long-term continuous monitoring.

WQ-001b: Watershed Monitoring Techniques – Implement Roadmap (Phase 2)

Objective: Implement the plan developed for Lake Lanier and the watershed under Phase 1, including: recommended water quality parameters; recommended sampling locations and frequencies; standardization of analytical methods and sampling procedures.

WQ-003: Assess Lake Lanier Water Quality (and Eutrophication) based on Transparency Measurements (Secchi Disk Depths)

Objective: Evaluate the transparency of Lake Lanier water based on available Secchi Disk depth data sourced from Georgia EPD, Chattahoochee Riverkeeper, Lake Lanier Association, and others, to assess eutrophication in the Lake. Determine if there is a linkage between Chlorophyll-a and Secchi depth.

Need: Lake Lanier water quality can be analyzed based on modeling using various straightforward analytical tools and methods. Using Secchi Disk depths is an inexpensive and simple method of measuring water clarity. Secchi depth can be used to estimate the concentration of algae in the water. This relationship is based on the idea that algal particles affect the penetration of light into the water and therefore, the Secchi depth. Secchi depth monitoring can be used to assess transparency and may possibly be used for trend analysis. Also, Secchi depths can be used as surrogate measures of algal chlorophyll or algal biomass, and therefore as an indicator of the trophic state of the lake. The Secchi disk can be used by volunteer lake monitoring programs. It is inexpensive and provides useful data. However, challenges need to be addressed by standardizing the equipment and training the volunteers.

WQ-004: Non-Algae Water Quality Drivers for Drinking Water Taste and Odor Events and Other Impacts

Objective: Establish a baseline of water quality conditions near drinking water intakes and other locations and non-algae water quality drivers for drinking water taste and odor events and other impacts. Determine the role of taste and odor compounds, such as geosmin and MIB, as well as whether these events are a function of water quality.

Need: Chlorophyll-a may not provide an accurate indication of drinking water taste and odor events. Different lake locations (e.g., coves, embayments, main lake, and proximity to main tributaries) experience unique intra- and inter-annual trends as a function of point and non-point loading. Understanding the relationship between exogenous (external) and endogenous (internal) lake biogeochemical drivers can provide data for managing taste and odor problems.

WQ-005: Assess the Impact of CECs in Lake Lanier and the Watershed

Objective: Assemble available data and use broad-spectrum analytical methods to assess the occurrence of CECs in Lake Lanier and the Watershed. Assess the relative impacts from point sources and non-point sources.

Need: Antibiotics, hormones, endocrine disrupting compounds, and other potential CECs, are inputs from non-point sources, point sources, and upstream and downstream of poultry farms and other activities in the watershed. Broad-spectrum analytical methods are available that can test for a wide selection of chemicals and potential CECs. In addition to point source discharges, there are a number of non-point sources that can contribute CEC's to the lake, including septic systems, farms, and urban runoff. Evaluate persistent CECs and chemicals that have the potential to bioaccumulate, and compound groups with known aquatic or human health impacts (e.g., endocrine disrupting chemicals [EDCs] and

per- and polyfluoroalkyl substances [PFAS]). There may also be a link between nutrient sources and CECs.

WQ-006: Survey of Inputs and Control Measures of CECs to Lake Lanier and the Watershed

Objective: Conduct an overall survey to assess the potential loads of CECs entering Lake Lanier and its watershed. The inputs of CECs may include wastewater treatment plant effluents, on-site septic systems, agricultural operations, and storm runoff that discharge to the Lake or tributaries of the Lake. The objective is to establish a comprehensive information base that identifies occurrence of CECs (or gaps of data), sources of CECs, as well as surrounding watershed characteristics for Lake Lanier. Along with the survey, control measures currently exist in the watershed that can help reduce the inputs of CECs will also be identified and summarized. This information base would be used to improve the understanding of the loads and potential problems of CECs and develop model prediction for the occurrence and concentrations of CECs. The results can also provide guidance for more effective, targeted monitoring programs and mitigation strategies, to improve water quality of Lake Lanier from CEC pollution.

Need: CECs are introduced into the aquatic environment via various sources, posing a potential risk to aquatic organisms and human health. CECs include a wide range of chemicals such as pharmaceuticals and personal care products (PPCPs), hormones, PFAS, flame retardants, detergents, and plasticizers. They are shown to have adverse ecological and human health effects, and some are quite resistant to (bio)degradation or removal by conventional wastewater treatment. Lake Lanier, with growing surrounding development and urban impact, has been exposed to increasing pollution of CECs over the years. However, there have not been comprehensive efforts to assess the CEC problem at the scale of the Lake Lanier watershed. To date, information is still limited to respond to questions such as the occurrences and sources of CECs, the risks to designated uses, or suitable actions to minimize CECs for Lake Lanier and the watershed.

WQ-007: Predictive Modeling of HABs

Objective: Develop and conduct predictive modeling of HABs and incorporate real time monitoring.

Need: Other communities use real-time monitoring of water quality and other parameters (i.e., weather) to produce forecasts of harmful algal blooms based on predictive models. Using machine learning algorithms, it is possible to develop daily to weekly forecasts about cyanobacteria concentrations and algal toxin levels. In addition, the information could be used to evaluate the drivers of the occurrence of harmful algal blooms.

3.4.4 Stormwater

As shown in Table 4, two project descriptions were developed addressing stormwater topics. These proposed projects addressed indicator bacteria tracking and effectiveness of BMPs.

Table 6: Projects for Stormwater

PD No.	Title
SW-001	Fecal Bacteria Source Tracking in the Watershed
SW-002	Effectiveness of BMPs for First Flush Events

SW-001: Fecal Bacteria Source Tracking in the Watershed

Objective: Identify major sources of fecal contamination that pose a threat to human health and water quality in the Lake Lanier watershed. Determine best methods of microbial source tracking (MST) for the Lake Lanier watershed.

Need: Fecal contamination from septic systems, combined sewer overflows, pets, agriculture, and wildlife can pose a threat to human health in recreational waters. Identifying the sources of the pollution can help prioritize management to reduce human exposure to harmful pathogens and

improve water quality. Microbial source tracking (MST) offers a number of improved strategies over fecal indicator bacteria (FIB) for managing fecal pollution in surface waters.

SW-002: Effectiveness of BMPs for First Flush Events

Objective: Evaluate the effectiveness of BMPs, including green infrastructure, for nutrient control for first flush stormwater events. "First flush" refers to the initial surface runoff of a rainstorm. Characterize the water quality for these events, examine the feasibility requirements, and evaluate how existing BMPs could be used or expanded for first flush stormwater events.

Need: First flush events carry the bulk of pollutant loads. In Georgia, communities with Phase 1 and Phase 2 MS4 NPDES permits must incorporate management practices that ensure the implementation of green infrastructure with the goal to infiltrate the first inch of stormwater. On a state level, the Georgia Stormwater Management Manual provides guidance for utilizing the practices in new development and redevelopment scenarios. There are a number of different sources of BMP information that could be evaluated, including industry associations (WEF and WRF), Georgia stormwater management manual for urban BMPs, and EQIP and NRCS for agricultural BMPs.

3.4.5 Other Topics

Project descriptions were developed for several other topics as shown in Table 7. These projects addressed land use, outreach, policy, and recycled water topics.

Table 7: Projects for Other Topics

PD No.	Topic	Title
LU-001	Land Use	Understand Benefits and Develop Incentives to Maintain Forests for Watershed Protection
LU-002	Land Use	Assess Issues Associated with Urbanization and Develop Best Practices for Managing Land Use
O-001	Outreach	Lake Lanier Water Quality Outreach Program (Phase 1)
O-002	Outreach	BMPs for Municipalities, Agriculture Community, and Businesses/Residences (Phase 2)
P-001	Policy	Innovative Solutions for Nutrient Management
WR-001	Water Reclamation	Assess Potential and Benefits for Expanded Recycled Water in the Region

LU-001: Understand Benefits and Develop Incentives to Maintain Forests for Watershed Protection

Objective: Investigate potential and observed lake impacts due to deforestation and identify how to create incentives for landowners to maintain forests for watershed protection**.**

Need: Forest ecosystems play a critical role in maintaining clean water. Forests provide a range of ecosystem services that are essential to water quality and overall watershed health. These forests can protect and enhance water quality. In addition, forests slow storm runoff, reducing soil erosion, and improving water infiltration rates and recharge to aquifers. Streamside forests filter pollutants, such as sediments, fertilizers, and pesticides, from agricultural and urban runoff. Private landowners can be considered stewards of the forests and the watersheds. As the population grows, the demand for resources will increase, posing an increased risk of conversion to developed uses. The loss of forests can impair watershed health and the ecosystem services forests provide. As a result, investments in the protection and restoration of forested watersheds can help sustain these services.

LU-002: Assess Issues Associated with Urbanization and Develop Best Practices for Managing Land Use

Objective: Understand the impacts of urbanization in the Lake Lanier watershed and develop recommendations for future land use.

Need: Urbanization can have an impact on water bodies, including increasing population, landscape changes, waste and debris, increasing use of chemicals and fertilizers, and competing demands for water. Urbanization cause changes to natural watershed conditions by altering the terrain, modifying the vegetation and soil characteristics, and introducing pavement, buildings, drainage, and flood control infrastructure. In order to prevent problems, understanding how urbanization affects the local water resources is critical. Increasing urbanization often results in the removal of trees and vegetation and a subsequent increase in stormwater runoff and erosion because there is less vegetation to slow water. More sediment is washed into streams. Flooding can occur because water-drainage patterns are changed. The runoff from the increased pavement goes into storm sewers, which then goes into streams. Changing a stream channel can cause flooding and erosion along the stream banks. Environmental changes, including on a watershed scale, occur with urban development. Inputs of nutrients or sediments at any point along streams can cause degradation downstream.

O-001: Lake Lanier Water Quality Outreach Program (Phase 1)

Objective: Develop and implement an effective watershed-wide outreach program as part of a water quality improvement effort through a public outreach program for the Lake Lanier watershed to raise awareness for the need to protect the Lake, rivers, and streams.

Need: Outreach is needed to encourage change in behaviors to control runoff and reduce sedimentation into the Lake from all sources. It is important that the stakeholders and the general public be aware of the significance of their behavior; their actions can result in more nutrients into the Lake or can result in protection of waterways. In addition to nutrients and sedimentation, the program addresses other issues such as trash and debris. Existing programs such as MS4s require education of communities on the pollution potential of common activities and increase awareness of the direct links between land activities, rainfall-runoff, storm drains, and their local water resources. The education programs should include clear guidance on steps and specific actions to be taken to reduce stormwater pollution-potential. The benefits of public education efforts cannot be understated, especially on topics such as nonpoint source pollution and stormwater runoff. Outreach information can describe the BMPs and generally provide applicability, implementation, and effectiveness information to help municipal stormwater programs, homeowners, and construction site operators to improve stormwater and NPS control.

An outreach program can help motivate the public to support activities such as restoring impaired waters or protecting local water resources. A formal watershed program would reach out to audiences in the watershed, create messages that resonate, find ways to communicate messages, and help make changes in behavior to improve water quality. Components of a program can be current and innovative, such as using social media, videos, “adopt-a-stream”, and creating opportunities to listen to the needs of communities. The program would help increase the understanding of ecological systems among the general public, identify steps they can take to help protect the health of the Lake, and educate the public on the importance of protecting Lake Lanier as an essential water resource. It could also educate landowners on the impacts of non-point source pollution and on strategies to reduce pollutants (pesticides, animal waste, cleaning products, etc.).

O-002: BMPs for Municipalities, Agriculture Community, and Businesses/Residences (Phase 2)

Objective: Develop outreach materials on BMPs for various users, including municipalities, the agricultural community, businesses, and residences. The outreach materials would be based on BMPs vetted for the region and would raise awareness about current practices and develop interest in implementing BMPs by these stakeholders.

P-001: Innovative Solutions for Nutrient Management

Objectives: Review and assess innovative solutions for nutrient management related to chicken farm litter, wastewater treatment such as for nutrient recovery, co-digestion, biosolids treatment for land application or energy production, and regional treatment opportunities for biosolids. Include innovative treatments for BMPs.

Need: Effective nutrient management in the Lake Lanier watershed will necessitate development of innovative solutions for nutrient management, including technology and policy solutions. Innovative treatment technologies may present opportunity for greater nutrient treatment or more efficient treatment, while forward-thinking policy can also provide opportunities to foster regional collaboration and spur innovation on the scale required to effectively address these nutrient challenges. Examples of technology solutions include treatment of chicken litter to produce fertilizer pellets and co-management of chicken litter and wastewater treatment biosolids. These approaches present opportunities for more productive use of the materials when compared to disposal to landfills. Policy examples include measures aimed at efficient regional collaboration including co-digestion and regional management of biosolids, providing opportunities to pool regional resources to develop useful end products such as energy and fertilizers, while effectively reducing loads of nutrients into the watershed.

WR-001: Assess Potential and Benefits for Expanded Recycled Water in the Region

Objective: Evaluate the potential for additional recycled water projects in the watershed in order to offset potable water use. Determine the benefits associated with these projects.

Need: If it is properly treated, recycled water can be used for most water demands. Common uses for recycled water include agricultural irrigation, dust control, construction projects, industrial applications, landscape irrigation, cooling water for power plants, park and golf course irrigation, and mixing concrete. In addition, recycled water has a range of benefits. The use of recycled water offsets potable use. Recycling water can also decrease nutrients to the environment by decreasing the amount of wastewater that must be discharged. Recycled water can be treated for various intended uses, also referred to as fit-for-purpose treatment. Water recycling has the potential to be cost and energy efficient and can help communities create a dependable water source that improves the environment.

3.5 Stakeholder Review

After the projects were compiled, a process was conducted to classify the results by level of stakeholder interest. The stakeholders were asked to review the projects based on their needs.

3.5.1 Overview of Process

In the review of the 32 proposed research projects, the stakeholders were surveyed to rate the level of interest of each of the projects. Specifically, the stakeholders were asked to consider the need and timeliness of each the projects.

In presenting the 32 project descriptions to the stakeholders, the project descriptions were organized into topic areas that better described the types of projects. The following areas were used:

- Modeling
- Sediment
- BMPs
- Nutrient Trading
- Poultry Industry
- Water Quality and Monitoring
- Collaboration
- Communications
- Land Use

- Water Quality (CECs)
- Water Reclamation

3.5.2 Project Review

The slate of project descriptions addressed topics of interest identified by the stakeholders. In addition, the TAC focused their efforts on developing project descriptions that met these stakeholder concerns. As a result, all the proposed projects are relevant for supporting water management efforts in the Lake Lanier watershed. The stakeholders were surveyed to determine their level of interest in the projects and the results are presented in Table 8.

Table 8: Results of Stakeholder Review of Project Descriptions

Project Number	Project Description	Topic Area	Stakeholder Review
N-003	Lake Lanier Watershed Nutrient-Algae-HABs Working Group	Collaboration	**Very High Interest**
N-007	Improved Information for EPD Base Nutrient Modeling Tool	Modeling	
NPS-001a	Improved Modeling of Non-Point Sources in Lake Lanier Watershed (Phase 1)	Modeling	
NPS-001b	Improved Modeling of Non-Point Sources in Lake Lanier Watershed (Phase 2)	Modeling	
NPS-005	Analysis of Land/Locations for Suitability of BMPs	BMPs	
O-001	Lake Lanier Water Quality Outreach Program (Phase 1)	Communications	
P-001	Innovative Solutions for Nutrient Management	Poultry Industry	
SW-001	Fecal Bacteria Source Tracking in the Watershed	Water Quality and Monitoring	
SW-002	Effectiveness of BMPs for First Flush Events (initial surface runoff of a rainstorm)	BMPs	
WQ-001a	Watershed Monitoring Techniques – Current Assessment and Roadmap for the Future (Phase 1)	Water Quality and Monitoring	
WQ-001b	Watershed Monitoring Techniques – Implement Roadmap (Phase 2)	Water Quality and Monitoring	
WQ-003	Assess Lake Lanier Water Quality (and Eutrophication) based on Transparency Measurements (Secchi Disk Depths)	Water Quality and Monitoring	
WQ-007	Predictive Modeling of Harmful Algal Blooms (HABs)	WQ and Monitoring	
LU-001	Understand Benefits and Develop Incentives to Maintain Forests for Watershed Protection	Land Use	**High Interest**
LU-002	Assess Issues Associated with Urbanization and Develop Best Practices for Managing Land Use	Land Use	
N-001a	Nutrient Trading for the Lake Lanier Watershed (Phase 1)	Nutrient Trading	
N-001b	Nutrient Trading for the Lake Lanier Watershed (Phase 2)	Nutrient Trading	
N-006a	Water Quality Monitoring Dashboard/Indicators (Phase 1)	Communications	
N-006b	Water Quality Monitoring Dashboard/Indicators (Phase 2)	Communications	
NPS-004	Contribution of Nutrients and Non-Point Source Pollution from Septic Systems	Water Quality and Monitoring	
NPS-006	Capturing Sediment as a Resource	Sediment	
NPS-008	Review of Efficacy of Agriculture and Urban BMPs for the Lake Lanier Watershed	BMPs	
NPS-007a	Nutrient Management Practices for Chicken Litter (Phase 1)	Poultry Industry	
NPS-007b	Nutrient Management Practices for Chicken Litter (Phase 2)	Poultry Industry	
O-002	BMPs for Municipalities, Agriculture Community, and Businesses/Residences (Phase 2)	BMPs	

WR-001	Assess Potential and Benefits for Expanded Recycled Water in the Region	Water Reclamation	
WQ-004	Non-Algae Water Quality Drivers for Drinking Water Taste and Odor Events and other Impacts	WQ and Monitoring	
WQ-005	Assess the impact of CECs in Lake Lanier and the Watershed (CECs Phase 1)	Water Quality (CECs)	
WQ-006	Survey of Inputs and Control Measures of CECs to Lake Lanier and the Watershed (CECs Phase 2)	Water Quality (CECs)	
NPS-002a	Assess Sediment Loading Over Time (Phase 1)	Sediment	**Additional Review Needed**
NPS-002b	Assess Sediment Loading Over Time (Phase 2)	Sediment	
NPS-003	Modeling Techniques for Surveys of Soils and Corings	Sediment	

Chapter 4

Summary and Next Steps

4.I Review of Outcomes

The 32 research projects developed under this project represent the foundation of the 5-Year Lake Lanier Watershed Research Plan. In addition, the initial stakeholder prioritization conducted on the projects can support the further implementation of the Plan by TWT.

The project also provided several other additional benefits, including the following:

- **List of Stakeholders.** Under the project, a broad list of stakeholders was developed representing local governments, planning districts, water and wastewater utilities, environmental groups, and regulators. This list of stakeholders can be used to further advance the research efforts for the region.
- **Technical and Scientific Advisors.** The Technical Advisory Committee that developed the project descriptions included a wide range of devoted and dedicated scientists and engineers that have strong interests in the Lake Lanier watershed and the research topics developed. This list of contacts can be used by TWT as it moves into the implementation phase. These experts can serve as future collaborators and potential principal investigators for TWT projects.
- **University Partners.** The Technical Advisory Committee included representatives of universities in the region, including the University of Georgia, the University of North Georgia, and Georgia Tech. These institutions have tremendous researchers and resources that could support research in the Lake Lanier watershed.
- **Federal Agencies.** The Technical Advisory Committee included representatives of the USDA's Natural Resources Conservation Service. NRCS can provide resources for future research efforts with the agricultural community.

In summary, the project provided TWT with this Lake Lanier Watershed 5-Year Research Plan and helped develop partnerships with stakeholders and researchers that will be valuable assets in future research efforts.

4.2 5-Year Research Plan Next Steps

The Lake Lanier Watershed 5-Year Research Plan will provide TWT with a framework to sponsor research under its formal research process. This research process was developed to provide TWT with a robust and credible approach to managing and conducting research that provides meaningful results for water and wastewater utilities and other stakeholders. These results would be used to inform decisionmakers on regulatory, compliance, and other policy questions as well as water resources, treatment, and engineering questions.

TWT's research process involves the use of the following:

- **Research Advisory Committee (RAC).** The RAC is comprised of experts who will review research concepts and provide recommendations to TWT's Board of Directors for funding consideration.
- **Board of Directors.** The Board provides overall direction for TWT's research program and provides final funding approvals.
- **Project Advisory Committees (PAC).** A PAC is assigned for each project approved by the Board of Directors and provides technical oversight throughout the life of the project.

The roles of each group are defined by TWT's research process and are summarized in Figure 10.

Figure 10. The Water Tower's Research Process

4.3 Future Collaborations

As TWT manages the implementation of applied research projects under its research process, a key element of that process will be the identification of research and funding partners on projects. TWT is well positioned to lead research collaborations for the Lake Lanier watershed based on its nonprofit status, its focus on applied research, and its mission to create a thriving ecosystem of water innovation informed by research.

4.3.1 Partners and Collaborators

Research organizations work to leverage their resources with partners to increase the impact of their programs. To maximize the effective use of available resources, TWT will seek to develop strong relationships with partnering organizations and research collaborators who maintain similar interests. Potential partners include the following:

- Water and wastewater agencies in the Lake Lanier watershed
- Local and county governments in the Lake Lanier watershed
- Planning districts
- Federal agencies with responsibilities in the region including the Army Corps of Engineers and the Natural Resources Conservation Service
- Universities (e.g., University of Georgia, University of North Georgia, Georgia Tech).
- Environmental NGOs

These entities and organizations can partner with TWT in several ways, including co-sponsoring projects, serving on TWT committees, and providing additional resources on projects, including in-kind resources.

4.3.2 Funding

Funding for projects will be secured using several approaches, including the following:

- **Stakeholders.** TWT will serve as a forum for stakeholders, including water and wastewater utilities and planning organizations to collaborate on research projects. The list of stakeholders can be expanded over time to include organizations representing other industries, such as agriculture and forestry.
- **Research Partnerships.** TWT will collaborate with other research partners on projects, including government agencies, environmental NGOs, universities, and other research institutes.
- **Grants.** TWT will work to secure grants from public, non-profit, and private sector organizations.
- **Crowdsourcing.** TWT will develop innovative and non-traditional approaches to funding, including organizing crowdsourcing approaches by enlisting the services of a large number of people or groups via social media and the internet.

After securing funding for projects, the applied research projects will be competitively bid. Each project will be managed by TWT and will include third party technical expert oversight.

4.4 Project Management

Once projects are approved and funded under the Plan, TWT will manage the research process under its research program. Under TWT's direction, the applied research projects will be competitively bid, with third party technical expert oversight, and managed by TWT staff.

References

MNGWPD (2017). Water Resources Management Plan. Prepared for the Metropolitan North Georgia Water Planning District, Prepared by CH2M and Black and Veatch, June 2017.

Appendix A

Summary of Existing Lake Lanier Research Projects

Title	Lead Organizations	Brief Summary	Status (as of 2020)
Lake Sidney Lanier Water Quality Trend Monitoring	Upper Chattahoochee Basin Group, University of North Georgia	The principal objective of the 30+ year monitoring program is to provide base-line data concerning selected water quality characteristics in eleven streams at or near their point of entry into Lake Lanier and water leaving the Lake at Buford Dam spillway. Additional objectives of the project over the last 30 years have included determining loss in holding capacity resulting from sedimentation, quantifying the silt import from certain tributaries, determining fecal coliform bacteria concentrations at selected recreation sites and quantifying selected toxic metal concentrations in water and sediments. Future objectives of this project may include determining loading rates of pollutants leading to the impairment of state water quality standards. Construction of a geospatial database will expand the utility of the 30-year dataset allowing for deeper examination of watershed catchment land use influences and contributions from non-point sources.	Ongoing
Septic System Impacts on Water Quality in Lake Lanier	Gwinnett County Department of Water Resources, Georgia Tech	The project objectives are to assess the historical and current septic system impacts on water quality in Lake Lanier, both within and outside Gwinnett County, assess the lake water quality restoration expected from progressive removal of septic systems in lakeshore areas within and outside Gwinnett County, and provide environmental lakeshore management recommendations for Gwinnett and other Lake Lanier counties.	Ongoing
Utility Responses to Cyanobacterial/Cyanotoxin Events (WRF4914)	Hazen and Sawyer, Gwinnett County Department of Water Resources	The objective of this project is to gather and present case studies that illustrate drinking water utility experiences and associated responses to cyanobacterial and cyanotoxin events, in their source and/or finished waters. The project will develop guidelines that would help utilities develop and implement successful programs for managing cyanobacteria and cyanotoxins.	Ongoing
Diagnostic/Feasibility Study of Lake Sidney Lanier, Georgia	University of Georgia	Methods for establishing water quality targets that maintain the long-term economic growth within the Lake Lanier basin while at the same time maintaining a high level of environmental protection. Summarizes the processes necessary for the establishment of community-based water quality targets for Lake Lanier using examples taken from other regions of the U.S. Demonstrates a process incorporating effects of selected water parameters on human health, environmental integrity, and quality of life measures. Recommends water quality targets and compared with existing water quality information. http://www.hydrology.uga.edu/rasmussen/tools/lanier/Lanier1998.pdf	Completed 1998

Lake Sidney Lanier Economic Impact Analysis	Bleakly Advisory Group, Inc.	The goal of the study was to provide a quantitative measure of the economic impacts of low lake levels on the economies of the counties bordering the Lake, the Metro-Atlanta Region and the State of Georgia. This information was used to estimate the direct and indirect economic impacts associated with documented reductions in visitor spending during 2008. http://lakelanier.org/wp-content/uploads/2012/03/Lake-Lanier-Economic-Impact-Analysis-Final-Report.pdf	Completed 2010
Erosion and Sediment Modeling of the Lake Sidney Lanier Watershed	University of Georgia	This project is a study of spatially distributed Universal Soil Loss Equation (USLE) based erosion and sedimentation in the Lake Lanier watershed. Study examines non-point source erosion, sedimentation modeling, and GIS based modeling. This study lays a foundation for more detailed spatially distributed erosion and sedimentation studies of the Lake Lanier watershed, conducted at higher spatial and temporal resolutions. https://npdestraining.com/wp-content/uploads/2018/04/EROSION_AND_SEDIMENT_MODELING_OF_THE_LAKE_SIDNEY_LANIER.pdf	Completed 2008
Evaluation of Water Quality Management Alternatives for Lake Lanier Feasibility Study	University of Georgia Institute of Natural Resources	The feasibility study portion of the clean lakes study combines the research results, proposed BMPs, and regulations to assist in protecting the water quality of Lake Lanier. In this paper, an effort is made to express the current status of alternative development and evaluation. https://smartech.gatech.edu/bitstream/handle/1853/33153/SellersJ-93.pdf	Completed 1993
Geospatial Modeling and Field Verification Approach for Watershed Based Decision Support System Design for Water Quality Improvement in Lake Lanier	University of North Georgia	This study highlights the methods used to collect and build field data and sources used to retrieve available data along with procedures for data analysis and results exploration, highlighting the spatial aspect of land cover, soil, and slope towards the erosion and runoff contribution to stream health. https://ung.edu/institute-environmental-spatial-analysis/student-projects/water-quality-improvement.php	Completed 2019
Web-based Information Management System for Environmental Data	Georgia Water Resources Institute, Georgia Tech	The IMS is a web-based application that includes modules such as (1) a mapping component to represent the geospatial nature of the data (e.g., water samples and field measurements taken at different locations and depths), (2) several different data formats for representing data types such as time series and depth profiles, (3) an account management system that allows multiple users to view, edit, upload, and share information, (4) functionalities to keep track of project equipment and field campaigns, and (5) tools for visualizing and analyzing project data. While this application is focused on the SSIS project, it is designed to be generally applicable. The application's user-driven nature allows organizations and individual users to create, share and manage content dynamically without having to rely on site administrators.	Ongoing

Comprehensive Watershed Management Decision Support System Development with Hydro-Geospatial Models Integration - Lake Lanier Watershed, the Case Study	University of North Georgia	Watershed analysis models developed with geospatial technology used in the comprehensive decision support system development are: Stream Health Assessment Model; Non-point Source Pollution Spatial Determination Model; Weight-based Subwatershed Pollution Vulnerability Analysis Model; Virginia Tech Bacteria Source Load Calculation model; Soil and Water Assessment Tool (SWAT) Model; Land-use Change Analysis Model; and RUSLE Model. For these model development high-resolution and easily available data were procured and processed in ArcGIS Pro software. Other than the SWAT model, all these models were developed as automated Geospatial Models in ArcGIS Pro ModelBuilder platform. All these model results were integrated together with a 12-digit HUC scale based spatial resolution to determine the integrity of each. The study result will help Lake Lanier watershed managers to pinpoint the environmentally regressed locations in the watershed and take initiative for its restoration so that Lake Lanier, a direct economic lifeline for over half a million people, would survive longer.	Ongoing
Stream Health Analysis Using Geospatial Data to Assist in Further In-situ Water Quality Analysis: Lake Lanier Watershed, a Case Study	North Georgia University	The goal of the study was to develop a geospatial model using different watershed physical parameters in line with the Watershed Habitat Evaluation and Biotic Integrity Protocol (WHEBIP) to determine the stream integrity (health) of the RF2 level streams in the watershed. WHEBIP is a score assessment approach that was developed to rate the quality of streams depending on certain parameters that surround it. The benefit of this study is that the entire process is an automated method to know the stream health of a watershed without direct visit to the field or any costly water quality analysis. At the same time, it would support watershed management planners to take measures for improvement where it is necessity.	Ongoing
Assessing Geophysical Methods to Detect Nutrient Movement from Septic Systems to Lake Lanier	University of Georgia Crop and Soil Sciences	Detecting failing septic systems is a challenging task due to the number of septic systems present and the sudden nature of their failure. Hence it is important to 1) investigate environmental conditions most susceptible to failing septic systems and 2) determine ideal monitoring locations to detect septic system contribution to water bodies. Towards this effort, we are attempting to quantify nutrient contributions by individual septic systems installed in heterogeneous (topography, soils and vegetation) environments around the lake. We are exploring the use of geophysical methods, specifically, Electrical Resistance Tomography (ERT) and Electro-Magnetic Induction (EM31) to delineate the wastewater plume from individual systems to the lake by mapping sub-surface conductivity.	Ongoing
Going Green at Collins Hill Library is a Win for the Community	W.K. Dickson, Gwinnett County DWR	Retrofitting the existing Collins Hill Library with Green Infrastructure and stormwater BMPs not only provided improved water quality for the basin, but also provided educational opportunities at the library with numerous improved sit conditions. As a bonus for the County, the project provided a testing ground for different BMP applications, maintenance and potential monitoring opportunities.	Ongoing

Water Supply Forecasting as a Potential Tool for Regional Planning and Utility Management	Hazen and Sawyer, Hydrologics	Forecasts are produced by applying multiple potential scenarios of upcoming inflows to water balance models of reservoir storage and supply operations, producing corresponding storage trajectories emanating forward from the most recent levels. From this information the probability (percent of scenarios) that elevation reaches prescribed critical levels can be determined and updated as droughts continue. Shortage plans can use these probabilities as a basis for action criteria. Forecast-based trigger methods have significant advantages over static methods in that they provide an intuitive portrayal of true supply risk and that they are highly adaptable, automatically incorporating up-to-date knowledge on refill and drawdown seasonality and demand conditions. This study focuses on application of reservoir supply forecasting for water supply systems in North Carolina and Georgia, and will discuss how these methods could be further applied throughout Georgia.	Ongoing
Analysis of Quality Control Split-Replicate Discrete Water Quality Samples on an Urban Water Quality Program in Gwinnett and DeKalb Counties, Georgia	USGS South Atlantic Water Science Center	This study examines variability in five constituents including total nitrate plus nitrite, total phosphorus, total zinc, total suspended solids, and total dissolved solids by estimating the standard deviation as a function of concentration over a range of observed constituent concentrations.	Completed
Gene Flow Among Fish Populations Spanning the Continental Divide in Gwinnett County	School of Science and Technology, Georgia Gwinnett College	This study is working to sample fish species in and around county parks on either side of the continental divide to address the central question, does the continental divide act as a physical barrier to gene flow? Future research will seek support for the sub-species designations using morphological and behavioral analyses. These results will be used to further develop and test hypotheses related to evolutionary patterns among species spanning the eastern continental divide in Georgia.	Completed
Groundwater Conditions in Georgia, An Interactive Website	USGS South Atlantic Water Science Center	The USGS has been publishing a Groundwater Conditions Report in Georgia about every two years since 1978. During 2017, the publication series was converted into an interactive website that pulls data directly from the USGS National Water Information System database to summarize water-level data on maps and graphs for each aquifer. The website initially presents hydrographs for the entire period of record but allows the user to zoom in to any date range of interest. The USGS Cooperative Water Program, an ongoing partnership between the USGS and State and local agencies, enables joint planning and funding for groundwater monitoring and systematic studies of water quantity, quality, and use. Data obtained from these studies are used to guide water-resources management and planning activities and provide indications of emerging water problems.	Completed

Flood-inundation Maps for the Yellow River from River Drive to Centerville Highway, Gwinnett County, GA	USGS South Atlantic Water Science Center	Digital flood-inundation maps for a 16.4-mile reach of the Yellow River in Gwinnett County, Georgia, from 0.5 mile upstream from River Drive to Centerville Highway (Georgia State Route 124) were developed to depict estimates of the areal extent and depth of flooding corresponding to selected water levels (stages) at two USGS stream gages in the mapped area. A one-dimensional step-backwater model was developed using the US Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) software to simulate water-surface profiles of the mapped reach for the selected stages. The simulated water-surface profiles were then combined with a geographic information system digital elevation model-derived from light detection and ranging (lidar) data having a 5.0-ft horizontal resolution-to delineate the area flooded at the selected stages. Real-time stage information from these stream gages can be used with these maps to estimate near real-time areas of inundation. National Weather Service forecasted peak-stage information for these two USGS stream gages can also be used to show predicted areas of flood inundation in the mapped area.	Completed
Long-Term Monitoring Results of Benthic Macroinvertebrate Communities in Gwinnett County	CH2M, Gwinnett County Department of Water Resources	Since 2004, the Gwinnett County Department of Water Resources (GCDWR) has implemented a long-term monitoring program as a part of the County's Watershed Protection Plan (WPP). As part of the Plan, GCDWR conducted annual monitoring of benthic macroinvertebrates to assess stream conditions. Additionally, GCDWR collected pre- and post-construction macroinvertebrate data from Watershed Improvement Program (WIP) projects, including 36 individual samples from seven stream restoration projects, to evaluate the effects of restoration on the benthic community. Overall, benthic macroinvertebrate scores for most long-term sampling locations indicated some level of environmental degradation compared to scores from reference locations with fewer environmental stressors. These results along with other notable trends from the study will help to inform future watershed management decisions by Gwinnett County. http://gwri.gatech.edu/sites/default/files/files/docs/2017/belltyagiwrightgwrc2017.pdf	Completed
Thirty-five Years of Georgia Water Use Information: What Do We Know from the Data and Its Trends?	USGS South Atlantic Water Science Center	Knowledge of the amounts withdrawn by source, surface water and ground water, and the amounts consumed or returned for further use, is necessary to effectively manage the water resources of Georgia to ensure that all water users have sufficient water supply to meet current and future needs. Water use information, including water withdrawals, deliveries, consumptive use, return flows and losses, have been collected and compiled in Georgia since 1980. Driving forces behind the observed water-use changes include 1) population changes in number and location; 2) Five periods of major drought 3)Water conservation efforts and education programs initiated by state and local governments and water utilities, and; 4) changing water needs for power generation, industry, and agriculture activities.	Completed

Estimating Selected Low-Flow Frequency Statistics and Mean Annual Flow for Ungaged Locations on Streams in North Georgia	USGS South Atlantic Water Science Center	Developed regional regression equations for estimating selected low-flow frequency and mean annual flow statistics for ungaged streams in north Georgia that are not substantially affected by regulation, diversions, or urbanization. Selected low-flow frequency statistics and basin characteristics for 56 stream gage locations within north Georgia and 75 miles beyond the State's borders in Alabama, Tennessee, North Carolina, and South Carolina were combined to form the final dataset used in the regional regression analysis.	Completed

Appendix B

Lake Lanier Watershed 5-Year Research Plan Project Descriptions

Non-Point Sources

PD No.	Title
NPS-001a	Improved Modeling of Non-Point Sources in the Lake Lanier Watershed (Phase 1)
NPS-001b	Improved Modeling of Non-Point Sources in the Lake Lanier Watershed (Phase 2)
NPS-002a	Assess Sediment Loading Over Time (Phase 1)
NPS-002b	Assess Sediment Loading Over Time (Phase 2)
NPS-003	Modeling Techniques for Surveys of Soils and Corings
NPS-004	Contribution of Nutrients and Non-Point Source Pollution from Septic Systems
NPS-005	Analysis of Land/Locations for Suitability of BMPs
NPS-006	Capturing Sediment as a Resource
NPS-007a	Nutrient Management Practices for Chicken Litter (Phase 1)
NPS-007b	Nutrient Management Practices for Chicken Litter (Phase 2)
NPS-008	Review of Efficacy of Agriculture and Urban BMPs for the Lake Lanier Watershed

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-001a (Phase 1) and NPS-001b (Phase 2)**

Project Title: Improved Modeling of Non-Point Sources in the Lake Lanier Watershed

Issue Area: Non-Point Sources

Objectives

In Phase 1, assess current non-point source modeling work in the watershed, focusing on the various sources, and determine additional work needed that would assess loadings and identify knowledge and data gaps that would improve the models. Phase 2 of the project would apply modeling to answer resiliency questions through analysis of longer-term scenarios.

Background

NPS modeling has been done primarily for large categories like agriculture. However, the modeling would benefit from a better understanding of items such as: refining the partitioning of phosphorus loads from in-lake erosion; sedimentation in the upper reaches; verifying assumptions from the impacts of septic systems (although the results from the current septic system study by Gwinnett County will be available in mid-2021); verifying nutrient loadings from poultry operations; tributary channel incision and gullying; and other sources.

Research Approach

The proposed approach would involve the following:

Phase 1:

- Develop a summary of current modeling work, including by sources.
- Improve description of current land uses through better classification / resolution of agricultural land uses, tributary erosion processes, and onsite waste treatment systems.
- Use best available monitoring data to test and refine models.
- Identity knowledge/data gaps.
- Develop a list of additional work that would improve loading estimates and partitioning of P sources.
- Based on that information define a larger study based on various parameters (nutrients, bacteria, etc.) and spatial aspects (e.g. sub-watersheds).

The summary and review can then lead to improved hydrologic and nonpoint source modeling of diffuse and channel sources (e.g., SWAT, channel evolution modeling, Bayesian network) and refined loading allocation to be performed in this project, as well as sub-basin prioritization / dashboard

Phase 2:

- Conduct a longer-term (over the next several decades) modeling effort using Surface Water Assessment Tool (SWAT) that assesses the resilience of the lake due to changing land use and climate impacts by modeling in different time scales and conducting stress tests under different climate scenarios.

Deliverables

- Report, including Phase 2 Study approach (Phase 1)
- Models (Phase 2)
- Support tools (Phase 2)

Estimated Duration

- Phase 1: 12 months

Estimated Budget

- $50,000-$75,000

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-002a (Phase 1) and NPS-002b (Phase 2)**

Project Title: Assess Sediment Loading Over Time

Issue Area: Non-Point Sources

Objectives

In Phase 1, perform an initial assessment of sediment sources and deposition rates in key areas of Lake Lanier. Determine areas with the greatest impacts from sedimentation using water quality data to map and estimate sediment loadings over time and to estimate deposition patterns. Evaluate bank erosion and other sources that contribute to the total sediment deposition rates. Review water-quality characteristics and potential sources of constituents of concern or other emerging contaminants. Phase 2 of the project would result in further analysis of sediment and nutrient dynamics associated with key locations identified in Phase 1. This may include sediment fingerprinting and the application of source tracking approaches. Following this effort effective mitigation approaches would also be assessed.

Background

There is an issue with increasing sedimentation in the lake, including from runoff and shoreline erosion. In addition, there is erosion in headwater areas (and associated nutrient loads) due to bank erosion. There is some research in this area, including in the Chesapeake Bay region. Sediments can also be a source of nutrients such as particulate-bound phosphorus.

In addition, there is an issue with small ponds and impoundments and this area is missing in the models. Movement of legacy sediment from historic mill ponds has also been identified to contribute to sediment budgets throughout the southeast US and the piedmont specifically.

DOT is involved in projects on channel processes (with native phosphorus). The effort is looking at sediment loads by subbasin. This information can provide spatial prioritization information.

The USGS has expertise with advanced sensors and other technologies that could be utilized in the assessment of sediment movement and the characterization of water-quality properties throughout Lake Lanier and its watershed.

This work would cross over into HABs. Resuspension of fine material in the upper lake and embayments during summer months and under certain conditions has been identified as a potential source of “fuel” for HAB outbreaks. Better understanding these processes could lead to predictive approaches to assist in public awareness of threats to lake health.

The project would involve: evaluating bank erosion and other contributions to the total sediment deposition rates; reviewing water-quality characteristics and potential sources of constituents of concern or other emerging contaminants; identifying key areas to perform coring with the goal of locating the most impacted areas; and collecting bed-material to assist in the identification of depositional areas and to characterize the sediment entering the reservoir.

It is important to first understand sediment dynamics as it will assist in developing an understanding of nutrient dynamics due. Efforts should focus on understanding the relative loading of subbasins, sediment fingerprinting, and identifying the sources of the sediments. It is also important to assess N and P in sediments located in tributaries as nutrients sourced in upstream areas can move through the watershed by adsorbing to sediments.

Research Approach

The proposed approach would involve the following:

Phase 1:

- Using water quality data, map and model sediment loads over time. Identify subbasins of interest to study in order to focus watershed mitigation on specific subbasins.
- Identify key areas and conduct sediment analysis in areas that are the most impacted.
- Design a water-quality sampling program, on contributing tributaries, to collect and analyze water-quality samples with the goal of providing estimates of sediment loads and trends and an overview of sediment related pollutants and other constituents of concern.
- Review existing bathymetric data, and supplement with additional bathymetric surveys to map below surface features and water-quality distribution.
- Sediment analysis of physical properties to include particle size distribution and deposition rates.
- Spatial analysis of trends in sediment deposition.

Phase 2:

After the Phase 1 assessment of key locations linked to increased sedimentation, Phase 2 will focus on potential watershed mitigations on specific subbasins. Understanding the sediment dynamic will help with understanding the nutrient dynamic. In addition, it may be possible to conduct sediment fingerprinting for source tracking to determine where sediments originate.

Deliverables

- Web interface to display water-quality distribution at key areas of the lake (potentially with the status of human health action levels highlighted for relevant contaminants such as HABs)
- Bathymetric survey to map below surface features and water-quality distribution.
- Water-quality report on sediment related constituents of concern and other emerging contaminants
- Fully realized watershed model with estimated sediment deliveries from multiple source types that would highlight areas of interest for possible remediation (this could include field verifications utilizing sediment finger printing techniques and measured/calculated budgets).

Estimated Duration

- Depends on final scope

Estimated Budget

- Depends on final scope

Potential PAC Members

- Amber Ignatius, University of North Georgia

Resources

- Examples of sediment budgets, sediment source tracking, and fingerprinting by the Army Corp of Engineers. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100QVM1.PDF?Dockey=P100QVM1.PDF

- Watershed modeling techniques (such as SWAT, HSPF, etc.) can be used to determine sediment yields at management relevant scales and potential areas of source attribution. [https://doi.org/10.3390/w12010039] [https://doi.org/10.1111/1752-1688.12731]
- The USLE approach to develop watershed erosion estimates for Lanier watershed was conducted as a PhD project at UGA and may have useful information to build upon. [https://npdestraining.com/wp-content/uploads/2018/04/EROSION_AND_SEDIMENT_MODELING_OF_THE_LAKE_SIDNEY_LANIER.pdf]

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-003**

Project Title: Modeling Techniques for Surveys of Soils and Corings

Issue Area: Non-Point Sources

Objectives

To determine how much sediment is accumulating in creeks over time, develop an underwater soil map in Lake Lanier bays and inlets by assessing subaqueous soils. This assessment can be verified with corings (10-20 ft. deep). Examine modeling techniques for applicability to the Lake Lanier Watershed.

Background

The underwater topo maps can identify different ecosystems, depths of sediment, and other information related to sedimentation in Lake Lanier. This information can assist in identifying the sources of sediments and areas for potential sediment removal.

For the coastal zone survey on the east coast, NRCS is using a program called Navionics, which produces underwater topo-maps. Soil Scientists can use these maps to take soil cores and describe the soil properties. An underwater soil map is produced that shows different ecosystems, depths of sediment, and many other attributes. For Lake Lanier, the mapping can be focused on the creeks and streams connecting to the lake.

Soil scientists could use probes in the sand deposits and record the depths with a GPS. Once data points are collected with a GPS, the data can be transferred onto ArcGIS. Corings could be performed in different areas representing different ecosystems and other factors. The benefits of this information include a better understanding of the sedimentation and the types of sediments. This effort is expected to involve a significant commitment based on the time and equipment requirements.

Research Approach

- Develop an appropriate experimental approach. Review the lake and watershed to develop priority areas. The depth of water should be less than 15 feet. It may be best to focus on the smaller creeks that feed into the lake.
- Use Navionics to map areas with sedimentation. Conduct corings to assess sedimentation depths. Assess how much sediment is accumulating in creeks.
- Produce a GIS Shapefile of the sediment found in the lake and within the watershed.

Deliverables

- Final Report and sedimentation maps

Estimated Duration

- 12 months

Estimated Budget

- Depends on the final scope.

Potential PAC Members

- Greg Taylor, NRCS

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-004**

Project Title: Contribution of Nutrients and Non-Point Source Pollution from Septic Systems

Issue Area: Non-Point Sources

Objectives

Assess whether data from the 2020 Gwinnett County Water Resources septic study is sufficient and representative of the watershed. Develop a more robust data set on nutrient movement from septic systems to receiving waters in the Lanier watershed to better inform current and future model load estimates.

Background

Estimating non-point source pollution contributions from septic systems is challenging. Various factors (system age, performance, water usage, distance, soil characteristics, etc.) can affect pollutant loads to receiving waters. Current estimates may not be accurate due to a lack of watershed specific data. Phosphorus adsorbs to clay particles, and in theory, should take many decades to reach the lake. It is likely, however, that some septic effluent makes its way to the water table and eventually the lake via preferential flow, through cracks and other pathways of least resistance.

Gwinnett County is currently conducting a study with GT, UGA, and Cornell University to estimate nitrogen and phosphorus loads from septic effluent at home-sites adjacent to the lake in the southeastern region of the watershed. The study incorporates groundwater and surface runoff sampling, as well as lake water quality monitoring in coves that are adjacent to properties utilizing septic systems, and then also at control sites. DNA tracers and electrical resistivity tomography (ERT) are being tested to assess the capabilities of these approaches to identify septic plumes and preferential pathways.

Research Approach

The proposed approach would involve the following:

- Assess whether data from the Gwinnett septic study is sufficient and representative of the entire watershed.
- If necessary, apply techniques and lessons learned from the Gwinnett study, NRCS coastal zone survey, and conduct additional studies throughout the watershed. Consider the following in the design of the additional studies:
    - Homeowner surveys to determine age and performance of septic systems and water usage
    - Site assessments to identify distance to receiving waters, failing systems
    - Soil surveys and core samples to assess site specific soil characteristics and soil nutrient concentrations
    - Tomography (ERT) to locate septic plumes and bedrock
    - Groundwater and surface runoff sampling (monthly for 12 consecutive months) for N, P, C, Cl, other pollutants (e. coli, CECs)
    - Tracers to identify preferential flow pathways and transit time

- Consider the use of Smart water meters to obtain accurate loads and assist in assessing failing systems. Also, consider the use of in situ monitoring such as “SepticSitter” to link with smart water meters. These systems can monitor at the household level and can identity partially failing systems.

Deliverables

- Report including watershed specific dataset to better inform current and future model estimates.

Estimated Duration

- 12-24 months

Estimated Budget

- $100,000 per site per year (including lab fees)

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-005**

Project Title: Analysis of Land/Locations for Suitability of BMPs

Issue Area: Non-Point Sources

Objectives

Conduct an analysis of the watershed to identify locations that are the most suitable for application of specific nutrient/sediment/erosion control BMPs. Use the Soil Water Assessment Tool (SWAT) to assess suitability of land for various BMPs and model the loading reductions by BMP to assess problem areas and locations where BMPs could be used to maximum benefit.

Background

Verification of BMP effectiveness for the region, including local validation of removal efficiencies provided in the literature for various pollutants, is an important issue for nutrient management in the watershed. A review is also needed of both urban and agricultural BMPs used to control erosion and sedimentation.

The NRCS Field Office Technical Guide (FOTG) website (https://efotg.sc.egov.usda.gov/#/details) can be used as a resource to assist in the evaluation of BMPs.

Another resource is the Georgia Soil and Water Conservation Commission (GSWCC) 2016 BMPs Manual (https://gaswcc.georgia.gov/urban-erosion-sediment-control/technical-guidance).

The Soil Water Assessment Tool (SWAT) can be used in the assessment of land/locations by assessing runoff, nutrient loading, erosion prediction, etc. This project has the potential to provide significant results for the selection of BMPs in the region.

Texas A&M partners with the NRCS and the Agriculture Research Service (ARS) to provide access to, and support for, the SWAT tool. Access to the Texas A&M SWAT Program website is available here: (https://hydrologicmodels.tamu.edu/inventory/hydrology/).

Research Approach

The proposed approach would involve the following:

- Use the SWAT tool to assess the suitability of land for various BMPs, including the following:
    - Use the same model for all BMP assessments
    - Collect all the data needed for the modeling efforts
    - Calibrate for P. Once the model is calibrated for P and baseline conditions, then assess BMPs and loading reductions
- Assess existing site-specific challenges and locations to determine which BMPs could be the most effective.
- Include monitoring as needed.

Deliverables

- Last Report

- User tools. For example, review the outcomes at the Texas A&M website SWAP Program website (https://hydrologicmodels.tamu.edu/inventory/hydrology/).

Estimated Duration

- 18-24 months

Estimated Budget

- Depends on the final scope

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-006**

Project Title: Capturing Sediment as a Resource

Issue Area: Non-Point Sources

Objectives

Investigate the potential of capturing nutrient-laden sediment to develop marketable products and to reduce nutrients and sediments reaching Lake Lanier.

Background

A significant portion of the sediment contained in dredging spoils (i.e., unconsolidated, randomly mixed sediments composed of rock, soil, or shell materials) can be reused for beneficial purposes. Dredging also has sustainable benefits such as maintaining ecosystems, removing trash and debris, and reconfiguring waterways amongst others. Dredging is also a viable remediation option to reduce the potential for eutrophication by the removal of nutrients in the sediment. Another benefit from dredging can be habitat restoration. By applying dredged spoils to farmland, topsoil can be conserved and reclaimed, while also improving drainage and potential flooding.

Dredging, the process of removing mud, weeds, and other materials from ponds, lakes and rivers, results in dredged sediment. A significant amount of this sediment can be reused for beneficial purposes. The dredged material can be a waste product, a recovered product or byproduct, or a primary product. If the dredged material is a waste product the sand can be used for beach nourishment or wetland habitats. Finer materials such as clay and fine dirt can be used for land creation and construction fill. Fine dirt is also often mixed with additives such as manure, biosolids or compost to create or enhance topsoil. Beneficial use of dredged material involves the placement or use of dredged material for some productive purpose (USEPA). Dredging also has sustainable benefits such as maintaining ecosystems, removing trash and debris, and reconfiguring waterways amongst others. Dredging is also one of the most viable remediation options for eutrophication. A specific benefit to Lake Lanier from dredging would be a possible habitat restoration.

There are many ways to recover a product. Dredging has been used to harvest peat moss, which is used to enhance soil. Dredging is also used to recover organic material such as Biosolids. If you're mining or dredging for a primary product, there are several potential uses for the dredged materials. Dredge materials can be used to replace eroded topsoil, elevate the soil surface, or improve the physical and chemical characteristics of soil (EPA & USACE, 2007).

Research Approach

The proposed approach would involve the following:

- A detailed literature review to identify recovery methodologies, potential beneficial uses, and valuable components of dredged sediment. Review current dredging practices and operations (mainly for sand). Note that wet dredging is one option; however, dry dredging is less expensive. A program would want to take advantage of dry years.
- Analyze which of the beneficial use opportunities and valuable components apply to the Lake Lanier Watershed.

- Conduct a cost-benefit analysis for the capture of selected valuable components of dredged sediment.
- Create a sediment management and sediment placement plan based on the beneficial uses identified in the cost-benefit analysis. The management plan should include a business model showing that this is a sustainable beneficial reuse option.
- Based on an understanding of where and how the dredged material is used, consider the potential of utilizing sediment capture as a management practice that could be used in support of nutrient trading.
- Compile the results of the literature review, analysis of opportunities specific to Lake Lanier, cost-benefit analysis, and sediment management plan into a final report.

Deliverables

- Final Report
- Sediment management plan
- Webinar detailing the project approach and results
- Outreach materials (handout, quick video, etc.) that show the cost-benefit analysis of reusing dredged materials

Estimated Duration

- 12 - 18 months

Estimated Budget

- $100,000 - $125,000

Leaders in the field/Potential PAC Members

- Nick Basta, Ohio State University
- Andy Bary, Washington State University
- Sally Brown, University of Washington
- Ned Beecher, NEBRA
- Saul Kinter, DC Water

Resource

EPA Beneficial Use Planning Manual for Projects Using Dredged Material (https://www.epa.gov/cwa-404/beneficial-use-planning-manual-projects-using-dredged-material-under-cwa-section-404)

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-007a (Phase 1) and NPS-007b (Phase 2)**

Project Title: Nutrient Management Practices for Chicken Litter

Issue Area: Non-Point Sources

Objectives

Under Phase 1, assess the current number of chicken farms and current and past chicken litter management strategies (including BMPs) at these farms to develop or supplement data for models and to assess the types and usefulness of current strategies. Enhance working relationships between stakeholders and develop a forum to facilitate a better understanding of chicken litter management practices and their effect on nutrient loads to the lake.

Background

The chlorophyll-a TMDL prepared by GAEPD in 2017 states that Georgia is consistently among the top three states in the U.S. in terms of poultry operations, and that the majority of poultry farms are dry manure operations where the manure is stored for a time and then land applied. TMDL stakeholders determined that to meet the chlorophyll-a limit in the lake at the various compliance points would, in part, require that the agricultural nutrient accumulation loading rates, including chicken litter application, be reduced by 34%. Better information is needed on the current number of active chicken farms, current and past poultry litter management strategies and practices, and current disposal practices and BMPs. This information would be used to update or validate current nutrient models and to refine load assessments. Better lake water quality outcomes will also be realized through the enhancement of working relationships with the chicken industry to partner on future nutrient management studies and activities.

The TMDL allocates nutrient loads to land uses associated with poultry. During TMDL development, aerial photography was used to identify 1540 broiler houses within the watershed, yet the TMDL acknowledges an overestimation due to the inclusion of an unknown number of houses that are no longer active. The TMDL also assumes that litter is currently, or has in the past, been land applied within pastures located within a radius of 0.75 km of each of these houses. It is also acknowledged that there is no accounting for a "significant amount of manure that is transferred out of the watershed for use as a fertilizer in other parts of the State." A review of the agronomic rate of land application of chicken litter would be useful in understanding the impact of current and past nutrient management practices on lake water quality.

A practical approach to soliciting information from chicken farmers is to establish trust and build relationships by partnering with the Georgia Poultry Federation (GPF) in a survey of its members. Development of an inventory and then review of currently existing data sources regarding active and inactive chicken houses and litter transfer records could provide invaluable information to assist in answering the above questions. Engagement of the USDA, NRCS, Georgia Department of Agriculture, and UGA's Department of Animal and Dairy Science, and others should also be considered in developing a clearer picture of available data and litter management practices.

Research Approach

The proposed approach would involve the following:

Phase 1:

- Constitute a working group with representation from the poultry industry (individual house operators, Georgia Poultry Federation, poultry integrators) local government interests, USDA-NRCS, Georgia Agriculture Department, UGA, and others to discuss data and gaps in the TMDL.
- Inventory known data sources for active and inactive poultry operations and litter management practices.
- Survey poultry operators and others in the poultry industry to identify:
    - Site history and the activity status of houses, and
    - Trends and practices in litter management.
- Seek to clarify and understand varying perspectives on litter management and its impact on lake water quality and seek opportunities to align perspectives and interests and build trust, collaboration, and consensus amongst stakeholders.
- Complete a literature review to determine available data and data gaps associated with understanding the agronomic rate of land application of chicken litter; consider whether additional research is needed.
- Compare collected data and understandings against TMDL assumptions and review whether any differences are significant; identify and describe those differences.
- Summarize results of research and analysis and recommend future actions.

Phase 2:

Under Phase 2, based on the findings from Phase 1, identify opportunities to improve nutrient management on poultry farms, building on the relationships established with the poultry industry and farmers.

Deliverables

- Project report with recommendations

Estimated Duration

- 9 - 12 months

Estimated Budget

- $80,000 - $100,000

Potential PAC Members

- Liz Booth, GAEPD
- Linda McGregor, City of Gainesville
- Representative from the poultry industry
- USDA representative
- Georgia Department of Agricultural representative

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **NPS-008**

Project Title: Review of Efficacy of Agriculture and Urban BMPs for the Lake Lanier Watershed

Issue Area: Non-Point Sources

Objectives

Conduct a literature review on the performance and effectiveness of nutrient and sediment control BMPs that would be applicable for the region, including the validation of removal efficiencies in the literature for various pollutants, for both urban and agricultural settings. Conduct an initial assessment of agricultural and urban BMPs that are targeted for the region, including for upland BMPs.

Background

To support BMP selection specific to the Lake Lanier watershed region, an assessment of the effectiveness and operations of current and innovative BMPs for nutrient and sediment control is needed. A review is needed for both urban and agricultural BMPs, including for multiple BMPs working together. Often BMP removal efficiencies are presented for "idealized" conditions. As a result, an assessment of BMPs for the region by effectiveness, performance, cost, operations, and current installations would inform the selection of solutions tailored for the region.

A number of existing programs and studies in the U.S. have either assembled or evaluated the effectiveness and operations of BMPs for nutrient and sediment control. These sources can be reviewed for applicability to the region. Existing practices and information for both urban and agricultural BMPs include the following:

- Virginia Tech maintains a VA stormwater BMP Clearinghouse (https://www.swbmp.vwrrc.vt.edu/) and has installation certification guidelines.
- Water Research Foundation International Stormwater Best Management Practices (BMP) Database (http://www.bmpdatabase.org/)
- Metropolitan North Georgia Water Planning District's Proprietary Technology Assessment Protocol (TAP) https://northgeorgiawater.org/proprietary-best-management-practices/
- Florida Department of Agriculture and Consumer Services (FCACS) Agricultural Best Management Practices (https://www.fdacs.gov/Agriculture-Industry/Water/Agricultural-Best-Management-Practices)
- EPA's National Menu of Best Management Practices (BMPs) for Stormwater (https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#edu)
- Natural Resources Conservation Service (NRCS) Conservation Practices Field Office Technical Guides (FOTGs). (https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/)

A potential issue for BMPs is that they are often only assessed under "idealized" conditions. As a result, an assessment is needed of agricultural and urban BMPs that are targeted for the region, including for upland BMPs.

Research Approach

The proposed approach would involve the following:

- Review existing sources of information and supplement that review with a targeted literature search.
- Assess BMPs for the region by effectiveness (including removal efficiencies), performance, cost, operations, and current installations. Consider multiple BMPs working together. Consider using the Surface Water Assessment Tool (SWAT).
- Consider other potential co-benefits (e.g., fencing of cattle out of streams) and interconnections (e.g., supporting a nutrient trading program)
- Document findings in a searchable database or tool.
- Develop a guidance document for applicable BMPs.

Deliverables

- Final Report and Resource/Guidance Document
- Database or tool

Estimated Duration

- 18-24 months

Estimated Budget

- $125,000-$175,000 depending on the scope

Nutrients

PD No.	Title
N-001a	Nutrient Trading for the Lake Lanier Watershed (Phase 1)
N-001b	Nutrient Trading for the Lake Lanier Watershed (Phase 2)
N-003	Lake Lanier Watershed Nutrient-Algae-HABs Working Group
N-006a	Water Quality Monitoring Dashboard/Indicators (Phase 1)
N-006b	Water Quality Monitoring Dashboard/Indicators (Phase 2)
N-007	Improved Information for EPD Base Nutrient Modeling Tool

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **N-001a**

Project Title: Nutrient Trading Program for the Lake Lanier Watershed (Phase 1)

Issue Area: Nutrients

Objectives

The research objective of this project is to evaluate the stakeholder interest and economic viability of nutrient trading in the Lake Lanier watershed to efficiently meet NPDES permit requirements for total phosphorus, implemented in response to the 2017 TMDL for Chlorophyll *a*. If interest and economic feasibility indicate the value of nutrient trading, additional research steps can be conducted to support implementation.

Background

Nutrient trading as an alternative nutrient management strategy may help improve water quality in the Lake Lanier Watershed while helping communities meet permit requirements more cost-effectively. Nutrient trading is one type of water quality trading that is defined by U.S. EPA as an option to comply with water-quality-based effluent limitations in an NPDES permit.[1] In addition, the Georgia EPD identified nutrient trading as a compliance tool in the 2017 Lake Lanier TMDL.

Water quality trading can provide greater flexibility on the timing and level of technology a facility might install, reduce overall compliance costs, and encourage voluntary participation of nonpoint sources (NPS) within the watershed. Point to point source trading has been successfully implemented in several other states within TMDL watersheds. Nonpoint to point source trading programs and nutrient mitigation banks are more complicated but offer an opportunity to reach agriculture, residential and urban land uses in the watershed. Trading can provide ancillary environmental benefits such as carbon sinks, and riparian and habitat improvement.

The North Georgia Water Resources Partnership, working with the Coosa-North Georgia and Savannah-Upper Ogeechee Regional Water Planning Council, has conducted several studies including evaluating the legal, technical, and financial feasibility of nutrient trading.[2] A 2-year poultry litter export field monitoring study showed demonstrated reductions in total and ortho phosphorus runoff.[3] Recently, a national review of state and regional programs and strategies was performed. Based on these efforts, recommendations to implement a trading program for the Lake Lanier watershed include the following:

- Work with EPD to develop a "watershed" permit so that a community would be in compliance if meeting an individual permit limit or the watershed permit limit. This approach provides additional legal authority for nutrient trading for individual permit holders within an entire basin.
- Develop a Technical Guidance Document to provide specific details on issues such as trading ratios, BMP effectiveness (and assumptions), watershed TP loading zones, reporting and enforcement requirements, etc.

[1] Alternative Nutrient Management Strategies – Final Report. Prepared for the North Georgia Water Resources Partnership, prepared by Brown and Caldwell, December 14, 2018.
[2] Nutrient Trading in the Coosa Basin: A Feasibility Report. October 2013.
[3] Poultry Litter Export Monitoring Project. July 2018.

- Set up a watershed trading organization and develop a trading plan. A permittee led organization would document trades within the watershed and keep the balance sheet of available and sold credits. In addition, the organization may hold "insurance" credits for emergency use by members.

Research Approach

The first phase would assess stakeholder interest and demonstrate the potential value of a nutrient trading program. Stakeholder support and political will are needed to fully realize the application of this permitting tool. The value of nutrient trading to stakeholders must be clearly defined to move forward. Therefore, under a phased approach, the first steps in the Lake Lanier watershed would address the following:

- Review the literature on the topic of nutrient trading as well as current or planned nutrient trading programs for both point and non-point sources in Georgia and other regions of the U.S. Develop an understanding on how to develop a successful trading program. Document key conditions for implementation (i.e., level of participation, regulatory acceptance, etc.).
- Conduct a stakeholder survey to assess the level of interest in nutrient trading. Provide background information to stakeholders about the options and results of the Alternative Nutrient Management Strategies study and evaluate the interest in a trading program in the Lake Lanier Watershed. A survey set of questions would be developed and permit holders in the watershed would be sent the survey. A follow up call and email will help promote participation, with results shared with all who participated. In addition, permit holders will be asked if they are interested in participating in an economic evaluation.
- To demonstrate the potential value of nutrient trading, conduct an economic analysis of nutrient trading in the watershed. Evaluate up to five NPDES permit holders and evaluate the cost of meeting permit limits using current and planned technology at the plant versus a point to point source and/or a point to nonpoint source trade. Using future discharge flow projections, discuss with utilities needed upgrades to meet required load limits and estimated capital and operational costs to achieve those limits. Evaluate if short term or permanent trading is economically feasible for the permit holders.

Possible Deliverables

- Stakeholder education materials
- Stakeholder survey results, summarized and distributed
- Economic evaluation of up to five utilities within the basin

Estimated Duration

- 6 months

Potential PAC Members

- Laurie Hawks, Hawks Environmental
- Brian Watson, Tetra Tech
- Liz Booth, GAEPD
- Brooke Anderson, Etowah Water and Sewer

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **N-001b**

Project Title: Nutrient Trading for the Lake Lanier Watershed (Phase 2)

Issue Area: Nutrients

Objectives

Based on the results of the project *Nutrient Trading for Lake Lanier Watershed Phase 1*, Phase 2 of the project is designed to support implementation of nutrient trading by producing a Nutrient Trading Plan specifically designed for the Lanier Watershed. Phase 1 focused on determining if there is sufficient interest and economic feasibility for trading from the demand side – assumed to be wastewater permit holders interested in cost effectively meeting their total phosphorous load limit. Phase 2 will focus on how to meet that demand and the rules and procedures associated with setting up a trade(s).

The research objectives are to complete a Nutrient Trading Plan based on results from Phase 1 and Phase 2, gather input from other point sources and nonpoint sources in the watershed interested in providing credits, exchange information with Georgia EPD, describe characteristics of the watershed and lake as related to trading ratios and delivery factors and provide information from successful programs in other watersheds tailored to the specifics of Lake Lanier.

Background

Nutrient trading as an alternative nutrient management strategy may help improve water quality in the Lake Lanier Watershed while helping communities meet permit requirements more cost-effectively. Nutrient trading is one type of water quality trading that is defined by U.S. EPA as an option to comply with water-quality-based effluent limitations in an NPDES permit.[2] In addition, Georgia EPD identified nutrient trading as a compliance tool in the 2017 Lake Lanier TMDL.

Water quality trading can provide greater flexibility on the timing and level of technology a facility might install, reduce overall compliance costs, and encourage voluntary participation of nonpoint sources (NPS) within the watershed. Point to point source trading has been successfully implemented in several other states within TMDL watersheds. Point source to nonpoint trading programs and nutrient mitigation banks are more complicated to set up but offer an opportunity to reach forest, agriculture, residential, and urban land uses in the watershed. However, the details of a trading program must be developed that provide certainty for both permit holders and regulators.

Phase 1 of the project is expected to meet two objectives: 1) evaluate interest among permit holders in using nutrient trading to meet NPDES permit requirements and 2) conduct a needs assessment of nutrient trading in the Lake Lanier watershed. This demand-side information on nutrient trading has to be supplemented in Phase 2 by information on point and nonpoint sources in the watershed to assess a potential supply of credits for nutrient trading and evaluate the overall feasibility of a nutrient trading

[2] Alternative Nutrient Management Strategies – Final Report. Prepared for the North Georgia Water Resources Partnership, prepared by Brown and Caldwell, December 14, 2018.

program in the Lanier watershed.[3] The overall goal is to develop a Trading Plan that identifies credit sellers and buyers, and to provide the details of how those trades would take place.

Research Approach

The information provided by Phase 1 is one part of the essential information needed to implement nutrient trading in the Lanier watershed. Engagement of point and nonpoint credit sources, feedback on regulatory constraints, and setting of priorities based on the watershed's mix of point and nonpoint sources and the spatial heterogeneity of the watershed are also essential to fully realize implementation of this tool. Phase 1 will provide essential information on the value of nutrient trading to permit holders. Phase 2 will add the remaining information needed to evaluate feasibility and move forward with implementation, if warranted.

Phase 2 activities in the Lake Lanier watershed would include the following:

- Revise educational materials produced in Phase 1 to provide background information for point and nonpoint source stakeholders on nutrient trading and examples of programs in other states. Work with trade associations and technical assistance organizations to distribute materials and identify nonpoint source stakeholders who would consider participating in a nutrient trading program and survey those stakeholders to evaluate threshold requirements for participation.
- Prioritize potential sources of credits for nutrient trading by identifying the sources that can have the greatest impact on chlorophyll response in the lake based on available information on spatial distribution of P loading to waters in the watershed and modeled flow and fate of P in the watershed and lake. Create delivery ratio zones of the watershed based on existing modeling information.
- Collect information from Georgia EPD on critical elements of a trading program for Lake Lanier, including permitting alternatives, key regulatory constraints, public notice, and threshold requirements from a regulatory perspective.
- Conduct an economic and institutional analysis to determine feasibility of nutrient trading in the Lanier watershed. Evaluate the impact of the following factors on trading feasibility, given available information: definition of trading area(s) and compliance points; potential trading ratios based on available information on performance of BMPs in the watershed or in similar settings; specification of a trading baseline and alternatives for implementation given the nonpoint source reduction requirements of the Lake Lanier chlorophyll *a* TMDL; and assessment of institutions where trading activities may be housed.
- Develop a Lake Lanier Nutrient Trading Plan based on information gathered and developed above to be approved by stakeholders, participating parties, and EPD. The Trading Plan would outline potential credit buyers and sellers, delivery and/or risk ratios, permit compliance requirements, annual reporting, credit insurance bank and other potential enforcement options (as needed). Separate financial agreements could be set up between parties that trade but would not be reported in annual reports to EPD. Average price per pound of TP would be made available to stakeholders.

[3] Hoag, Dana L.K.; Mazdak Arabi; Deanna Osmond; Marc Ribaudo; Marzieh Motallebi; and Ali Tasdighi. 2017. Policy utopias for nutrient credit trading with nonpoint sources. Journal of the American Water Resource Association 53(3): 514-520.

Deliverables

- Revised nutrient trading background materials – power point, printed documents, existing reports
- Documentation of activities and results of outreach to point and nonpoint source credit providing stakeholders
- Documentation of activities and results of outreach to Georgia EPD
- Prioritization of potential sources/land uses/economic sectors of credits for nutrient trading
- Results of economic and institutional analysis to determine feasibility of nutrient trading
- Lake Lanier Nutrient Trading Plan

Estimated Duration

- 12-18 months

Potential PAC Members

- Laurie Hawks, Hawks Environmental
- Anna Truszczynski, GAEPD
- Brooke Anderson, Etowah Water and Sewer

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **N-003**

Project Title: Lake Lanier Watershed Nutrient-Algae-HABs Working Group

Issue Area: Nutrients

Objectives

Organize and launch a "Lake Lanier Watershed Nutrient-Algae-HABs Working Group" comprised of a range of stakeholders in the region that would coordinate and plan activities and projects to reduce water quality impacts associated with nutrient-algae-HABs in the Lake Lanier watershed.

Background

The issues surrounding nutrients, algae blooms, and HABs in the Lake Lanier Watershed are complex and wide-ranging. To address water quality issues associated with nutrients, coordination across several areas is required including water quality monitoring, research studies, implementation of BMPs, and land use activities.

There are a number of current activities in the watershed sponsored or conducted by regulatory agencies, water and wastewater utilities, NGOs, and universities. However, these monitoring and nutrient control efforts are conducted independently and without an overall vision or common objectives.

A working group or coalition of interested entities and stakeholders would provide a forum for dialogue and sharing of information related to nutrient monitoring and control studies. In time, the group would coordinate planning and studies that could enhance nutrient control outcomes. Improved results, that help inform better policies and decisions, could be achieved by collaborating on monitoring programs to align purposes, and by sharing and targeting the use of resources. This coordination and collaboration could optimize monitoring data collection, analysis, and evaluation. The working group could also collaborate on BMP evaluations and implementation of BMPs in urban and rural areas.

Initially, the working group could include water and wastewater utilities, university researchers, and environment NGO representatives. Regulators would participate as non-members. In time, the agricultural and business communities could be involved.

The workshop would create a number of benefits. Monitoring and research efforts would be better coordinated, and the outcomes would have a wider distribution. In addition, joint grant funding opportunities could be pursued. The working group would also focus efforts and help develop trust with various stakeholders.

Other potential benefits include:

- Strengthen monitoring and research programs, enhance outcomes, and accelerate change.
- Take advantage of regional skills and resources that can be shared.
- Develop strategic approaches and share responsibilities.
- Provide a forum for discussion and support of a common goal.
- Reduce the chance of duplicating efforts.

Research Approach

The proposed approach would involve the following:

- **Form core group.** Develop a core group to initiate and organize the working group. This initial group could include water and wastewater utility staff, university researchers, and environment NGO representatives. Regulators could be invited as observers.
- **Develop an organization.** Develop a structure for managing the working group. Although the group would operate as an informal partnership, some structure and guidelines would be helpful in facilitating group management. Some of these tasks would include maintaining the participant list and contact information, organizing meetings, and preparing agendas and meeting summaries.
- **Create a vision.** Come to an agreement on the overall vision of the working group. This vision would be supported by shared goals and interests as well as strategic activities. A clear scope will be essential in guiding the group.
- **Gather information.** Assemble information on nutrients, algal blooms, and HABs as well as current projects and activities. The group would serve as a clearinghouse of resources and information for use by water and wastewater utilities and other organizations.
- **Complete an action plan.** Develop an action plan that supports the vision and the needs of the working group members. The action plan would translate strategies and goals identified by the group into actions. Each action would have a lead, approach, and timetable. The progress on actions would be tracked.
- **Coordinate activities.** Because the group would be comprised of a number of organizations, coordination would be needed to support the collaboration. Coordination would help secure collaboration across the organizations and enable the group to work towards specific goals and strategies.
- **Funding strategies.** Develop a plan for collaborating on funding opportunities, including state and federal grants. Evaluate NSF grant opportunities.

Deliverables

- Group membership list and participation guidelines.
- Meeting support, including agenda and meeting summaries.
- Action plan and tracking outcomes.

Estimated Duration

- Ongoing

Estimated Budget

- <$15,000 per year

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **N-006a (Phase 1) and N-006b (Phase 2)**

Project Title: Water Quality Monitoring Dashboard/Indicators

Issue Area: Nutrients

Objectives

Assemble available water quality data sources in the Lake Lanier Watershed and develop a GIS based database and dashboarding tool to consolidate, share, and communicate data with researchers, utilities, and the public.

Background

Stakeholders have identified water quality (including nutrients, sediment, organics) and resulting water quality issues such as promotion of HABs as critical challenges to understanding and managing future lake water quality. Although the watershed has been studied extensively, data from such monitoring efforts has been stored in a variety of locations with specific academic researchers, utilities, government agencies, and non-governmental advocacy organizations. Once assembled, a thorough analysis of the data should be performed, focusing on discerning seasonal variations, long-term trends, and identifying data gaps and future monitoring needs to fulfill water quality monitoring and management objectives.

While researchers, utility managers, and regulatory agencies would benefit from access to the broad assemblage of Lake Lanier Watershed data, an additional benefit of assembling the available data can be to foster communication with stakeholders and the public about the Lake's water quality. To achieve this end, a GIS based, dashboard approach could be effectively leveraged to provide both access and accessibility to the data, facilitating public notification and the explanation of important water quality data and providing opportunities for citizen science and collaboration.

One example of a working dashboard is the Detroit Lake Water Quality Prediction System in Salem, OR (https://detroitlake.thepredictionlab.com/home).

Research Approach

The proposed approach would involve the following two phases:

Phase 1:

- Assemble and review available watershed water quality monitoring data from academic, governmental (USGS, EPD), and utility monitoring efforts.
- Assemble data in a publicly available database with appropriate security measures.
- Develop a plan for updating water quality monitoring data long-term, including identifying methods for regularly "scraping" available public data, and providing secure access and convenient interfaces for uploading future data.
- Perform data analysis, evaluating seasonal and long-term fluctuations and trends.
- Develop a public-facing GIS/dashboard interface to provide data access to researchers, utilities, and the public.

Phase 2:

Based on the results of Phase 1, Phase 2 would support the design and implementation of a dashboard based on selected indicators.

Deliverables

- Report and database of information on indicators and approach for developing dashboard (Phase 1)
- Dashboards, updatable database, and hosting (Phase 2)

Estimated Duration

- 12 - 18 months (Phase 1)

Estimated Budget

- $75,000-$100,000 (Phase 1)

Potential PAC Members

- Adil Godrej, Virginia Tech Occoquan Watershed Monitoring Lab

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **N-007**

Project Title: Improved Information for EPD Base Nutrient Modeling Tool

Issue Area: Nutrients

Objectives

To improve nutrient modeling of Lake Lanier using the Georgia EPD tool to predict lake response to nutrient loading, develop better data to inform the model and develop better caveats and assumptions for items such as active poultry houses, nutrient loading from specific land uses, and septic inputs. The improved model would produce better nutrient response estimations and would help to make more informed decisions.

Background

A coupled watershed model and lake model for Lake Lanier, has been utilized by the Georgia Environmental Protection Division (GAEPD) to develop a Total Maximum Daily Load (TMDL) for Lake Lanier. These models included inputs from both point and non-point sources. Non-point sources into the model include land use, septic systems, nutrient fluxes, poultry operations, and are represented by information obtained from literature reviews, previous studies, as well as best professional judgement. An updated model would help assess the various assumptions input into the models and what the impact would be on critical locations in the lake, such as GAEPD compliance points.

Research Approach

The proposed approach would involve utilizing the existing watershed model and lake model for Lake Lanier to perform a number of analyses. These analyses would include:

1. **Sensitivity analysis on modeling assumptions for septic systems.** This analysis will look at various assumptions in the watershed model including, but not limited to the following:
    - Number of people per household
    - Number of gallons of water used by each person
    - Initial concentrations of TN and TP at the edge of septic system drain fields
    - Travel time of septic system outflow to lake
    - Nutrient decay rate
    - Number of failing septic systems
2. **Sensitivity analysis on modeling assumptions for land use specific loading.** This analysis will look at various assumptions in the watershed model including, but not limited to the following:
    - The “build-up” rate and maximum storage limit of nutrient loading on each specific land use
    - The “wash-off” rate of nutrients from the land uses
    - The interflow and groundwater concentrations of nutrients:
        - Develop annual average unit area export loads for each land use and compare to published values (i.e., Harvey Harper Florida)
        - Perform field studies to determine land use unit area export of nutrients as published values may not be representative of conditions in the Lake Lanier watershed
    - Rates, constants, and kinetics for in-stream water quality interactions

3. **Sensitivity analysis on modeling assumptions for chicken/poultry loading.** This analysis will look at various assumptions in the watershed model including, but not limited to the following:
    - Nutrient content in chicken manure
    - Number of active chicken houses
    - Chicken operations nutrient management (i.e. is chicken manure exported out of the watershed?)
    - Chicken manure land application
4. **Simulation of a conservative substance.** The conservative substance would act as a tracer (or dye) and would have no decay rate. This analysis will take the existing lake model and input a conservative substance at several locations within the model to evaluate the dispersion of the nutrient loads within Lake Lanier.
5. **Particle tracking.** This analysis will take the existing lake model and will evaluate the travel path of a neutrally buoyant particle released from several locations within the lake.

Deliverables

- Final Report describing the analyses performed and the results

Estimated Duration

- 24 months

Water Quality and Monitoring

PD No.	Title
WQ-001a	Watershed Monitoring Techniques – Current Assessment and Roadmap for the Future (Phase 1)
WQ-001b	Watershed Monitoring Techniques – Current Assessment and Roadmap for the Future (Phase 2)
WQ-003	Assess Lake Lanier Water Quality (and Eutrophication) based on Transparency Measurements (Secchi Disk Depths)
WQ-004	Non-Algae Water Quality Drivers for Drinking Water Taste and Odor Events and Other Impacts
WQ-005	Assess the Impact of CECs in Lake Lanier and the Watershed
WQ-006	Survey of Inputs and Control Measures of CECs to Lake Lanier and the Watershed
WQ-007	Predictive Modeling of HABs

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WQ-001a (Phase 1) and WQ-001b (Phase 2)**

Project Titles: Watershed Monitoring Techniques – Current assessment and roadmap for the future (Phase 1)

WQ-001b: Watershed Monitoring Techniques – Implement roadmap (Phase 2)

Issue Area: Water Quality

Objectives

For Phase 1, compile and assess the parameters and methods used to sample and analyze water quality in Lake Lanier and the watershed. Under Phase 1, develop a plan to harmonize techniques and include additional or different parameters, locations, and collection frequencies to allow a more holistic approach. The Phase 2 project would implement the plan developed under Phase 1.

Background

There are a number of entities that conduct monitoring in the Lake and watershed, including EPD, University of North Georgia, Chattahoochee Riverkeeper, various utilities, Lake Lanier Association, and others. These monitoring plans are conducted for various reasons depending upon the agency and funding mechanism. Some monitoring is conducted for compliance with EPD permitting of discharges and drinking water supplies. Some monitoring is done to assess lake health and general recreational quality. Each entity has their own list of parameters, sample collection frequency and procedures, analytical techniques, and laboratory. The data is used for various purposes, including as inputs for models. Chlorophyll-a data is used by regulators to classify water bodies as impaired.

Assembling and analyzing this monitoring information (parameters, methods, frequency, locations, etc.) would allow for a broad evaluation of the monitoring efforts and would inform future decisions and investments in monitoring. An evaluation of the parameters being measured, comparability of data, locations that should be investigated, and use of long-term continuous monitoring should all be assessed.

Are the right parameters being measured? Is the data truly comparable even for the same parameter given differing techniques and laboratories? Are there other locations that should be investigated? Should flowrate monitoring be included to provide context for analytical results especially on or near tributaries and streams? Should long term continuous monitoring via “Sondes” or other devices be considered?

Evaluate current efforts by other river basin groups that may have developed dashboards. The City of Gainesville has an active program and has collated data.

Research Approach

The proposed approach would involve the following:

<u>Phase 1 (Watershed Monitoring Techniques – Current assessment and roadmap for the future):</u>

- Assemble and review all the monitoring plans from various entities and assess the objectives of each monitoring effort. The data collected needs to address specific questions.

- Assess the parameters, methods, frequency, and spatial distribution of the current monitoring plans collectively to outline the current objectives and develop recommendations for improvement.
- Conduct collaborative meetings with stakeholders to present findings and garner feedback.
- Develop short-term and long-term plans, including a potential dashboard, to improve monitoring to meet the current objectives and expand the list of objectives as needed.

Phase 2 (Watershed Monitoring Techniques – Implement Roadmap)

Objective: Implement the plan developed for Lake Lanier and the watershed under Phase 1, including: recommended water quality parameters; recommended sampling locations and frequencies; standardization of analytical methods and sampling procedures.

Deliverables

- Final Report, including summaries of current monitoring plans
- Short-term and long-term plans

Estimated Duration

- 18 - 24 months (Phase 1)

Estimated Budget

- $150,000 (Phase 1)

Potential PAC Members

- Brigette Haram, Gwinnett County
- Linda McGregor or Jill Graham, City of Gainesville

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WQ-003**

Project Title: Assess Lake Lanier water quality (and eutrophication) based on transparency measurements (Secchi Disk Depths)

Issue Area: Water Quality

Objectives

Evaluate the transparency of Lake Lanier water based on available Secchi Disk depth data sourced from Georgia EPD, Chattahoochee Riverkeeper, Lake Lanier Association, and others, to assess eutrophication in the Lake. Determine if there is a linkage between Chlorophyll-a and Secchi depth.

Background

Lake Lanier water quality can be analyzed based on modeling using various straightforward analytical tools and methods. Using Secchi Disk depths is an inexpensive and simple method of measuring water clarity. Secchi depth can be used to estimate the concentration of algae in the water. This relationship is based on the idea that algal particles affect the penetration of light into the water and therefore, the Secchi depth.

In essence, the light entering the water will be either absorbed or scattered by particles, dissolved colored matter, and the water itself. As the attenuation of light by dissolved colored matter or particles increases, the Secchi depth decreases. This inverse relationship produces the typical hyperbolic curve when Secchi depth is plotted against potential attenuating substances, such as algal chlorophyll, color, turbidity, or suspended solids.

Secchi depth monitoring can be used to assess transparency and may possibly be used for trend analysis. Also, Secchi depths can be used as surrogate measures of algal chlorophyll or algal biomass, and therefore as an indicator of the trophic state of the lake. The Secchi disk can be used by volunteer lake monitoring programs. It is inexpensive and provides useful data. However, challenges need to be addressed by standardizing the equipment and training the volunteers.

Compare existing data to empirical chlorophyll-Secchi Disk relationships to see how they predict chlorophyll-a based on the Secchi Disk data. The Secchi disk measurements are subject to interferences related from non-algal or non-chlorophyll materials in the water. Use residual analysis to detect interfering variables. Although empirical relationships can be established relating Secchi depth to algal chlorophyll, these relationships can change seasonally and between lakes. There is a need to re-calibrate the relationships often.

Because of the potential for variation between users, Secchi Disk methods should be standardized as much as possible.

Research Approach

The proposed approach would involve the following:

- Assemble existing Secchi Disk depth data and chlorophyll a data from EPD, Riverkeeper, and others as available.
- Model the initial result to determine if there is a relationship between Secchi depths (transparency) and chlorophyll a.

- Design a Secchi Disk depths and chlorophyll a data study – possibly using volunteer groups.
- Conduct and analyze data.

Deliverables

- Report
- Volunteer monitoring groups

Estimated Duration

- Depends on scope of monitoring program

Estimated Budget

- Depends on scope of monitoring program

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WQ-004**

Project Title: Non-Algae Water Quality Drivers for Drinking Water Taste and Odor Events and Other Impacts

Issue Area: Water Quality and Monitoring

Objectives

The goal of this project is to establish a baseline of non-algae water-quality conditions near drinking water intakes and other locations to determine potential drivers of taste and odor events and other impacts. Evaluate the role of specific taste and odor compounds, including geosmin and 2-methylisoborneol (MIB), which are naturally occurring compounds. Determine if taste and odor events are a function of other water quality parameters, such as pH, DO, and ammonia.

Background

The occurrence of chlorophyll-a, which is an indicator of phytoplankton abundance and biomass in water environments, may not provide an accurate indication of drinking water taste and odor events. Different lake locations (e.g., coves, embayments, main lake, proximity to main tributaries) experience unique intra- and inter-annual trends as a function of point and non-point loading. Understanding the relationship between exogenous (external) and endogenous (internal) lake biogeochemical drivers can provide data for managing taste and odor problems.

Most taste and odor problems in drinking water reservoirs can be narrowed down to MIB and geosmin. MIB creates a “musty” odor and geosmin creates an “earthy” taste and odor. Cyanobacteria (blue-green algae) and other bacteria are the major sources of MIB and geosmin in lakes and reservoirs.

Previous studies have captured (with low resolution) algal blooms that exhibit distinct water-quality signatures, including elevated chlorophyll-a, dissolved oxygen, and pH. This association is consistent with endogenous releases of sediment bound phosphorous due to mixing of benthic sediments in the overlying water column. Higher resolution data would provide an improved understanding of specific indicators and causes of these events.

Research Approach

The proposed research approach involves the follows tasks:

- Establish a network of real-time water-quality sensors near tributary inflows and within coves, embayments, mid-lake locations, as well as near drinking water intakes.
- Complement real-time sensors with biweekly grab samples for sensor evaluation and redundancy.

Look for opportunities to install permanent data collectors near specific location such as docks. Consider locating permanent data collectors at Lake Lanier Association buoys. In addition, it may be useful to select compliance or regulatory monitoring locations.

Deliverables

Deliverables for this project could include:

- Baseline water-quality dataset of real-time and biweekly water quality observations.

- Statistical summary of intra- and inter-annual trends and associations between locations, water-quality parameters, and taste-and-odor events and indicators.
- Lake simulation model based on biogeochemical model of system behavior.

Estimated Duration

- Minimum of one annual cycle, preferably longer.

Estimated Budget

The estimated budgets for startup costs and annual monitoring costs are as follows:

- $250,000: One-time initial startup cost for datasonde acquisition and deployment. Datasones are automated instruments that provide near continuous water quality data. At each monitoring location, the datasonde monitors and records water temperature, salinity, dissolved oxygen, pH, and depth every 15-60 minutes.
- $150,000: Annual cost for water quality samples (geosmin and MIB) and datasonde collection, analysis, and interpretation of data.

In addition, consider NSF funding for this type of project.

Potential PAC Members

- Todd Rasmussen, UGA Warnell School of Forestry & Natural Resources
- Susan Wilde, UGA Warnell School of Forestry & Natural Resources
- Uttam Saha, UGA Agricultural & Environmental Services Laboratory

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WQ-005**

Project Title: Assess the impact of CECs in Lake Lanier and the watershed

Issue Area: Water Quality

Objectives

Assemble available data and use broad-spectrum analytical methods to assess the occurrence of CECs in Lake Lanier and the Watershed. Assess the relative impacts from point sources and non-point sources.

Background

Antibiotics, hormones and other endocrine disrupting compounds, and other potential CECs, are inputs from non-point sources, point sources, and upstream and downstream of poultry farms and other activities in the watershed. Broad spectrum analytical methods are available that can test for a wide selection of chemicals and potential CECs.

There are a number of sources that could enter the lake, including septic systems, farms, and urban runoff. In addition, there are point sources into the watershed. The project would involve collecting data, determining data gaps, and conducting a mass balance. Evaluate persistent CECs and chemical that have the potential to bioaccumulate, and compound groups with known aquatic or human health impacts (EDCs, PFAS, e.g.).

There may also be a link between nutrient sources and CECs (e.g., Potomac River study on this topics). Coordinate with nutrient studies – that is, assess NPS such as from farms.

This study could involve a partnership with USGS, which could look at tributaries to the river and lake. Use of broad-spectrum analyses is now common. Data may be available from the Gwinnett County DPR pilot study.

The initial focus is on concentration and if warranted fish/vitogellenin studies could be used to confirm effects

Research Approach

The proposed approach would involve the following:

- **Literature Review.** Review of existing literature on non-point source contributions of CECs to surface waters, with emphasis on any studies specifically conducted on Lake Lanier. This review should also include a current inventory of potential contributors to the lake.
- **Data Gaps.** Identify data gaps relative to probable CEC contributions to the lake and address those data gaps through targeted sampling.
- **Mass Balance.** Select a small number of indictor compounds representing major classes of CECs (estradiol for EDCs, PFOS/PFOA for PFAS, e.g.) and perform a mass balance on Lake Lanier using the data developed in the previous steps.
- **Mitigation Strategies.** Identify potential mitigation strategies to address the sources of CECs.

Deliverables

- Final Report providing detail on the occurrence, fate, and transport of CECs in Lake Lanier.

Estimated Duration

- 18 - 24 months (12 months for sampling plus setup, analysis, and reporting)

Estimated Budget

- $280,000 based on the following:
  - $50,000 for lit review
  - $150,000 for analytical
  - $50,000 for data analysis and mass balance work
  - $30,000 for reporting

Potential PAC Members

- Bryan Brooks, Baylor University

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WQ-006**

Project Title: Survey of inputs and control measures of CECs to Lake Lanier and the watershed

Issue Area: Water quality

Objectives

Conduct an overall survey to assess the potential loads of CECs entering Lake Lanier and its watershed. The inputs of CECs may include wastewater treatment plant effluents, on-site septic systems, agricultural operations, and storm runoff that discharges to the Lake or tributaries of the Lake. The objective is to establish a comprehensive information base that identifies the occurrence of CECs (or gaps of data), sources of CECs, as well as surrounding watershed characteristics for Lake Lanier. Along with the survey, control measures that currently exist in the watershed and that can help reduce the inputs of CECs will also be identified and summarized. This information base would be used to improve the understanding of the loads and potential problems caused by CECs and develop model predictions for the occurrence and concentrations of CECs. The results can also provide guidance on the utilization of more effective, targeted, monitoring programs and mitigation strategies, to improve water quality in Lake Lanier from CEC pollution.

Background

Chemicals of emerging concern (CECs) are introduced into the aquatic environment via various sources, posing a potential risk to aquatic organisms and human health. Lake Lanier, with growing surrounding development and urban impact, has been exposed to increasing pollution of CECs over the years. However, there have not been comprehensive efforts to assess the CEC problem in the scale of the Lake Lanier watershed. To date, information is still limited regarding questions such as the occurrence of CEC's, sources of CECs, the risks to designated uses, and suitable actions to minimize CECs for Lake Lanier.

CECs include a wide range of chemicals such as pharmaceuticals and personal care products (PPCPs), hormones, perfluorinated alkylate substances (PFAS), flame retardants, detergents, and plasticizers. These contaminants have been shown to have adverse ecological and human health effects, and some are quite resistant to (bio)degradation or removal by conventional wastewater treatment. Previous studies have identified relationships between the presence of CECs in water and broad-scale watershed characteristics (e.g., Kiesling et al. 2019; Bai et al. 2018; Lindim et al. 2016; Fairbairn et al. 2016). However, relationships between the presence of CECs and source-related watershed characteristics have not been explored for Lake Lanier.

Research Approach

The proposed approach would involve:

<u>Phase 1</u>

- **CECs Data Review:** Conduct a comprehensive literature review for the occurrence of CECs related to Lake Lanier. Literature review should also include publications on lessons learned from other watersheds and pharmaceutical consumption data in Georgia. This information can help inform where data are significantly lacking with respect to Lake Lanier.

- **Watershed characteristics:** A wide range of Lake Lanier watershed characteristics, such as land cover, land use pattern, number of permitted point sources, distance to point sources, number and locations of septic systems, and others, should be collected.
- **Assessment of relationships between the occurrences of CECs and watershed characteristics:** If occurrence data is insufficient, alternatively the watershed characteristics will be utilized to identify areas of high priority where CEC occurrence will likely be higher.
- **Outreach:** This research project should be conducted through active coordination across the counties within the Lake Lanier watershed to compile information consistently. A communication plan should be developed in the proposal on how the results will be communicated broadly to the public, stakeholders, government officials, and industry.

Phase 2:

A Phase 2 of the project could be considered after successful completion of the Phase I study. The Phase 2 study will address the data gaps identified in Phase 1 to conduct sampling and monitoring of CECs in key areas and the results will be used to improve the relationships between the presence of CECs and source-related watershed characteristics for Lake Lanier. Other areas that Phase 2 could address include the reduction of CECs by wastewater treatment, CECs in biosolids, CECs in chicken operations (source reduction).

Deliverables

- Final Report
- Publication of the findings in journal papers or conference/workshop presentations

Estimated Duration

- 12-18 months for the literature survey

Estimated Budget

- Depends on the scope of the study

References

Xuelian Bai, Alex Lutz, Rosemary Carroll, Kristen Keteles, Kenneth Dahlin, Mark Murphy, David Nguyen. Occurrence, distribution, and seasonality of emerging contaminants in urban watersheds, Chemosphere Volume 200, June 2018, Pages 133-142.

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R.L. Kiesling, S.E. Elliott, L.E. Kammel, S.J. Choy, S.L. Hummel. Predicting the occurrence of chemicals of emerging concern in surface water and sediment across the U.S. portion of the Great Lakes Basin, Sci. Total Environ., 651 (1) (2019), pp. 838-859

C. Lindim, J. van Gils, D. Georgieva, O. Mekenyan, I.T. Cousins. Evaluation of human pharmaceutical emissions and concentrations in Swedish river basins, Sci. Total Environ., 572 (2016), pp. 508-519

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WQ-007**

Project Title: Predictive Modeling of Harmful Algal Blooms

Issue Area: Water Quality

Objectives

Develop and conduct predictive modeling of HABs and incorporate real-time monitoring**.**

Background

Other communities use real-time monitoring of water quality and other parameters (i.e., weather) to produce forecasts of harmful algal blooms (HABs) based on predictive models. Using machine learning algorithms, it is possible to develop daily to weekly forecasts about cyanobacteria concentrations and algal toxin levels. In addition, the information could be used to evaluate the drivers of the occurrence of harmful algal blooms.

Develop and conduct predictive modeling of HABs. One example is the City of Salem Public Works Technical Group and The Prediction Lab for the Detroit Lake. The project includes a website, Detroit Lake Prediction, and incorporates real time monitoring (https://thepredictionlabllc.github.io/detroit-lake-predictions/)

The real-time monitoring can be provided through daily and weekly forecasts of HABs. Data will be collected from the lake, including water samples, as well as information on local and regional weather. This information is provided as inputs into machine learning algorithms. Potential outcomes include forecasts on a daily or weekly basis of constituents including cyanobacteria and algal toxic concentrations. The specific drivers of the occurrence of HABs can be provided.

Historical data, including temperature, humidity, wind speed, nutrient levels, algal and toxin concentrations, can be compiled. Machine learning techniques, such as Bayesian Neural Networks, are used to develop algorithms for predicting HABs. The overall goal is to use these methods to predict HABs in Lake Lanier on a daily to weekly basis. Selection of sampling locations, frequency, and timing can also be identified through the process.

Research Approach

The proposed approach would involve the following:

- Develop the approach for model prediction based on a review of existing projects, including for the Detroit Lake (Salem, OR).
- Assemble historic data required for the machine learning approach.
- Develop and validate and predictive model. Consider developing risk factors.

Possible Deliverables

- Final Report
- Predictive model
- Website

Estimated Duration

- Depends on the final scope

Estimated Budget

- Depend on the final scope

Potential PAC Members

- City of Salem, OR representative

Stormwater

PD No.	Title
SW-001	Fecal Bacteria Source Tracking in the Watershed
SW-002	Effectiveness of BMPs for First Flush Events (initial surface runoff of a rainstorm)

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **SW-001**

Project Title: Fecal bacteria source tracking in the watershed

Issue Area: Stormwater

Objectives

Identify major sources of fecal contamination that pose a threat to human health and water quality in the Lanier watershed. Determine best methods of microbial source tracking (MST) for the Lanier Watershed.

Background

Fecal contamination from septic systems, combined sewer overflows, pets, agriculture, and wildlife can pose a threat to human health in recreational waters. Identifying the sources of the pollution can help prioritize management to reduce human exposure to harmful pathogens and improve water quality. Microbial source tracking (MST) offers a number of improved strategies over fecal indicator bacteria (FIB) for managing fecal pollution in surface waters.

Various library-dependent and library-independent methods are available. Each method has advantages and disadvantages, which should be addressed when selecting the best method for each site. An overview of the approach is provided in the U.S. EPA document titled: Using Microbial Source Tracking to Support TMDL Development and Implementation (https://www.epa.gov/sites/production/files/2015-07/documents/mst_for_tmdls_guide_04_22_11.pdf).

The North Georgia Water Resources Partnership is conducting a similar study that is evaluating the entire region. They are developing a tool to review sources by looking at 303d listed streams and assessing why streams are listed and prioritizing streams for delisting.

Research Approach

The proposed approach would involve:

- Review the state of the science for microbial source tracking and determining best methods for the watershed. Develop an approach based on available information will be important
- Identify and map priority fecal contamination “hotspots” in the watershed using information based on 303d listings and beach closures
- Select locations and identify likely sources at these sites using existing FIB data and land use surveys etc. Map priority areas based on EPD shape files based on 303d listings and beach closures (if feasible)
- Develop test plan (i.e., site sampling and analysis daily for 3 weeks each season). Consider the use of coliphages instead of E. coli, etc. It will be important to differentiate between sources. In addition, non-human vs. human is a concern.
- Conduct monitoring (qPCR).
- Determine best MST method for each site.

Deliverables

- Report
- Dataset

Estimated Duration

- 12-18 months

Estimated Budget

- Depends on final scope

Potential PAC Members

- North Georgia Water Resources Partnership representative
- Mark Risse, University of Georgia
- Veronica Jarrin, P.E., Stantec

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **SW-002**

Project Title: Effectiveness of BMPs for first flush events

Issue Area: Monitoring

Objectives

Evaluate the effectiveness of BMPs, including green infrastructure, for nutrient control for first flush stormwater events. "First flush" refers to the initial surface runoff of a rainstorm. Characterize the water quality for these events, examine the feasibility requirements, and evaluate how existing BMPs could be used or expanded for first flush stormwater events.

Background

First flush events carry the bulk of pollutant loads. In Georgia, communities with Phase 1 and Phase 2 MS4 NPDES permits must incorporate management practices that ensure the implementation of green infrastructure with the goal to infiltrate the first inch of stormwater. The Metropolitan North Georgia Water Planning District has published a model ordinance.

On a state level, the Georgia Stormwater Management Manual provides guidance for utilizing the practices in new development and redevelopment scenarios. Also, there are areas without stormwater permits. There are a number of different sources of BMP information that could be evaluated, including industry associations (WEF and WRF), Georgia stormwater management manual for urban BMPs, and EQIP and NRCS for agricultural BMPs.

There are different sources of BMP information available, including Georgia's stormwater program (urban), and the NRCS and U.S. Department of Agriculture's Environmental Quality Incentives Program (EQIP) that provides financial and technical assistance to agricultural producers. EQIP is also a source of funding for agriculture BMPs.

For existing BMPs, the feasibility requirements would need to be reviewed. In addition, the application and use of these BMPs could be expanded.

Research Approach

The proposed approach would involve the following:

- Develop an approach using the Soil Water Assessment Tool (SWAT) to assess the suitability of various BMPs. SWAT can be used to assess soil erosion prevention and control, non-point source pollution control, and regional management in watersheds. SWAT can also be used to model soil properties such as infiltration rates for first flush areas.
- Model how well the BMPs work across various landscapes for different types of rain events. Soil Scientists can identify soil properties in the field at these first flush sites. This information would support the SWAT model.
- Review the NRCS Program Practices in the FOTG (field office technical guide) for BMPs.
- For stormwater BMPs, refer to the Georgia Soil and Water Conservation Commission's Field Manual for Erosion and Sediment Control. This report has vegetative and structural BMPs for many urbanized activities.

- Estimate how much runoff and infiltration are measured at first flush sites. Texas A&M's SWAT Program has examples of projects and approaches (https://swat.tamu.edu/).
- Develop findings on the suitability of various BMPs based on the modeling. Based on the findings, develop a set of recommendations for the use of BMPs for various applications, a summary of additional mitigation measures, and a list of future research activities to address any knowledge gaps.

Deliverables

- Final Report, including findings and recommendations

Estimated Duration

- Depends on the final scope

Estimated Budget

- Depends on final scope

Other Topics

PD No.	Topic	Title
LU-001	Land Use	Understand Benefits and Develop Incentives to Maintain Forests for Watershed Protection
LU-002	Land Use	Assess Issues Associated with Urbanization and Develop Best Practices for Managing Land Use
O-001	Outreach	Lake Lanier Water Quality Outreach Program (Phase 1)
O-002	Outreach	BMPs for Municipalities, Agriculture Community, and Businesses/Residences (Phase 2)
P-001	Policy	Innovative Solutions for Nutrient Management
WR-001	Water Reclamation	Assess Potential and Benefits for Expanded Recycled Water in the Region

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **LU-001**

Project Title: Understand Benefits and Develop Incentives to Maintain Forests for Watershed Protection

Issue Area: Land Use

Objectives

Investigate potential and observed lake impacts due to deforestation and identify how to create incentives for landowners to maintain forests for watershed protection.

Background

Forest ecosystems play a critical role in maintaining clean water. Forests provide a range of ecosystem services that are essential to water quality and overall watershed health. These forests can protect and enhance water quality. In addition, forests slow storm runoff, reducing soil erosion, and improving water infiltration rates and recharge to aquifers. Streamside forests filter pollutants, such as sediments, fertilizers, and pesticides, from agricultural and urban runoff.

Private landowners can be considered stewards of the forests and the watersheds. The management of forests within a watershed ensures a sustainable supply of ecosystem services. As the population grows, demand for resources will increase. As a result, there is a risk of conversion to developed uses. Loss of forests can impair watershed health and the ecosystem services forests provide. As a result, investments in the protection and restoration of forested watersheds can help sustain these services and can often result in cost-effective alternatives to building new water treatment facilities.

Funding can be provided to local landowners on a competitive basis to help them implement land management practices that reduce phosphorus and nitrogen runoff. The reduction generates credits that wastewater treatment plants can use to meet regulatory requirements. Reducing the cost of regulatory compliance is an incentive for watershed management. Water quality standards and regulations can serve as drivers for watershed management.

Economic incentives for watershed management can accelerate water quality improvements and help private and community landowners serve as stewards for the forests. Support of private landowners for forest management and improvement are emerging as alternative financing mechanisms for ensuring water quality and other important watershed services. These payments may offer private forest landowners the necessary additional economic incentive to stay on the land.

Private investments in watershed management and protection are motivated by a variety of factors such as improving corporate image, maintaining quality source water, and protecting investments. A primary motive, however, is to reduce the cost of compliance with regulatory requirements.

The Forest Service is working to advance market-based approaches to conservation and stewardship on private and community lands. Private investment in ecosystem services promotes sustainable land management, supports ecological restoration, and provides an economic incentive for landowners to own and manage forest land. Capturing the true value of nature's capital will help protect the Nation's private forests and grasslands and the essential public benefits they provide

As an example, the Southeastern Partnership for Forests and Water (Partnership) and the Georgia Forestry Commission Water Quality Program are collaborating on developing a water fund in the

Oconee River watershed. In 2020, the Partnership has held one regional forum with over 40 participants and two Partnership meetings with over 20 participants each. A Conservation Finance Committee has been established to help guide the finance strategy of the Partnership. Since 2017, the Oconee River Watershed Partnership has been working to secure adequate supplies of clean drinking water in the Oconee River Watershed through long-term forestland conservation. This multi-jurisdictional Partnership aims to bring together the public utility, forestry, and conservation sectors to work collaboratively to implement source water protection measures in this source water watershed.

Through conservation easement acquisition and Best Management Practice implementation, the Partnership is working to retain the current forestland cover level of 60%. This tool will help guide implementation of stewardship and preservation activities while the Partnership will develop sustainable conservation finance mechanisms to realize these goals.

Research Approach

The proposed approach would involve:

- Conduct a review of potential and observed lake impacts due to deforestation for the Lake Lanier watershed. Develop a Conservation Prioritization Index that identifies parcels of land greater than 50 acres that are at risk of future urbanization and have characteristics that are contributory to degraded water quality.
- Review existing programs, including the Southeastern Partnership for Forests and Water, that have created incentives for landowners to maintain forests for watershed protection
- Investigate alternatives for funding from EPA and Georgia Forestry Commission and other entities for a forestry project to enhance sustainability and create incentives for owners to support forest/land projection.
- Investigate opportunities to encourage water quality credit stacking (i.e., using one conservation practice to generate credits for multiple environmental markets) to incentivize water quality improvements through conservation credits and wetland mitigation credits.
- Develop a plan for a demonstration project based on existing programs. Document lessons learned from programs that have converted agricultural land to forests.
- Review synergies with water quality trading study.

Deliverables

- Report documenting the findings and a plan for a demonstration project.

Estimated Duration

- 12-18 months

Potential PAC Members

- Cassidy Lord, Oconee River Watershed Partnership

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **LU-002**

Project Title: Assess Issues Associated with Urbanization and Develop Best Practices for Managing Land Use

Issue Area: Land Use

Objectives

Understand the impacts of urbanization in the Lake Lanier Watershed and develop recommendations for future land use.

Background

Urbanization can have significant impacts on water bodies. Increasing population, landscape changes, waste and debris, increased use of chemicals and fertilizers, and competing demands for water are all issues with urbanization. To help mitigate or prevent problems, understanding how urbanization affects the local waters and addressing the effects will inform planning efforts.

Increasing urbanization can result in the removal of trees and vegetation, which results in more storm runoff and erosion due to less vegetation to slow water. More sediment is washed into streams. Flooding can occur because water-drainage patterns are changed. The runoff from the increased pavement goes into storm sewers, which then goes into streams. Also, changing a stream channel can cause flooding and erosion along the stream banks.

Environmental changes, including on a watershed scale, occur with urban development. Urban development results in an increase in the number of contaminants released in the watershed, causes impacts on habitat, and increases streamflow variations which have been associated with the disruption of ecosystems. Every stream is connected downstream to larger water bodies, including rivers, reservoirs, and ultimately coastal waters. Inputs of nutrients or sediments at any point along the stream can cause degradation downstream with effects on biological communities and on economically valuable resources, such as fisheries and tourism.

Urbanization can cause changes to natural watershed conditions by altering the terrain, modifying the vegetation and soil characteristics, and introducing pavement, buildings, drainage, and flood control infrastructure. Hydrologic and geomorphic impacts are associated with an increase of impervious area resulting from urban development. Impacts have included: increased frequency of flooding and peak flow volumes, decreased base flow, increased sediment loadings, changes in stream morphology, increased organic and inorganic loadings, and loss of aquatic/riparian habitat.

Research Approach

The proposed approach would involve the following:

- Evaluate the rate of urbanization and types of changes in the region. Georgia EPD has developed future land use projections. In addition, consider the use of the USGS SLEUTH model, which simulates land use change. The SLEUTH model (slope, land use, exclusion, urban extent, transportation, hillshade) approach can incorporate different levels of protection for different areas. The Soil and Water Assessment Tool (SWAT) model can be used for watershed-scale

modeling of nutrient loading based on future scenarios. SWAT modeling brings together changing land use and water resources.

- Based on the modeling of future scenarios, investigate implications of changes to water quality and quantity based on land use changes and other impacts such as climate change. Consider conducting "stress tests" within the region based on possible long-term changes.
- Assess future water availability and whether current regional planning will sufficiently account for the anticipated changes. Compare to current regional planning by the Atlanta Regional Commission (ARC), Metropolitan North Georgia Water Planning District, and Georgia Mountains Regional Commission. These planning efforts developed land use plans for cities to be used in land use planning.
- Develop a set of recommendations for mitigating urbanization impacts on the watershed and for managing future land use.

Deliverables

- Report on the impacts of urbanization in the Lake Lanier Watershed, results of modeling and analysis, and recommendations for future land use planning and mitigation of impacts of urbanization.

Estimated Duration

- 18-24 months

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **O-001**

Project Title: Lake Lanier Watershed Outreach Program (Phase 1)

Issue Area: Outreach

Objectives

Develop and implement an effective watershed-wide outreach program as part of a water quality improvement effort through a public outreach program for the Lake Lanier Watershed to raise awareness for the need to protect the lake, rivers, and streams.

Background

Outreach is needed to encourage change in behaviors to control runoff and reduce sedimentation into the lake from all sources. It is important that the stakeholders and the general public be aware of the significance of their behavior and develop an understanding that certain behaviors can result in more nutrients being delivered into the lake, and that a change in behaviors can assist in the protection for Lake Lanier and its tributary waterways. In addition to nutrients and sedimentation, a program could address other issues such as trash and debris. In addition, existing programs such as MS4s require education of communities on the pollution potential of common activities and increase awareness of the direct links between land activities, rainfall-runoff, storm drains, and their local water resources. The education programs should include clear guidance on steps and specific actions to be taken to reduce stormwater pollution-potential. The benefits of public education efforts cannot be understated, especially on topics such as nonpoint source pollution and stormwater runoff. Outreach information can describe the BMPs and generally provide applicability, implementation, and effectiveness information to help municipal stormwater programs, homeowners, and construction site operators to improve stormwater and NPS control.

An outreach program can help motivate the public to support activities such as restoring impaired waters or protecting local water resources. A formal watershed program would reach out to audiences in the watershed, create messages that resonate, find ways to communicate messages, and help make changes in behavior to improve water quality. Components of a program can be current and innovative, such as using social media, videos, “adopt-a-stream”, and creating opportunities to listen to the needs of communities. The program would help increase the understanding of ecological systems among the general public, identify steps they can be taken to help protect the health of the lake, and educate the public on the importance of protecting Lake Lanier as an essential water resource. It could also educate landowners on the impacts of non-point source pollution and on strategies to reduce pollutants (pesticides, animal waste, cleaning products, etc.).

In order to develop and implement an effective watershed-side outreach program as part of a water quality improvement effort, it is important to determine the most effective approaches to reach out to target audiences and motivate behavior change.

Develop a model program that can be reproduced. Develop a toolkit of educational materials. Partner with other entities already involved in outreach such as the Metropolitan North Georgia Water Planning District (MNGWPD). Partner with cities with MS4 permits, which have an education requirement. Focus on water quality and pollution prevention and not just water conservation. Conduct outreach to schools. Develop general water education materials.

For the outreach program, take advantage of existing resources. It may be possible to utilize materials that have been developed by potential partners, including MNGWPD, Lake Lanier Association, Cities, and cooperative extension offices. In addition, these partners may have developed useful messages and can provide distribution channels.

Research Approach

The proposed approach would involve the following:

- Define the driving forces, goals, and objectives.
- Identify potential partners and analyze the target audience.
- Create, package, and distribute messages.
- Develop an operating plan, including metrics to measure outreach.

Deliverables

- Final Report
- Model Program
- Initial outreach materials

Estimated Duration

- 12 months

Estimated Budget

- $75,000 (Phase 1)

Potential PAC Members

- MNGWPD representative
- City MS4 representative

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **O-002**

Project Title: Outreach

Issue Area: BMPs for municipalities, agriculture community, and businesses/residences (Phase 2)

Objectives

Based on the outcomes of the Phase 1 outreach project, develop outreach materials on BMPs for various users, including municipalities, the agricultural community, businesses, and residences. The outreach materials would be based on BMPs vetted for the region and would raise awareness about current practices and develop interest in implementing BMPs by these stakeholders.

Background

Outreach is needed to encourage change in behaviors to control runoff and reduce sedimentation into the lake from all sources. It is important that the stakeholders and the general public be aware of the significance of their behavior and that their actions can result in more nutrients into the lake or can result in protection for waterways. In addition to nutrients and sedimentation, the program would address other issues such as trash and debris.

In addition, existing programs such as MS4s require education of communities on the pollution potential of common activities and increase awareness of the direct links between land activities, rainfall-runoff, storm drains, and their local water resources. The education programs should include clear guidance on steps and specific actions to be taken to reduce stormwater pollution-potential.

The benefits of public education efforts cannot be understated, especially on topics such as nonpoint source or stormwater runoff. Outreach information can describe the BMPs and generally provide applicability, implementation, and effectiveness information to help municipal stormwater programs, homeowners, and construction site operators to improve stormwater and NPS control.

Outreach materials could support municipal outreach programs such as stormwater outreach for commercial businesses. Consider using the media and promotional giveaways. Education for homeowners would involve alternatives to toxic substance, landscaping and lawn care, pet waste management, proposer disposal of household hazardous wastes. For businesses, topics would include pollution prevention as well as promoting low impact development and green infrastructure.

Ag outreach would involve developing materials in collaboration with industry associations such as for poultry farmers. Collaborating with NRCS, university extensions, and soil and water conservation districts could be important. Other groups could include cattleman associations and poultry integrators.

Build on the outcomes, including outreach plan, developed in the Phase 1 outreach project.

Research Approach

The proposed approach would involve the following:

- Refine and implement the outreach plan, including outreach strategy, developed in the Phase 1 outreach project. Confirm partners in the region for materials, training, and distributing information.
- Assemble existing materials as identified in Phase 1.

- Refine messages for different sectors: urban (residential, businesses), industry, agricultural, etc.
- Tailor outreach programs to minority and disadvantaged communities and children.
- Identify BMPs of interest and develop outreach materials such as fact sheets, videos, and PSAs.
- Develop information on low impact development and green infrastructure.
- Develop outreach materials on new and innovative solutions.

Deliverables

- Final Report (including operations plan)
- List of partners

Estimated Duration

- Ongoing (develop annual budget)

Estimated Budget

- Depends on final scope

Potential PAC Members

- Partner representatives

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **P-001**

Project Title: Innovative solutions for nutrient management

Issue Area: Policy

Objectives

Review and assess innovative solutions for nutrient management related to chicken farm litter, wastewater treatment such as for nutrient recovery, co-digestion, biosolids treatment for land application or energy production, and regional treatment opportunities for biosolids. Include innovative treatments for BMPs.

Background

Effective nutrient management in the Lake Lanier watershed will necessitate development of innovative solutions for nutrient management, including technology and policy solutions. Innovative treatment technologies may present opportunity for greater nutrient treatment or more efficient treatment, while forward-thinking policies provide opportunities to foster regional collaboration and spur innovation on the scale required to effectively address these nutrient challenges.

Examples of technology solutions include treatment of chicken litter that produces pellets for fertilizer. Co-management of chicken litter and wastewater treatment biosolids could present opportunities for more productive use of the materials when compared to disposal to landfills. Policy examples include measures aimed at efficient regional collaboration including co-digestion and regional management of biosolids, providing opportunities to pool regional resources to develop useful end products such as energy and fertilizers, while effectively reducing loads of nutrients into the watershed.

Research Approach

One possible approach to fund the innovations research could be to approach the project as a "challenge grant", or a "prize". The thought would be to spur innovation by awarding several small "seed money" grants of <$25k for research groups to prove concepts for innovative technologies. The winning group could be awarded a substantial research and development contract and access to a network of willing participants for piloting.

A second approach could be to provide small (<$25k) seed grants to NGOs to explore promoting effective policy solutions, with the goal of developing watershed-wide collaboration for effective policy solutions targeting nutrient management in Lake Lanier. The idea would be to turn these grants into larger state funded projects through lobbying for potentially effective solutions. By working together to develop solutions amenable to all of the "Lanier Partners" (stakeholders including agriculture, recreational, utility, and environmental advocacy groups with interests in Lake Lanier), a very large voice could be brought to the legislature for targeted funding designed to further study or advance collaborative nutrient management policy solutions.

Deliverables

- Challenge grant or prize program

Estimated Duration

- 6-9 months

Estimated Budget

- $200,000 (4 x $25k seed money projects, $100k prize) technology grants
- $100,000 for up to 4 policy grants

Potential Partners

- The Water Research Foundation's LIFT program
- Isle Utilities

Lake Lanier Watershed 5-Year Research Plan
Project Description

PD Number: **WR-001**

Project Title: Assess potential and benefits for expanded recycled water in the region, including decentralized projects

Issue Area: Water Reclamation

Objectives

Evaluate the potential for additional recycled water projects in the watershed to offset potable water use. Determine the benefits associated with these projects.

Background

If properly treated, recycled water can be used for most water demands. Recycled water has a range of benefits. The use of recycled water offsets potable use. Recycling water can also decrease nutrients to the environment by decreasing the amount of wastewater that must be discharged. Recycled water can be treated for various intended uses, also referred to as fit-for-purpose treatment. Water recycling has the potential to be cost and energy efficient and can help communities create a dependable water source that improves the environment. Common uses for recycled water include:

- Agricultural irrigation
- Dust control
- Construction projects
- Industrial applications
- Landscape irrigation
- Cooling water for power plants
- Park and golf course irrigation
- Mixing concrete

Research Approach

The proposed approach would involve:

- Assess potential drivers and benefits of water reuse in the region, including the reduction of nutrients into the watershed based on reduced wastewater discharges. Consider how water reuse fits into integrated planning efforts and One Water scenarios.
- Review the current regulatory framework for reuse in Georgia for both nonpotable and potable reuse.
- Assess current reuse projects in the watershed, including uses, applications, users and customers, level of treatment, source, and flow.
- Evaluate the use decentralized water reuse, such as satellite treatment facilities, and onsite use opportunities on a building and district (e.g., neighborhood, commercial block, industrial park) level.
- Inventory wastewater treatment facilitates that would be sources of recycled water in the region. Assess additional treatment requirements needed.

- Assess potential new projects where recycled water could be applied, including agricultural irrigation, other agricultural uses, industrial uses, commercial uses, urban irrigation, other urban uses, etc.
- Conduct a survey of stakeholders or hold a stakeholder meeting on the potential interest in the region.
- Develop the business case for more water reuse and make recommendations for expanding reuse in the region by source and use/application.

Deliverables

- Final Report
- Business case for water reuse

Estimated Duration

- 12 months

Estimated Budget

- $50,000-$75,000

Potential PAC Members

- Denise Funk, Brown and Caldwell
- Eva Steinle-Darling, Carollo Engineers
- Eric Rosenfeldt, Hazen and Sawyer
- Julie Minton, The Water Research Foundation