Campus Sustainability Grant Application – Cover Sheet

PROPOSAL INFORMATION

Project Title: Fecal Source Tracking and Nitrogen Analysis in the Lake Herrick Watershed

PRINCIPAL STUDENT INVESTIGATOR (PROPOSER) INFORMATION

Name: Thalika Saintil
Email: tas75808@uga.edu
Phone: (516)655-2497
Degree Program / Graduation Date: M.S. in Crop and Soil Sciences / December 2017

FACULTY / STAFF SPONSOR INFORMATION

Name: Dr. David Radcliffe
Email: dradclif@uga.edu
Phone: (706)542-0897
Title / Department: Soil Physics Professor / Crop and Soil Sciences Department

ADDITIONAL PROPOSAL INFORMATION

The proposal includes the following fields (check all that apply):

__X__ Education
__X__ Research
__X__ Service
__X__ Campus Operations
___ Sustainability + Arts submission

Summary of Budget:

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel Funding</td>
<td>$ 950</td>
</tr>
<tr>
<td>Equipment</td>
<td>$ 0</td>
</tr>
<tr>
<td>Supplies / General Expenses</td>
<td>$ 4,028</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$ 4,978</td>
</tr>
</tbody>
</table>

Campus Sustainability Grant Application Form, REV 08.18.15
Lake Allyn M. Herrick is part of the University of Georgia’s watershed. It is located within the Oconee Forest Park and is connected to a tributary pond called the Oconee Forest Park Pond (Parvo Pond). Due to the consistent degradation of the water quality, the lake, which served as a major recreational site for the University, was closed in 2002. The main concern was risk of human exposure to pathogens in the water. Many studies have been done in the past on the campus watershed regarding water quality. While some of the research have been scattered between departments, it was not until 2003 that the University contracted Brown and Caldwell environmental consulting firm to conduct a more rigorous water quality assessment of the entire campus watershed. Of all the water impairment factors (pH, Dissolved Oxygen, Turbidity, Conductivity), fecal coliform bacteria and total nutrients were high at all the sites. The figure below shows data collected for fecal coliform measurements by Brown and Caldwell from 2006 to 2013.

Although, Lake Herrick's fecal coliform concentrations seem to be decreasing throughout the years, Parvo Pond itself is way above the State’s acceptable levels. Parvo Pond channels loads of sediments into Lake Herrick. These sediments, once in the lake slowly release nutrients and bacteria in the water. This problem needs to be addressed in order to restore Lake Herrick and improve the overall health of the campus’s watershed.

The fecal coliforms data obtained from Brown & Caldwell only represent an estimate of the potential presence of fecal bacteria and intestinal pathogens in the lake. Fecal coliforms are common fecal indicator Bacteria (FIB) that are used as a standard method for determining the overall quality of water. Studies have shown that the presence of FIB do not necessarily correlate to the presence of pathogens and vice versa (Geldreich E., 1970). The detection of FIB in water also does not tell us anything about the sources of fecal pollution in order to develop appropriate mitigation strategies to target the potential sources.

Brown and Caldwell reported several possible sources of fecal coliform contamination including sedimentation due to erosion of trails and campus construction projects, urban storm water runoff, domestic pets and wildlife waste. This study will allow us to determine the specific contributors to the elevated bacterial levels at Lake Herrick and Parvo Pond.
The study’s main objectives are:

- To develop a more detailed bacterial and nitrogen analysis at Lake Herrick and Parvo Pond
- To determine the sources of bacteria using human, ruminant, and dog specific microbial markers
- To make the stream flow, bacteria, and nutrient data available for classes via the Watershed UGA website and develop a teaching module for Watershed UGA on bacteria tracking

Our budget includes funds for a student worker, bacteria source tracking, and nutrient analysis. The budget total is $4,978.

Relationship to UGA 2020 Strategic Plan:

Our research addresses Strategic Direction VII to “demonstrate and promote leadership in sustainable living and learning-contextualizing the local as part of the global in sustainability”, to “provide examples to other organizations and communities of how to integrate sustainability into existing and new operations” and “integrate sustainability into the student experience through curricular and co-curricular means both in the classroom and beyond”.

Contribution to enhance existing sustainability practices, initiatives, and awareness at UGA and beyond:

This study represents a subset of the on-going watershed management projects on campus. This research project is one of a kind because no data is available on microbial source tracking and stream flow at Lake Herrick and Parvo Pond. If we can target the different sources of bacterial contamination, the university can implement control strategies that will be more successful in the long run. Lake Herrick could be restored and reopened for campus recreation. The outcomes of the study will also be available to the students and faculty at UGA, enhancing both course contents and promoting further inter-departmental research opportunities.

List of partner organizations or departments:

- Dr. David Radcliffe and Dr. Mussie Y. Habteselassie; Crop and Soil Sciences Department
- Dr. Todd Rasmussen; Warnell School of Forestry
- River Basin Center

List of individuals contacted for input to this proposal:

- Seth Wenger and Laurie Fowler, River Basin Center
- Jill Stachura, Brown and Caldwell
- Brett Ganas, FMD Grounds Department
- Tom Breedlove, Office of University Architects
- Elizabeth Gardner, Watershed UGA
Campus Sustainability Grant Application – Compliance Form

Please answer all of the following questions, and explain in full where required.

Will this project require compliance review in any of the following areas?
Please place an “X” on the appropriate line to indicate “Yes” or “No” for all three compliance areas.

1. Animal Use
   ____ Yes
   ___ X__ No

If “Yes,” please reference the section and page number in the proposal describing animal use:

For more information contact:
706-542-5933

2. Biohazardous Materials
   ____ Yes
   ___ X__ No

If “Yes,” please reference the section and page number in the proposal describing biohazardous material use:

For more information contact:
706-542-9876

3. Human Subjects
   ____ Yes
   ___ X__ No

If “Yes,” please reference the section and page number in the proposal describing human subject use:

For more information contact:
706-542-5318

Name: Thalika Saintil
Title: Fecal Source Tracking and Nitrogen Analysis in the Lake Herrick Watershed
Date: 11/16/2015

___X__ By placing an “X” on this line, I certify I will fulfill all requirements pertaining to compliance if this grant is approved.
Campus Sustainability Grant Application – Budget Sheet

Complete all sections.

I. Personnel **

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Amount/Person</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UGA Staff</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UGA Student</td>
<td>1</td>
<td>$10/hour for 96 hours</td>
<td>$ 960</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Amount</td>
<td></td>
<td></td>
<td>$ 960</td>
</tr>
</tbody>
</table>

II. Equipment**

<table>
<thead>
<tr>
<th>Specific Equipment Items</th>
<th>Length of Use</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Total Cost</td>
<td></td>
<td>$</td>
</tr>
</tbody>
</table>

III. Supplies/General Expenses**

<table>
<thead>
<tr>
<th>Specific Supply Items</th>
<th>Comment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nitrogen analysis of samples</td>
<td>$40.50/sample for 36 samples</td>
<td>$ 1,458</td>
</tr>
<tr>
<td>2. Isotope analysis of samples</td>
<td>$60.00/sample for 36 samples</td>
<td>$ 2,160</td>
</tr>
<tr>
<td>3. Bacteria tracking supplies</td>
<td></td>
<td>$ 400</td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>$</td>
</tr>
<tr>
<td>Total Cost</td>
<td></td>
<td>$ 4,978</td>
</tr>
</tbody>
</table>

*Acceptable personnel funding include: 1) hiring outside consultants or contractors to perform required project tasks, 2) UGA Facilities Management Division staff labor charges for project implementation, 3) UGA student workers managed by participating UGA department to perform required project tasks.

**If more space is needed, please attach a separate document listing specific items and their costs.

Note: All Campus Sustainability Grant funds must be expended before June 30th.
In order to successfully achieve the objectives of this study, we will follow a series of peer-reviewed methods and guidelines. We will also use available resources within the collaborative departments to increase the feasibility of the project and decrease the costs. Our developed plan will help to answer specific questions addressed in the Project Overview on the water quality issues at Lake Herrick.

- **Phase I**: Installation of Research Equipment
- **Phase II**: Sampling and Lab Analysis
- **Phase III**: Interpretation and Release of Results
- **Phase IV**: Outreach
- **Phase V**: Recommendations for continuing and future studies

**Phase I: Installation of Research Equipment**

Two flumes and a weir have been installed at 3 locations on the Lake Herrick watershed: one below the dam, one on the Parvo Pond tributary, and one on the tributary that passes between the tennis courts and the parking deck. We will install automated ISCO samplers and water level recorders (that we have from a previous project) at each flume/weir. Three ISCO samplers have already been transported from previous research sites to the above locations. Some of the tubing and parts will be replaced and/or cleaned in order to perform test runs.

**Phase II: Sampling and Lab Analysis**

We will collect samples under baseflow conditions and during storms. The ISCO samplers will collect a composite sample during each storm. We will collect monthly samples under baseflow conditions at the location of the weirs. The samples will be analyzed for bacteria sources, forms of nitrogen (total nitrogen, ammonium, and dissolved nitrate) and for nitrogen and oxygen isotopes. The isotope analysis will help identify the sources of nitrogen since fertilizer, human and animal waste, and atmospheric nitrogen have different isotope ratios (it is not possible to distinguish between human and animal waste).

Samples will be processed no later than 48 hours after collecting the samples from the ISCO samplers. A portion of the samples will be filtered for nitrate, ammonium and isotopes. Unfiltered samples will be saved for total Kjeldahl nitrogen (TKN) analysis and the remaining samples will be archived. The nitrate, ammonium and TKN samples will be sent to the Feed and Environmental Water Lab located on the UGA Athens campus. This lab uses a cadmium reduction method for nitrate analysis recommended by United States department of Environmental Protection Agency (U.S. EPA). The TKN samples will be digested prior to analysis. A gas diffusion-conductivity technique using TL-2800 AMONIA/NITRATE ANALYZER System will be used. The same technique will be used for ammonium. Total Nitrogen will be calculated by adding TKN and nitrate results together.

The filtered samples for nitrogen and oxygen isotopes will be shipped frozen to the University of California Davis Isotope lab. The $^{15}$N and $^{18}$O isotopes of nitrous oxide coming from nitrate will be measured by bacterial denitrification assay.

The samples collected for bacterial analysis will be refrigerated for storage and analyzed in the Microbiology laboratory located on the UGA Griffin campus. The samples will be filtered to concentrate the DNA before extracting nucleic acid.
E. coli and Enterococci concentrations will be measured using Colilert-18 and Enterolert systems (IDEXX Laboratories, Inc.). The systems are based on the most probable number (MPN) method approved by the U.S. EPA.

The markers that will be used for human, ruminant and dog derived fecal contamination are part of the genus Bacteriodes. However, a combination of specific genes and assays will be subjected to each of the hosts (Wuertz et al., 2011). For the human fecal source tracking, the HF183 genetic marker (Seurinck et al., 2005) will be used. BacR marker (Reischer et al., 2006) will be used to track ruminant sources and BacCan marker (Kildare et al., 2007) for dog sources. Additionally, AllBac marker will be used to measure total fecal pollution (Layton et al., 2006). A virus assay (human adenoviruses) will also be performed by collecting surface samples twice in the season.

Phase III: Interpretation and Release of Results

We will ensure to compare the results of the study and coordinate our sampling data with Jill Stachura at Brown & Caldwell, due to the fact that they have been monitoring nutrients and FIB at Lake Herrick since 2006. We will also download the hourly stream flow data and our sample results and post these on the Watershed UGA website. The data will be useful to several classes taught at the university:

<table>
<thead>
<tr>
<th>Courses</th>
<th>Number</th>
<th>Department</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Dimensional Drawing</td>
<td>ARTS 1080</td>
<td>Art</td>
<td>Georgia Strange</td>
</tr>
<tr>
<td>Soil Physics</td>
<td>CRSS 4600/6600</td>
<td>Crop and Soil Sciences</td>
<td>David Radcliffe</td>
</tr>
<tr>
<td></td>
<td>ECOL 4310/6310</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshwater Ecosystems</td>
<td>4310L/6310L</td>
<td>Ecology</td>
<td>Amy Rosemond</td>
</tr>
<tr>
<td></td>
<td>FORS 4200/6200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquatic Biology Lecture</td>
<td>4200L/6200L</td>
<td>Forestry</td>
<td>Susan Wilde</td>
</tr>
<tr>
<td>Senior Project</td>
<td>FORS 4500</td>
<td>Forestry</td>
<td>Susan Wilde</td>
</tr>
<tr>
<td>Senior Thesis</td>
<td>FORS 4600</td>
<td>Forestry</td>
<td>Susan Wilde</td>
</tr>
<tr>
<td>Watershed Scale Modeling</td>
<td>GEOL 8040</td>
<td>Geology</td>
<td>Milewski/Radcliffe</td>
</tr>
<tr>
<td>Quantitative Methods in Hydrology</td>
<td>WASR 4500/6500</td>
<td>Forestry</td>
<td>Todd Rasmussen</td>
</tr>
<tr>
<td>Introduction to Water Resources</td>
<td>WASR 1020</td>
<td>Crop and Soil Sciences</td>
<td>Radcliffe/Rasmussen</td>
</tr>
</tbody>
</table>

Phase IV: Outreach

We will work with Elizabeth Gardner with Watershed UGA to develop a module on bacteria source tracking that will explain why bacteria is a contaminant, how bacteria DNA can be used to identify specific sources of bacteria, and what our results show for the Lake Herrick Watershed. Chandler Lipham, the secretary of the American Water Resources Association student chapter at UGA, will schedule a time for us during the semester to present the research project to other students that might be interested in getting involved.

Phase V: Recommendations for continuing and future studies

Based on the outcomes of this study, we will be able to identify the specific contaminant sources at Lake Herrick. With that information, we will be able to make recommendations on how to reduce nutrient and fecal bacteria pollution in the Lake. We will also be able to share the data with the FMD Grounds Dept and the Office of University Architects to implement better construction and development plans that could help to improve and sustain the health of the campus watershed in the long run.

Campus Sustainability Grant Application Form, REV 08.18.15
Campus Sustainability Grant Application – Communications Plan

There are several approaches to promoting our project on campus. The main approach we mentioned in the Project Overview will be to upload the research findings on the UGA Watershed website and develop a teaching module on bacteria tracking. All of the information about the project will be available to the students, faculty and staff. However, a lot of students don’t have instant access to the website unless they are looking for something specific. In this case we will use some non-traditional and creative means to reach out to the campus population and surrounding community.

Although the lake is not opened for swimming, fishing and boating, a lot of people still use the trails for jogging and/or walking their dogs. If we can find funding from another source or from the Grounds department, we will come up with a series of signs with fun facts about how human activities affect the water quality of the lake. These facts can vary from phrases on how to remember to pick up dog wastes, to the current level of FIB in the lake, to basic knowledge about water quality.

Another major way to reach the student population will be through social media. This will allow us to reach a larger crowd of students both science and non-science majors. We will be doing that by using the same methodology of short fun facts, pictures and phrases. We will coordinate with the UGA Instagram (@universityofgeorgia, @sustainable_uga) and Facebook (UGA Office of Sustainability, UGAGradstudies, University of Georgia) official pages.

The main focus of this communication plan will be to emphasize the importance of such water quality and how it affects sustainability at UGA in a positive way.
November 10, 2015

Campus Sustainability Grants Program
Office of Sustainability
University of Georgia

Dear Committee Members:

I am writing this letter in support of the sustainability grant submitted by my MS graduate student, Thalika Saintil. The proposal is entitled “Fecal source tracking and nutrient analysis in the Lake Herrick watershed”. Thalika just started graduate school this semester and we have been trying to decide what her MS project would be. We knew that she would be doing bacterial tracking (co-advised by me and Mustie Habteslassie on the Griffin campus) but I suggested she could work on several urban streams in Gwinnet County where we have done work, a new set of streams in Atlanta, or the UGA streams. As soon as she heard about the Watershed UGA program, she made it clear that she preferred to work here. We selected the Lake Herrick watershed because that is the only stream with devices to measure flow (at three locations). We have installed automated sampling equipment (from the Gwinnett project) that will sample during storms at these locations.

Thalika has done much of the writing of this proposal and is quite excited about both the research and education possibilities. This project would form the core of her MS project and we would seek grant support from other sources to expand it to other campus streams. I fully endorse the project and its significance with respect to sustainability and will be fully engaged in the project throughout the planning and implementation process including monitoring progress, managing the budget, verifying the metrics, and taking it to the classroom.

Sincerely,

David Radcliffe
Professor
Our results will become part of a refereed journal article on sources of bacteria in urban streams.

The stream flow, bacteria concentration, and nitrogen concentration data will be made available on the Watershed UGA website for use by students, faculty, and the Athens community.

According to Laurie Fowler, Watershed UGA has received some funds from the Riverview Foundation towards restoration of water quality of Lake Herrick and the information generated from our project should help inform the selection of best management practices for restoration. Dr. Radcliffe will be serving on a committee to help oversee the Lake Herrick restoration efforts.

Our project for installing flow measurement devices and automated storm sampling in the Lake Herrick watershed could become a model for how to make these types of measurements on the other streams on campus. The same is true for our work on determining the sources of bacteria in the Lake Herrick watershed.

Specific metrics will be:

- Concentrations of fecal coliform and E. coli bacteria at three locations in the Lake Herrick watershed during the period February through June of 2016
- Concentrations of nitrate, ammonium, and total nitrogen at three locations in the Lake Herrick watershed during the period February through June of 2016
- A comparison of bacteria concentrations during storms vs base flow conditions
- A comparison of nitrogen concentrations during storms vs base flow conditions
- Determination of which of the two streams is contributing the most bacteria, or if they are similar
- Determination of how bacteria concentrations change after they exit the lake
- Estimates of what the main sources of bacteria are (dogs, wildlife, or human)
- Estimates of what the main sources of nitrogen are (human/animal or fertilizer)