Stormwater Management and Water Conservation at Emory University

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Introduction

Today, universities have emerged as global leaders in realizing the importance of sustainability. These institutions raise awareness of the negative impacts human actions have on our world, and foster sustainable cultures and mindsets while providing the resources required for sustained environmentally beneficial change. However, universities do not achieve such status automatically—it takes extensive efforts on several fronts to create lasting change.
Emory University is one of the foremost institutions tackling the questions and practices of sustainability, having grown to its present position as a nationally-recognized leader in campus sustainability. Emory is especially well known for its achievements in water conservation and stormwater management. Though often overlooked, issues surrounding water are increasingly important to examine as water becomes one of the most important aspects of sustainability across the globe. Over the past twenty years, the university has overcome significant challenges in traditional practices surrounding water, with a focus on continued innovation and cultural change. Support by forward-thinking individuals in positions to implement and encourage change has been integral to advancements. These individuals also foster an environment where risks are accepted, leading to the significant advances in the way water is treated at the university. As time moves forward, it is important to document how Emory has made it to where it is today, celebrating past and current successes as well as acknowledging setbacks while looking to the future of sustainability at Emory.

Methods

This report on water conservation and stormwater management was written in Spring of 2017 as part of a compilation of the sustainability history of Emory University. This compilation, headed by Dr. Peggy Barlett, is the objective of an Emory College Anthropology class (ANTH 385W). In 2008, four reports covering green buildings, energy, transportation, and forest preservation were completed. This report and eight fellows seek to expand upon these initial histories and document changes in the ten years since the initial reports were published. Information utilized in this report is the result of research gathered from official university publications and websites, oral interviews, discussion with other members of the class and other relevant resources found online and in print. This report focuses on Emory's Atlanta campus due to general separation of the Oxford and Atlanta Campuses and the importance of an individual report examining the sustainability history of Oxford. An important note is that relative dates and years were investigated to the extent possible, though some of the information has been lost to time. Interviews were scheduled via email, and in the revision process interviewees were given the chance to review the document and give feedback. We are incredibly grateful to all those who contributed, for their generous help in creating these histories. The individuals interviewed for this report are listed below, along with the date of the interview:

- **Matthew Early:** Early started at Emory in 2010 as the Vice President for Campus Services. In this position, he oversees several departments including Planning, Design, and Construction and Facilities Management. He deals with issues surrounding both stormwater management and water conservation through these departments, and holds a personal commitment to environmental concerns. Interviewed in office 3/13/2017.
- **Jen Fabrick:** Fabrick worked at Emory from 1998 until 2017, serving as the University Architect. She oversaw the design and growth of the university. She also led the implementation of LEED and water-saving features in building and campus design. Interviewed over phone 3/24/2017.
- **James Johnson:** Johnson came to Emory in 1999 and currently serves as the university landscape architect. In this position, he works frequently with water in terms of irrigation, where he is involved in the development of irrigation systems for new construction projects and stormwater, and he works to make sure that water is captured and reused as efficiently as possible. Interviewed on campus 2/20/2017.
- **Mike Mandl:** Mandl worked as the Executive Vice President, Business and Administration, overseeing many aspects of Emory including Campus Services until 2016. Through this position, he was involved in several key decisions surrounding water and was influential in campus directions for sustainability. Interviewed with class on 3/29/2017.
- **Barbara (Bobbi) Patterson:** Patterson joined Emory as a professor in the Department of Religion in 1994, and has served as Assistant University Chaplain and Interim Dean of Students. Through these positions and her interest in Emory as place, she has worked with several aspects of water on campus. Interviewed in office 3/29/2017.
- **Taylor Spicer:** Spicer arrived at Emory in 2013 to pursue a Masters in Development Practice. After her graduation in August 2015 she took the position of program coordinator for the Office of Sustainability Initiatives. As program coordinator, she works with students and departments to further Emory's sustainability goals. Interviewed on campus 2/7/2017.
- **Matt Vinson:** Vinson came to Emory in June 2015 when new engineers were hired by Sustainable Water to manage the WaterHub. Through this position, he functions primarily as an engineer for the WaterHub, as well as working with student and community engagement. Interviewed on campus 2/14/2017.
- **John Wegner:** Wegner has been a faculty member in the Environmental Science Department since the fall of 1998. He has served in many different positions related to sustainability and the environment, including serving as the campus environmental officer and as a member of the University Senate's Committee on the Environment. This position involved the responsibility to look after environmental related issues, which included water. Interviewed in office 2/14/2017 and 2/16/2017.
- **Brent Zern:** Zern served as the Assistant Director of Operational Compliance and Maintenance Programs for Emory Campus Services from 2008 to 2016. In this position, he worked as a civil engineer working on the creation and implementation of stormwater management and conservation strategies on campus and building. Interviewed on campus 2/17/2017.

Water in the Context of Atlanta, Georgia, and the Southeast

It is well-known to many that Atlanta and its surrounding region have difficult issues to face concerning water. Despite this, it can be difficult to look beyond Emory's beautiful landscaping and forests to confront these harsh realities. At Emory, the idea of an "Emory Bubble" is often felt—referring to the tendency to separate Emory's campus and community from the areas that surround it. However, the two are tightly intertwined, even if this is not always obvious. To put into perspective the history of water at Emory, it is important to quickly summarize the increasingly complex water history of Georgia and the Southeastern United States. This is not to say that these issues have been the driving force behind Emory's achievements, but they are an integral part to any story of water.

Georgia has suffered from intermittent drought conditions since about 1998, according to the website for Emory's Office of Sustainability. While every region occasionally experiences drought, Georgia's droughts have reached a chronic level. One particularly harsh drought occurred in 2007, resulting in over half of Georgia's counties being placed under a state of emergency, as well as enforcement of a variety of water restrictions for the entire state (United States Army Fort Stewart 2017; NBC News 2007). In 2016, Georgia was again considered to be under a relatively severe drought (National Public Radio 2016; U.S. Drought Monitor 2017). Low reservoir levels, sparse rain, and widespread wildfires in northern Georgia in recent months have visibly added to public concerns. Though most people's day-to-day lives remain unaffected, drought persists as a thought in the back of many minds.

One aspect of water in Atlanta is the complicated and decades-long legal dispute between Georgia, Florida, and Alabama called the Tri-State Water Wars. Since the late 20th century, Atlanta has been rapidly growing in population and is now the ninth-most-populated metro area in the country (United States Census Bureau). Due to this, Atlanta uses a large amount of water that would otherwise travel downriver to Florida and Alabama. Extensive agricultural water use in southern Georgia also increases the water used in the state. Each state has its own very valid economic concerns in the debate, from Florida's famed oyster beds to Alabama agriculture's irrigation needs. Environmental interests are also influential, especially through the Endangered Species Act, used to protect endangered mussel species downstream of Lake Lanier (Atlanta Regional Commission 2014). The lake is very important in Georgia, not only as a drinking water reservoir for Georgia residents, but also for hydroelectric water generation. Lake levels are monitored based on water flow requirements for downstream power plants and federal mandates concerning the protected mussels (U.S. Army Corps of Engineers). Many Georgia residents find this frustrating, saying that the lake was created primarily as retained water for human use, though this is a common misconception (NBC News 2007). In fact, during the 2007 drought, Georgia's governor requested that the Army Corps of Engineers ease restrictions on human use of Lake Lanier's water (NBC News 2007). Continuing conflict indicates that much more litigation is necessary to fully resolve the battle, and the case is currently before the U.S. Supreme Court, where a special master has been appointed to determine equitable apportionment of the water resource among the three states.

Another very important facet of water as it pertains to Emory is the struggle that DeKalb County, in which Emory resides, has with its wastewater treatment and stormwater management. DeKalb's difficulties stem from the combined problems of aging sewer infrastructure (much of which is over 50 years old), inadequate systems to manage periods of extensive rainfall, and systemic underreporting of spills (South River Watershed Alliance 2017). The county has frequently been fined large sums of money by the state and federal Environmental Protection Agencies for noncompliance, and millions of gallons of untreated sewage ends up in streams and rivers each year, threatening both the health of humans and the environment (Environmental Protection Agency 2010). It is predicted that it will cost DeKalb well over a billion dollars to update and fix its sewage treatment, and many consider that the efforts are occurring much more slowly than needed (Creative Loafing 2016; Wegner 2017a). The neighborhoods around Emory report frequent sewage spills as well (Creative Loafing 2016). Emory itself is an important resident of DeKalb County, and any improvements made to campus water use and management contribute to alleviating the problems of Atlanta and the region as a whole.

First Forays into Stormwater Management

From an ecological perspective, stormwater management is incredibly important to the preservation of natural systems. When rain falls, it either filters into the ground and is captured by plants or recharges the aquifer, or flows over ground as runoff into the nearest ditch or creek (U.S. Geological Survey 2009). As Dr. John Wegner, an Emory Environmental Science professor and former Campus Environmental Officer, summarized in his interview, when landscapes are built up, impervious surfaces such as rooftops and roads are added into a watershed, and less water filters into the ground (2017b). The proportion of precipitation that percolates into the soil versus what flows into streams is drastically changed, and the increased stormwater runoff then flows faster into storm drainage systems. Many potential pollutants are picked up by the increased flow, including "sediment, nutrients (from lawn fertilizers), bacteria (from animal and human waste), pesticides (from lawn and garden chemicals), metals (from rooftops and roadways), and petroleum by-products (from leaking vehicles)" (U.S. Geological Survey 2009). As time goes on, streams become wider and deeper than they were previously due to an increase in water flow (Center for Watershed Protection). Natural habitats are destroyed, and leaf litter, an important food-chain base, is washed downstream (Wegner 2017b). Creeks in areas of impervious (hard, non-permeable) surfaces are also prone to cycles of lower flow and sudden flood from rainfall (Wegner 2017b). Two important terms for an understanding of stormwater management are retention and detention. Water detention describes slowing the entry of stormwater into creeks to decrease cycles of flooding, often achieved by using holding ponds. Water retention captures stormwater and does not return it to creeks, instead using it for other purposes such as irrigation or toilet flushing.

Emory's first stormwater management plan, titled "Hydrology Study for Future Development," was created in 1992 and is perhaps one of the first official documents created by the university addressing issues surrounding water. According to Wegner, this was in the early days of environmental awareness on campus, before ideas of sustainability had been fully accepted (2017a). To create the plan, Emory hired Precision Planning, Inc., an outside group of civil engineers who were tasked with putting together a document that summarized consistent standards for stormwater management on campus. Primarily, it focused on the central part of

Emory's campus west of Clifton Road (Wegner 2017a; Johnson 2017). It also solved problems of excessive runoff by using existing stream corridors as detention ponds, holding water so as to slow its flow and reduce the widening and deepening of streams associated with increased water flow (Wegner 2017a). Nettie's Creek in Baker Woods was an example of such a creek (marked as B in Figure 1).

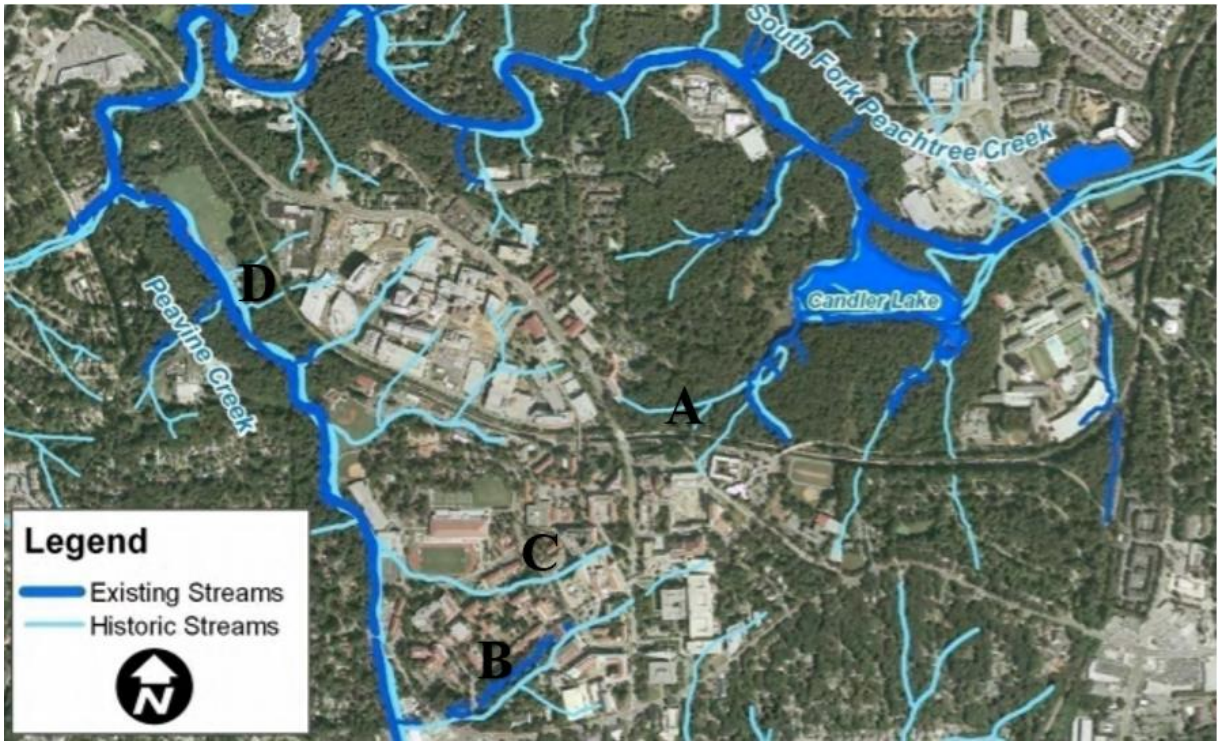

Figure 1. Emory Historic Stream Patterns, today as compared to 1927. From 2007 Emory Stormwater Master Plan.

A: Ernest Richardson Creek
B: Antoinette (Nettie) Candler Creek
C: Henry Hornbostel Creek

While useful in its time, this first stormwater management plan is looked upon today with a critical eye. Both James Johnson, the University landscape architect, and Wegner pointed out that when the decision was made to focus the plan on the central campus, substantial parts of Emory, including Lullwater Preserve, were left out, though consistent stormwater management was needed in these areas as well (Johnson 2017; Wegner 2017a). According to Wegner, the plan also lacked accurate information that detailed stormwater and sewer pipe location and size. This caused general confusion among those who tried to follow the plan. Often when new buildings were linked to the detention network, it was unclear to which detention pond stormwater would flow.

When there was plainly some sort of contamination flowing into a stream, Wegner often took it upon himself to determine where the contaminants came from, a task that was almost impossible to accomplish without knowing the location of the pipes (2017a). In his interview, Wegner included an interesting anecdote about his attempts to investigate contamination in streams. At

one point, Hornbostel Creek (marked as C in Figure 1) was discovered to periodically turn white and soapy. After many days of searching, Wegner was finally able to determine the cause, tracking it back to the loading dock of Cox Hall. Cox Hall, located near the center of Emory's campus, is primarily the location of an often-frequented dining hall. When maintenance workers needed to wash mops, they would often illegally use the sloping edge of the outdoor loading dock, finding it more convenient than the mop cleaning station located inside. Water runoff from the loading dock drained into Hornbostel Creek, so when employees washed mops, the soapy water would run down into the creek. After Wegner discovered the practice, employees were reminded that this was not allowed, and a sign was put up to ward off infraction. After the creek continued to turn white and soapy, food services made the decision to use an outside service to clean mop heads, officially stopping these episodes of contamination in Hornbostel. With stories such as this, it shows how positive changes can be made when an individual decides to make a difference.

According to Brent Zern, a former environmental civil engineer with Campus Services, stormwater management is also complicated because it is not seen as its own utility in university budgeting, unlike drinking water or energy (2017). Similar to how grey and black water is removed and cleaned, rain falls on a site and has to be similarly managed. However, because stormwater is not considered a utility, it does not receive separate funding. It is important to note that funding problems are not unique to stormwater management, but are consistent throughout efforts to improve water use and management on campus.

Creation of the 2007 Stormwater Master Plan

As the importance of sustainability increased in campus culture and decision making, it became clear to members of Campus Services (the branch of the university that oversees Planning, Design, and Construction as well as Facilities Management) that the 1992 stormwater management plan no longer reflected the goals and focus of the University. The initial idea for a new stormwater management plan started at Emory around 2005, with a variety of different reasons for its conception (Johnson 2017).

According to both James Johnson and John Wegner, one of the main reasons that the 2007 Stormwater Master Plan (also known as the 2007 stormwater management plan) was created directly resulted from the new adoption of the Leadership in Energy and Environmental Design (LEED) rating system and the "push for sustainable design" that accompanied it (Johnson 2017; Wegner 2017a). Briefly, LEED is a set of certifications created by the United States Green Building Council to encourage sustainably focused building standards (Office of Sustainability Initiatives Green Buildings). LEED certification contains four levels: certified, silver, gold, and platinum, with points earned through sustainable advances in indoor air quality, energy, sustainable building material, and water conservation, as well incorporating the sustainability goals of each particular region (for the southeast region, this includes water) (Office of Sustainability Initiatives Green Buildings; Hahn 2008; Johnson 2017). Water points are gained mainly though collecting and reusing rainwater, as well as for inventiveness and new approaches to water sustainability (Fabrick 2017). However, water is not the most heavily weighted section of LEED (Spicer 2017). When Bob Hascall, the Vice President of Campus Services at the time, brought the LEED proposal to the Board of Trustees, it was accepted not only because of the

environmental benefits but also because it was proven that Emory would save money in the longrun (Fabrick 2017). Now, Emory has one of the highest totals of LEED-certified square footage in the country for a university (Office of Sustainability Initiatives Green Buildings).

Besides the implementation of LEED, several other reasons for the creation of the stormwater management plan were discussed. One of the most prominent, as put forward by Johnson, included "a desire to better manage stormwater on campus" (2017). This sentiment was echoed by Wegner, who agreed that as the university administration was becoming more environmentally aware, they recognized the importance of water and stormwater management for environmental action (2017a). Wegner also added that because a Campus Master Plan update was published in 2005, the time was right to begin looking more at stormwater. The first Emory University Master Plan was created in 1998, and like its 2005 update did not include much information concerning environmental issues. Therefore, the 2007 stormwater management plan was created to start incorporating environmental concerns into the plan.

Another important influence on the discussions surrounding the plan, put forward by both Johnson and Wegner, was a new regulation created by DeKalb County (Johnson 2017; Wegner 2017a). This regulation, called the Stormwater Utility Fee, was put in place in 2004 to help address issues with stormwater management and drainage in the county (DeKalb County Stormwater Utility). Fees are assessed "in direct proportion to the demand placed on the stormwater drainage system" by each property's runoff (DeKalb County Stormwater Utility). Money collected is then used to improve DeKalb County's stormwater system. Through adoption of an extensive stormwater management plan, Emory hoped to streamline and potentially decrease the fees it paid (Johnson 2017).

Interestingly, the severe 2007 drought did not have much impact on the creation and implementation of the plan, though everyone was aware of the drought and its potential repercussions (Wegner 2017a). The information put forward by Johnson and Wegner is consistent with the actual language of the stormwater management plan, which states that "the primary drivers for [the] Stormwater Master Plan were regulatory compliance and the University's commitment to environmental stewardship" (Johnson 2017; Wegner 2017a; Emory University 2007).

Emory hired the firm Jordan, Jones and Goulding, Inc. to develop a comprehensive stormwater management plan addressing stormwater management, waste-water management, and overall water conservation on Emory's campus (Emory University 2007). As the plan was created, it passed through several channels, gathering input and approval from such groups as the University Senate's Committee on the Environment (Johnson 2017). In brief, the plan determined that the current conditions of stormwater on the campus were "ecologically unsustainable" and needed to be updated. It included many key recommendations:

- Improve and repair the existing stormwater infrastructure to maximize the efficiency of the in-place drainage system.
- Reduce stormwater runoff volume and increase stormwater quality through the implementation of best management practices, including stormwater infiltration basins, porous pavement, vegetated roof systems, and rain gardens.

- Harvest rainwater to achieve a campus goal of providing at least 75 percent of irrigation for established landscapes

Ultimately, the 2007 plan set out a path to improve water quality, reduce erosion and flooding, alleviate stresses on the University's stormwater systems, and practice forward thinking environmental stewardship (Emory University 2007). A separate document titled "Waste and Wastewater" was published in October 2008 as a secondary part of the stormwater update. This supplement included information on where the stormwater and sanitary sewer pipes ran, solving many of the problems that plagued the 1992 stormwater management plan (Wegner 2017a).

The creation of the 2007 Stormwater Management Plan was a helpful step forward for Emory, putting into one document clear, forward-thinking goals from the perspective of sustainability. The differences between it and its predecessor highlight the increasing focus on sustainability within campus departments. Campus Services today makes sure to consult the report before any new building or addition, because these increase the amount of impervious surface on campus (Early 2017). However, the plan had its drawbacks. Wegner points out that while the plan is incredibly useful to consult when buildings are constructed, the recommendations given by the plan were not adopted into the official design standards for the university (2017a). This means that instead of automatically being a part of building design, stormwater management is often seen as an extra cost. Zern agreed, pointing out that "everyone is vying for the same money," and the existing money for extra projects can only go so far (2017). Zern also pointed out another drawback of the plan. As the Assistant Director of Operational Compliance and Maintenance Programs, a significant part of Zern's position involved the implementation of the plan. While the plan is "an intelligent road map for our stormwater goals on campus," Zern states, "there isn't a lot of meat to it." In his opinion, while the stormwater management plan identified important guidelines to inform projects surrounding stormwater, it would have been more effective if projects were more specifically identified.

Campus Stream Preservation

The treatment and management of streams on campus has a fairly long and complicated history, which, as shown, connects frequently to the implementation of stormwater management. Emory's campus contains almost a dozen natural streams (Emory University 2007). Some are more visible, while others are all but hidden by construction and development. Historically, little regard was given for the maintenance of stream ecosystems (Wegner 2017b). However, many of the actions surrounding streams in the past ten to twenty years have shown significant progress in the treatment of streams, though there is still much to be done.

According to James Johnson, it has been difficult to prioritize action surrounding streams and streambank restoration due to a lack of funds and campus interest (2017). As he points out, the majority of people at Emory have no interaction with streams, meaning that the benefit of any money put in is hard to see. This unintentionally can cause funds to be directed other ways, leading the university to not focus as many resources to streams as it needs to maintain ecosystem health (Johnson 2017).

Occasionally, streams on campus have been used in attempts to increase campus water engagement. In 2003, the Ad Hoc Committee on Environmental Stewardship and the Friends of the Emory Forest came together to more prominently display campus streams and designate official names (Emory Magazine 2003). Tim Bryson, the then chair of the University Senate's Committee on the Environment (COE), first proposed the idea (Wegner 2017b). In a Spring 2003 article in the Emory Magazine, Bryson described the ideas behind the effort, saying that the "concern was that the streams were being neglected in campus planning and environmental consciousness," and without names, people often forgot the streams existed (Emory Magazine 2003). Emory already had an emphasis on saving trees and greenspace, but Bryson believed focus should be equally placed on stream restoration (Emory Magazine 2003). John Wegner was one of the members of the Stream Naming Committee, with Bryson as the chair. After extensive discussion and approval by the Board of Trustees, four streams eventually received names: Ernest Richardson Creek, Antoinette Candler Creek (a.k.a. Nettie's Creek), Henry Hornbostel Creek, and George Cooper Creek (Barlett 2017). In an email to Dr. Peggy Barlett, Bryson detailed the descriptions of the namesakes of the stream as well as the streams themselves, as proposed by the streams committee. The descriptions, as well as the locations of the creeks, are summarized briefly here:

- **Richardson Creek** is located in Lullwater Preserve, flowing from behind Woodruff Residential Center east into Candler Lake. Ernest Richardson, the namesake for the creek, was a longtime caretaker of Lullwater, from 1926 to 1962. Well-known on campus as approachable and friendly to all, he fostered a deep love and appreciation for the preserve. (Marked A in Figure 1)
- **Antoinette Candler Creek (Nettie's Creek)**, flows from a spring originating underneath Harris residence hall, travels underneath Woodruff Library, and reaches light in Baker Woodlands. It eventually flows into Peavine Creek in Emory Village, just southwest of Emory's campus. Baker Woodlands was originally named Antoinette's Garden after Antoinette (Nettie) Candler, wife of Warren Candler, the Chancellor of Emory from 1914-1922. Antoinette Candler often led plantings in the wood. (Marked B in Figure 1)
- **Henry Hornbostel Creek** was named after the original architect for Emory's campus, who used the stream to mark the north boundary of the campus quad in 1915 as a part of the first campus plan. The stream flows underground from its source on the east side of Clifton Road, primarily through pipes. The stream surfaces briefly as it travels out from underneath Cox Hall through a small wooded ravine. (Marked C in Figure 1)
- **George Cooper Creek** is named for a popular player and coach from Emory's Sports Hall of Fame. He earned a bachelor degree from Emory in 1941 and a graduate degree in 1952. During his work at Emory he also served from 1947 to 1976 as the Director of Emory's Intramural Sports Program. He included outdoor activities such as hiking, camping, and backpacking as a part of his curriculum. George Cooper Creek originates underneath the CDC campus, and travels above ground near Emory's lower sports fields on Peavine Creek Road before finally entering Peavine Creek. (Marked D in Figure 1)

This is by no means a complete list of the streams on Emory's campus, but it provides an insight into the way they are approached by the university. The initial naming of these creeks included a discussion on the problems that streams faced, such as accumulation of sediment as well as pollution and erosion from occasional storm surges. The efforts to rename the streams provided hope for restoration as well as suggestions for future action.

Emory has also increased community engagement surrounding streams through work with outside groups, such as the Peavine Watershed Alliance (PWA). The PWA was formed in 1999 as one of the first Watershed Alliances in the state of Georgia (Best Business GA). According to Wegner, the goal of the alliance was primarily to bring together all of the large stakeholders within the watershed, including Fernbank Museum, the City of Atlanta, and Emory University to increase awareness and lead action on stream restoration and maintenance (2017b). The PWA would often lead events that brought together Emory and its surrounding community. In an article discussing one such event, PWA founder and executive director Patricia White emphasized the importance of stream preservation and the role that all citizens in the area play (Emory Report 2000). White is quoted as saying, "we need to develop our community-based partnerships to protect our watersheds," and stressed that water issues must be tackled on a local level. The PWA also worked with Emory to lead creek clean-ups both on Emory's campus and in the surrounding area (Emory Report 2000). For a period of time Wegner himself was the representative to the PWA for the university (2017b). However, the PWA disbanded in 2010 when White retired and no one took her place (Best Business GA; Wegner 2017b). Emory was also involved with outside groups when the student group ECO-SEAC, for which Wegner was the advisor, adopted a piece of Peavine Creek through Georgia's Adopt-a-Stream program (Wegner 2017b). As a part of the program, those adopting the stream submitted chemical and biological monitoring data, provided community awareness, and hosted periodic clean-ups of the stream and its bank.

More recently, the Office of Sustainability Initiatives has been leading an effort to engage the community around its streams' health and pollinator protection. OSI, Campus Services and volunteer faculty, staff and students have engaged in native plantings to augment the 25-foot vegetated stream buffer critical for water quality with species that attract and provide habitat for pollinator species. These projects display a synergy between Emory's pollinator protection commitment and water quality protection efforts.

Despite efforts to increase campus awareness surrounding streams, the difficulties of action are clear. Specifically, problems surrounding funding within stream restoration are made evident in the main stream restorations attempted in recent years. The first stream restoration occurred in the beginning of 2010. As a part of the Lullwater Comprehensive Management Plan, recommendations were made surrounding streambank erosion and restoration for the streams in Lullwater (Emory Report 2010b). To bolster the recommendations outlined by the plan, an outside consultant was hired to design a streambank restoration project specifically for Richardson Creek (Wegner 2017b). However, according to Johnson, "the cost to do stream bank restoration is incredibly expensive and there was not the financial will to implement" (2017). The small amount of the original budget that remained was used to improve the detention dam behind Woodruff Residential Center (Wegner 2017b). While this was extremely successful, the remaining streambank restoration has not yet been completed due to the lack of funds.

In his time at Emory, Johnson said that he has only completed one full stream restoration, which took place within Baker Woodland in 2010, around the same time as the streambank restoration work in Lullwater Preserve (2017). This particular project was prioritized when construction was underway to remove the five-way intersection stoplight in Emory Village and replace it with the roundabout currently in place (Emory Report 2010a). As a part of the construction, there was some disturbance to the stream, and land was lost from Baker Woodland. Through negotiations surrounding this loss, the Committee on the Environment achieved a commitment from the university to perform streambank restoration on Nettie's Creek in Baker Woodland (Wegner 2017b; Johnson 2017). Similar to the Lullwater, Richardson Creek project, creating a streambank restoration outline was extremely expensive, decreasing funds available for the actual stream restoration. While there is more work to be done and progress to be made in that location, the efforts on Nettie's Creek were a firm step forward in stream restoration and water management at Emory (Wegner 2017b; Johnson 2017).

One particularly difficult issue that needed to be addressed concerning streams was stormwater runoff into Peavine Creek (Early 2017; Wegner 2017b). It was discovered that the fields, road and path running along the stream were improperly designed, angled in a direction so that when it rained, water was shed into the creek at such a rate that the creek bank was eroding (Early 2017). The plants would also erode away, which were needed to help filter the water as it entered the creek. A study was funded to examine what was happening, recommending that storm drainage be put in. In late 2016 the recommendations were implemented; storm drains were put in that lightly filter the water and carry it underground into the creek (Early 2017).
Besides specific stream restorations and projects, Campus Services also routinely cleans trash out of campus streams (Early 2017). Matthew Early, the Vice President for Campus Services, said that he sometimes receives pictures of areas of streams that are particularly bad, which helps alert him to areas that need attention (2017). He points out that most of the trash is not from Emory, but washes in from further upstream during storms. Regardless of where the trash came in, he still sees it as Emory's responsibility to help.

Overall, Wegner, Johnson, and Zern all agree much more needs to be done surrounding stream restoration (Wegner 2017b; Johnson 2017; Zern 2017). Zern specifically pointed out that much work is needed for Peavine Creek and South Fork Peachtree Creek, as well as Lullwater in general. These projects do often suffer from lack of funds due to the large variety of sustainability projects that occur on campus. However, with the creation of the 2007 stormwater management plan and recent improvements to streambanks, it is clear that the university places importance on how it approaches the natural campus ecology.

Construction Projects and Buildings

Whenever a new building is constructed, inevitably there will be challenges to sustainability (Mandl 2017). However, since the adoption of LEED in 2001, construction projects on campus have increasingly incorporated sustainable water use and management practices into their design. In the opinion of Wegner, some of the University's greatest successes have directly related to LEED, though the adoption of the Stormwater Management Plan in 2007 both displayed and contributed to these changes (2017a). Jen Fabrick, formerly Emory's lead university architect,

also sees the drought as an impetus, which increased the understanding of conserving water within the various campus services and construction and design departments (2017). According to Taylor Spicer, a program coordinator with the Office of Sustainability Initiatives, "folks in the field want to see more [green infrastructure] because it is just a smart way to manage your resources" (2017). The changes in water use and management at Emory over the past two decades have reflected this sentiment.

To Campus Services, water (from municipal water supplies and recycled sources) is seen as a utility much the same as electricity, though Matthew Early points out that it is the least-managed utility on campus (2017). Focus is placed on water quality standards that need to be met, and making sure that water lines get to each building and each individual output point (Early 2017). This needs to happen regardless of views on sustainability.

The landmark building for Emory in terms of water conservation measures was the Whitehead Biomedical Research Building, constructed in 2000. This was the first building on campus to receive LEED certification, in part due to the inclusion of innovative and forward-thinking technologies (Fabrick 2017). Almost all of those interviewed mentioned the importance of the project on their own accord. The full history of this achievement is discussed in one of the original 2008 reports, Hahn's "Constructing a Movement, One Building at a Time," but is imperative to summarize here as well. In 2000, several campus leaders including Wegner, Barlett, Fabrick, John Fields (then Director of Project Management and Construction for Facilities Management), and Bob Hascall (then Vice President of Facilities Management) attended a Second Nature Regional Conference. At the conference LEED was presented, and it was the first time that several of the attendees including Fields and Fabrick had heard of the certification. Intrigued, the attendees decided that this was something they wanted to explore at Emory, the sooner the better (Fabrick 2017). Plans for Whitehead had already been created, but the building was chosen for the University's first implementation of LEED standards. After several discussions surrounding the possibility, the idea was approved, in part due to a comprehensive cost benefit analysis led by project manager, John Fields. According to Fabrick, Whiting-Turner, the contractor on the Whitehead project, was a sustainably minded company and had already included several sustainable building features in their plans (2017). After more conversation and the tireless efforts by those who had attended the conference, Whitehead officially became the first LEED building on campus. Without the support of these influential people and their devotion to the idea, it is unlikely the building would have achieved LEED, or that the university would soon after adopt a LEED silver standard.

One innovative feature that contributed to the certification of Whitehead were "large heat wheels" added to the roof of the building "to wring the humidity out of the atmosphere, resulting in almost 4 million gallons per year of water being captured and used in Emory's chilled-water system" (Office of Sustainability Water Conservation). Not only does the system conserve massive amounts of water, but it also contributes to significant cost savings. Both Johnson and Wegner noted this project to be a first step in future of water management and use efforts at Emory (Johnson 2017; Wegner 2017a). This initial leap into sustainable design displays the willingness to take risks and the support of such endeavors by the university.
The "greening" of Whitehead led the way for the inclusions of sustainable water features in future building design. Fabrick discussed how her role in water design inclusion changed as time

progressed (2017). In the early stages after the construction of Whitehead, Fabrick worked closely to include water features in building design. However, with Fabrick's encouragement, people began to embrace sustainability, and issues of water became more directly incorporated into the thinking around building design. Fabrick "was happy to hand the responsibility over to people who were so enthusiastic" about working with sustainable design. Now, she points out, within Campus Services sustainable practices are considered during each project. These changes were incredibly important, as during the tenure of President James Wagner (2003-2016) over 21 new buildings were constructed on Emory's main campus, as well as several major renovations and collaborative projects (Hauk 2017).

Here, water management (in terms of buildings) includes ways in which buildings deal with and utilize rainwater, while water use refers to the use of potable water and its replacements within buildings. These two aspects have been loosely separated in an attempt to give a clearer account of the history of buildings and their water projects. However, there remains some overlap between the two.

Construction Projects and Buildings—Water Management

Following the construction of the Whitehead Biomedical Research Building, the next large water management innovation project was the inclusion of dual plumbing in the Few and Evans Residence Halls in 2008, the first time this had been done on Emory's campus (Zern 2017). This inclusion allows an alternative water source, in this case rainwater collected from the roof of the building, to be used for toilet flushing. Jamie Nadler's report "Sustainability in Campus Life: The Changing of Behavior" further discusses innovations in Few and Evan's water and general sustainability (2017). For Brent Zern, this project "is a great way of managing our site's water footprint," and recycles water to help achieve sustainability goals. He points out that in some aspects the first drought was a stimulus behind the plan's creation, though both LEED and the 2007 stormwater management plan remained the main drivers. Understandably, the main pushback from this project was from DeKalb County. Few and Evans were the first buildings in the county that used recycled stormwater for toilet flushing. Because of this, Jen Fabrick recalls, the county did not know what questions to ask and was reluctant to try something new (2017). In a compromise, DeKalb allowed the recycled water to be used if clearly marked as not potable water, resulting in the blue tinted water that is seen today. Also of interest are the on-site solar panels at Few and Evans that run a pump moving the collected rainwater up to the dual-flush toilets in the residence halls—providing a good model for water stewardship for building occupants and others. The push by those at Emory to include sustainable features in the building despite opposition highlights the emerging culture within university departments to push the boundaries and implement new ideas.

Previously, construction projects were often complicated by a lack of adequate erosion and sediment control standards. County and state codes surrounding stormwater management must be followed when a project is built and therefore are a prominent component of building design. According to Zern, these regulations are mainly for stormwater management during construction and controlling erosion on site (2017). Both Emory's standards for management and ideas about the sustainability of buildings have increased much faster than county codes have been updated—thanks largely to LEED—leading Zern and Wegner to maintain that Emory goes far

above and beyond regulations with stormwater management both in building design and construction (Zern 2017; Wenger 2017a). On the other hand, James Johnson is not so sure (2017). He finds it difficult to quantify how far beyond the county requirements Emory goes. Each project is different and depends on both the county and campus individuals who are approving the systems. However, it is clear that the focus on sustainable water features of Emory's departments has pushed forward the incorporation of beneficial stormwater management features.

Two aspects of water management that were emphasized in the 2007 Stormwater Management Plan were the use of pervious pavement and green roofs. In both categories, Emory has made strides. The first inclusion of a green roof on campus was the roof of the Woodruff Physical Education Center (WoodPEC). Dr. Bobbi Patterson, a professor in the Department of Religion and former chair of the Athletics Committee, remembers how the WoodPEC, built in 1983, was designed with specific "intention around the natural world." Unlike many indoor recreational facilities, the goal was to create a welcoming, open space (Patterson 2017). As Patterson remembers, the architect added skylights above the building's central walkway, and the building was filled with plants. Tennis courts topped the building, along with more green space and potted plants. Three sloping sides of the building were adorned with stepped earth berms containing more plantings. While this increased connections with nature and reduced environmental costs of heating and cooling, there were major drawbacks (Patterson 2017). The sloping plant-filled sides needed extensive maintenance that was in no way economical, and most importantly no one could determine a way to stop the building from leaking (Patterson 2017; Wegner 2017b). Sometimes after a particularly large rainfall, recalls Patterson, it seemed as though a waterfall was coming down the south side of the pool, and as Wegner pointed out, the gym floor was replaced multiple times due to water damage. By the early 1990s, the Board of Trustees demanded that something be done (Wegner 2017b). A fourth floor was designed and plantings were removed, which were determined to be the best ways to prevent leakage (Patterson 2017). In Wegner's opinion, these setbacks and the high cost made it difficult to advocate for further green roofs on campus for a number of years.

Today, green roofs are generally only approved when located over unoccupied space (Wegner 2017b). In total, Emory has 5 green roofs, two over parking decks, two other experimental green roofs, and one over labs and an underground walkway. One of the two experimental green roofs is located on top of the Math and Science Center and was the first green roof to be added after the failure of the WoodPEC green roof. It fell into disrepair at one point, but has been refreshed and the low groundcover plants are doing well (Wegner 2017b). The other experimental roof is located over Hopkins Hall, part of the residence hall known as Complex. This project was funded by an Incentives Fund grant from the Office of Sustainability Initiatives to a group of students who worked with Emory's Grounds Department to implement as a retrofit, with Wegner as an advisor (2017b). The two green roof parking decks are between the B. Jones and Admission Buildings and over the First Year Quad, located between several of the First Year Halls. The last green roof covers part of the underground Anatomy Department and corridor next to the Rollins Research Center.

While not well known, there has been a recent push through student groups for greater awareness surrounding campus green roofs. In fact, in 2017 an Office of Sustainability Initiatives grant was

given to an Emory College senior to revamp the roof of the Math and Science Center, demonstrating the increase in awareness surrounding water issues (Wegner 2017b). Despite the major setbacks with the WoodPEC, it is remarkable that green roofs have since been built, demonstrating the willingness of campus leaders to continue efforts for sustainable design.
In terms of pervious (water permeable) pavement, there are currently two installations on campus (Wegner 2017b). One is located on a sidewalk by the Peavine Parking Deck, added when the building PAIS was constructed (Wegner 2017b). The other location is the parking lot of the frequently renamed coffee shop and café located on Eagle Row (currently known as Kaldi's Coffee and formerly known as the Depot) (Emory Report 2013). As stated in the Emory Report, "Historically, the depot parking lot featured a gravel surface, but it had become so compacted and carved with ruts and potholes that it was no longer draining properly." When the project was brought to the Committee on the Environment, it recommended that pervious pavement be used, and after cost accounting and debate, the parking lot was constructed. The pervious pavement did cost more than the traditional concrete or asphalt options, with funding eventually provided by Emory's Food Services Administration (Emory Report 2013; Wegner 2017b).

Overall, the number of water storage cisterns at Emory has greatly expanded since the first use of cisterns in the early 2000s (Zern 2017). Fabrick was influential in the initial usage of cisterns, mainly collecting stormwater for irrigation purposes, following the first cistern in Whitehead (2017). While the cisterns did decrease the potable water used for landscape irrigation, many early cisterns were small, constructed individually per building. During times of drought, the water in the cisterns would be used quickly, without being replaced. Fabrick's team responded by prioritizing the water to certain areas, especially the larger trees, and used more drought-resistant plants in designs. Today, the campus cisterns are capable of holding over 350,000 gallons of rainwater, which is mainly used for irrigation (Office of Sustainability Water Conservation; Zern 2017). While numbers were not specifically available for the percentage of irrigation water that comes from water retention versus potable water, there remains some irrigation that comes from potable water (Zern 2017). However, Johnson points out that the grounds crews and Facilities Management do a remarkable job managing irrigation, especially considering the constantly changing county and state water restrictions from drought (2017).

Since the 2007 plan, there have also been three bioswales installed on campus (Spicer 2017). Bioswales are a system used to naturally treat and disperse surface runoff water. They clean contaminants from the water and "allow the water to drain at a slower rate, reducing the chance for overflow in low-lying areas" (Emory Healthcare 2016). Vegetation is installed whose roots clean the water and slow its return into the ground or into streams, decreasing erosion (Spicer 2017). Figure 2 below demonstrates a common construction for bioswales.

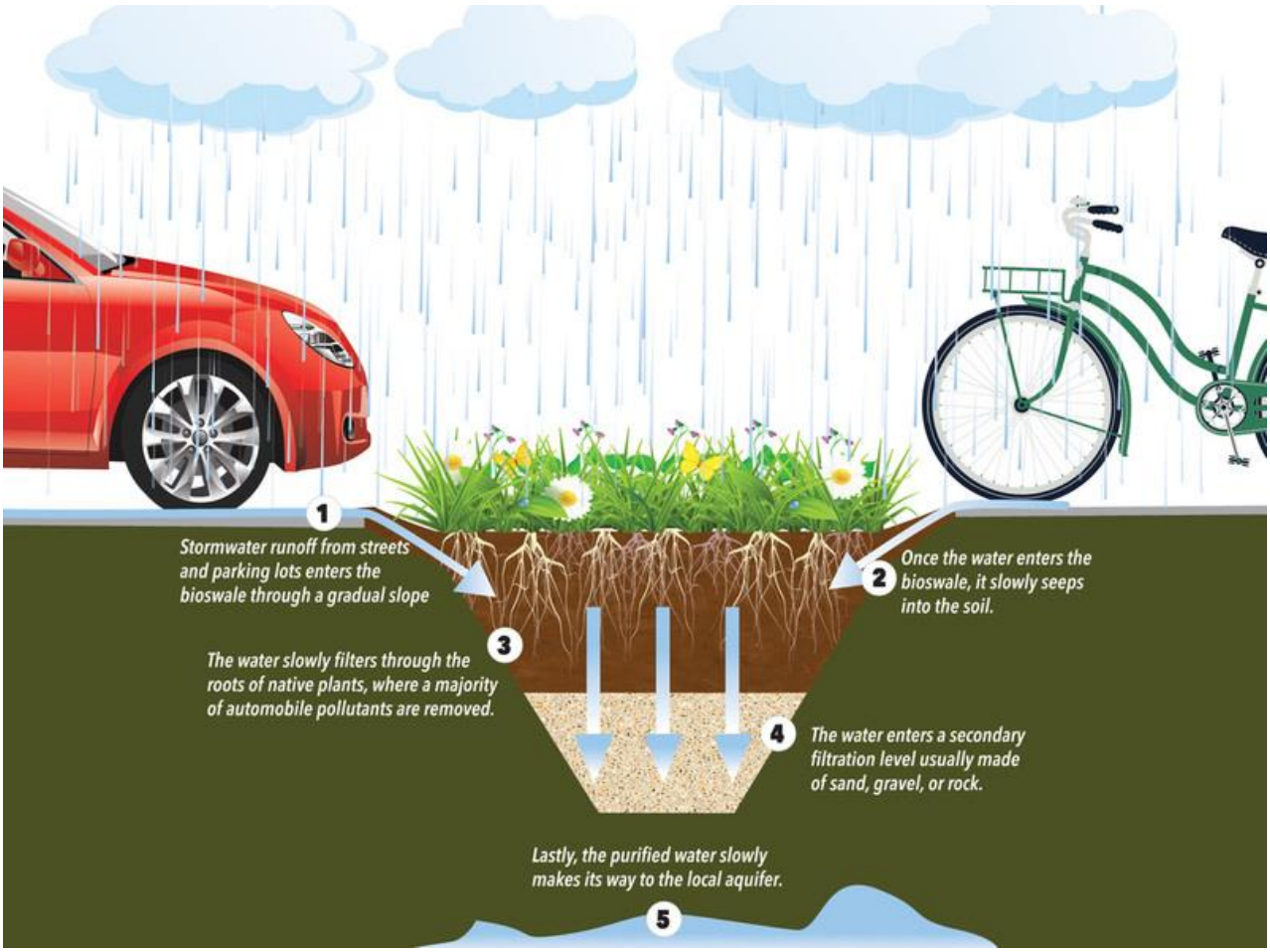

Figure 2. Common bioswale construction. From Watershed Council.

Since the 2007 plan, there have also been three bioswales installed on campus (Spicer 2017). In 2009, the first bioswale was installed as a part of construction of the Psychology and Interdisciplinary Sciences Building, and since then two more have been installed outside of Emory Hospital on Clifton Road and in the center of the Woodruff Circle shuttle drop-off area (Zern 2017; Spicer 2017; Office of Sustainability Initiatives Media Release 2009). More bioswales are planned to be included in current expansions to Emory Hospital. Bioswales offer the advantage of being good for the environment as well as aesthetically pleasing. They are also an excellent educational opportunity, with signage describing their purpose and importance recently installed nearby. It is hoped that the signage will help bring awareness to bioswale inclusion on campus, as many students, faculty, and staff seem to remain unaware of the bioswales' existence.

Construction Projects and Buildings—Water Use

To fundamentally change the way that a resource like water is approached and utilized, there are two methods: behavior change or infrastructure change. While Emory has worked on both, some of its largest strides have been made in the sphere of green infrastructure updates. This has occurred both at large and small scales.

One of the larger-scale projects that Emory embarked on to decrease water use was the implementation of a greywater recycling system in Longstreet-Means Residence Hall. Built in 2010, the Longstreet-Means greywater system runs wastewater from sinks, showers, and laundry through a filtration process and funnels it back to be used for toilet flushing (Office of Sustainability Water Conservation). These types of toilets are tied to recycled water for most flushing, but are also connected to the main municipal water system in case the recycled water runs out (Zern 2017). As in Few and Evans, the recycled water is dyed blue to distinguish it from potable water. In 2012, the system was expanded to include the Hamilton Holmes Residence Hall. While a great success from a water-savings point of view, Brent Zern, who helped to design the system, bemoaned its financial cost, which continues to be much higher than was expected due to complicated processes and the extensive maintenance the installation needs. Often the system has some sort of problem, and it can be difficult to determine the cause (Early 2017).

Another debate surrounding the use of greywater in toilet flushing occurred when students in Longstreet Means residence halls and especially Hamilton Holmes Hall began to complain about the smell of the water (Johnson 2017; Zern 2017; Wegner 2017a). According to Wegner, Facilities Management maintained that no such smell existed, and the issue was brought to the Committee on the Environment (2017a). The toilets were briefly switched back to regular water and the smell remained. Soon after, the greywater system was again put in place, though it has stopped occasionally due to various problems. However, Matthew Early points out that this system displays some of the great things about sustainability efforts at Emory (2017). Even though a system may not work perfectly, Campus Services can learn from the difficulties so that the next time a similar system is implemented, it can be redesigned in a more efficient way. Today, there are few complaints about the smell of the water, though this could be attributed to the fact that most students are unaware that their toilets use recycled water despite the blue color. On a smaller scale, but of no less importance, were the dual-flush toilet and low-flow shower, sink, urinal, and toilet installations at various locations on campus (Office of Sustainability Water Conservation). Over the past decade, these features have made their way into the design standards for buildings, and when possible are retrofitted into existing buildings (Fabrick 2017). These installations help buildings achieve LEED status and decrease overall water use costs, which helped to streamline their implementation on campus.

Wegner was able to provide a brief history of how dual-flush toilets became the design standard, a story representative of the similar measures (2017a). Dual-flush toilets were first implemented in the new Turman residence hall in 2007. The Committee on the Environment was insistent that dual-flush be used, but concerns were raised that users would be unfamiliar with the design, and the toilets would not be used effectively. However, as Turman was a residence hall and residents would live there for an entire year, the argument did not hold up. After this implementation, the challenge was to use dual-flush in non-residential buildings. The first non-residential building outfitted with them was the addition to the Rollins School of Public Health and no problems were reported. In the progression of water sustainability on campus, these successes were significant and showed the increased acceptance of sustainable features. However, even with these successes, some debate remained. Discussions over the benefits of dual-flush or automatic flush toilets caused both to be installed on campus, with the potential to confuse users. This exact

history is murky, with some buildings outfitted with dual-flush and some with automatic. Now, new toilets are generally dual-flush.

While it is often useful to retrofit existing buildings with low-water-use features, Matt Vinson, an engineer with the Emory WaterHub (a project discussed later in the report), makes the good point that in some cases it's not worth the cost to put recycled water systems requiring alternative piping into existing buildings, unless they are being redone (2017). With the exception of low flow sink, toilet and toilet updates, it is generally less sustainable to retrofit an entire building than leave the existing infrastructure. Reclaimed water for something like toilet flushing requires an entirely separate set of piping through the walls, which is difficult and expensive to implement retroactively.

According to the Office of Sustainability Website, Emory has also been able to reduce water use in Candler Library by 30%, Goizueta Business School by 20%, and Winship Cancer Center by 24%. These extremely successful reductions were accomplished through a combination of updated water infrastructure and behavioral change.

Water-use updates have not been limited to Emory's College/Graduate buildings and facilities, but have also spread to Emory's hospital systems. In one of the fellows to this report, "Sustainable Healthcare at Emory University," Lauren Balotin discusses several of the initiatives that Emory hospitals have implemented to decrease water use (2017). Looking to the future, the J-Wing, a new Emory University Hospital addition set to open in July 2017, will include a condensate recovery system that will save 2.5 million gallons of water per year. Its water-efficient fixtures will use a minimum of 30% less water than a typical hospital (Emory Healthcare 2016). Growing water awareness in Emory Healthcare has yielded new savings and allows sustainability efforts concerning water to catch up with other sustainability innovations in healthcare.

Water Outreach: Student and Community Engagement

The ultimate goal of a university is to be an institution of learning and growth for those who attend, work, and live around it. Sustainability is a clear way to accomplish this end. Compared to other aspects of sustainability at Emory, student and community engagement has remained relatively low, contrasting with the increasing water engagement within parts of the administration and campus services. In Zern's opinion, the way that a university can tackle issues surrounding water often does not impact students' lives (2017). "When it rains outside," he points out, "it has rained your whole life. You don't think anything of it. You know it isn't going to flood your dorm room. You just know it is going to drain into a pipe [that] takes it away." Early agrees, pointing out that even though Emory tries to teach conservation habits to its students and community, these things need to be imparted early in life when habits form for lasting behavior change (2017). When there are many different issues that students care about with political, social, and environmental dimensions, specific issues such as water can often be overlooked. Historically, campus interest has focused on energy and more recently climate change, a sentiment both Taylor Spicer and Zern agree with (Spicer 2017; Zern 2017). While these are both important topics to consider, many find that water needs to become more prominent in student concerns.

Some of the earlier efforts into campus engagement involved programming and events centered around water awareness. These events brought together various sections of campus as well as outside organizations, similar to those sponsored by the Peavine Watershed Alliance (Emory Report 2011). One of the largest programs surrounding water was the year-long exploration of water curated by the Emory College Center for Creativity and the Arts. From the fall of 2011 to the spring of 2012 several arts events were held that "examined water as through a series of creative projects" using platforms such as dance, theatre, visual arts, and music (Emory Report 2011). Several art exhibits tackled water and its connection to environmental health, an approach which was appropriate for Emory's campus wide emphasis on public health and medicine. The Women's History Month that February continued the theme with their "Women and Water" series, "celebrating the female point of view without losing sight of the social responsibility we all share as inhabitants of a water-dependent planet" (Emory Report 2012b). In the spring of 2017 another series sponsored by the Department of Environmental Health in the Rollins School of Public Health and the Institute for Quantitative Theory and Methods focused on water issues with several films and discussions (Emory Report 2017).

Another way that campus engagement in water has been promoted is through building water competitions. The competitions sought to "actively engage the campus community in achieving its sustainability vision of reducing overall water use," including 71 buildings on campus in the categories of research, residential, and other (Emory Report 2012a). The competition was run each year in the month of February from 2011 until 2013, showing substantial savings in water use and costs. However, the competition was halted after the 2013 year. According to Spicer, the competition was very difficult for Campus Services to support because obtaining the required information involves manually checking meters, which sometimes are linked to more than one building. Campus Services has reported that they do not have the capacity to have their staff check the meters as required for such a competition. However, Spicer recommends a return to the competitions due to their importance in campus education.

While overall engagement has been low, several campus classes have been offered that delve into the issues of water and sustainability, these are further discussed in Meggie Stewart's report "Teaching the Future: Academic Infusion of Sustainability at Emory" (2017). This report also discusses the Center for Global Safe Water, Sanitation, and Hygiene, operated by Emory's Rollins School of Public Health. Water is fundamentally related to human health, and with Emory's focus on medicine and health it seems that this encompasses the largest portion of campus water awareness.

From Spicer's perspective, student interest in water has declined since she came to campus in 2014 (2017). She points out that there used to be a student group called the Water Coalition that would meet and hold film screenings as well as other programming. The mission of the coalition was to "raise awareness of water-related issues within and outside of the Emory community" (Facebook 2017). However, like many student groups, interest faded and eventually disappeared before the start of Fall 2015.

Throughout its existence, Emory's Office of Sustainability Initiatives has directed several campaigns to increase campus education surrounding water. In 2010, the Office of Sustainability Initiatives led a community art competition to design a new logo for campus water initiatives to

be used on marketing and promotional items surrounding water. A design by a local middle schooler was chosen, and some water awareness signage in bathrooms and hallways still bears the logo (Emory Report 2012a). Emory has taken steps to add signage where needed to help impact behavior change and was one of the first universities to do so at a large scale (Patterson 2017). However, most students remain somewhat unaware of its existence. Over the past decade, there has been some outreach and education, especially during periods of drought and, at times, led by the Drought Response Task Force organized by the Office of Sustainability Initiatives. According to Spicer however, there has not been any recent programming to inform the student body about what drought in Georgia actually means and how it could affect them (2017). Education campaigns are complicated by constant student turnover. Fortunately, in the past few years, opportunities for student engagement have increased, particularly surrounding the creation of the WaterHub.

WaterHub—the Future of Water Conservation

One of Emory's shining achievements in the field of water came online in the spring of 2015. On April 30th the WaterHub was incorporated as Emory's water reclamation facility, the first facility of its kind in the nation (Emory Report 2015). Capable of processing up to 400,000 gallons of water a day (40% of the university's water use) the facility recovers wastewater taken directly from the sewer pipe and utilizes the recycled water for a variety of non-potable (non-drinking) purposes on campus.

Figure 3. View of Emory WaterHub from above. From Reeves Young.

Conversations surrounding the WaterHub began in 2011, when the owner of Sustainable Water (a company that provides "commercial-scale water reclamation and reuse solutions across the United States") approached two Campus Services employees (one of whom was Brent Zern) at a

conference (Sustainable Water 2017). Matthew Early's philosophy for Campus Services encouraged the principle that no idea is a bad idea, fostering innovation within his departments (Early 2017). Intrigued by Sustainable Water's proposition, the employees brought the project back to Early. Immediately interested, Early set up a meeting with Sustainable Water to learn more. While Emory had taken great strides in reusing grey water (water from showers, sinks, and laundry), no efforts had been made to reuse black water (water from sewer pipes). Getting the facility approved required a lot of education for those involved. Early frequently met with his superior Mike Mandl (Executive Vice President, Business and Administration) to discuss the WaterHub project (2017). Mandl gives the bulk of the credit to Early for the creation of the facility, saying that "he believed in it and did the work to answer my difficult questions." Some pushback to the project involved concerns around potential smell from the facility (Mandl 2017). No one wanted the smell of waste water wafting from one side of campus. A critical component to gain approval was the feasibility study conducted in the spring of 2012 by Zern, Sustainable Water, and others from Emory (Zern 2017; Mandl 2017). The study provided a detailed accounting of the benefits of the facility, both from a monetary and environmental perspective.

After over a year of back and forth, Mandl decided to go ahead with the project, in great part due to the persistence of Early (Mandl 2017). When Mandl brought the WaterHub to the Board of Trustees, it was straightforward to convince them of its merit. Because of Mandl's credibility, the Board gave him strong support and could see that the necessary work had been done to examine all aspects of the project (Mandl 2017). The financial agreement with Sustainable Water was also an important factor. Sustainable Water would build, maintain, and own the facility, while Emory would provide land and buy all the water processed, at a lower cost than from DeKalb County. From a financial standpoint, the agreement was ideal (Mandl 2017). Early points out how important it was that Mandl and others in the administration as well as the Board of Trustees were willing to take a chance with the project (2017). Without campus leaders' will to put in the effort and try new ideas, it is unlikely such a facility would ever have been completed.

Of course, the WaterHub not only needed Emory approval but approval from DeKalb County as well. Early points out that while receiving the proper permits was not difficult, pushing for a sewer credit was more difficult. Basically, every time water is used, a fee is charged that includes both the price of the water and the price to send it back to a waste treatment facility through the sewer. Because less water would be sent down the sewer line, the county eventually agreed to give credits for the reduced use of county facilities (Early 2017).

The arrangement offered to Emory by Sustainable Water made the agreement easy. Sustainable Water would own and operate the facility, paying completely for its construction and maintenance. Emory in turn would provide the land and purchase all water processed in the facility, at a lower cost than water from DeKalb County. This plan is projected to save millions of dollars for Emory over a 20-year period. According to Zern, once these groups saw the environmental benefits and the money that would be saved, approval was quickly given (2017). From there, the project catapulted forward, the contract with Sustainable Water was written, and the facility was designed and constructed. The building officially became operational in May 2015, one of the quickest turn-arounds for a building project that Zern saw in all his years at Emory.

To process water, the WaterHub uses natural water-treatment systems that are improved with human-made technology. Water goes through two parallel processes, a hydroponics treatment system and a reciprocating wetland system. These two technologies consume fewer chemicals and less energy than conventional wastewater treatment processes, "break[ing] down organic materials more efficiently and more completely" (Sustainable Water WaterHub). After processing, water is sent for end-use in the toilets at Raoul Hall (a freshman residence hall), and for heating and cooling buildings via the central Steam Plant, Michael Street Chiller Plant, Woodruff Memorial Building Chiller Plant and Quad Chiller plant.

Since 2015, the WaterHub has emerged as an impactful achievement for Emory, and visitors come from all over, offering an opportunity for students as well as the surrounding community to interact with water in a way that previously had been difficult to do. The impact has not just been within the community; numerous national and international visitors come as well. Starting in the spring of 2016, a WaterHub Docent program was created, giving students the opportunity to apply as tour guides for the facility. Taylor Spicer, in a 2016 interview for the Emory Report, states that "students in the program have the unique opportunity to learn about the WaterHub and its importance, develop techniques for and comfort with presenting to visitors of all ages and interests, and connect with often-prestigious campus and community leaders."

However, overall student interest in the facility has seemed to be low. From my personal observations as a WaterHub tour guide, when asked, many students do not know what the WaterHub is, and of those who are aware, few have visited. Matt Vinson, points out that he does see occasional student interest, with students coming to take pictures or show their parents (2017). The Office of Sustainability Initiatives is also hoping to expand the WaterHub docents program to include more efforts into campus and student body engagement with water, but time constraints and other commitments have slowed the growth of the program (Spicer 2017). The facility has been impactful for those within Campus Services, with many realizing how significant the facility is, more than other people on campus (Patterson 2017).

One successful aspect of campus engagement has been the research that is conducted at the facility, which occurs at least once per semester (Vinson 2017). In terms of overall community engagement, Vinson also sees the facility as very successful (2017). He pointed out that the surrounding community seems to love the WaterHub, and high numbers of people from the community have gone on tours, including Girl Scout troops and church groups. Since the facility has opened, community interest has been high and sustained. Because Emory has proved that the facility is possible, other universities have visited, many who are performing their own feasibility studies and are in various stages of the process (Early 2017). Early expresses his surprise that no other universities have built a similar system, even when Emory's initiative has proved it a profitable addition to a university.

The WaterHub also draws attention both regionally and nationally. Before the facility officially opened in 2015, Gina McCarthy, the head of the Environmental Protection Agency, visited (Emory Report 2015). It has garnered numerous awards, including the prestigious 2016 U.S. Water Prize given annually by the U.S. Water Alliance. Radhika Fox, CEO of the U.S. Water

Alliance, called the three institutions that won the award "true visionaries" in the quest for sustainable use of water (Emory Report 2016).

Recently, it was announced in the WaterHub's monthly publication the Hub Report that since the WaterHub's start in May 2015, over *100 million gallons* have been diverted from the sewer system (Hub Report 2016).

Changing Culture of Campus Water Sustainability

As the history put forward in this report shows, Emory could not have achieved its current position as a leader in water conservation and stormwater management without a campus culture that valued sustainability. However, this culture did not come about without extensive efforts. Almost all of those interviewed praised the influential leaders that fostered a culture that could seek sustainable choices.

One of the clearest ways that the immense changes in the culture of sustainability on campus can be seen is comparing the 2005 and 2015 campus sustainability visions. The creation and further significance of these visions can be found in Kristen Kaufman's report, "Institutionalization of Change: A History of Emory University's Office of Sustainability Initiatives" (2017). The original strategic plan's Sustainability Vision specifically covers the years 2005-2015, with lofty goals for many aspects of sustainability at Emory. However, the plan only briefly mentions water, focusing on water management, not water use. While this may seem today to be a lack of commitment to water, it was a step forward in incorporating water into the mindset of campus. The main water-related goals of the plan were:

- Mark natural features such as streams on Emory maps and nearby signs
- Restore streams and improve water management practices to achieve healthy watershed function on university campuses
- Develop a stormwater management plan by 2007 and set targets for implementation.

While important, these goals were small with few quantitative requirements. Within the years that it covers, the 2007 stormwater master plan was created and several stream improvement projects undertaken. However, as described, the effectiveness of these efforts has at times been limited. The willingness of Executive Vice President Mike Mandl, as well as other members of Emory's administration and those who would work to achieve the goals, made it possible for Emory to accomplish clear goals that other universities were slower to adopt.
As the years of the first Sustainable Vision were coming to a close, Emory started looking forward to goals for a new sustainable vision. In 2016, the Emory Sustainability Vision and Strategic Plan was released, set to last until 2025. Unlike the 2005 version, this plan addressed water as an important part of sustainability at Emory and set far reaching goals, goals that would not have been possible to think about at the time the first vision was created. The deep change in approaches to sustainability that Emory underwent in ten years are clearly displayed.
Water related goals put forward in the 2016 Sustainability Vision include:

- Eliminate drinking water use for heating, cooling, toilet-flushing, and other non-potable uses, with a goal to reduce Emory water use by 50%

- Revise and implement Stormwater Management Plan, including goals to reduce water runoff and enhance stream quality
- Improve water quality, groundwater recharge, and greenspace through new or enhanced green infrastructure projects such as rain gardens, stream buffers, and bioswales
- Incorporate major building renovations into LEED silver commitment or higher

Several other goals that focus on overall sustainability with an indirect relation to water were also included. While certainly achievable, these goals can only be completed through a continued and growing commitment to water sustainability by the university and its partners. However, the deep incorporation of a campus culture of sustainability makes this possible. Fabrick points out that now people are much more knowledgeable about water and other sustainability issues, which were not often considered when she started 20 years ago (2017). She describes her pride in what Emory has achieved, and the excitement her department found in the competitive mindset of beating other institutions to sustainable practices. She carried her desire to "create the Emory campus as a recognizable entity which a sense of place, beauty, and community centered around a sustainable focus" throughout her time at Emory. She, along with other campus leaders such as Early, Mandl, and many others, encourage sustainability where possible for their departments. Of course, there is still significant progress to be made for further incorporation of sustainable water thinking and practices. There are still those who are resistant to change or who prioritize other goals over water sustainability. It is helpful to have department heads on board, but it will take more time and energy before Emory can meet its new water goals.

It is important to note that as time progressed it was not only the culture of sustainability that improved possibilities for water infrastructure advancement, but also the increasing financial benefit. Mandl points out that, especially in his position, it is important to consider economic concerns (2017). With the constant improvements in sustainability technologies, it became easier for sustainability to meet the financial bottom line (Patterson 2017; Fabrick 2017). This reason has eased the incorporation of sustainable design into the thinking of Campus Services and the administration (Patterson 2017). Projects such as the WaterHub display this clearly, but even LEED, which initially could be seen as an extra cost to building design, is more economical in the long run than traditional technologies (Johnson 2017; Fabrick 2017). Despite this, through the topics discussed in this report, it is clear there are times that certain things could not be accomplished because of financial constraints. This is perhaps most evident in stream management and building design, where, though money was given, more is necessary to achieve university goals.

Conclusions

For a university such as Emory, sustainability is not straightforward. At every turn there are new voices, perspectives, and problems that must be addressed. Water conservation and stormwater management are no exceptions to this idea. However, all those interviewed agreed that from a sustainability perspective, water has become increasingly incorporated into campus goals and decisions. Even though initial stormwater management had many difficulties and the first round of sustainability goals did not provide strong guidelines for change, much work has been achieved. The change from little conversation surrounding water in the 2005 Sustainability

Vision to the specific numerical goals set out in the 2015 Vision showcases perfectly how water consciousness has grown. We now have the WaterHub, a pioneering facility, as well as significant water saving infrastructure and stream restoration projects. While there is still much that needs to be done, Emory can take pride in its achievements. The encouragement by university leaders of sustainable activities as well as the incorporation of a culture of sustainable advancement made Emory's remarkable achievements possible. As Bobbi Patterson added, "sustainability is now systematically present; there's no going back" (2017).

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