



STORMWATER MASTER PLAN

Basin A
Georgia Institute of Technology
June 2013



JACOBS

LONG
ENGINEERING, INC

EXECUTIVE SUMMARY

The Georgia Institute of Technology is committed to developing its campus with “an integrated, ecologically based landscape and open space system that helps them achieve their goal of environmental sustainability.” This goal is reflected in the 2004 Campus Master Plan Update and expanded upon in the Landscape Master Plan (Revised September 2011). Stormwater is recognized as having a significant role in improving the ecological process occurring in the campus’ urban environment, and this Stormwater Master Plan for Basin A is meant to be a practical guide for the campus to further advance Georgia Tech towards environmental sustainability.

- The Stormwater Master Plan for Basin A (Figure ES-1) encompasses approximately 180 acres of the northern portion of the Georgia Tech campus; this represents 45 percent of the campus.
- Key Goals for the Stormwater Master Plan include: water capture and reuse, volume reduction, mimicking the natural process, a campus “regional” approach, and exceeding regulatory requirements.
- The development of the Stormwater Master Plan – Basin A utilizes a GIS based computer modeling software that simulates the runoff characteristics of the basin and hydraulic components (land use cover, pipes, streams, cisterns, detention ponds/vaults, infiltration basins etc.).

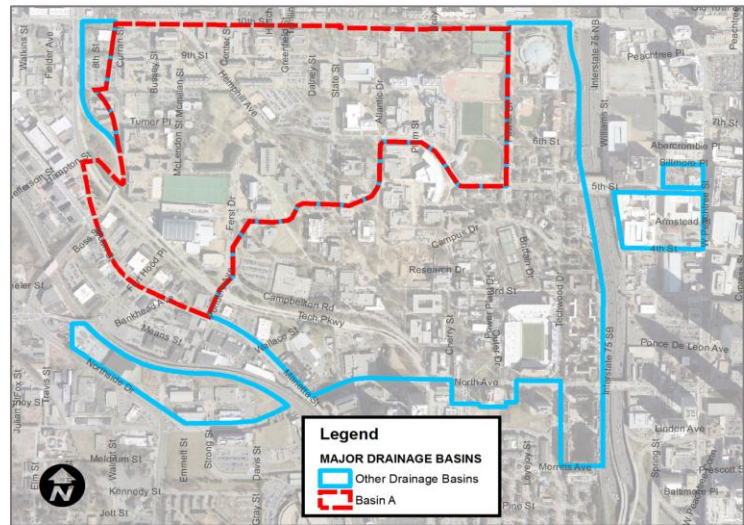


Figure ES-1: Basin A Overview

- The Stormwater Master Plan analyzed Basin A to determine the runoff volume and peak rates during the 1950’s (residential, 44 percent impervious), under current 2012 conditions (institutional, 53 percent impervious), and a future condition (institutional, 50 percent impervious) based on the 2004 Campus Master Plan and relevant sector plans for comparison between scenarios and with undeveloped conditions.
- In the future, if Georgia Tech were to decide only to meet the minimum City of Atlanta Stormwater regulations, it is estimated that 2.4 million gallons of storage would be necessary to provide for 1” of runoff for water reuse, channel protection and peak rate reduction volumes. The cost of this approach over a 25-year period would be approximately \$28.3 million. This includes the cost of using potable water for irrigation and flushing toilets, and the construction and maintenance of stormwater storage facilities.

- The Stormwater Master Plan – Basin A proposes to generally capture and reuse, infiltrate or evaporate the first 1.2” of rainfall using the following approach to water management:
 - Harvest rainwater from rooftops, building condensate and foundation dewatering, store in a “clean” water cistern and reuse for toilet flushing in future buildings. Excess water typically overflows to an irrigation/stormwater cistern (Figure ES-2).
 - The irrigation/stormwater cistern receives surface stormwater and overflows from the clean water cistern and supplies water for irrigation and Eco-Commons surface water features.

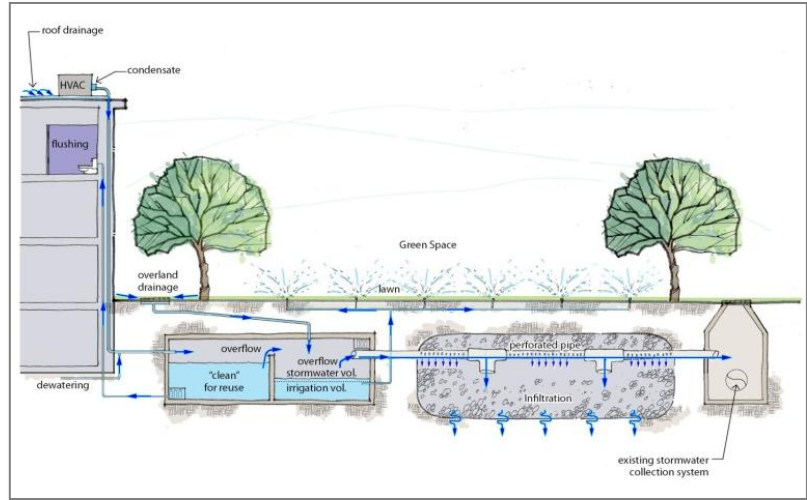


Figure ES-2: Stormwater Master Plan General Approach

- Excess water typically overflows to an infiltration system.
 - The infiltration systems, while incorporated in this plan into the Eco-Commons area, are strongly encouraged as a stormwater management tool throughout Basin A. Stormwater flows are infiltrated into the soils further reducing the volume that enters the City’s combined sewer system.
 - The cisterns are generally regionally located and interconnected. The terminal feature of the stormwater system is proposed as the Glade Pond in the Engineered Biosystems Building complex.
- The cost of constructing and maintaining the improvements proposed in the Stormwater Master Plan – Basin A is \$26.3 million, a slight savings over what would be required to meet the minimum City of Atlanta stormwater regulations. The cost savings is due primarily from the reduction in potable water used for irrigation and toilet flushing in new buildings.
- The ultimate value in implementing the stormwater master plan, however, is realized in a number of additional benefits associated with it, namely:
 - Capture, reuse, infiltrate or evaporate nearly the entire 1.2” event and preventing that stormwater from entering the City’s combined sewer system. The volume reduction is over four times what would be realized if the City’s minimum stormwater regulations were followed.
 - This 60 MG reduction in runoff volume will save the City approximately \$120,000 in annual treatment cost savings.
 - The peak runoff rate for the 25-year storm event from Basin A is reduced by 17 percent, over twice the reduction as meeting the minimum City regulations for the 42 acres of future redevelopment in the basin.

- The clean water cisterns will supply water for toilet flushing in all future buildings in the basin, reducing potable water usage by 10.9 MG, saving about \$90,000 annually.
- Using harvested rainwater to satisfy the 16 MG of anticipated annual irrigation demand saves approximately \$130,000 each year.
- Water supply for surface water features within the Eco-Commons can be supported by the implementation of the Master Plan. The proposed Glade Pond can be managed to maintain consistent water levels. The Master Plan system can also supply other small surface water conveyances by more slowly releasing stormwater flows after rainfall events. In an average year, 32 gallons per minute could be released over a 7-day period, providing visible flow in the water features for approximately 60 percent of the year. This percentage could be increased by enlarging the irrigation/stormwater cisterns.
- Operationally, the cisterns should be interconnected and have a robust control system to continually balance flows and monitor system performance. Dedicated personnel should be provided to operate and maintain the system.
- A funding vehicle should be established to ensure that the Stormwater Master Plan – Basin A is fully and timely implemented.
- There are also important research and educational opportunities, which should be integrated into the Stormwater Management system as it is implemented.
- Ideally, at some point in the future, Georgia Tech would complete a comprehensive Stormwater Master Plan for the entire campus thus allowing a truly campus-wide approach to stormwater management and potentially leveraging greater benefits both for the Institution and for the larger community.

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APPENDIX C – Stormwater Project Log Template

ABBREVIATIONS

SWMP – Stormwater Master Plan

MG – million gallons

MGD – million gallons per day

cfs – cubic feet per second

SWMM – stormwater management model

NRCS – Natural Resources Conservation Service

USGS – U.S. Geological Survey

GaSWMM – Georgia Stormwater Management Manual

TIA – total impervious area

ES&T – Environmental Science and Technology

CPSM – Capital Planning & Space Management

PDC – Planning & Development Committee

GSF – gross square feet

About this Document: This Stormwater Master Plan for Basin A is meant to be a guide for stormwater infrastructure planning and its interaction with the future redevelopment projects within drainage Basin A of Georgia Tech's Campus. The redevelopment projects are based on 2012 sector plans within Basin A and the 2004 Campus Master Plan Update, where specific sector plans have not been developed. This document is meant to be an evolving planning tool that can be updated when changes occur to the redevelopment plans, and it is not meant to be a construction document for future stormwater infrastructure in Basin A. Detailed design is required before completing any of the outlined stormwater projects, but this guidance document will provide a foundation for the schematic layout and goals of the general Basin A stormwater projects.

1. OVERVIEW

The Georgia Institute of Technology (Georgia Tech), as a technological leader and steward to future generations, has striven to develop the Institute into a sustainable community with growing intensity over the past decade. Sustainability is encouraged in the day-to-day operations of the campus, it has been introduced into classroom curriculums, and a department dedicated to sustainability was created in 1992. Additionally, this core goal is reflected in the 2004 Campus Master Plan Update and is intently expanded upon in the subsequent Landscape Master Plan (Revised September 2011). These documents provide a solid foundation for Georgia Tech to incorporate ecological considerations into the intelligent development of the future campus. Stormwater is recognized as having a large role in improving the ecological processes occurring in this urban environment, and this Stormwater Master Plan is meant to be a practical guide for the campus to further advance Georgia Tech towards responsible environmental stewardship.

The challenge facing Georgia Tech is similar to the challenge local municipalities face when trying to improve stormwater management in a continuously evolving environment which includes a collection of independent stakeholders often with differing agendas. For example, a team involved in developing a local project in a town, or on a campus, has a scope that is limited to the boundaries of the specific project site; however, when considering stormwater management, efficiencies can usually be found by expanding the stormwater goals to encompass an entire drainage basin and not limiting the stormwater management strategy to each new building project's location. Regional facilities can be much more effective at improving stormwater conditions experienced in the receiving waters compared to the traditional piecemeal approach. The advantage Georgia Tech has over a municipality is that the project sites may represent different colleges or campus facilities, but they share the common thread of the Institute and can combine resources to overcome the challenge of differing project schedules and designs with the right management tools in place. One key goal of this Stormwater Master Plan is to formulate a holistic approach to stormwater management that defines the roles and stormwater interactions



Figure 1-1: Clough Commons (with Roof Garden)

of anticipated projects along with outlining regional stormwater management facilities that will benefit the overarching goal of ecological sustainability.

Figure 1-1 shows the Clough Commons, which illustrates a major addition to stormwater management on Georgia Tech's campus. The project includes a roof-top garden and cistern water used for toilet flushing and irrigation.

“Plan an integrated functional open space system that reduces stormwater discharge to the city system.” – Campus Master Plan Update (2004)

“Develop an integrated ecologically based landscape and open space system that helps Georgia Tech achieve its goal of environmental sustainability.” – Landscape Master Plan (2005)

1.1 DRAINAGE BASIN A

This document represents the initial phase of a new, comprehensive and holistic approach the Institute is taking towards stormwater management by providing a master plan for one of the major campus drainage basins, Basin A.

Basin A Extents

Basin A represents approximately 180 acres or 45 percent of Georgia Tech's campus (total campus area is approximately 400 acres). Basin A is one of two major drainage basins (along with four minor drainage fragments) on Georgia Tech's campus. It comprises the north part of the Atlanta Campus between 10th Street (to the north) and the Ferst Drive vicinity (to the south). The Northside Drive area and Fowler Street are the respective west and east boundaries. Figure 1-2 illustrates the drainage basins within Georgia Tech's campus. Basin A's stormwater drainage is directed towards the Orme Street Combined Sewer Trunk, which is immediately west of Fowler Street. In addition to developing basin-specific stormwater management guidance, it is the intent of this effort to collaborate with Georgia Tech staff to develop stormwater management policies that can be extended to the entire campus for future development.

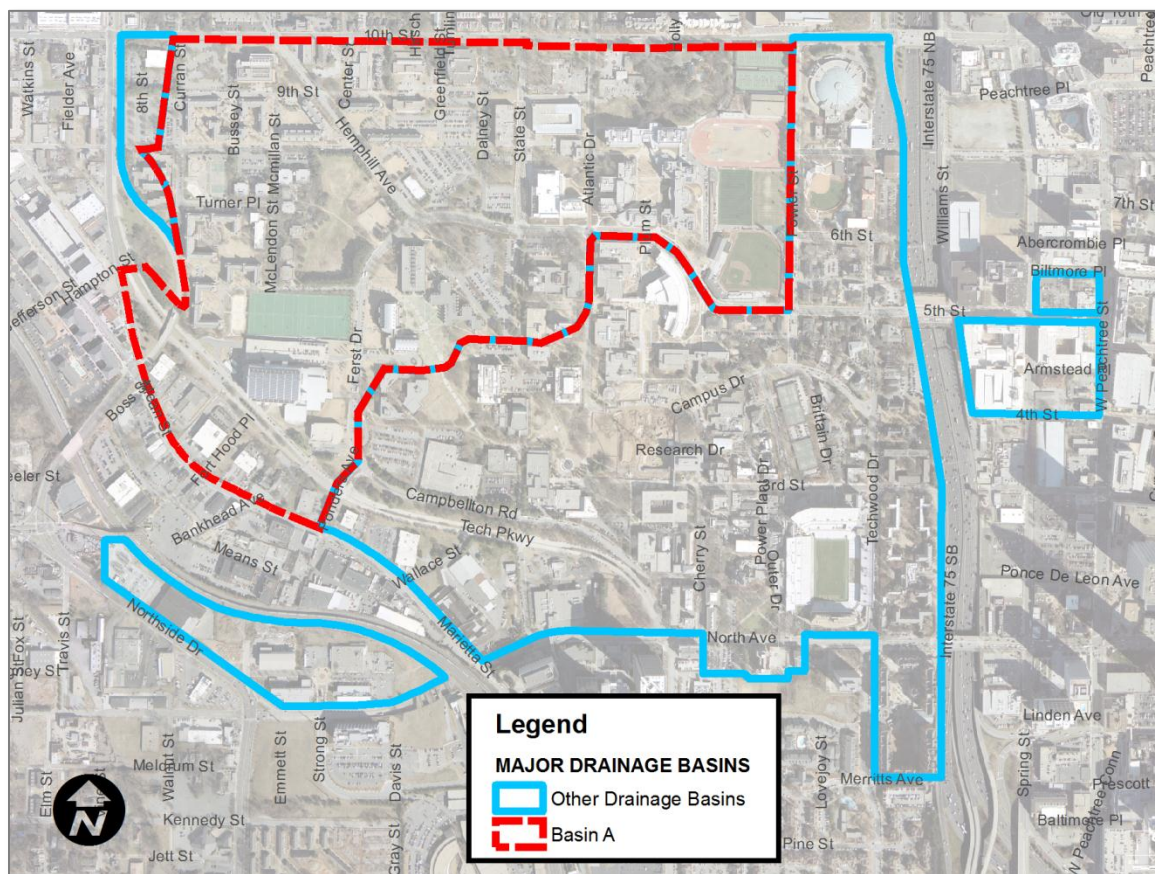


Figure 1-2: Georgia Tech Campus Drainage Boundaries

Basin A Collection System

Basin A's stormwater collection system is technically a combined sewer system (collecting both stormwater and sanitary flows), although most of the buildings within Basin A now contribute sanitary sewer flows to a parallel dedicated sanitary sewer line while stormwater flows into the combined sewer system. Both sanitary and stormwater flow from Basin A to the City of Atlanta's 1930's-era Orme Street Combined Sewer Trunk. This flows north to the Tanyard Creek Combined Sewer Overflow (CSO) Facility. Normal base flows pass through this Facility and flow to the west to the RM Clayton Water Reclamation Center (WRC) for treatment and discharge into the Chattahoochee River. During large rain events the trunk sewer leading to the RM Clayton WRC reaches capacity and flows are diverted to the West CSO Tunnel. This tunnel acts as a secondary transmission system to the RM Clayton WRC, as well as holding tank for excess flows. The combined storm and wastewater are pumped from the tunnel after the rain event for treatment at the RM Clayton WRC. During larger rain events, the tunnel reaches capacity and flows are then diverted from the Tanyard Creek CSO Facility into Tanyard Creek. Figure 1-3 schematically illustrates this drainage configuration for Basin A and the City's combined sewer system.

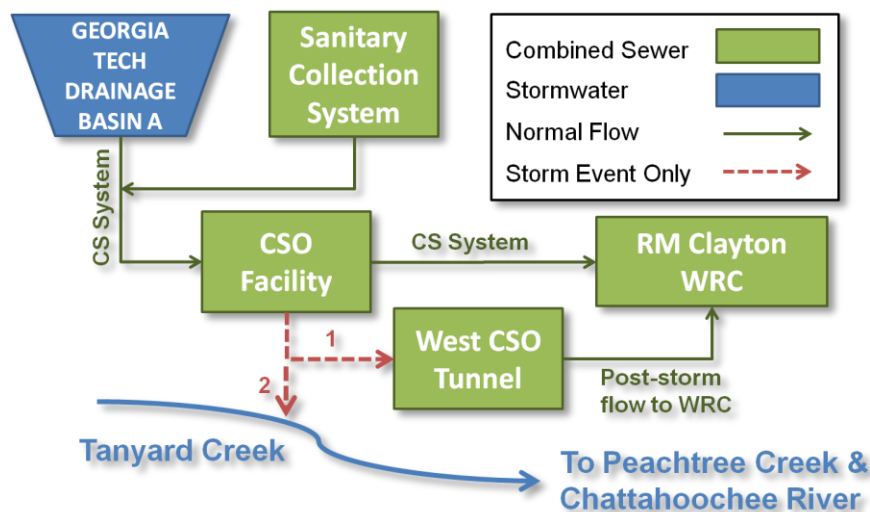


Figure 1-3: Basin A and Combined Sewer System Diagram

1.2 STORMWATER MANAGEMENT GOALS

One of the first challenges in developing this Stormwater Master Plan for Basin A was to compose a list of measurable goals that balance ecological sustainability with economic constraints. Specifically, the following goals were developed by expanding on concepts that were introduced in the Campus Master Plan Update and the Landscape Master Plan. These goals were refined through numerous workshops involving Georgia Tech stakeholders (Capital Planning & Space Management, Georgia Tech Facilities, and the Planning & Development Committee):

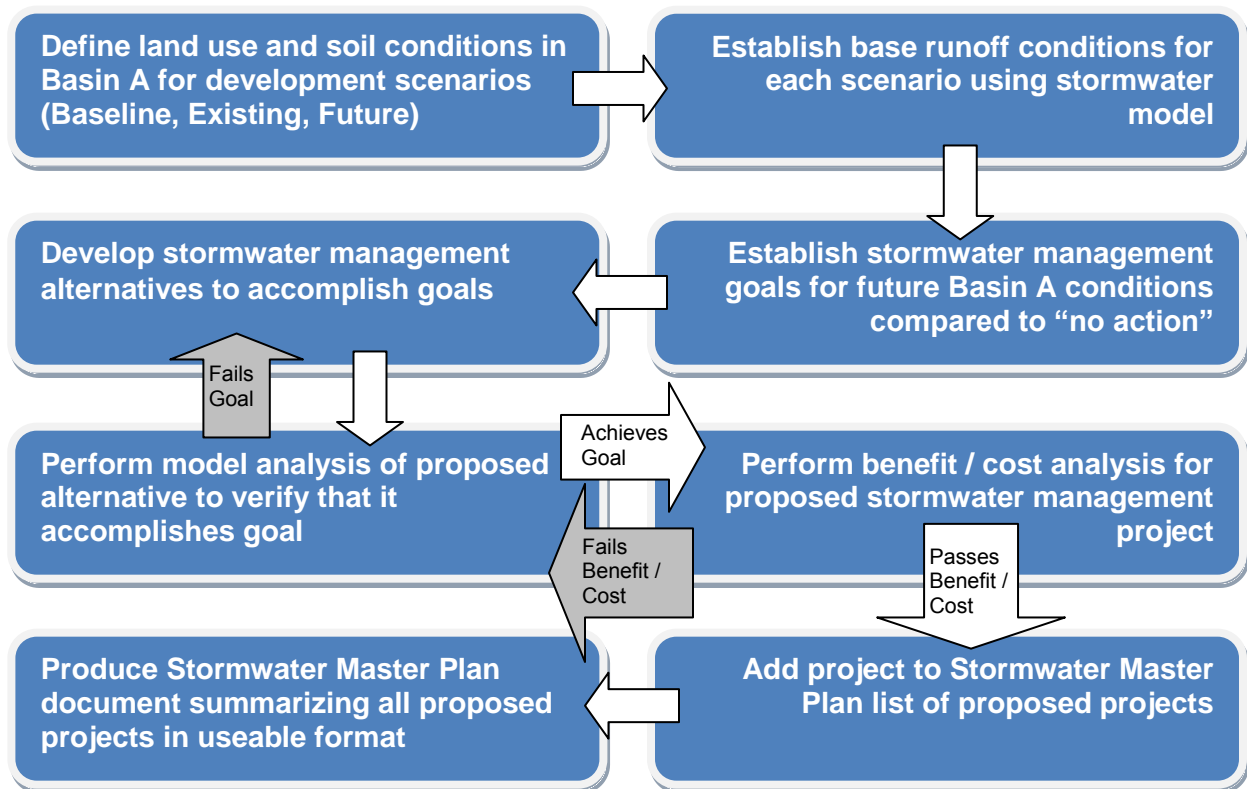
- Volume Reduction: Reduce the volume of stormwater runoff released from Basin A to the City's combined sewer system, which would result in reduced combined sewer overflow frequency and volumes to Tanyard Creek and eventually the Chattahoochee River during large storm events.

Reduce the volume of stormwater runoff released from Basin A to the City's combined sewer system, which would assist in reducing the combined sewer overflow frequency and volumes to Tanyard Creek and eventually the Chattahoochee

- Water Capture and Reuse: Reduce the potable water demand within Basin A through the capture and reuse of stormwater and condensate for non-potable uses such as irrigation and toilet flushing in new buildings.
- Return to Natural Processes: Mimic natural stormwater processes through infiltration, evaporation, and irrigation to return rainfall to its ecological purpose rather than create runoff over an urbanized environment. This complements the volume reduction and reuse goals as well as increases campus environmental sustainability.
- Regulatory Compliance: Comply with the recently adopted (February 2013) City of Atlanta stormwater ordinance.
- Basin-Wide Approach to Stormwater Management: Shift the trend from small on-site stormwater management facilities to regional (campus) stormwater management features. This approach is more economical, is more efficient at managing stormwater runoff on the campus and has a more beneficial impact to the receiving waters downstream.

1.3 APPROACH

The stormwater management goals, minimum ordinance requirements, and benefit/cost analysis guided the development of the stormwater management plan; additionally, a computer-based stormwater model was developed to estimate runoff conditions for the various land use scenarios (i.e. Baseline, Existing, Future) in Basin A and to test the effectiveness of proposed stormwater management alternatives for future conditions. The general approach for developing the Stormwater Master Plan for Basin A is illustrated by the following flow chart:



2. BASIN A DEVELOPMENT CHARACTERISTICS

Land use and soil type are major factors affecting an area's runoff characteristics (hydrology). The soil for most of Georgia Tech and 100 percent of Basin A is classified as urban land (Ub) by the Natural Resources Conservation Service (NRCS). The urban land designation signifies that it is not a natural soil, but a mixture of various soils or imported fill from previous urban development. Unlike natural soils, the NRCS does not have a hydrologic soil group designation for urban soils, to define its capacity to infiltrate, due to its non-uniform characteristics. For the purposes of this analysis, a compacted, poor-draining soil (hydrologic soil group C) was conservatively assumed for the Baseline and Existing scenarios. In the Future scenario, an improved soil (hydrologic group B) was assumed for areas where previously impervious areas were converted to open space or forested areas with the assumption that new, properly-draining landscaping would be installed along with soil enhancement outlined in the Landscape Master Plan.

Land use summaries for Basin A as it evolved through each time period (Baseline, Existing, and Future) are provided in the following subsections.

2.1 BASELINE (1950)

According to the 2004 Campus Master Plan Update it was recommended that the campus be returned to stormwater levels typical of the campus in 1950; this was expected to yield an approximate 50-percent reduction in stormwater runoff. This is a snapshot in time when Atlanta began to experience significant post World War II growth but prior to the major expansion of Georgia Tech's campus. The landscape of Atlanta was changing as increased wealth resulted in an increase in automobile ownership, which required more roads and parking lots. The increase in mobility allowed an expansion of the suburbs where people built new homes, businesses and recreation areas. This affected the hydrology of Atlanta, increasing impervious surfaces and decreasing stormwater runoff travel times resulting in increased peak rates of runoff and flooding.

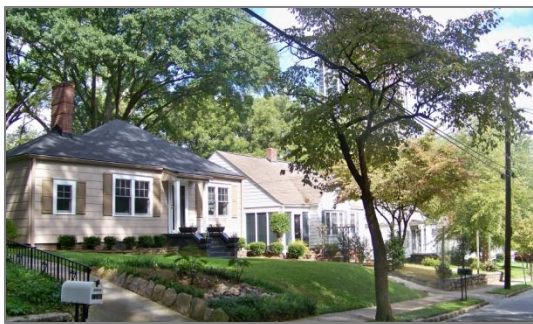


Figure 2-1: Representative 1950-Era Residential Area (Home Park)

The Georgia Tech Stormwater Master Plan used City of Atlanta Stormwater Inventory Maps that have topography information from the 1960's to delineate 11 sub-basin areas within the 177-acre Basin A (Table 2-1). Two 1950's aerial photographs obtained from Georgia Tech, Capital Planning & Space Management were used to analyze land use within each sub-basin area. The majority of the basin was developed as small lot, high density single family residential homes similar to the Home Park neighborhood (Figure 2-1), located to the north of the Georgia Tech campus. Within these areas, the number of units per acre

was determined and a curve number assigned in accordance with Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds*. Business, commercial, open space and woods were also identified, areas of each determined, and a curve number assigned based on TR-55. A composite curve number was developed for each sub-basin area, with a weighted average curve number of 85 for the 1950 Basin A.

Table 2-1: Baseline (1950) Land Use Summary

1950 - Basin A Total Area - 177 Acres		
Total Impervious Area (Acres)	Total Open (pervious) Area (Acres)	
Buildings, Streets, Sidewalks	Woods/Forest	Open Area
79	8	90

The percentage of drainage area that is impervious to infiltration of rainfall, or Total Impervious Area (TIA), was calculated for each sub-basin. The lagtime was then calculated using *Lagtime Relations for Urban Streams in Georgia*, prepared by U.S. Geological Survey (USGS). Lagtime (L) was converted to Time of Concentration, Tc, using the equation $T_c = L / 0.6$.

The aerial photographs also verified that the basin was substantially developed with roadways and buildings that would require a functional storm drainage system. Storm drainage layout and pipe sizes were based on as-built drawings from the 1960's, the City of Atlanta Storm Drainage Inventory Maps and more recent as-built surveys where it could be verified that the pipe likely existed in the 1950's. The main trunk that serves Basin A is a 72" pipe that begins near Dalney Street and flows east where it connects to the Orme Street Combined Sewer Trunk just west of Fowler Street. Upstream of Dalney the pipe diameter is 60" and progressively reduces in size, ending as a 24" diameter pipe near what is now Tech Parkway. There were no known water impoundment areas within Basin A during this time period.

2.2 EXISTING (2012)

Basin A has slightly increased in area to 181 acres (Table 2-2) under existing conditions, and it was further sub-divided into 24 sub-basins to define the runoff to each significant conveyance or storage node in the computer-based model. Basin A mapping utilized Google Earth imagery dated November 1, 2011. Sub-basin areas were delineated using contours contained in the UMAP mapping file provided by Georgia Tech Facilities. Within each sub-basin the limits of impervious surfaces such as rooftops, roadways and sidewalks were defined along with forest and open areas. The land use within Basin A was much more institutional (Figure 2-2) rather than residential, which would be expected from the significant campus expansion that has occurred since 1950. TR-55, Urban Hydrology for Small Watersheds, and NRCS soil surveys were used as a guideline to develop storm water runoff curve numbers for each surface characteristic within each sub-basin area. A composite curve number was calculated and used for each sub-basin. Overall, Basin A has a curve number of 87 based on 2012 land use. This is only a very slight increase over the 1950's value of 85.

Table 2-2: Existing (2012) Land Use Summary

2012 - Basin A Total Area - 181 Acres		
Total Impervious Area (Acres)	Total Open (pervious) Area (Acres)	
Buildings, Streets, Sidewalks	Woods/Forest	Open Area
91	14	76



Figure 2-2: Existing Campus Facilities (Love Manufacturing Building)

Similar to the Baseline (1950) scenario, the TIA's and Tc's for each sub-basin were calculated.

Significant drainage infrastructure constructed between the 1950's (Baseline Condition) and 2012 was based on a combination of design drawings and as-built surveys available from firms involved in the design of these facilities as well as information from Georgia Tech Facilities. The infrastructure added included new storm drainage pipes, stormwater detention facilities and cisterns. The most significant of these is the cistern and detention facilities associated with the Nanotechnology Building, Environmental Science and Technology (ES&T) Building and the Football Practice Facility. Additionally, some pipe connectivity was completed using preliminary mapping from the City of Atlanta Sanitary Sewer Evaluation and Survey and their Stormwater Inventory Maps. The imagery and infrastructure was compiled into a single drawing representing 2012 conditions.

2.3 FUTURE (MASTER PLAN)

The Stormwater Master Plan for Basin A utilizes the 2004 Campus Master Plan Update supplemented with the Engineered Biosystems Building Sector and South Central Sector Plan, which are being developed concurrently with the Stormwater Master Plan. Figure 2-3 illustrates these planning document drawings used to estimate the future land use in Basin A.

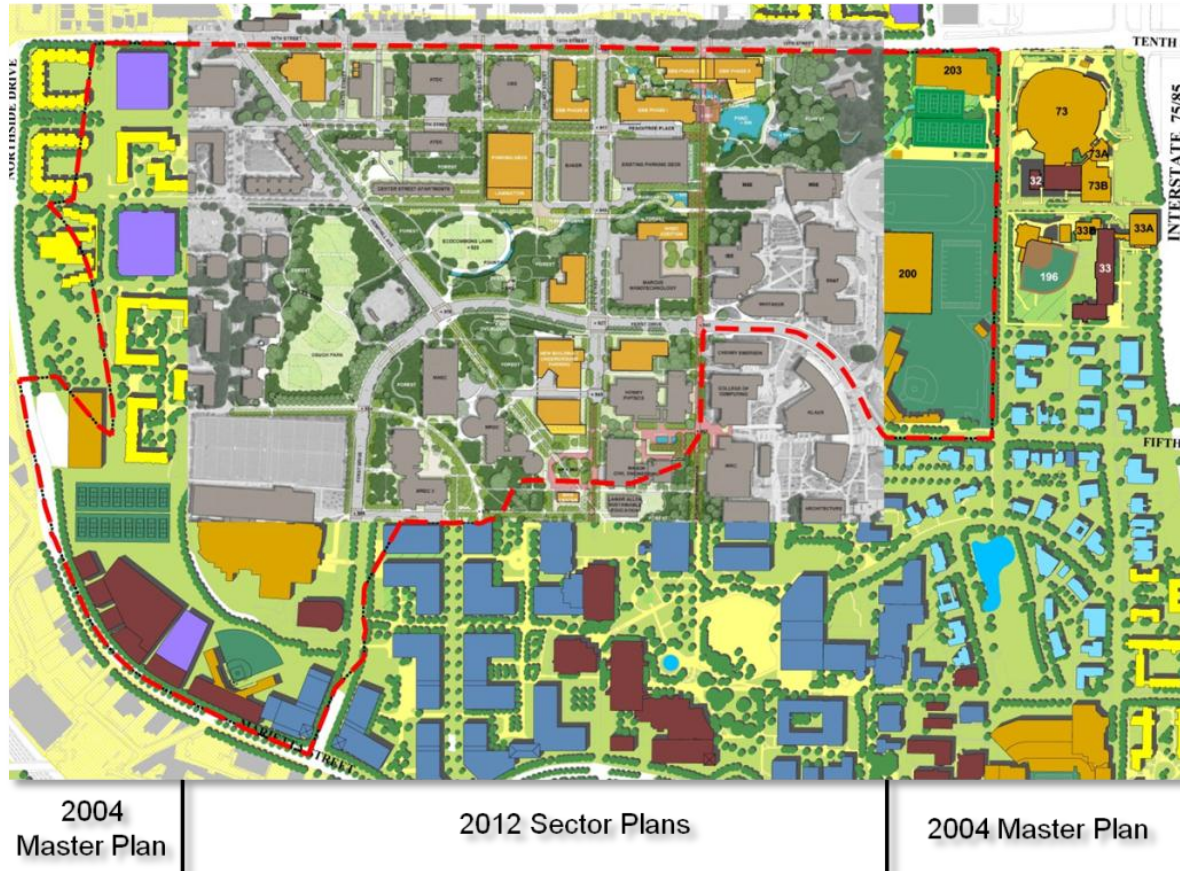


Figure 2-3: Future Land Use Overview

Sub-basin land use areas were reevaluated using the new development proposed in the 2004 Campus Master Plan Update and Sector Plans. Additional sub-basins were defined where future stormwater management facilities are planned. Impervious rooftops, roadways and sidewalks were identified along with open space and forest (Table 2-3). Reforestation areas were obtained from both the 2004 Campus Master Plan Update and the Sector Plans. Curve numbers within areas proposed for reforestation were modified to reflect this change in land use. TR-55 and NRCS soil surveys were used as guidelines to determine composite curve numbers for each sub-basin area within Basin A. The Future conditions curve number for Basin A is 84, a reduction over the curve number of 87 determined for the Existing (2012) conditions.

Table 2-3: Future Land Use Summary

Master Plan - Basin A Total Area - 181 Acres		
Total Impervious Area (Acres)	Total Open (pervious) Area (Acres)	
Buildings, Streets, Sidewalks	Woods/Forest	Open Area
82	24	75

Similar to the previous scenarios, the TIA's and Tc's for each sub-basin were calculated.

Future infrastructure improvements included condensate and rooftop rainwater collection and distribution systems, clean water cisterns for flushing toilets, irrigation/stormwater cisterns used to meet irrigation demand and stormwater management goals, infiltration areas, and the Eco-Commons Glade Pond located east of Atlantic Drive.

3. STORMWATER MODEL

A computer-based stormwater model makes it possible to estimate stormwater runoff characteristics from various rainfall events considering the land use and soil type of an area as outlined in Section 2. The large coverage of “hard” surfaces and less “spongy” soils throughout much of Georgia Tech’s Basin A translates into more stormwater runoff from rainfall events, compared to a naturally forested area that absorbs and holds a large percentage of the annual rainfall.

Additionally, the model will use these stormwater flows along with the configuration of the collection system to estimate how the system is performing and how much stormwater Basin A is contributing to the City’s combined sewer system. An advantage of having a dynamic stormwater model is that alternative stormwater projects can be compared for general effectiveness, and it allows for documentation of proposed projects and land use changes for regulatory compliance using established hydrologic and hydraulic calculations. The predicted runoff effects from land use changes could even consider the projected growth in wooded areas and canopy cover to complement the recent tree inventory effort that occurred on campus.

3.1 MODEL DEVELOPMENT

The computer-based model was developed in the Geographic Information System (GIS)-based InfoSWMM (v12 Innowyze) modeling software so that land uses and project locations on campus were spatially referenced within the modeling environment. Pipes, nodes, and stormwater storage components were input into the model as point and line features with the attributes (i.e. inverts, sizes, and geometry) populated using survey data and record drawings that were obtained from previous projects and field surveys conducted within Basin A. A small portion of pipe size, pipe invert, or outlet structure details for a storage facility were not available, and values of neighboring pipes or similar structures on campus were used to fill in the data gaps.

Specifically, the model development process consisted of the following general components:

- Existing Stormwater Drainage Network
- Existing Stormwater Storage and Peak Flow Reduction Facilities
- Sub-basin Drainage Delineation
- Scenario Definition
- Proposed Stormwater Projects (**Section 4**)

3.1.1 Existing (2012) Stormwater Drainage Network

An initial step in developing a collection system model is to establish the network of primary flow routes, or trunk sewers, of the system. For Basin A, the downstream terminus into the City's combined sewer system at the Orme Street Combined Sewer Trunk is a former 72-inch arch pipe that was recently lined to form a 69-inch circular pipe that extends west from the Orme Street Combined Sewer Trunk through the low-lying area between 10th Street and Ferst Drive. The trunk sewer decreases in size as it extends upstream through the system from 69 inches in diameter to 60 inches, 42 inches, and finally 36 inches. The general direction of the trunk system turns southwest near Hemphill Avenue as you move upstream through Couch Park, under Stamps Field, and terminates at Tech Parkway's drop inlets. The collection system that feeds this trunk includes hundreds of storm system (and some sanitary) pipes connecting to surface inlets and roof drains. However, for the level of detail required in this master planning effort, only pipes 24 inches or larger were included in the stormwater model. The existing drainage system that was included in the stormwater model is illustrated in Figure 3-1, with the pipe diameters indicated.

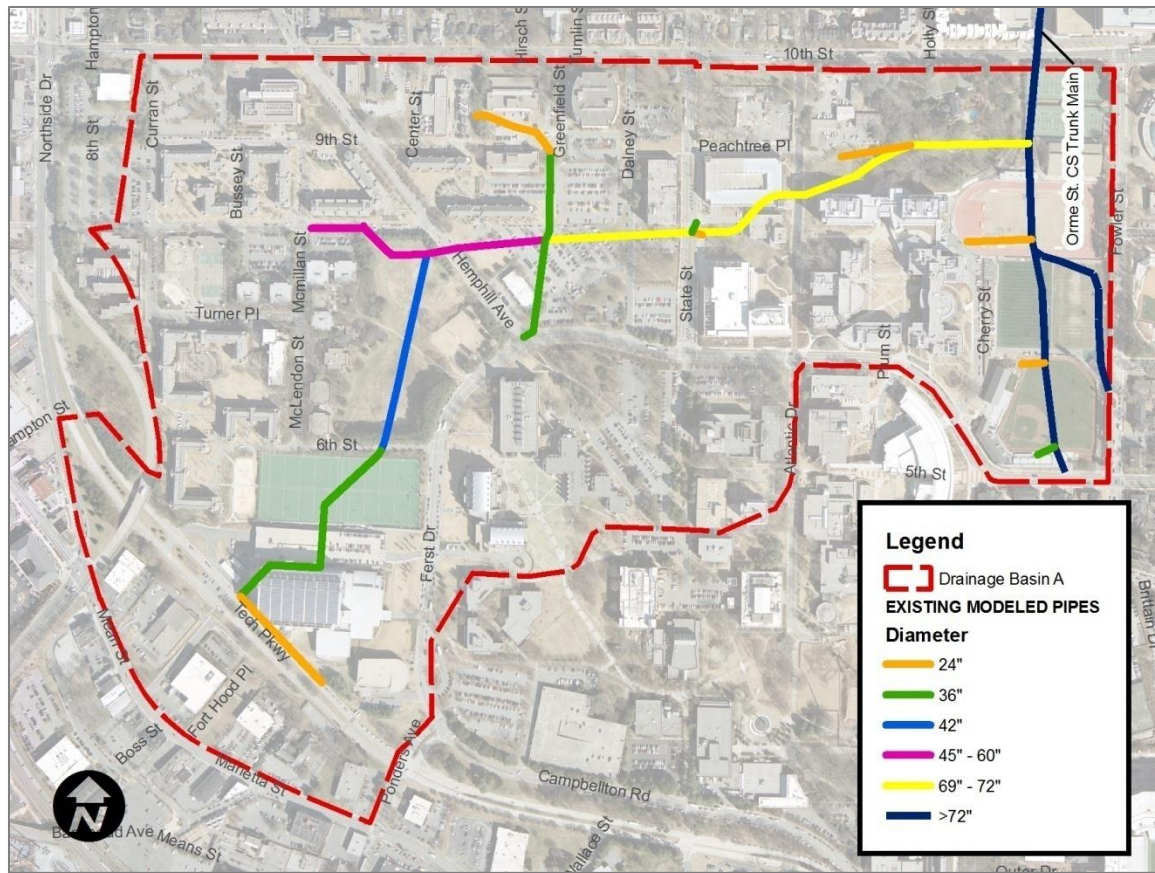


Figure 3-1: Existing (2012) Stormwater Drainage Network

3.1.2 Existing (2012) Stormwater Cistern and Detention Facilities

Significant existing stormwater storage facilities within Basin A were included in the stormwater model. These include large (over 10,000 gallons) cisterns, detention facilities, or most commonly large linear storage facilities that collect site drainage to reduce the peak runoff rates to pre-project conditions or the regulatory requirement at the time of construction. There is a large cistern located at the ES&T Building that was not included in the existing stormwater model due to Georgia Tech reporting that it was constantly full and overflowing to the Football Practice Cistern, effectively not adding any rainfall storage to the system. Table 3-1 summarizes the existing stormwater storage facilities that were included in the model, and Figure 3-2 illustrates the location and relative capacity of these facilities.

Table 3-1: Existing (2012) Stormwater Storage (included in model)

Label (Fig. 3-2)	Description	Capacity- Cisterns (gallons)	Capacity- Detention (gallons)
1	Chandler Field Detention		76,300
2	Football Practice Detention		95,200
3	Football Practice Cistern	285,800	
4	MSE Cisterns	23,300	
5	MSE Detention (Water Quality Pond)		29,900
6	IBB & ES&T Detention		8,900
7	Marcus Nanotechnology Building Detention		93,500
8	North Campus Parking Deck Detention		8,800
9	GTRI South Parking Detention		16,600
10	Centennial Research Parking Detention		31,500
11	GTRI South Detention		10,300
12	GTRI North Detention		14,700
13	AJAX Infiltration Field		71,700
14	Crecine (a.k.a. Hemphill) Apartments Detention		71,700
15	CRC Parking Deck Detention		48,900
TOTAL CISTERN CAPACITY (GALLONS)		309,100	
TOTAL DETENTION CAPACITY (GALLONS)			578,000
TOTAL COMBINED STORAGE CAPACITY (GALLONS)		887,100	

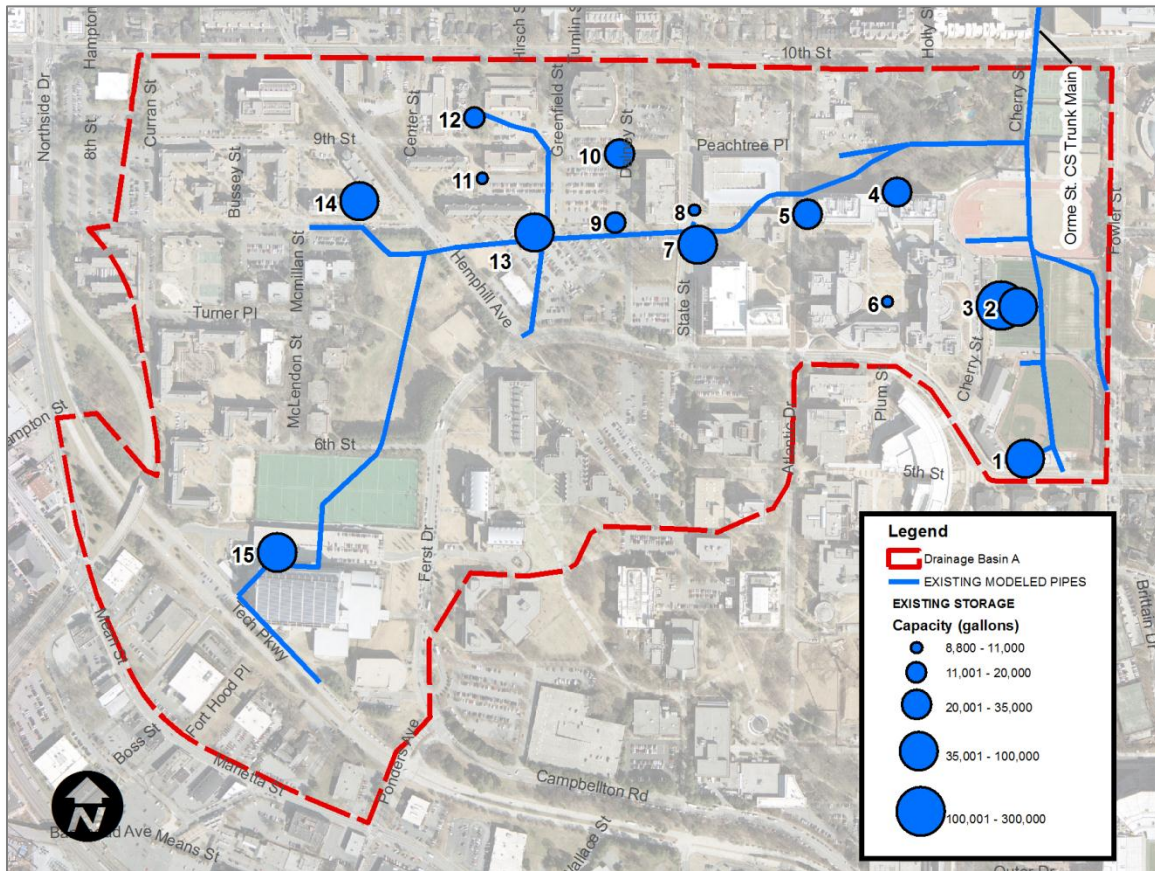


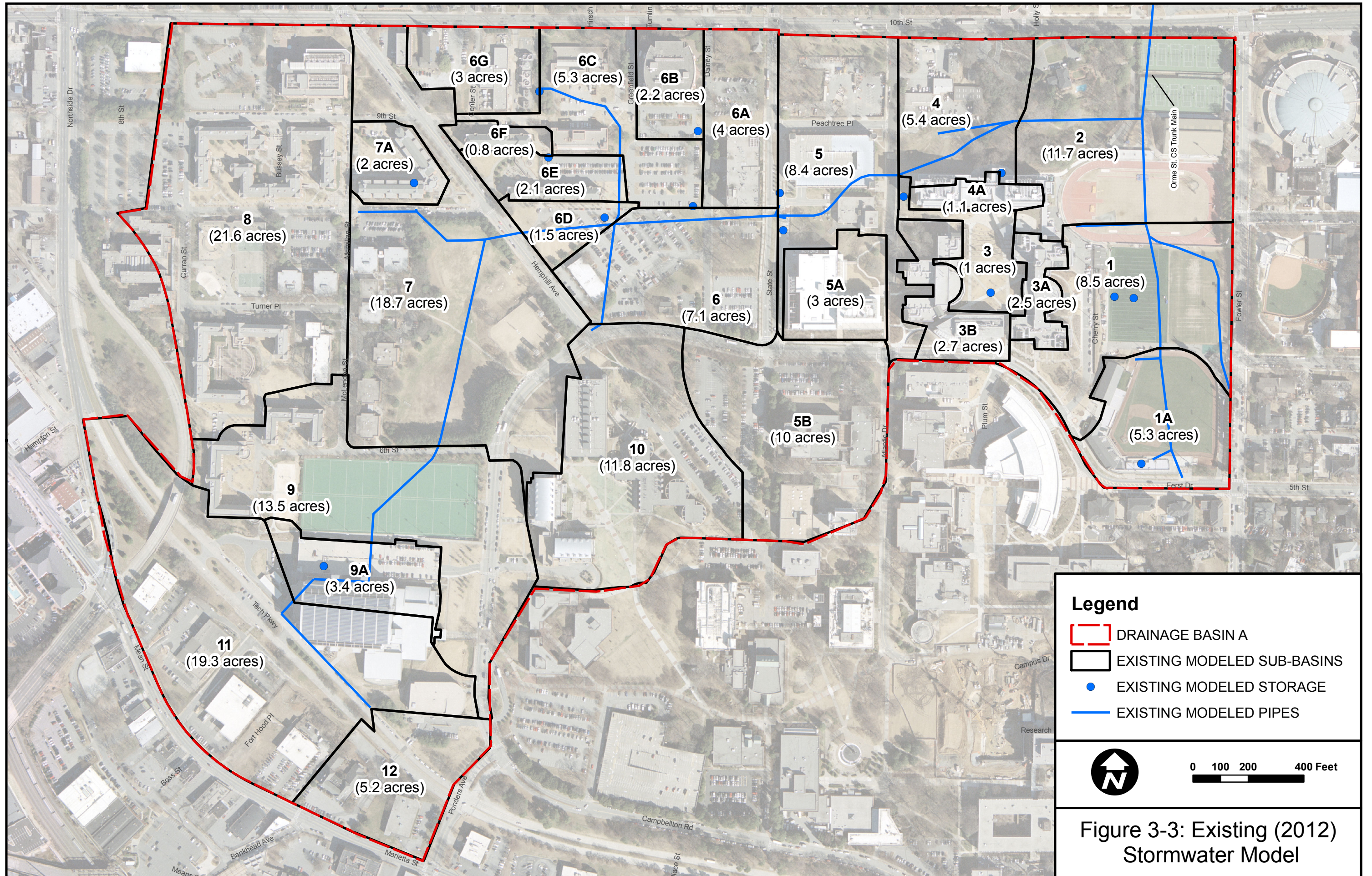
Figure 3-2: Existing (2012) Stormwater Storage (included in model)

3.1.3 Existing (2012) Sub-basin Drainage Delineation

Once the physical components of the Basin A stormwater system were defined, the model required hydrologic parameters, which translate rainfall into runoff, for estimating stormwater flows into the system. This was accomplished by delineating drainage areas within Basin A that contribute to their respective location within the drainage network; these delineated drainage areas are referred to as sub-basins for the purposes of this study. The storage facilities typically would have their site drainage area designated by the record drawings (if available), and the remaining sub-basins were delineated using elevation data and known drainage system layouts. Once the sub-basin boundaries were defined, attributes such as area, slope, time of concentration, hydrologic curve number (generated from composite land use and soil characteristics), and receiving node within the stormwater system were calculated and defined for each sub-basin. These values are what the calculation engine of the modeling software used to estimate infiltration losses, runoff volumes, and peak runoff flows for each sub-basin given any applied rainfall event.

Figure 3-3 provides an overview of the model layout, depicting the drainage network, the storage facilities, and the sub-basin delineations for the existing conditions stormwater network within Basin A on Georgia Tech's campus.

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3.1.4 Scenario Definition

The configuration of the drainage network was the first stage of the model development; the following task involved defining model scenarios for the system analysis. Changes to hydrologic characteristics (land use, soil, curve number) were applied to the modeled sub-basins, and hydraulic (physical flow constraints) changes were applied to the conveyance components for each applicable scenario. With the same rainfall event applied to each scenario, the resulting stormwater performance could be compared for the various campus conditions and measured against designated benchmarks. The following stormwater scenarios were modeled for this project with the hydrology and hydraulic conditions as defined:

1. **Undeveloped:** Hypothetical condition simulating Basin A as an undeveloped, forested drainage basin. This scenario will have the lowest stormwater runoff and represents Basin A before the influence of humans.
2. **Baseline (1950):** Basin A conditions around 1950, representing a time period for comparison that was prior to the campus' major post-war development.
3. **Existing (2012) – No Action:** Hypothetical condition for Basin A, representing 2012 campus land use and soil conditions without any stormwater management features installed. This scenario will demonstrate the changes in stormwater characteristics from land use changes alone without any of the benefits from the existing stormwater management facilities.
4. **Existing (2012):** Basin A 2012 campus land use conditions with the major stormwater management components (i.e. detention) that have been installed since 1950. This will quantify the benefits of constructed stormwater management facilities within Basin A.
5. **Future (Master Plan) – No Action:** Future land use conditions within Basin A according to 2004 Campus Master Plan Update and applicable sector plans with no additional stormwater management actions proposed. This is to identify future stormwater characteristics attributed to land use changes, only. The changes in land use include an approximately 50-percent increase in canopy coverage and 34-percent increase in roof area.
6. **Future (Master Plan):** Scenario with future land use conditions within Basin A and with the incorporation of proposed projects that were developed in this Stormwater Master Plan. This would reflect improvements proposed by the Stormwater Master Plan for Basin A under ultimate build out of the 2004 Campus Master Plan Update/Sector Plans.

1. Undeveloped

- **Hydrology**
 - Land Use - Forest, 0% Impervious
 - Hydrologic Soil Group - B
 - Composite CN - 55
- **Hydraulics**
 - Stream Channel
 - Manning's n - 0.03
 - No Storage

2. Baseline (1950)

- **Hydrology**
 - Land Use - Dense Residential, 44% Impervious
 - Hydrologic Soil Group - C
 - Composite CN - 85
- **Hydraulics**
 - Existing Pipes w/o Rehabilitation
 - Manning's n - 0.013 to 0.025
 - No Storage

3. Existing (2012) - No Action

- **Hydrology**
 - Land Use - 2012 Campus, 53% Impervious
 - Hydrologic Soil Group - C
 - Composite CN - 87
- **Hydraulics**
 - Existing Pipes w/ Rehabilitation
 - Manning's n - 0.011 to 0.025
 - No Storage

4. Existing (2012)

- **Hydrology**
 - Land Use - 2012 Campus, 53% Impervious
 - Hydrologic Soil Group - C
 - Composite CN - 87
- **Hydraulics**
 - Existing Pipes w/ Rehabilitation
 - Manning's n - 0.011 to 0.025
 - Existing Stormwater Storage

5. Future (Master Plan) - No Action

- **Hydrology**
 - Land Use - Future Campus, 50% Impervious
 - Hydrologic Soil Group - B & C
 - Composite CN - 84
- **Hydraulics**
 - Existing Pipes w/ Rehabilitation
 - Manning's n - 0.011 to 0.025
 - Existing Stormwater Storage

6. Future (Master Plan)

- **Hydrology**
 - Land Use - Future Campus, 50% Impervious
 - Hydrologic Soil Group - B & C
 - Composite CN - 84
- **Hydraulics**
 - Existing Pipes w/ Rehabilitation
 - Manning's n - 0.011 to 0.025
 - Existing & Proposed Stormwater Storage

Figure 3-4: Scenario Summary

The six scenarios quantify the impact of development on the stormwater runoff characteristics within Basin A. They also illustrate the improvements to stormwater and general resource sustainability attributed to adopting this ambitious Stormwater Master Plan.

3.2 MODEL CALIBRATION

As previously mentioned, the Basin A stormwater model was created in the GIS-based InfoSWMM modeling software. The calculation engine is based on the EPA-developed stormwater management model (SWMM) with the runoff calculations and infiltration estimates based on the NRCS curve number method. The NRCS curve number method estimates the volume of infiltration from a drainage area's hydrologic curve number that is based on the land use and soil type, with the runoff estimated using the time of concentration, area, the non-infiltrated volume, and initial losses. However, the NRCS curve number method tends to over-predict peak runoff from design storms (e.g. 2-, 5-, 100-year, events), while under-estimating a storm's runoff volume when compared to measured results in Georgia. To improve the accuracy of the model's estimates, it was calibrated using urban hydrology estimates that are specific to Atlanta. Specifically, USGS recently released a report, *Magnitude and Frequency of Floods for Urban and Small Rural Streams in Georgia* (Gotvald and Knaak, 2011), where rain gauges and flow gauges with long-term records, primarily in the metropolitan Atlanta area, were used to develop mathematical regression equations to estimate Georgia-specific runoff rates for design storms. The Basin A runoff results predicted by the model were adjusted using time of concentration and initial loss variables to achieve agreement with the GA-USGS urban regression equations within 10 percent of the peak runoff rates and runoff volumes for the 2- through 100-year design storm events; an example of this calibrated agreement is illustrated for the 25-year event in Figure 3-5.

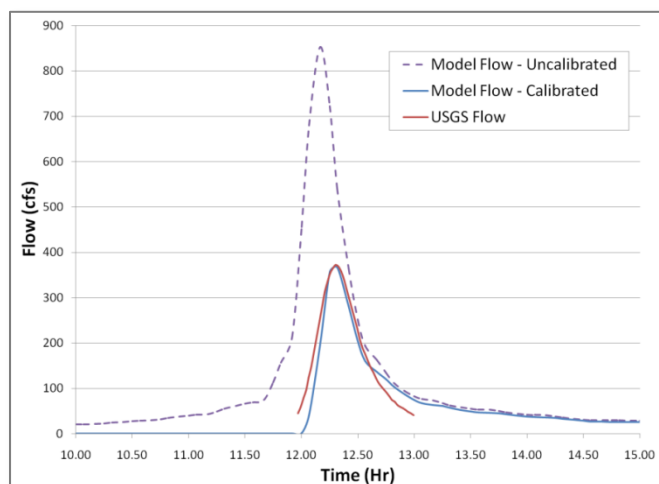


Figure 3-5: Model Calibration Comparison (25-Yr, 24-Hr Event)

3.3 MODEL RESULTS (WITHOUT IMPLEMENTING STORMWATER MASTER PLAN)

The calibrated stormwater model can estimate runoff results from specific design storms or actual rain gauge data for any of the scenarios defined in the previous sub-section (i.e. Undeveloped, Baseline, Existing, Future). Prior to the development of the Stormwater Master Plan, the approach to stormwater management on campus was generally to comply with City of Atlanta stormwater regulations. Future development within Basin A would have followed the recently adopted stormwater ordinance by the City of Atlanta, where peak runoff rate reductions are required up to the 25-year event (6.48 inches for the 24-hour storm). Results from this large rainfall event will be summarized in this section for illustrating *peak runoff rate* events in Basin A. The City of Atlanta Ordinance also requires complete containment of the 1-inch event or treatment of the water quality volume if none of the 1-inch event can be captured as defined by the Georgia Stormwater Management Manual (GaSWMM). The water quality volume is defined as the runoff produced by the 1.2-inch rainfall event, and the results for this 1.2-inch event will be illustrated for a *runoff volume* reduction discussion. For reference, the 1.2-inch event is

defined by the GaSWMM as the 85-percent exceedance event in an average year for Georgia, meaning that 85 percent of the rainfall events that occur in an average year will have a rainfall depth of 1.2 inches or less. Results for additional design events (1-100 year) are included in Appendix A.

3.3.1 Undeveloped Scenario Results

The Undeveloped scenario exhibits the runoff conditions for Basin A if it remained forested without the influence of humans. These conditions represent the hypothetically lowest peak runoff rate and volume for the Basin. It would take extreme stormwater management to reach these results, which are only displayed for comparative purposes. Table 3-2 summarizes the runoff results for the Undeveloped scenario followed by the resulting runoff hydrograph for the 25-year, 24-hour event (Figure 3-6).

Table 3-2: Undeveloped Runoff Results Summary

Scenario	Event	1.2-Inch	25-Year
		24-Hr Rainfall (inches)	1.2
Undeveloped	Peak (cfs ¹)	0	208
	Volume (MG ²)	0	7.3

1 - cubic feet per second; 2 - million gallons

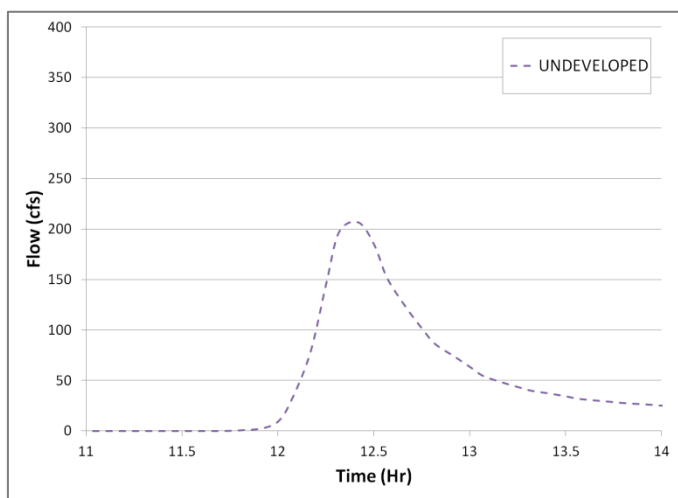


Figure 3-6: Undeveloped Runoff Results, 25-Year, 24-Hour Event

As indicated in Table 3-2, the hypothetical undeveloped Basin A does not produce any runoff from the 1.2-inch rainfall event; instead, the model estimates that the entire rainfall volume is absorbed by the forested canopy or infiltrated into the soil.

In terms of peak rates, the estimated runoff slightly exceeds 200 cfs during the 25-year, 24-hour event. This is significantly lower than the peak runoff rates anticipated from the modeled Basin A once development is introduced to the basin, as illustrated in the following scenarios.

3.3.2 Baseline (1950) Scenario Results

The Landscape Master Plan specified the 1950's, a period before the modern campus expansion, as a time period that the future campus may want to mimic in terms of runoff conditions. It loosely estimated that this might be equivalent to a 50-percent decrease in peak rates and runoff volume. However, the land use of that time period, according to a 1950 aerial image, was dense residential (e.g. Home Park) and some commercial areas with very little green space. Consequently, the model estimates significantly higher volume and peak runoff rates for Basin A in the 1950's when compared to the undeveloped conditions. The results for the Baseline (1950) scenario are summarized in Table 3-3 and Figure 3-7.

Table 3-3: Baseline (1950) Runoff Results Summary

Scenario	Event	1.2-Inch	25-Year
	24-Hr Rainfall (inches)	1.2	6.5
Undeveloped	Peak (cfs)	0	208
	Volume (MG)	0	7.3
Baseline (1950)	Peak (cfs)	45	341
	Volume (MG)	1.2	10.1

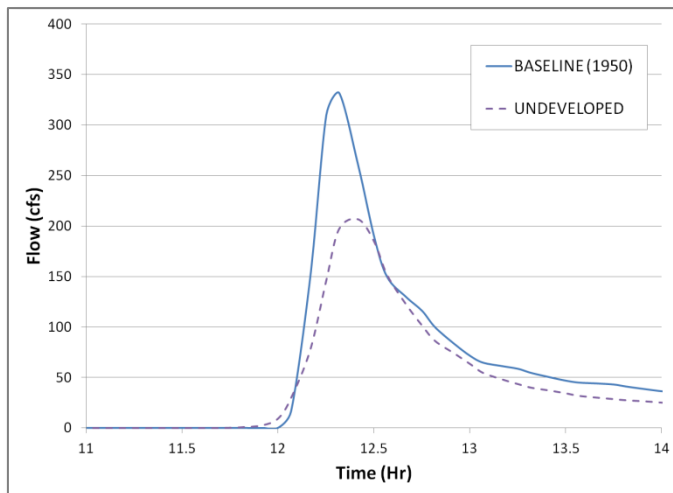


Figure 3-7: Baseline (1950) Runoff Results, 25-Year, 24-Hour Event

The introduction of the 1950's development increased the impervious percentage of Basin A to 44 percent compared to the zero-percent-impervious Undeveloped scenario. This resulted in 1.2 MG of runoff volume entering the combined sewer system from the 1.2-inch rainfall event and an approximately 64-percent increase in peak runoff rate during the 25-year event.

3.3.3 Existing (2012) Scenarios Results

Two scenarios were modeled to estimate the runoff characteristics resulting from the 2012 campus conditions: (1) hypothetical 2012 campus conditions without consideration of existing stormwater management components (e.g. cisterns, detention), and (2) the actual campus conditions represented by the 2012 land use and soil conditions with the significant stormwater management facilities that have been installed included in the model. The hypothetical scenario (“Existing (2012) – No Action”) represents the changes in runoff volumes and rates that can be attributed to land use changes only, while the “Existing (2012)” scenario with stormwater management components represents a more realistic estimate of current runoff characteristics experienced in Basin A for 2012. This allows us to quantitatively determine the impact of past stormwater management efforts. The results for the Existing (2012) scenarios are included in Table 3-4 and Figure 3-8.

Table 3-4: Existing (2012) Runoff Results Summary

Scenario	Event	1.2-Inch	25-Year
	24-Hr Rainfall (inches)	1.2	6.5
Undeveloped	Peak (cfs)	0	208
	Volume (MG)	0	7.3
Baseline (1950)	Peak (cfs)	45	341
	Volume (MG)	1.2	10.1
Existing (2012) - No Action	Peak (cfs)	50	376
	Volume (MG)	1.6	11.0
Existing (2012)	Peak (cfs)	44	363
	Volume (MG)	1.4	10.8

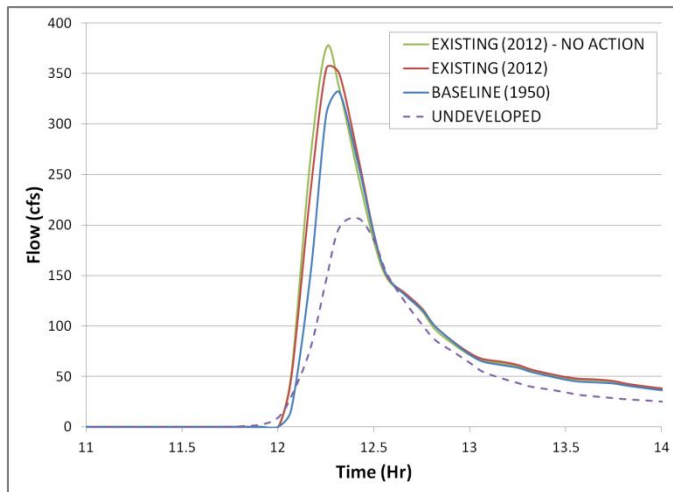


Figure 3-8: Existing (2012) Runoff Results, 25-Year, 24-Hour Event

Contrary to the estimation that the 1950’s runoff rate and volume was 50 percent of the 2012 conditions, they are actually very similar. The smaller than expected increase is due to the full

development of the basin, primarily as small lot residential, in the 1950's. Over this time period, the basin changes from 44-percent to 53-percent impervious coverage.

The runoff volume was estimated to increase by as much as 17 percent in the smaller 1.2-inch event and by a lower percentage in the less-frequent storms (e.g. 7-percent increase in the runoff volume for the 25-year event). It is worth noting that the estimated volumes of runoff in the "Existing (2012) – No Action" scenario and the "Existing (2012)" scenario are similar, despite the additional 800,000+ gallons of storage included in the latter scenario. This can be attributed to the previous stormwater regulations being more concerned with peak runoff rate reduction and not volume reduction, which resulted in the majority of stormwater management facilities installed on campus consisting of linear (large diameter pipe) detention that temporarily held back flow but released the entire volume over time.

The peak runoff rates for the 25-year event do increase from 2012 to the Baseline (1950) conditions by either 6 percent or 10 percent depending if stormwater storage facilities were included or not. The Existing (2012) scenario with storage results in almost a 75-percent increase in the 25-year peak runoff rate when compared to the Undeveloped (forested) Basin A results.

3.3.4 Future (Master Plan) Scenario Results

Similar to the Existing (2012) scenarios, two scenarios were analyzed for the future master plan development of Basin A. However, for the purpose of this section, and before we define the Stormwater Master Plan projects (Section 4), only one of the future scenarios will be included in this subsection. This scenario illustrates runoff characteristics resulting from changes in future land use only. The land use changes are defined by the 2004 Campus Master Plan Update and the more-recent Engineered Biosystems Building Sector and South Central Sector Plans, where applicable. No additional stormwater management facilities are introduced to the collection system compared to the Existing (2012) system. The "Future (Master Plan) – No Action" scenario results are summarized in Table 3-5 and illustrated in Figure 3-9.

Table 3-5: Future (Master Plan) Runoff Results Summary

Scenario	Event	1.2-Inch	25-Year
	24-Hr Rainfall (inches)	1.2	6.5
Undeveloped	Peak (cfs)	0	208
	Volume (MG)	0	7.3
Baseline (1950)	Peak (cfs)	45	341
	Volume (MG)	1.2	10.1
Existing (2012) - No Action	Peak (cfs)	50	376
	Volume (MG)	1.6	11.0
Existing (2012)	Peak (cfs)	44	363
	Volume (MG)	1.4	10.8
Future (Master Plan) - No Action	Peak (cfs)	40	342
	Volume (MG)	1.2	10.2

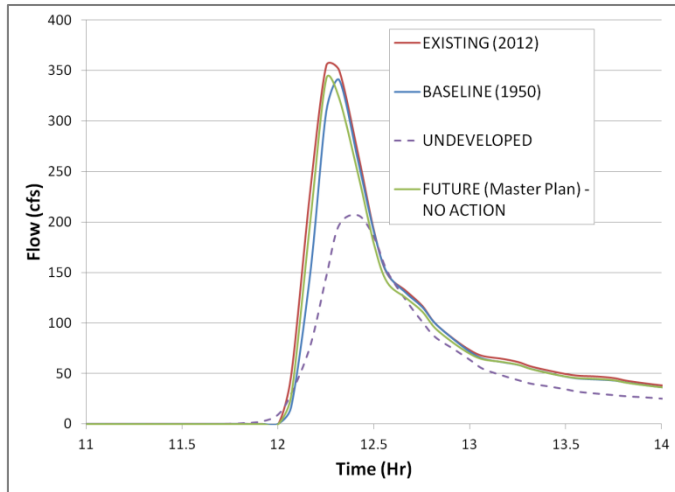


Figure 3-9: Future (Master Plan) Runoff Results, 25-Year, 24-Hour Event

The results summarized above indicate that the general land use changes projected in the future are maintaining the high runoff rates and volumes that reflect an urban watershed. Appendix A summarizes the runoff results for additional design events. Though there is a decrease in the future impervious percentage and hydrologic curve number in Basin A, it results in only a marginal improvement in runoff conditions compared with the Existing (2012) scenario. The runoff characteristics for most storms are similar to 1950 Basin A conditions without any additional stormwater management projects proposed.

However, it is the commitment by Georgia Tech to make additional improvements to stormwater management in Basin A to both comply with a recently adopted City of Atlanta stormwater ordinance and to advance Georgia Tech's mission of promoting a sustainable campus.

4. PROPOSED STORMWATER MANAGEMENT PROJECTS

A series of proposed stormwater management projects were developed as part of this Stormwater Master Plan. The goal was to develop projects that enhanced Georgia Tech's stormwater management efforts to promote the campus' sustainability mission within the financial constraints of the Institute. The process of developing projects that accomplished this goal along with a summary of the final project list is described in this section.

4.1 METHODOLOGY

Stormwater management goals were developed by establishing the minimum performance requirements defined by the recently (February 2013) adopted City of Atlanta stormwater ordinance, then establishing more stringent goals that would result in significant improvement to stormwater quality, rate and volume reduction in the City's combined sewer system, and establish Georgia Tech as a sustainable and ecological user of stormwater within Basin A. Through meetings with Georgia Tech and the experience of the stormwater project team, the following specific performance goals regarding stormwater runoff from Basin A under future conditions were developed; these goals are consistent with the general goals of the overall Plan defined in Section 1.2:

- Volume Reduction – Contain the majority of rainfall from the 1.2-inch event for the entire Basin A. Because Basin A contributes runoff to the combined sewer system, volume reduction was deemed the most beneficial stormwater criteria for the community (i.e. reducing volume in the City's combined sewer system reduces treatment cost for the City as well as reduces the volume of combined system overflows during large storm events).
- Peak Reduction – Exceed the minimum performance criteria. Surface flooding is not a major issue within Basin A, so peak reduction was not considered as important as volume reduction. The City of Atlanta requires all new projects to comply with their stormwater ordinance, so peak reduction that exceeds this minimum criteria will be a derivative of the implementation of the Stormwater Master Plan.
- Reduction in Potable Water Use – Develop a water capture system that will reduce potable water use within Basin A for activities that do not require potable water, such as irrigation, flushing, maintaining the surface water elevation of the future pond, and possibly supporting a flowing surface water feature.

4.1.1 Minimum Performance Criteria

At a minimum, the stormwater management criteria for the future Basin A are to meet the recently adopted City of Atlanta stormwater ordinance standards, with which redevelopment projects within Basin A are required to comply.

The minimum performance criteria for stormwater management of redevelopment in the City's ordinance are defined as:

- Stormwater Runoff Reduction: The stormwater runoff volume generated by the first 1.0 inch of rainfall shall be retained on-site and reused, infiltrated, or evaporated
- Water Quality Protection: If due to site constraints, the entire volume of runoff from the 1.0-inch event cannot be retained, the remaining volume shall be increased by a 1.2 multiplier and treated with stormwater management practices that provide at least an 80-percent reduction in total suspended solids
- Stream Channel Protection: 24-hour extended detention of the one-year, 24-hour event
- Overbank Flooding Protection: Reduce the peak runoff rate up to the 25-year, 24-hour event by half of the pre-development impervious percentage

- Additional Measures: No increase in peak discharge rates for any event compared to pre-development conditions and compliance with guidelines outlined in the Georgia Stormwater Management Manual

All areas of redevelopment within Basin A would be subject to this new City regulation. Approximately 42 acres of redevelopment area was estimated from the Engineered Biosystems Building Sector and South Central Sector Plans as well as the 2004 Campus Master Plan Update, where applicable, and are illustrated in Figure 4-1.

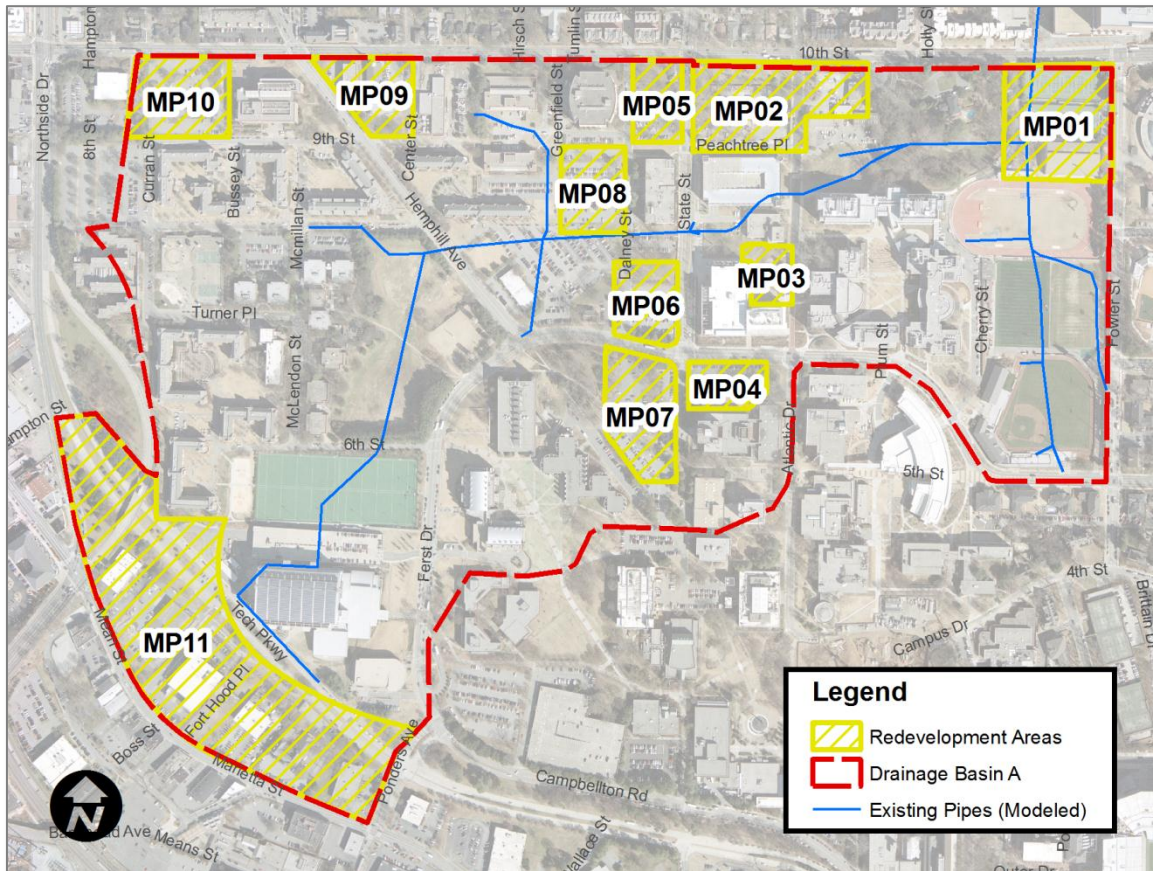


Figure 4-1: Basin A Redevelopment Areas Overview

If the redevelopment projects used the traditional methods of stormwater management required by the recently enacted City of Atlanta stormwater ordinance, the storage volumes would need to completely contain the 1-inch event (column B), the extended detention requirements (column C), and the peak runoff reduction requirements (column D) as summarized in Table 4-1.

Table 4-1: Basin A Redevelopment Results and Storage Requirements

(A)	(B)	(C)	(D)	(E)
Total Redevelopment Area, Basin A (acres)	Required Future 1-Inch Runoff Volume (MG)	Required Future 1-Year, 24-Hr Runoff Volume (MG)	Required Storage Volume to Meet 25-Yr, 24-Hr Peak Reduction Goal (MG)	Required Minimum Stormwater Storage Volume (MG)
42.0	0.2	2.2	0.9	2.4

As indicated in the table above, a minimum of 2.4 MG of stormwater storage would be required for the redevelopment projects to comply with the current City of Atlanta stormwater ordinance if using a traditional stormwater management approach. Additional detail regarding the analysis of this minimum storage requirement is provided in Appendix B.

This minimum performance criteria will be set as the minimum requirement for the proposed stormwater management projects; additionally, they will be used for estimating the comparable cost of the “no action” stormwater management plan if the proposed Stormwater Master Plan is not implemented in Basin A.

4.2 PROPOSED STORMWATER PROJECTS

Best Management Practices (BMPs) are typically grouped into two categories, structural and non-structural. Structural BMPs are those designed and constructed features in which stormwater volume is mitigated in some manner, whether through storage, infiltration, reuse, or biological uptake. These include engineering and scientific designs to reduce volume or pollutants from the stormwater runoff that would otherwise be introduced to the drainage system. Non-structural BMPs, on the other hand, are those practices, procedures and management programs that seek to prevent or reduce the volume of stormwater entering the stormwater collection and conveyance system in the first place. Non-structural BMPs typically represent a shift in site design techniques and are synonymous with low-impact development. Previous construction techniques and designs were not as ecologically mindful as many of the currently applied techniques. In order to achieve the optimal level of stormwater improvement, both structural and non-structural BMPs must be applied on Georgia Tech's campus. It is assumed that the 42 acres of redevelopment will apply low-impact development techniques for each project site, consistent with the goals and techniques outlined within the Landscape Master Plan and 2012 Sector Plans. The proposed projects in this Stormwater Master Plan provide Georgia Tech with a planning outline for an optimal configuration of structural BMPs for Basin A.

Four types of structural BMPs have been recommended to implement on Georgia Tech's campus to reduce the stormwater volume entering the collection system:

- Cisterns
- Infiltration Systems
- Bioretention (Rain Gardens)
- Green Roofs

Cisterns

Capturing and reusing rainfall for irrigation and flushing in future buildings is one of the goals of the Stormwater Master Plan, and cisterns are the most logical method of accomplishing that goal. Cisterns can also provide some stormwater volume reduction and peak rate reduction, although sometimes not in the most cost-effective manner. Georgia Tech currently has over 20 cisterns distributed around campus that typically serve localized collection and supply roles for stormwater harvesting. Figure 4-2 illustrates an example of these cisterns on campus, at the CRC. There are three significantly sized (> 40,000 gallons) regional cisterns on campus; they



Figure 4-2: Localized Cisterns on Campus (Campus Recreation Center, CRC)

are located at the Football Practice Facility, ES&T, and the Clough Commons. Regional cisterns are recommended for the Basin A Stormwater Master Plan. Fewer, larger cisterns are recommended to serve clusters of future new buildings within the Basin. It is more cost effective to build and interconnect fewer, larger cisterns partially due to the high cost of the controls and pumps associated with connecting many smaller cisterns.

Infiltration Systems

Infiltration systems are designed specifically to collect stormwater and infiltrate it into the groundwater table or surficial aquifer. Infiltration systems can be constructed under large open areas such as ball fields, parks, and at Georgia Tech, the Eco-Commons. In this way they not only accept drainage from off-site areas, they can also serve to help drain the surface above them. They can also be combined with a cistern where the water in the cistern is used to irrigate the open space above, essentially creating a self-contained re-use system.

Infiltration systems have to be properly engineered. The volume within the underground chamber, including the void space if a filter media (such as gravel) is employed, must be sized correctly to temporarily hold the stormwater design volumes. These volumes should be held in the underground chamber while infiltration occurs. A bypass system should be designed so that when runoff exceeds the volume capacity, the excess can be passed over into the campus stormwater collection system (Figure 4-3). In addition, some type of pre-filtering is necessary to prevent the system from becoming clogged with stormwater trash and debris. Although infiltration will occur more rapidly when the underlying soils are sandy, acceptable levels of infiltration can be achieved in clay soils with appropriate design modifications. Accordingly, all infiltration systems should be designed only after having an infiltration test.

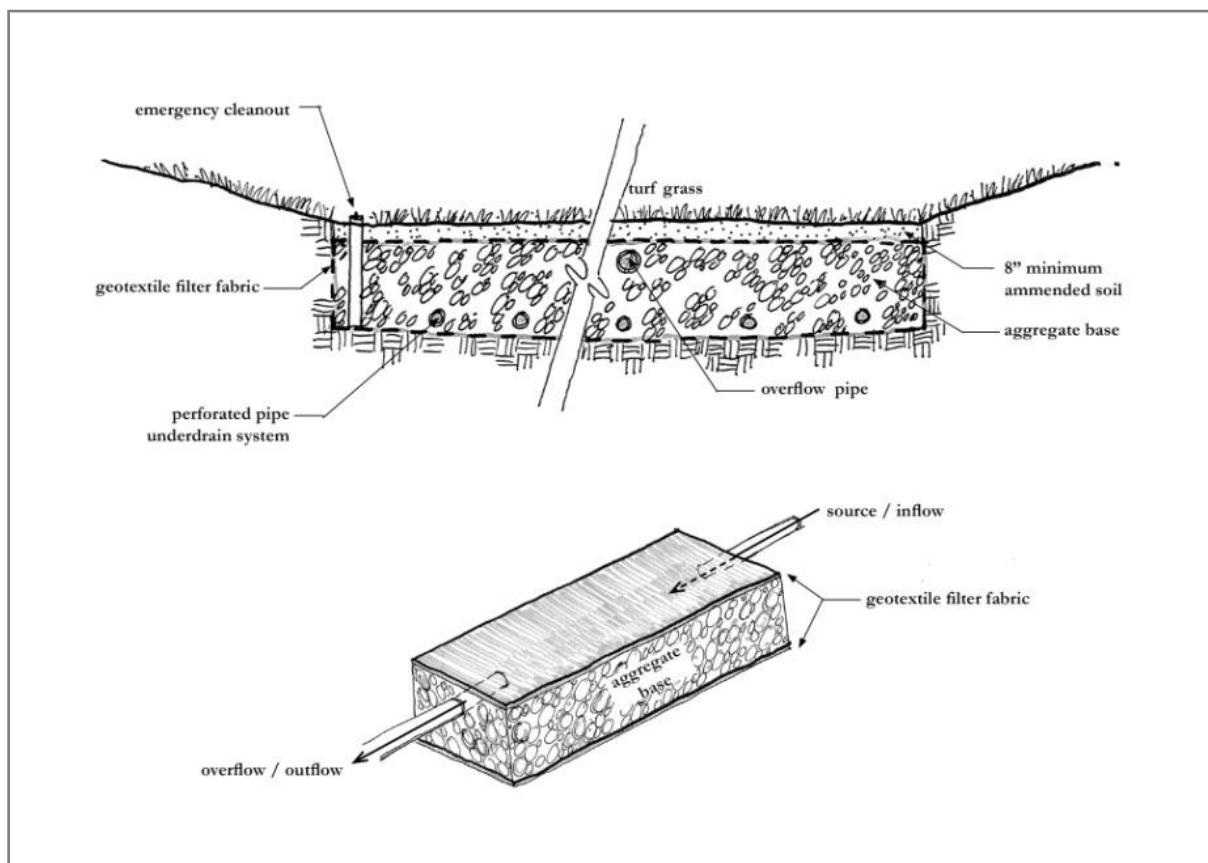


Figure 4-3: Example Infiltration System Schematic

Bioretention (Rain Gardens)

Institutional and commercial landscapes are often designed as areas built up from the surrounding ground in raised islands, generally to bring them into a higher visual plane. Irrigation water is then applied, taken up by the plants and soaks into the ground. Excess water flows off the landscape and sometimes over the pavement or sidewalk, and ultimately into the stormwater collection system.

Bioretention is a simple twist to this historic landscaping practice (Figure 4-4). Planting gardens of native plants in localized depressions allows runoff water from impervious surfaces to collect in the gardens and infiltrate into the subsurface soil. The use of native plants reduces or eliminates the need for irrigation since they are acclimated to the rainfall cycle of the local environment. The simple inversion of the garden is a tremendous advantage in managing stormwater. Now, instead of having direct runoff from pavement to pipe, the rain garden slows the runoff, thus increasing groundwater recharge and decreasing downstream runoff volumes.

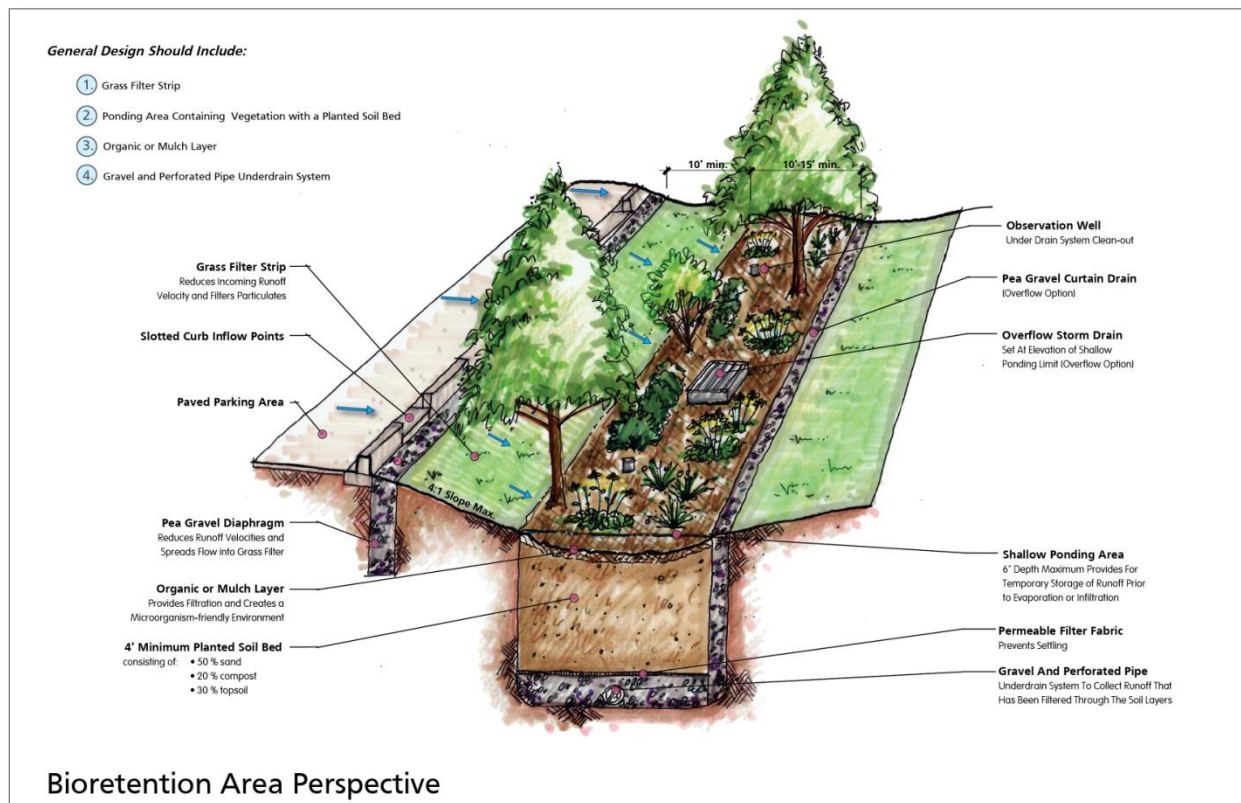


Figure 4-4: Typical Bioretention Overview

Bioretention can take a variety of forms in addition to the landscaped depression in a parking lot. Rain gardens can be installed in a series and have visible water during wet periods. Tree trenches along sidewalks and roads can become stormwater runoff receptors with the appropriate consideration of elevation and flow paths. Additionally, runoff water that does not infiltrate into the subsurface of the bioretention is nevertheless slowed down significantly.

Green Roofs

Another method for mitigating the impact of impervious roofs is to plant them with vegetation. This practice, which has been implemented in Europe for many years, is gaining popularity in the U.S. and has been incorporated into a number of buildings in the Atlanta area, including the roof garden that was recently installed at the Clough Commons (Figure 4-5). Green roofs can be quite useful in controlling stormwater peak flow and pollution. In addition to stormwater



Figure 4-5: Clough Commons Roof Garden

benefits, green roofs can reduce a building's energy cost from the additional insulation, extend a roof's lifespan, reduce heat island impacts, and are eligible for LEED credits for these multiple categories of benefit. However, green roofs are one of the most expensive BMPs when comparing the stormwater volume reduction and cost ratio to other BMPs. Despite the high relative cost, they are the one of the most visible stormwater management applications. Strategically placed green roofs on campus can add considerable aesthetic benefit to highly trafficked areas, while promoting Georgia Tech's sustainability mission.

Green roofs are typically placed into two categories: intensive and extensive (Figure 4-6). Intensive green roofs are more complex with a greater soil depth (> 6 inches); capacity for larger plants, shrubs, and small trees; a greater loading to the building structure; and relatively complex irrigation and drainage systems. Intensive roofs are more expensive, typically requiring active maintenance and irrigation, but create the desirable, park-like gathering location for students and visitors on campus.

Extensive systems are less complex, require less active maintenance, and typically add a much smaller load to the building structure than an intensive system. Extensive green roofs are not typically intended to be an aesthetic feature of the structure to the same degree as the intensive system. Green roofs are continuously becoming more cost-effective as the technology becomes more widely adopted along with the development of pre-fabricated systems. Green Roofs for Healthy Cities (www.greenroofs.org) is an industry organization that can provide additional information and resources about green roofs.

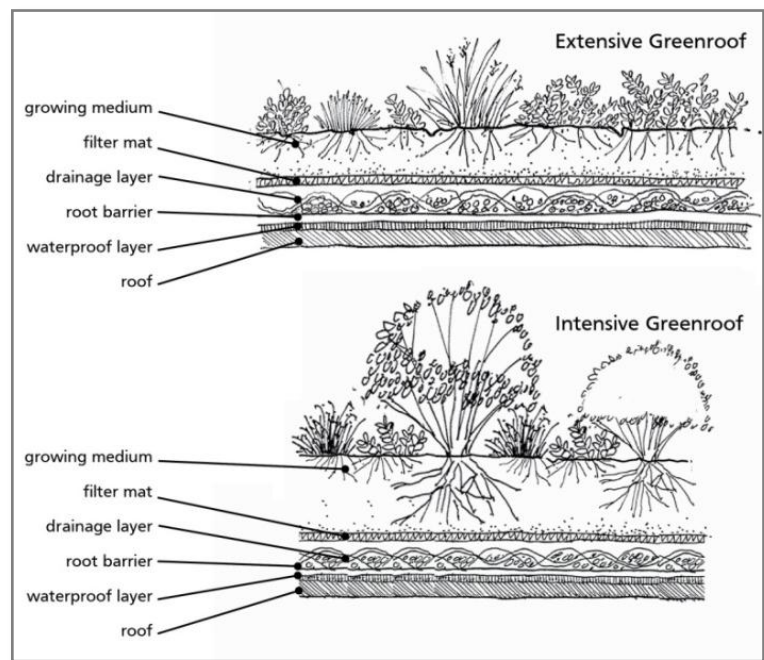


Figure 4-6: Extensive versus Intensive Green Roofs

Stormwater Management Plan Approach

A tiered approach was taken in developing the proposed Basin A stormwater management project configurations. Specifically, “useful” stormwater volumes are collected before overflowing into facilities where volume is infiltrated and returned to the groundwater. (1) The roof runoff, condensate, and foundation dewatering is routed to the clean water cistern chamber, where the water is reused to flush toilets in future buildings. This clean water overflows into a stormwater chamber. (2) The stormwater chamber is filled with surface stormwater runoff, or clean water overflow, and used for irrigation with any excess overflowing into an infiltration system. (3) Lastly, during large events excess stormwater overflows from the infiltration system to the existing stormwater collection system. The various project components were iteratively sized so that the rainfall event would have to exceed 1.2 inches before reaching the existing collection system. This general approach is illustrated in Figure 4-7.

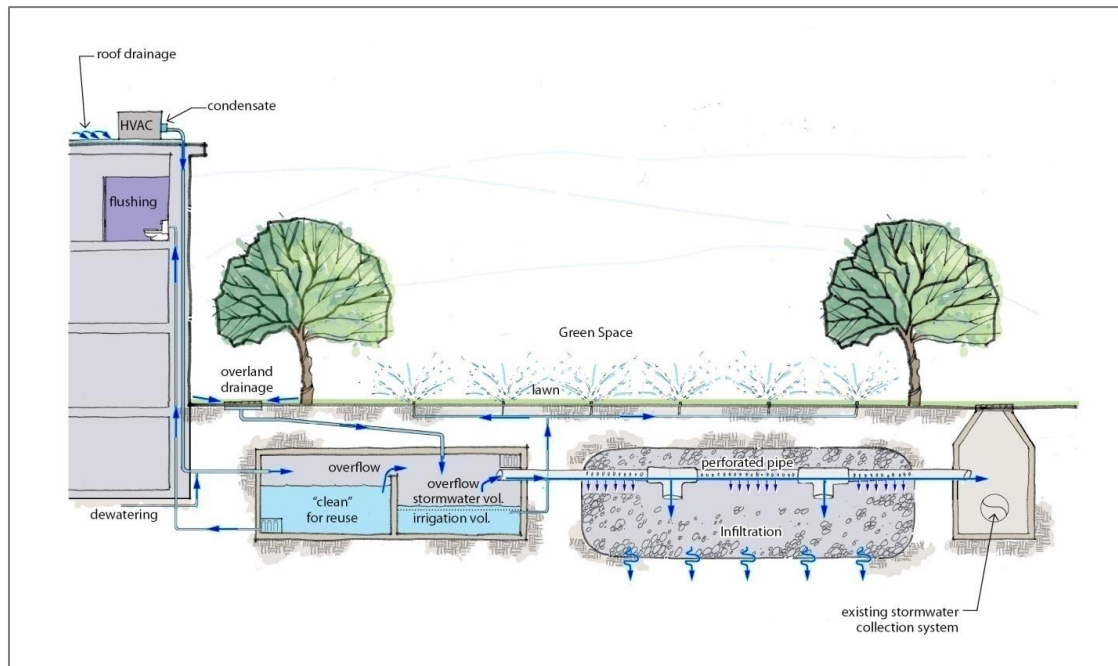


Figure 4-7: Stormwater Management Approach

The figure above illustrates the general tiered approach of a regional cistern and infiltration system at a single location. Additionally, there is an intended interconnection between each component of the Stormwater Master Plan, with the proposed Glade Pond being a major downstream feature. Figure 4-8 schematically outlines this interrelationship between systems, and the series of recommended stormwater management projects are illustrated in a plan view of Basin A in Figure 4-9. A detailed description of the projects along with a recommended phasing will be presented later in the section (sub-section 4.4.1).

In addition, there is a Blackwater Feasibility Study, which is ongoing at the time of the preparation of this report. The possibility of the implementation of a future blackwater treatment system, associated with supplying water to the 10th Street Chiller Plant, has been incorporated into the master plan and is shown conceptually on the master plan graphics. Should Georgia Tech choose to move forward with the implementation of that system that project can be incorporated into the stormwater model.

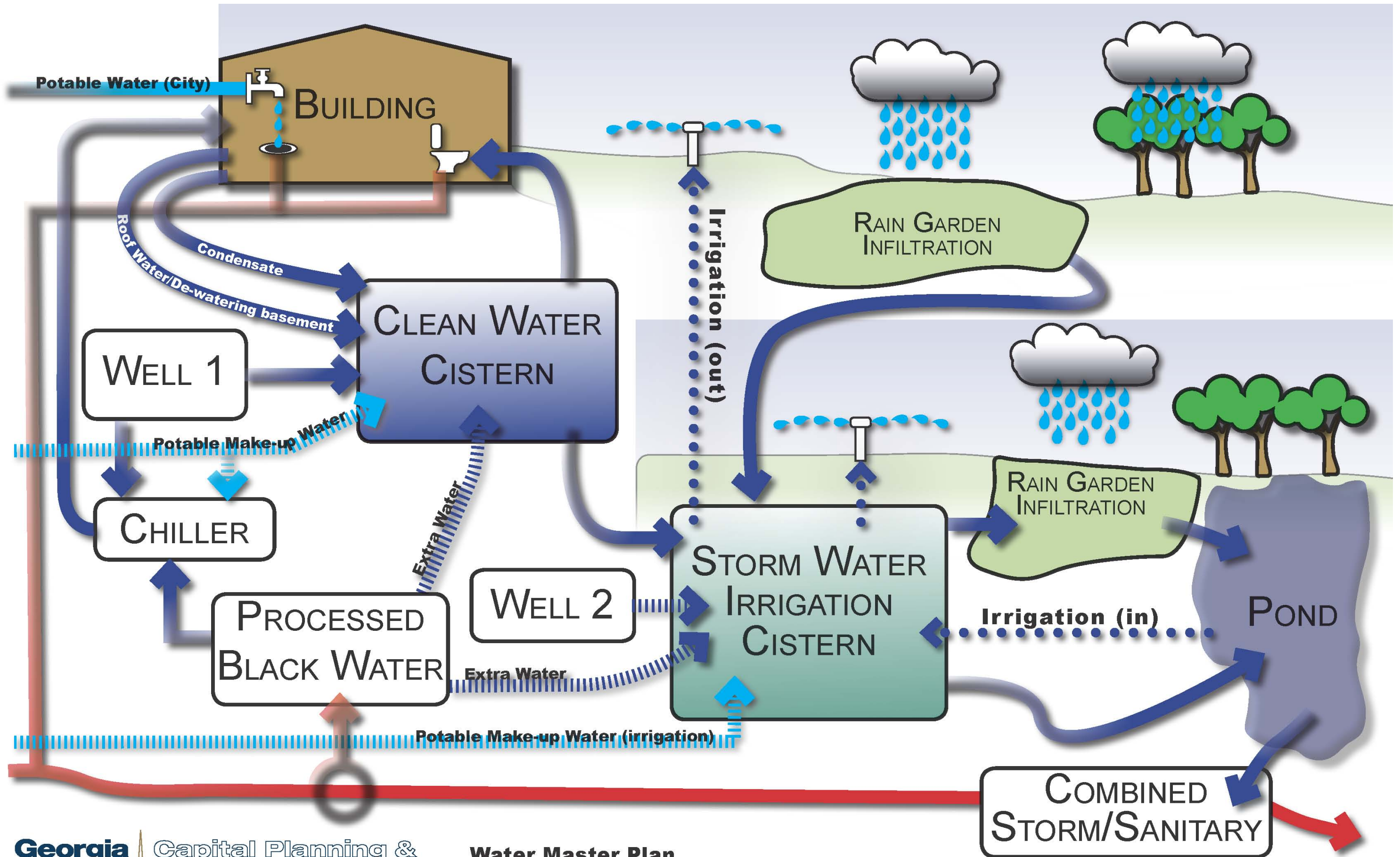
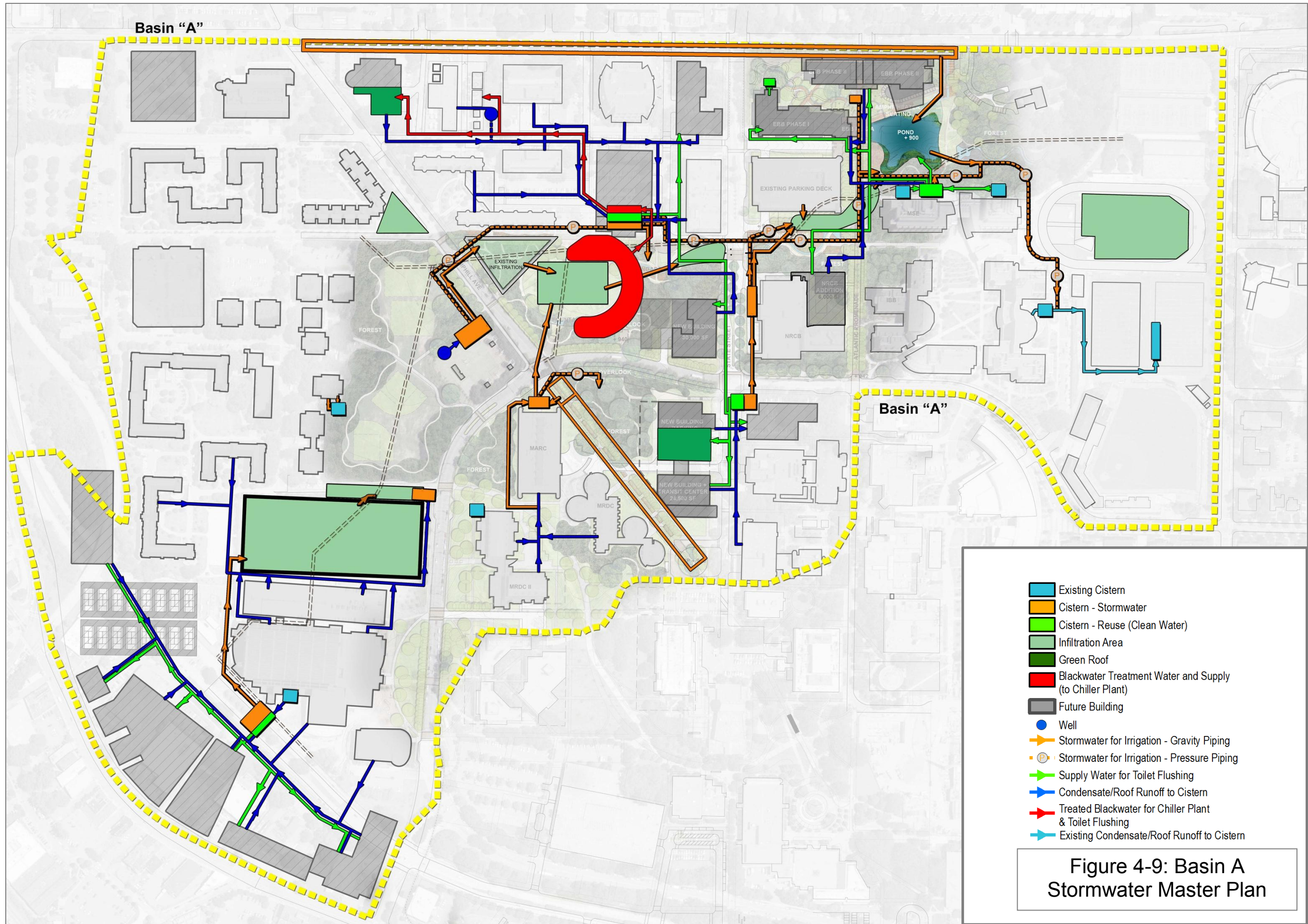


Figure 4-8: Basin A Flow Diagram



4.3 POST-PROJECT RESULTS

Through an iterative modeling process that validated the stormwater master plan goals being met, followed by a cost comparison between alternatives to identify the more cost-effective approach, a final configuration of the proposed stormwater management projects was defined. The collection of projects were input into the model, with the geometry based on physical constraints in each project's location, pre-defined layouts for projects in the sector plans (Hemphill Rain Garden, Eco-Commons Glade Pond), and engineering judgment. As a result, design events such as the 1.2-inch event and the 25-year event could be analyzed for proposed runoff conditions from Basin A considering the combined effects of all the projects. Long-term simulations could also be modeled to illustrate the stormwater benefits from an average year's rainfall under proposed conditions with the implementation of the Stormwater Master Plan.

Volume Reduction

With the full implementation of the proposed stormwater management projects, nearly all of the 1.2-inch event can be contained for the entire Basin A area in the future. This far exceeds the City's stormwater ordinance requiring containment of the 1-inch event for the 42 acres of redevelopment by at least four times. There may be minor areas within Basin A where it is not feasible to re-route the existing storm drains to future stormwater management projects (e.g. Ken Byers Tennis Complex, President's House), allowing some pass-through runoff to the combined system. However, the proposed projects were conservatively sized to provide enough volume for the 1.2-inch event as if the entire Basin A were eventually routed to the Stormwater Master Plan projects.

The modeling of the Existing (2012) conditions indicate that there was approximately 217 MG of runoff estimated from Basin A after an average year of rainfall. Using an industry standard of \$2/1000 gallons of treatment cost at the wastewater treatment plant, this would equate to approximately \$434,000 of treatment burden on the City of Atlanta due to stormwater being an unbilled discharge to the collection system. For the future scenario, with the Stormwater Master Plan implemented, this average rainfall year's runoff was reduced to 157 MG or an estimated 28-percent reduction. This would translate to an annual treatment cost of \$314,000, with the City of Atlanta realizing approximately \$120,000 in annual treatment cost savings. This is assuming that this entire volume makes it to the treatment plant with no overflows; regardless of the destination, the benefit is 60 MG of stormwater that would not have to be treated at the wastewater treatment plant or overflow into Tanyard Creek during an average year if the Stormwater Master Plan is implemented.

Peak Reduction

Peak reduction is a performance criterion to check for compliance with the City Ordinance, even though it is a lesser goal compared to volume reduction. The reduction in peak runoff rate estimated by the stormwater model for the 25-year, 24-hour storm was approximately 17 percent. Existing peak runoff for the 25-year event was 360 cfs, and the peak runoff for the future Stormwater Master Plan scenario was estimated to be 300 cfs as illustrated in Figure 4-10.

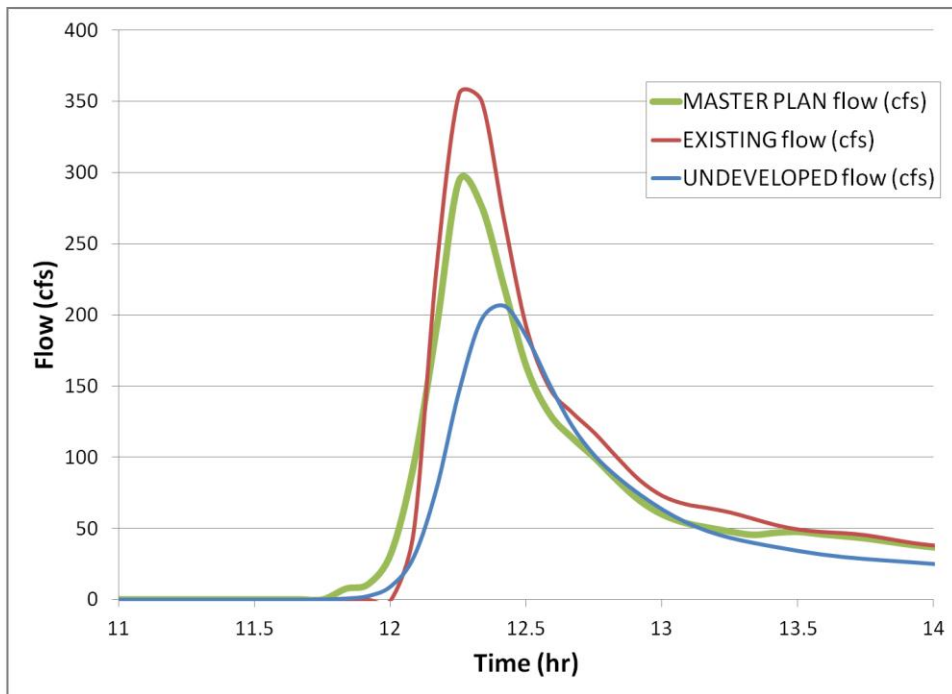


Figure 4-10: Peak Rate Reduction with Stormwater Master Plan (25-Yr, 24-Hr Event)

The 17-percent reduction in peak runoff rate from the entire Basin A was over twice the reduction estimated when the minimum stormwater management facilities were modeled to meet compliance for the 42 acres of redevelopment.

Reduction in Potable Water Use

Proposed cisterns within Basin A were strategically placed, typically with a two-chamber system with one chamber reserved for clean water recharged from condensate and runoff from building rooftops. The clean water is proposed to be pumped to small holding tanks within each new building where it would then be used for toilet flushing. The majority of existing buildings within Basin A have been recently renovated and therefore re-plumbing to accommodate water reuse for toilet flushing in these buildings was deemed to be cost prohibitive. The clean water cisterns were sized to provide 30 days of flushing supply based on calculated condensate demand and 75 percent of the average monthly rainfall that would be expected to result in roof top runoff. Once all of the buildings proposed in the campus master plan are constructed and water reuse systems are in place, it is expected that the potable water usage will be reduced by 10.9 million gallons annually. This equates to a cost savings in potable water usage of approximately \$90,000 each year.

The full development of Basin A is expected to have a nominal impact on the annual volume of water used for irrigation. In 2012, approximately 16 million gallons were used for irrigation, and this usage is expected to continue in the future. Excess clean water and the harvesting of surface stormwater runoff are expected to satisfy this demand. The irrigation volume reserved in the cistern has been configured to provide 14 days of irrigation demand assuming 75 percent of the average annual rainfall occurs in any given month. In an average year, potable water will not be used for irrigation. This will result in an estimated cost savings of \$130,000, annually. Should an unusually dry month occur, the well in Couch Park can be utilized to supplement the water supply used for irrigation. However, the well is not considered a sustainable water supply, and should only be used in extreme conditions.

4.4 PROBABLE COST SUMMARY

The probable costs for the recommended Basin A projects were evaluated comparing a “no action” future scenario with implementation of the Stormwater Master Plan (SWMP). The “no action” scenario develops each proposed building site independently, meeting the required City of Atlanta Stormwater Ordinance for that location and providing standard domestic water and sewer services as well as irrigation water connections. The Stormwater Master Plan takes a regional approach to Basin A where stormwater is managed basin-wide through strategically locating irrigation/stormwater cisterns to efficiently capture runoff for irrigation reuse. In addition, clean water cisterns capture roof-top rainfall runoff and building condensate water for reuse within the proposed buildings for toilet flushing. These cisterns in combination effectively reduce overall basin runoff, reduce the demand for potable water for domestic use, and eliminate the use of potable water for irrigation. The cost assumptions for comparing these two options are summarized in Table 4-2.

Table 4-2: Stormwater Cost Assumptions

Stormwater Management Item	Item Cost Assumption
Infiltration	\$0.80/Gallon + Real Estate
Cistern	\$3.00/Gallon + Pumping/Controls (\$100k)
Rain Garden	\$5.00/ Gallon

The two options were compared over an estimated 25-year build-out period with the assumption that an Inflation Rate and a Discount Rate would remain virtually equivalent over this time period, resulting in little if any adjustments needed for Present Value analysis. Option 1 is referred to as Future Costs Required to meet City Stormwater Ordinance (no SWMP) and Option 2 is referred to as Future Costs with Implementation of SWMP. Both scenarios are summarized here:

Option 1: Future Costs Required to meet City Stormwater Ordinance (no SWMP)

• Irrigation (16 MG) using Potable Water :	\$ 3,300,000
• Domestic Water/Sewer in Future Buildings:	\$14,100,000
• Detention/Cistern Vaults (Installation / O&M):	<u>\$10,900,000</u>
Total	\$28,300,000

Option 2: Future Costs with Implementation of SWMP

• Irrigation (16 MG) using Potable Water:	\$ 0
• Domestic Water/Sewer in Future Buildings:	\$11,900,000
• Irrigation/Stormwater Cisterns (Installation / O&M):	\$ 7,700,000
• Clean Water Cisterns (Installation / O&M):	\$ 5,300,000
• Infiltration Areas & Rain Gardens (Installation):	<u>\$ 1,400,000</u>
Total	\$26,300,000

As can be seen from the above comparison, over time, implementation of the Stormwater Master Plan results in a slightly more economical approach to water management within Basin A. However, the benefits of implementing the Stormwater Master Plan, as discussed in the previous section, far exceed the cost savings.

4.4.1 Project Summaries by Phase

The following represents potential phases in which to implement the recommended Basin A Stormwater Master Plan improvement projects. These phases, as depicted in Figure 4-11 and summarized in Table 4-3, are in numerical succession and represent current and future projects and a possible sequence to put the projects into operation. Phasing could change in the future and will depend on the phasing of building construction and elements of the Eco-Commons.



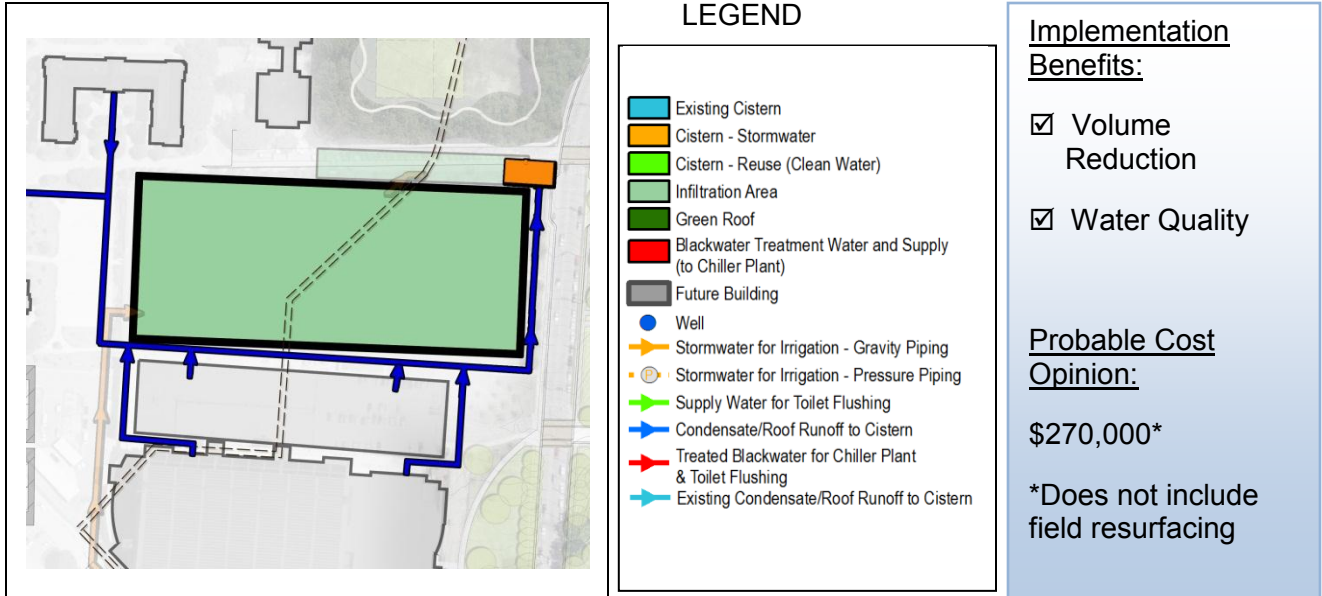
Figure 4-11: Stormwater Master Plan Phasing Overview

Table 4-3: Stormwater Master Plan Project Summary by Phase

Phase	Description	Location
1	Infiltration area under Stamps Field (45,000 cubic feet of voids), irrigation cistern and related piping	Stamps Field
1A	Modification of the nanotechnology cistern to Irrigation only (84,000 gal), Eco-Commons infiltration area (15,000 cubic feet of voids) and related piping	Between State Street, the north parking deck, Atlantic Drive and the Nanotechnology Building
2	Infiltration area (5,400 cubic feet of voids) and related piping	6 th Street between Tech parkway and Ferst Drive
2A	Clean water cistern (341,000 gal), rain garden and related piping	Cistern is located north of Molecular Science & Engineering, rain garden is located along 10 th Street between State Street and Atlantic Drive
3	Rain Garden (3,800 cubic feet) along 10 th Street and related piping	Between State Street and Atlantic Drive
4	Irrigation cistern (547,000 gal) with existing well backup, infiltration area (2,000 cubic feet of voids) and related piping	Cistern is located in Couch Park or on adjacent GT property, infiltration area located on east side of Hemphill Avenue
5	Clean water cistern (300,000 gal), irrigation cistern (253,000 gal), infiltration area (42,400 cubic feet of voids) and related piping	South of the future parking deck west of Dalney Street and the infiltration area
6	Irrigation cistern (97,000 gal), rain garden, rainforest demonstration project and related piping	At Hemphill Avenue south of Ferst Drive
7	Clean water cistern (87,000 gal), irrigation cistern (89,000 gal) and related piping	At State Street south of Ferst Drive
8	Clean water cistern (190,000 gal), Irrigation cistern (352,000 gal) and related piping	On the south side of the Campus Recreation Center

More detailed descriptions for each phase are included in the following phase summary sheets. The project descriptions and the probable cost opinions are planning-level summaries for the stormwater-specific components only and are not meant to encompass the capital projects in the area. For example, the phases involving the 10th Street rain garden do not include the associated cost with the design and construction of the sidewalk and roadway.

Stormwater Master Plan Phase 1 – Sub-basin 9



Description

Phase 1 implementation begins with the construction of the proposed Stamps Field Infiltration Area at the time Stamps Field is resurfaced. This infiltration area will capture rainfall that falls onto Stamps Field as well as overflows from the proposed CRC irrigation cistern at the southeast corner of Stamps Field and the cistern constructed with Phase 8. Phase 1 will contribute towards compliance with the City’s stormwater ordinance, improve water quality, increase groundwater recharge, and reduce stormwater volumes in the City’s combined sewer system. Overflows from the Stamps Field Infiltration Area will drain into the local combined sewer system.

Key Elements:

- Sub-basin (9) drainage area – 17 acres
- Stormwater reduction volume – 335,000 gallons
- Stamps Field Infiltration Area volume – 45,000 cubic feet (voids)
- Cost opinion includes stone pad with required void volume but does not include artificial turf resurfacing

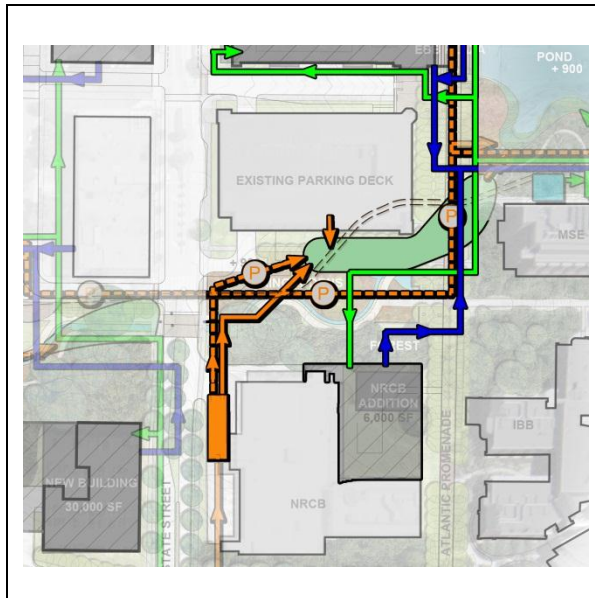
Project Considerations

- Diversion of roof drainage and condensate from parking deck and building should be considered
- Access to systems under playing field will be limited

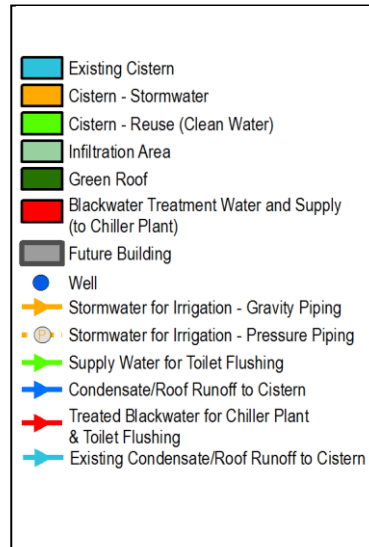
Related Campus Projects

- Stamps Field Resurfacing

Stormwater Master Plan Phase 1A – Sub-basin 5A



LEGEND



Implementation Benefits:

- Volume Reduction
- Water Reuse
- Water Quality

Probable Cost Opinion:

\$400,000

Description

Phase 1A implementation begins with modification of the Nanotechnology detention/irrigation vault to an irrigation cistern and the construction of the Eco-Commons infiltration area west of State Street and infiltration area west of Atlantic Drive. The converted irrigation cistern will capture surface water and building roof rainfall runoff, reducing overall runoff volume in compliance with the City's Stormwater Regulations, and provide irrigation for the area. The Phase 1A cistern will have the options of gravity flow into the Eco-Commons infiltration area and interconnected pumping of water to other Eco-Commons irrigation cisterns. Phase 1A cistern pumping and controls are to be designed to allow a water balance between cisterns. The pipes within Atlantic Drive are included in the Engineered Biosystems Building Phase 1 (in design at the time of this report).

Key Elements:

- Sub-basin (5A) drainage area – 3 acres
- Irrigation Water Cistern volume (14-day supply for peak demand month [July] plus stormwater reduction volume) – 84,000 gallons
- Eco-Commons Infiltration Areas volume – 5,000 cubic feet (voids) east side State Street; 10,000 cubic feet (voids) west side State Street

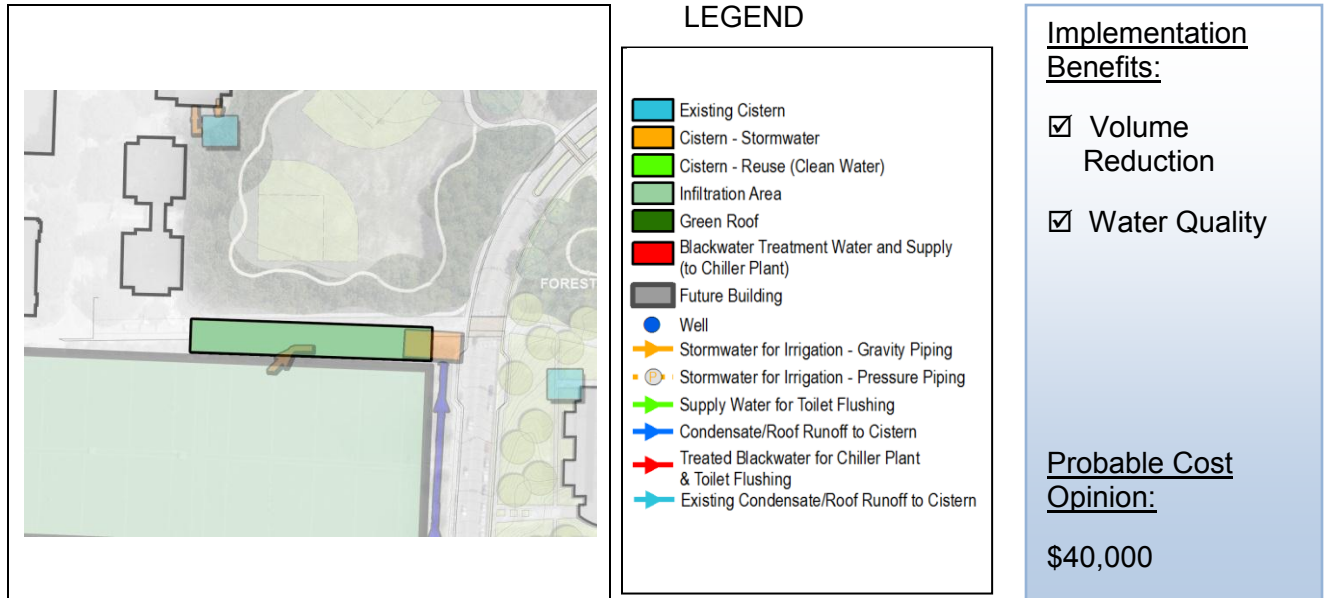
Project Considerations

- Recommend planning for interconnections between systems early
- Significant utility conflicts in Atlantic Drive
- Coordinate connection of overflow structure west of State Street with City of Atlanta

Related Campus Projects

- Engineered Biosystems Building Phases 1 & 2
- Marcus Nanotechnology Building Expansion

Stormwater Master Plan Phase 2 – Sub-basin 7



Description

Phase 2 implementation begins with construction of the proposed 6th Street infiltration area. 6th Street infiltration area will capture rainfall runoff from the street and area parking, reducing overall runoff in compliance with the City's Stormwater Regulations, and improve water quality. Overflows from the 6th Street Infiltration Area will drain into the local combined sewer system.

Key Elements:

- Sub-basin (7) drainage area – 19 acres
- Stormwater reduction volume – 41,000 gallons
- Sixth Street Infiltration Area volume – 5,400 cubic feet (voids)
- Potential location for infiltration area is under the on-street parking area utilizing pervious pavement over a thickened stone base or modular, high capacity storage chambers.
- Potential “green-street” project location where rain gardens are incorporated into street landscaping

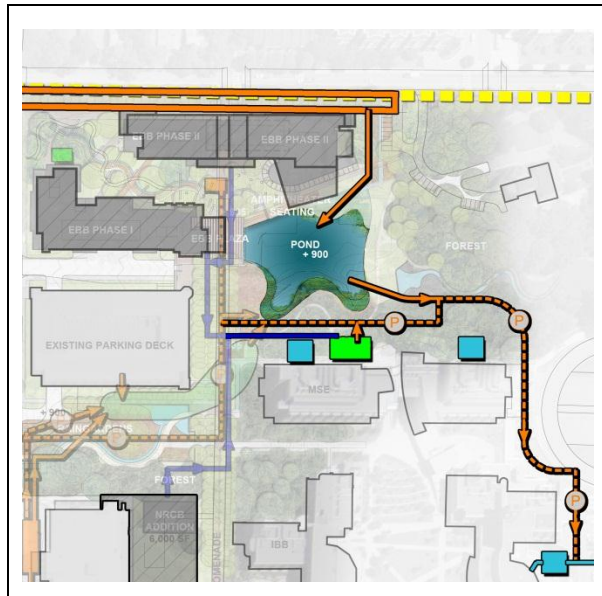
Project Considerations

- Coordination/incorporation required with ongoing TEA funded project

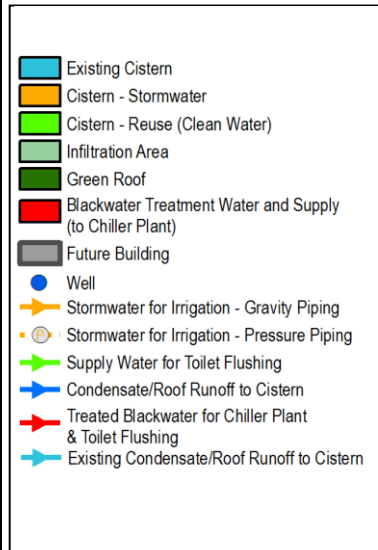
Related Campus Projects

- 6th Street Streetscape

Stormwater Master Plan Phase 2A – Sub-basin 4



LEGEND



Implementation Benefits:

- Volume Reduction
- Water Reuse

Probable Cost Opinion:

\$1,500,000*

*Does not include Glade Pond or 10th St. sidewalk & road

Description

Phase 2A implementation begins with construction of the proposed clean water cistern located just north of the Molecular Science and Engineering Building and a portion of the 10th Street Rain Garden located between Atlantic Drive and State Street. The clean water cistern will capture and store clean rainfall runoff from building roofs supplemented with condensate water for reuse in the proposed buildings to flush toilets. The Phase 2A cistern and rain garden will help reduce overall demand for potable water, improve stormwater quality and reduce stormwater runoff volume. Phase 2A clean water cistern will overflow into the Eco-Commons Glade Pond.

Key Elements:

- Sub-basin (4) drainage area – 5 acres
- Clean Water Cistern volume (30-day toilet flushing supply) – 341,000 gallons
- Supplements the existing Engineering Biosystems Building Phase 1 clean water cistern
- Rain gardens improve the quality of storm inflows into the Eco-Commons Glade Pond.
- The existing Molecular Science and Engineering Building cisterns (2-10,000 gallons) could be decommissioned to reduce operational and maintenance costs
- Interconnect stormwater cisterns with existing ES&T cistern and subsequently Football Practice Facility cistern

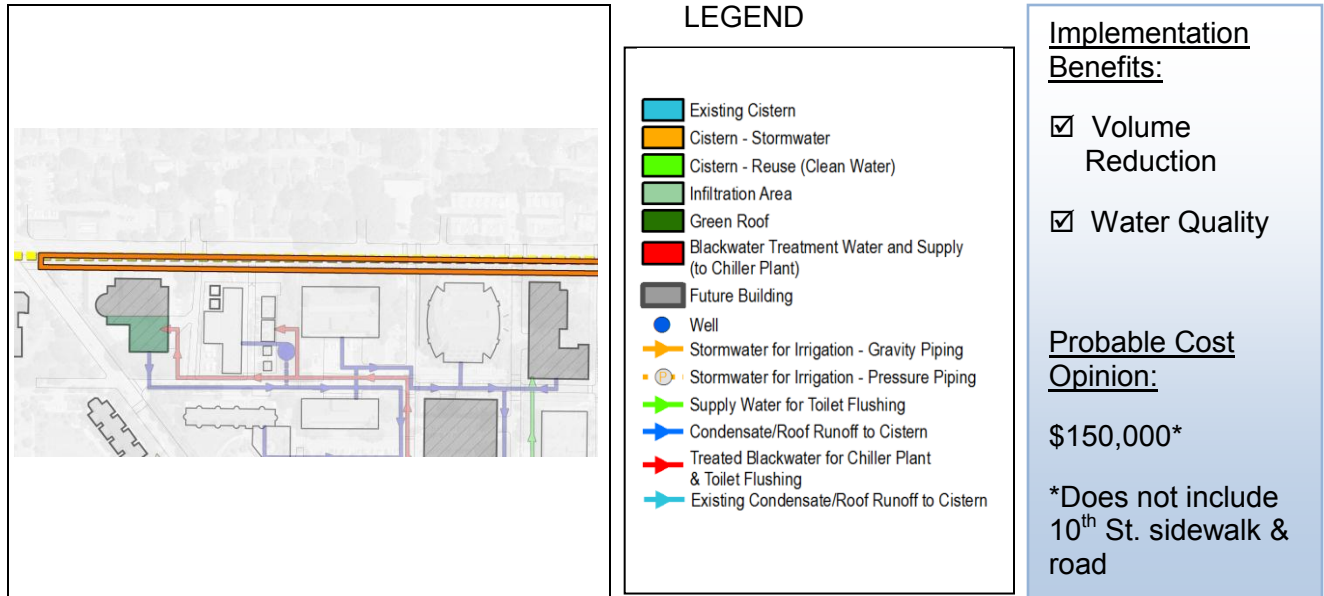
Project Considerations

- Pump considerations for distance between cisterns and ES&T cistern
- Coordination of Eco-Commons Glade Pond with sewer easements with City of Atlanta
- Pond lining

Related Campus Projects

- Engineered Biosystems Building Phase 2 & 3

Stormwater Master Plan Phase 3 – 10th Street Rain Garden



Implementation Benefits:

- Volume Reduction
- Water Quality

Probable Cost Opinion:

\$150,000*

*Does not include 10th St. sidewalk & road

Description

Phase 3 implementation includes the construction of a new rain garden along 10th Street from Hemphill Avenue to State Street. The rain garden will capture rainfall and surface runoff from 10th Street, significantly improving the water quality emanating from this busy thoroughfare. The filtered water from the rain garden will overflow into the Eco-Commons Glade Pond, or may connect to drainage systems flowing south of each intersection.

Key Elements:

- Stormwater reduction volume – 28,000 gallons
- Rain Garden volume – 3,800 cubic feet
- Streetscape improvements along 10th Street are not included in the probable cost opinion

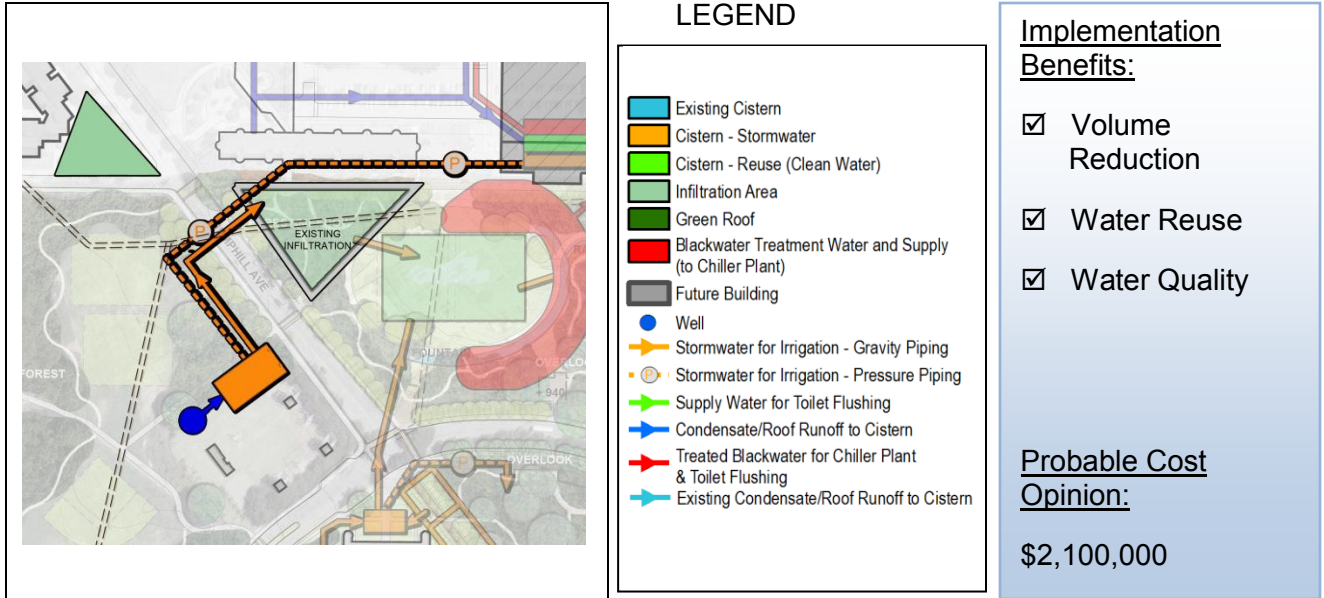
Project Considerations

- Coordinate with utility relocations
- Existing 30-inch water main along 10th Street
- City of Atlanta permitting
- 10th Street Rain Gardens can be constructed in phases with adjacent building projects or in a single phase that could provide cost savings and homogenous design, materials and construction techniques

Related Campus Projects

- Future buildings east & west of State Street and north of Ferst Drive
- Engineered Biosystems Building Phases 2 & 3

Stormwater Master Plan Phase 4 – Sub-basins 7, 7A & 8



Description

Phase 4 includes the construction of a proposed irrigation cistern west of Hemphill Avenue and an existing infiltration area east of Hemphill Avenue. The irrigation cistern is critical to meeting area irrigation demands and captures significant surface water runoff from Couch Park and the area to the west, reducing runoff volume and providing irrigation supply. The Phase 4 cistern will have the options of gravity overflows into the existing Hemphill Avenue infiltration area and interconnected pumping of water to other Eco-Commons irrigation cisterns. The Phase 4 cistern pumping maintains a water balance between cisterns, and in drought conditions the Couch Park well can supply water to the cistern for distribution throughout Basin A. The infiltration area proposed north of Couch Park and west of Hemphill Avenue accommodates 2,000 cubic feet of storage.

Key Elements:

- Sub-basin (7, 7A & 8) drainage area – 42 acres
- Stormwater reduction volume – 185,000 gallons
- Irrigation Water Cistern volume (14-day supply peak irrigation demand month [July] plus stormwater reduction volume) – 547,000 gallons
- Infiltration Area volume – 2,000 cubic feet
- Couch Park Well supplying water as needed during dry periods (cisterns sized based on 75 percent of average monthly rainfall)

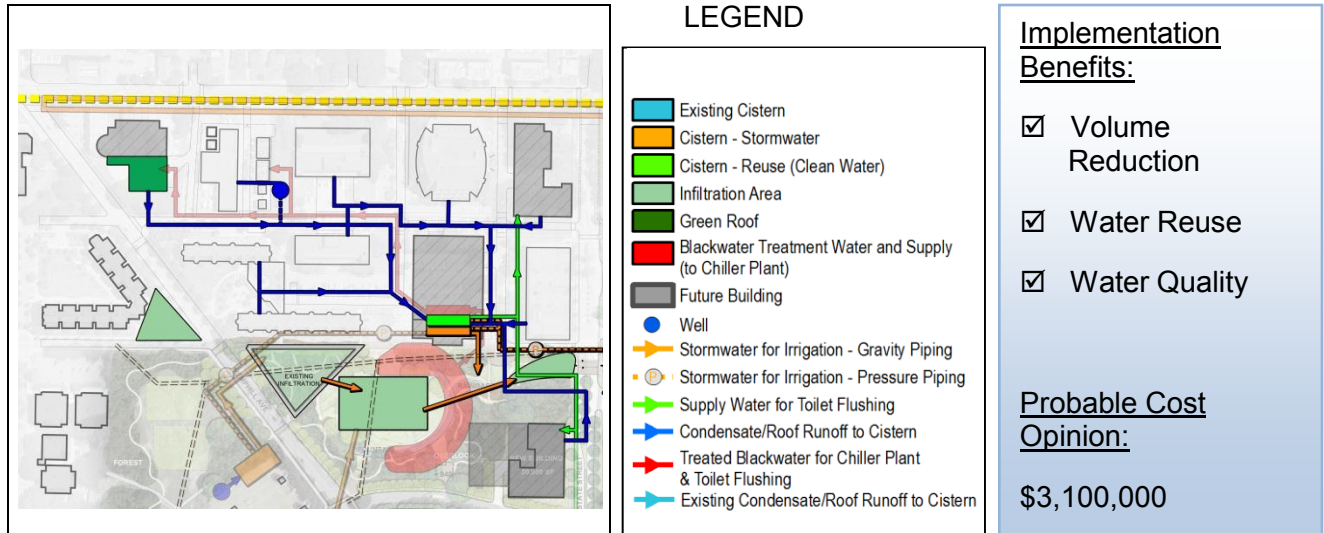
Project Considerations

- Interconnection crossing Hemphill Avenue difficult due to two 100+ year old water transmission mains in right-of-way
- Agreement with City of Atlanta may be required if cistern cannot be entirely located on Georgia Tech property (may require locating in parking lot northwest of Couch Park)

Related Campus Projects

- Eco-Commons project or stand-alone project due to critical function

Stormwater Master Plan Phase 5 – Sub-basins 6 - 6G



Description

Phase 5 implementation anticipates the construction of two cisterns below or adjacent to a future parking deck. One is for the capture of rainfall for irrigation, and the other is a clean water cistern designed to capture and store rainfall runoff from building roofs supplemented with building condensate for reuse in the proposed buildings for flushing toilets. The irrigation cistern will capture surface water runoff, reducing area overall runoff rates and volumes, and provide irrigation for the area. An infiltration area within the Eco-Commons east of Hemphill Avenue will receive overflows from the existing infiltration area east of Hemphill Avenue and the Phase 5 cistern. This will result in a reduction of peak rate and runoff volume discharged to the City’s combined sewer system. Both cisterns will help reduce overall demand for potable water. Phase 5 irrigation cistern pumping allows maintaining water balance between cisterns, and in drought conditions the Couch Park well can supply water to the cistern for distribution.

Key Elements:

- Sub-basin (6 - 6G) drainage area – 26 acres
- Stormwater reduction volume – 86,000 gallons
- Clean Water Cistern volume (30 day toilet flushing supply) – 300,000 gallons
- Irrigation Water Cistern volume (14-day supply peak demand month [July] plus stormwater reduction volume) – 253,000 gallons
- Eco-Commons Infiltration Area volume – 42,400 cubic feet (excludes existing infiltration area)
- Chiller Plant well will supply water as needed

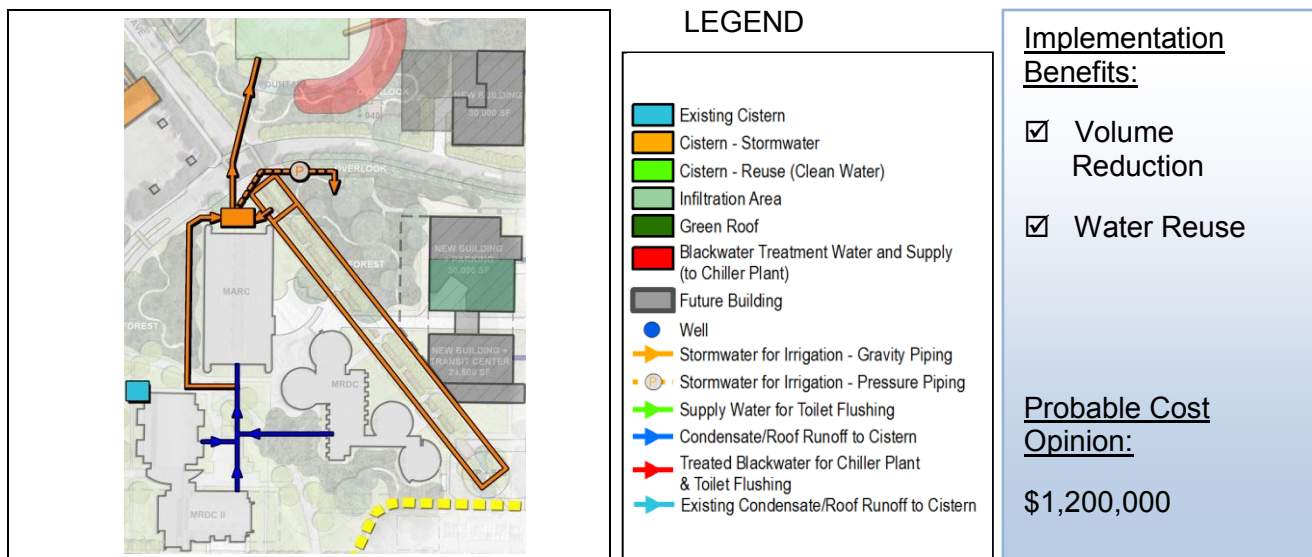
Project Considerations

- Phasing of Chiller Plant upgrades, new building, deck, blackwater treatment

Related Campus Projects

- Future Parking Deck west of Dalney Street

Stormwater Master Plan Phase 6 – Sub-basin 10



Description

Phase 6 implementation calls for the construction of a proposed irrigation cistern and rain garden along the Hemphill Avenue alignment. The rain garden will capture surface runoff, and the irrigation cistern will capture surface water and building roof rainfall runoff, reducing the overall runoff in compliance with the City’s stormwater ordinance, and provide irrigation for the area. The rain garden overflows into the irrigation cistern, and the irrigation cistern overflows into the Eco-Commons infiltration area. The irrigation cistern and rain garden will help reduce overall runoff and use of potable water for irrigation. Excess water can be used in the Pilot Woodlands as a demonstration project to measure the benefits of the increased application of irrigation water to enhance soils, improve biomass creation and sequester carbon.

Key Elements:

- Sub-basin (10) drainage area – 12 acres
- Stormwater reduction volume – 28,000 gallons
- Rain Garden volume – 107,000 gallons
- Irrigation Water Cistern volume (14-day supply peak demand month [July] plus stormwater reduction volume) – 97,000 gallons
- Pilot Woodlands Area (existing) – Rainforest Demonstration Project

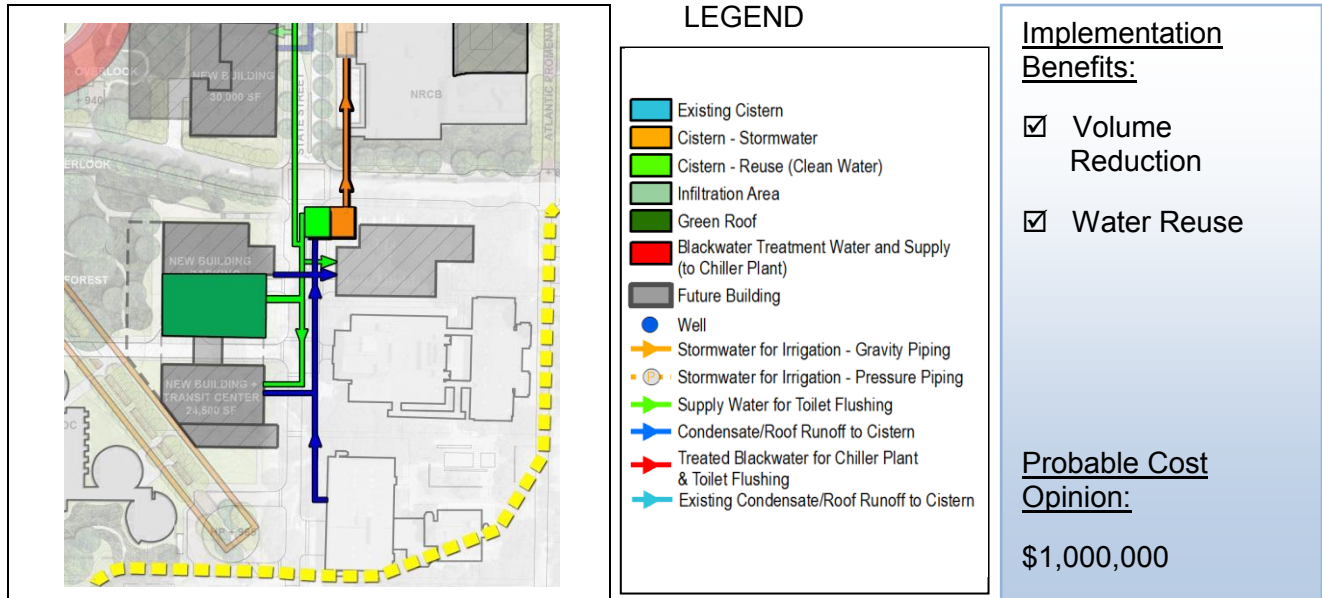
Project Considerations

- Protecting two 100+ year old City of Atlanta water mains under Hemphill Avenue during/after rain garden construction

Related Campus Projects

- Future Buildings west of State Street and south of Ferst Drive

Stormwater Master Plan Phase 7 – Sub-basin 5B



Description

Phase 7 includes construction of two cisterns to capture rainfall. One is a clean water cistern to store harvested rainfall runoff from building roofs with supplemental condensate water for reuse in the proposed buildings for flushing toilets. The second cistern is used for irrigation to capture surface water runoff from sub-basin to provide irrigation for the area. Both cisterns will help reduce overall demand for potable water and reduce stormwater runoff. Overflows from the clean water cistern enter the irrigation cistern while overflows from the irrigation cistern discharge into the Nanotechnology’s converted irrigation cistern.

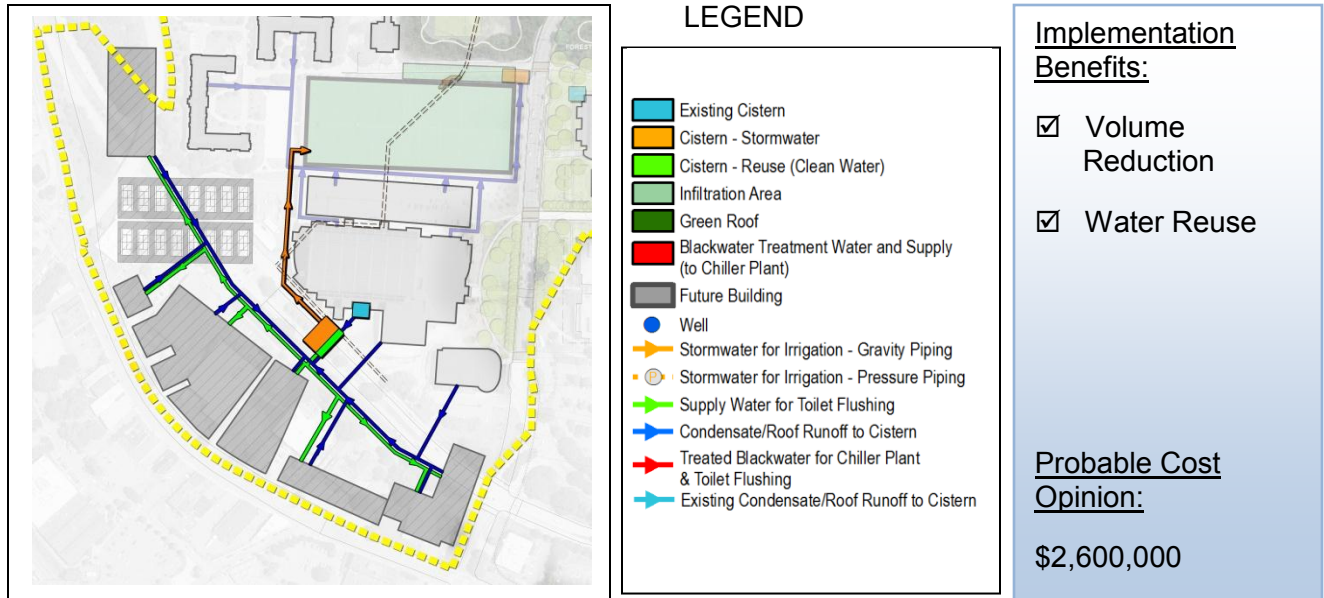
Key Elements:

- Sub-basin (5B) drainage area – 10 acres
- Clean water cistern volume (30-day toilet flushing supply) – 87,000 gallons
- Stormwater reduction volume – 44,800 gallons
- Irrigation water cistern volume (14-day supply peak demand month [July] plus stormwater reduction volume) – 89,000 gallons
- Divert roof and condensate drainage from existing academic buildings to clean water cistern

Related Campus Projects

- Future Buildings northwest and southeast of the State Street and Ferst Drive intersection

Stormwater Master Plan Phase 8 – Sub-basins 11 & 12



Description

Phase 8 implementation should begin with the construction of two cisterns located south of the CRC Building. The clean water cistern will capture and store rainfall runoff from building roofs supplemented from building condensate water for reuse in the proposed buildings to flush toilets. The irrigation cistern will capture surface water runoff, reducing area overall runoff in compliance with the City’s stormwater ordinance, and provide irrigation for the area. Both cisterns will help reduce overall demand for potable water and reduce stormwater runoff volume. Overflow from the stormwater/irrigation cistern will discharge to the Stamps Field infiltration area.

Key Elements:

- Sub-basin (11 & 12) drainage area – 25 acres
- Stormwater reduction volume – 58,300 gallons
- Clean Water Cistern volume (30-day toilet flushing supply) – 190,000 gallons
- Irrigation Water Cistern volume (14-day supply peak demand month [July] plus stormwater reduction volume) – 352,000 gallons

Project Considerations

- Campus projects for this area are projected to occur in the distant future, so stormwater configurations may need to be re-visited

Related Campus Projects

- Future Buildings southwest of Tech Parkway and the Campus Recreation Center

Future Basin A Redevelopment Projects

It may also be useful to view how individual redevelopment projects within Basin A relate to the proposed stormwater management projects. According to the 2004 Campus Master Plan Update and 2012 Sector Plans there are approximately 42 acres of redevelopment planned within Basin A. Figure 4-12 illustrates these Basin A project footprints, followed by a brief project narrative and a description of its interaction with the Stormwater Master Plan.

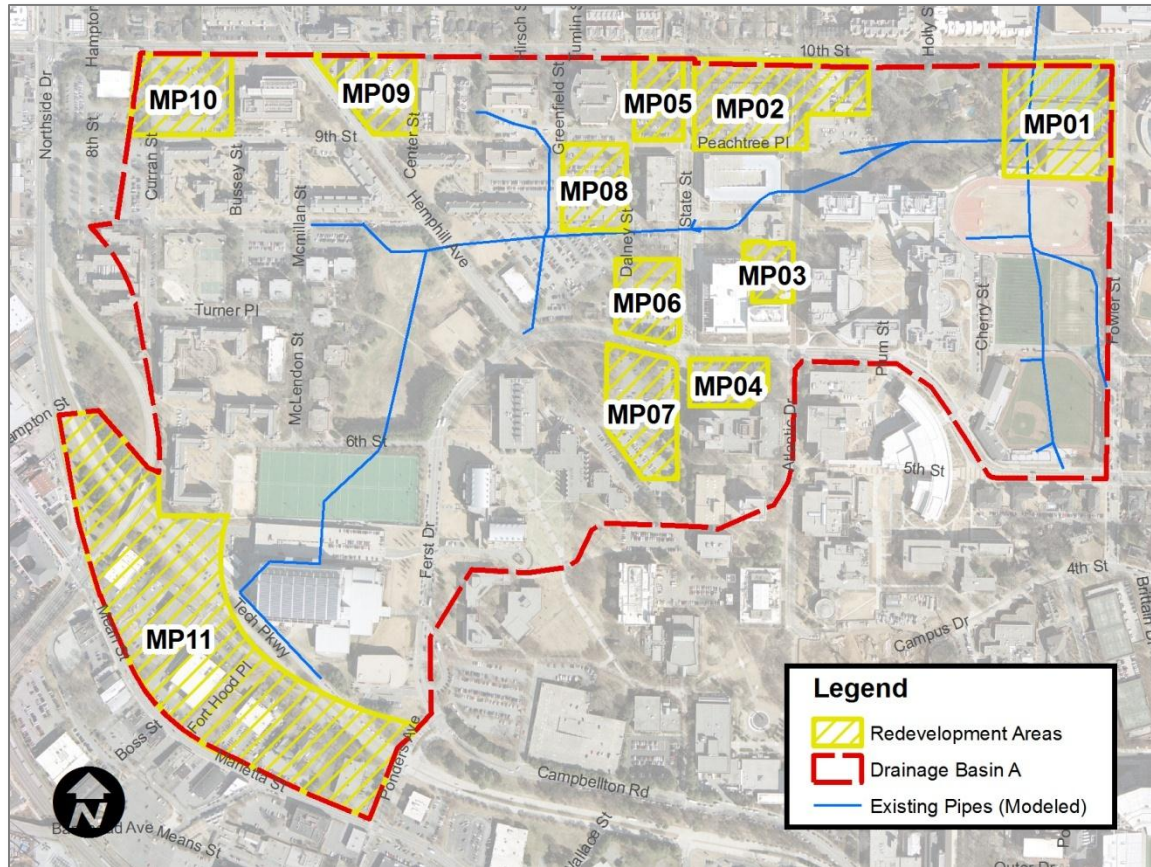


Figure 4-12: Basin A Redevelopment Areas

MP01 – Ken Byers Tennis Complex: This Project replaces an existing facility for NCAA tennis competition, and includes interior and exterior courts, office space, and locker rooms. The site is approximately 4.4 acres. The previous facility did not provide storm water management systems for control of water quantity or quality. During design and permitting of the new facility Georgia Tech and the City of Atlanta agreed to defer the storm water quantity control to a later date. This agreement requires that the future stormwater facilities account for the redevelopment of this site in all calculations and assessment of the system’s performance in relation to City of Atlanta regulations. This project was completed in January 2013, and the deferred stormwater management is planned to be incorporated into the Stamps Field renovation.

MP02 – Engineered Biosystems Building Phases 1 and 2: A proposed 425,000 gross square feet (GSF) research facility with frontage on 10th Street and overlooking the future Eco-Commons Glade Pond. The predevelopment site included several small residential lots along 10th Street and a landscape services yard along Peachtree Place. The landscape services yard was constructed in 2003, and included parking lot detention to meet City of Atlanta stormwater

requirements. Phase 1 of the new facility will include both clean water and irrigation/stormwater cisterns, whose overflows will discharge to the Eco-Commons Glade Pond. Phase 1 of the project is under construction as of December 2012, and its stormwater management meets the City of Atlanta stormwater regulations.

MP03 – Marcus Nanotechnology Research Center Expansion: This expansion of the facility completed in 2009 will be constructed in an open space adjacent to the current facility. It is anticipated to be approximately 60,000 GSF and will include clean room laboratories and office space for researchers. Cisterns for clean water and irrigation will be located directly north of the facility and provide water for flushing toilets in the new building. These cisterns will be interconnected with other stormwater master plan improvements along the Eco-Commons and associated Glade Pond.

MP04 – New Academic Building: This facility will be constructed in the visitor parking lot adjacent to the Physics Building and will provide approximately 70,000 GSF of academic and collaborative learning space. A clean water cistern will be required, with this project or MP07, to provide water for toilet flushing. This cistern is expected to obtain additional water supply from the diversion of condensate and roof runoff from the Physics Building and the Mason Building. Any surplus from this system should be diverted to the cistern provided with MP06.

MP05 – Engineered Biosystems Building Phase 3: The final phase of the Engineered Biosystems Building project also fronts 10th Street and is located just west of Phases 1 and 2. This site is currently open space, having recently been cleared of the small lot residential development. This building will provide an additional 85,000 GSF of research space. Coordination of the scheduling of construction will determine the location of a cistern to supply water for flushing toilets. Diverting the appropriate flows to the cistern in MP02 and sharing this facility is one option. The second option is for water to be supplied from the large system located in MP08.

MP06 – State Street Administrative Facility: This proposed 70,000 GSF office facility overlooks the Eco-Commons and replaces an existing surface parking lot. The facility shall have a clean water cistern that collects roof runoff and condensate from this facility and also overflows from the clean water cistern located south of Ferst Drive in MP04 or MP07.

MP07 – Ferst Drive Research and Academic Center: This facility will be constructed in the large parking lot behind the Physics Building and will provide 150,000 GSF of academic and research space. A clean water cistern will be required, with this project or MP04, to provide water for toilet flushing. This cistern is expected to require additional water supply, which should come from the diversion of condensate and roof runoff from the Physics Building and the Mason Building. Any surplus from this system should be diverted to the cistern provided with MP06.

MP08 – Dalney Street Parking Deck: The proposed parking facility will have approximately 600 spaces (216,000 GSF) and will replace the current surface parking lot. The facility may have an administrative use included in the structure (30,000 GSF). This facility will include a large clean water and irrigation/stormwater cistern within the structure. All overflows from the cistern should be directed into the adjacent Eco-Commons for transfer or infiltration prior to any discharge to the City sewer.

MP09 – Hemphill Avenue Administrative Building: This facility is located at Hemphill Avenue and 10th Street and is currently the site of a former church being used as administrative space for Georgia Tech. The new building will provide 83,000 GSF of new space for administrative purposes and also a more recognizable entrance to the campus. A small irrigation/stormwater

cistern, if required, should be considered for this site, and clean water will be supplied from the cistern at the MP08 development. Due to the substantial utility corridor in 9th Street, additional interconnectivity to connect runoff from this site to other facilities will not be practical.

MP10 – Graduate Living Facility: This facility on the west edge of campus along 10th Street will provide up to 800 beds for graduate students. The site will redevelop a surface parking lot. Collection of clean water for toilet flushing may require the cistern be located off the building site to collect flows from nearby facilities.

MP11 – Marietta Street Campus Expansion: After the proposed expansion of campus west to Marietta Street, the removal of Tech Parkway and relocation of Ferst Drive several facilities will be constructed in this area. A number of uses will be included in this area and will provide an estimated 345,000 GSF of new buildings. The area redevelops the right-of-way of Tech Parkway and several parcels along Marietta Street to create a new edge of campus. A pair of regional cisterns will be proposed between the redevelopments and the Campus Recreation Center (CRC) to serve both irrigation and clean water needs. Overflow from this system should be diverted to the storage and infiltration areas in the CRC complex.

Additional Projects (not included in 2004 Campus Master Plan Update or 2012 Sector Plans)

West Campus Dining Hall: This facility is being planned, however it is not a part of either the 2004 Campus Master Plan Update or the current sector planning effort. Therefore, this development has not been included in the hydraulic model of Basin A. The facility will provide dining space, possibly along with a fitness center or dormitory space. The sites under consideration are currently surface parking lots. A cistern will need to be included in the project to provide water for toilet flushing. To provide an adequate supply it is anticipated that roof runoff and condensate will need to be collected from the adjacent dorms to increase the available water. Any overflows from this facility should be diverted to a minimum of one additional storage, detention or infiltration system prior to final discharge into the City sewer.

Stamps Field Renovation: A resurfacing and other improvements of Stamps Field is under design and planned for summer 2013 construction. The project will replace the existing synthetic turf with an improved product and a realignment of the fields and storage buildings to optimize the space for functionality and student recreation. The project proposes two large infiltration cells to provide the stormwater management required by the City of Atlanta ordinance as well as the deferred rate reductions from the Ken Byers Tennis Complex project.

5. RECOMMENDED STORMWATER MASTER PLAN

The previous section outlined the development process and summarized the proposed projects of the Stormwater Master Plan for Basin A. It also outlined the probable cost and ultimate benefits to Basin A's runoff characteristics that were associated with implementing those projects. The general conclusion is that for a cost comparable to treating stormwater in a "business-as-usual" fashion, Georgia Tech's campus and the surrounding community can experience much higher benefits from a stormwater perspective by implementing these recommended improvements.

5.1 ADDITIONAL STORMWATER MASTER PLAN CONSIDERATIONS

In addition to implementing the recommended projects outlined in Section 4, there are more recommendations to consider for campus stormwater management.

Low-Impact Development

The implementation of the proposed stormwater management projects does not remove all stormwater responsibility for redevelopment on campus. Although structural stormwater BMPs may no longer be necessary on site, low-impact development techniques (non-structural BMPs) should still be considered for the project sites. Valuable, sustainable development initiatives were introduced in the Landscape Master Plan that will continue to improve the stormwater performance of Basin A as well as increase the aesthetics and overall environment of the campus. These low-impact development initiatives should still be adhered to for new projects within Basin A.

Surface Water Features

Georgia Tech has expressed the desire to have flowing surface water features in designated portions of the Basin A Eco-Commons. The proposed cistern volumes include some additional volume for stormwater storage that could provide a supply to this surface feature following rainfall events when this excess volume is available. If this excess volume was allowed to flow out of the cisterns over a 7-day period, an average supply of 32 gallons per minute could provide flow to these surface water features for an estimated 228 days out of the year, according to the long-term model simulation. If flow was desired for more than this 62 percent of the year, either the Couch Park well could supplement these features or the cisterns could be enlarged to provide additional supply.

5.2 OPERATIONAL PLAN

For the Stormwater Master Plan to be a long-term success there should be structured, on-going operation of some key recommendations. The recommendations for an operational plan for the stormwater management system include:

- Cistern control system: The control system should include a single point hub (either centralized or a de-centralized web-based platform) that allows for at-a-glance viewing of all cistern levels and flows. Logic controls should be programmed to include an operational hierarchy where excess water should be transferred along with overrides. Additionally, the system should document the historic levels and outflows of each cistern to gauge the performance and allow for optimization of the system.
- Dedicated personnel to the operation and maintenance of the stormwater management plan: There is a much higher probability of success if someone on staff has the defined role of implementing the day-to-day operations of the complex stormwater management system rather than incorporating it into the roles of the existing operation and maintenance staff that has a full docket of responsibilities involved with the general

operation of the campus. The stormwater individual(s) could then have personal responsibility for the system's proper operation and maintain the necessary familiarity with the system's intricacies.

- Defined maintenance schedule of the stormwater management system: To ensure that the initial investments are protected and that the stormwater system is performing as intended, there should be a maintenance schedule that includes calendar-based activities for general good-housekeeping measures as well as defined post-event observations to ensure that anything that may have temporarily failed will be repaired for the next rainfall event.
- Utilize stormwater model in design: The stormwater model would be a valuable tool to utilize during the design process for any new projects within Basin A. Not only could it confirm that specific stormwater design components are being implemented as recommended within this Stormwater Master Plan, but it should document the compliance with minimum performance criteria of the City of Atlanta stormwater ordinance for permitting.
- Maintenance of the stormwater model: Proposed stormwater management projects may be designed and installed differently than initially planned. Moreover, a building project in the 2004 Campus Master Plan Update may look completely different when it is actually constructed in the future. It would be advantageous to maintain the stormwater model that was developed with the Stormwater Master Plan to reflect these future projects as they actually were constructed in Basin A to represent the estimated stormwater characteristics most accurately. It is critical that the relevancy of the model and the previous efforts to develop it are not lost. Requiring future design teams to submit stormwater infrastructure data in a standardized GIS format is recommended to facilitate relatively easy updates to the model. This would also benefit Georgia Tech's GIS utility map maintenance.
- Maintenance of the Stormwater Master Plan: Similar to other master plans, it is recommended to regularly (every five years) update the Stormwater Master Plan. This will allow for realignments in future campus plans as well as interim projects since the last Stormwater Master Plan to be documented.

5.3 IMPLEMENTATION CONSIDERATIONS

There are several logistical activities that should be considered by Georgia Tech for the successful implementation of the Stormwater Master Plan. These activities include funding of the plan, record keeping, and future planning efforts that complement the Stormwater Master Plan.

5.3.1 Funding Alternatives

Traditionally, funding of stormwater management projects on campus has been the burden of the specific building project with the stormwater facility contained within that project's campus footprint. With the more holistic approach of this Stormwater Master Plan and regional nature of some of the proposed stormwater management facilities, it is not as straightforward for the direct benefactor of the stormwater management facility to pay for the project. Furthermore, some projects within Basin A may be built later than the stormwater management facility to which it drains. Some funding vehicles for the Stormwater Master Plan for Georgia Tech to consider should include:

- Fee-based campus stormwater utility – Similar to many municipalities that now have stormwater utility fees (in addition to water and sewer), each campus entity (school, organization, building) would pay a stormwater fee (monthly, annually, etc.) that would pay for the estimated annual cost for campus stormwater management (capital cost

funding plus operation and maintenance) pro-rated by either land area, impervious surface, roof area, or other similar parameters.

- Development stormwater fee – For any development project on campus, the project would pay a stormwater management fee that is equivalent to the cost of traditional, site-specific stormwater management facilities. This would need to be estimated and potentially adjusted if underfunding of the basin’s stormwater management was projected.
- Water savings payback – For cistern projects where buildings are anticipated to have an annual cost savings due to reuse from flushing or area irrigation, pay into the stormwater management fund the estimated annual cost savings for either a set period of time after the cistern project was in place or the cistern project costs were recouped.

5.3.2 Record Keeping

Stormwater management facilities can be the “forgotten” projects once they are installed, with access manholes sometimes the only visible indication of an underground structure. Georgia Tech does an adequate job of keeping record drawings of building projects. However, improvements could be made in keeping hydrology/drainage studies in a discoverable fashion. Due to the disconnected nature of some of the stormwater management projects proposed in Basin A, it is recommended that a log of stormwater related projects be kept in a central location (with this Stormwater Master Plan perhaps) along with a copy of each project’s hydrology study. This would allow for direct drainage and storage related to the project specific area to be accounted for as well as any compensatory storage planned for future drainage areas. The Stamps Field project could lend itself to being the demonstration project of record because of its scheduled construction (Summer 2013). A template for an example stormwater project log is included in Appendix C.

5.3.3 Future Planning Efforts

Future Research Related to the Stormwater Master Plan

To obtain the full benefits related to the implementation of the Stormwater Master Plan, future campus research opportunities should be integrated within the design of individual and combined stormwater facilities. Faculty and student research efforts could be critical to the implementation of the Stormwater Master Plan, future changes to the Stormwater Master Plan, and the transfer of knowledge to the Georgia Tech community and other similar efforts within Georgia and nationwide. To facilitate these research efforts the design of components and systems within the Plan should integrate data gathering equipment that will facilitate research efforts and encourage exploration efforts within every aspect of the Stormwater Master Plan. A brief survey of stormwater related efforts across the United States, and abroad, indicates the lack of sufficient data to improve the design and implementation of measures to control the quantity and quality of urban runoff and the collection and use of this runoff. Georgia Tech has the opportunity to make a significant contribution in this important area as we attempt to maximize the use of stormwater within the entirely urban water system.

To implement the research activities related to the Georgia Tech Stormwater Master Plan, it is recommended that a research overlay plan be developed to utilize the research potential related to this plan. Elements within the effort should include:

- Develop an overlay plan for the campus-wide Stormwater Master Plan that will identify stormwater research opportunities on campus.

- This plan should identify items such as: monitoring sites and equipment needs, observation wells within the infiltration areas, access to stormwater management facilities for data gathering, etc.
- This plan should be developed with assistance from the Stormwater Master Plan consultant team with significant input from Georgia Tech faculty and research staffs that have an interest in stormwater research efforts at Georgia Tech.
- A program where Georgia Tech provides seed money to encourage future research efforts for faculty, graduate and undergraduate students, and resources to integrate these efforts into classroom instruction.

Capturing the Education Opportunities Related to the Stormwater Master Plan

Given that a core mission of Georgia Tech is to provide superior education opportunities for undergraduate and graduate students, the Stormwater Master Plan and its implementation offers unique education related opportunities. Using the campus as a laboratory, students can not only learn about stormwater facilities used to control stormwater runoff quality and quantity and capture this runoff for water needs, but have the opportunity to see and experience these facilities that will be implemented throughout the campus. It is always difficult to replace “real world” applications with textbook photographs and slides of applications in other locations. Thus maximizing education opportunities related to the Stormwater Master Plan should be included in the design and implementation of stormwater facilities and systems. To accomplish this goal, it is recommended that the following be considered as future efforts related to the implementation of the Stormwater Master plan.

- Education opportunities could be directed at Georgia Tech undergraduate and graduate students, local high school and grade school students, campus visitors, and professionals within the Atlanta metropolitan area.
- Items that could be included in the plan would be identification of sites where access will be needed (i.e., Eco-Commons), access to data gathering sites and equipment, etc.
- Plaques and signage identifying the location of major stormwater facilities should be implemented throughout the campus.
- Since many of the stormwater facilities will be underground some consideration should be given to development of some displays that could be located on campus (digital or models) for education purposes where students can see and interact with these facilities.
- Development of a video documenting the stormwater activities on campus. Such a video might be very useful to the development department at Georgia Tech to solicit funds from possible donors who have an interest in sustainability, green architecture, and other aspects of this plan.
- Encourage input from faculty to outline other educational opportunities that can be integrated into future implementation of different aspects of the stormwater plan.

5.4 SUMMARY

The Stormwater Master Plan for Basin A was developed to assess the possibilities for improved stormwater management on the campus and to shift the campus away from a series of individual, project-site specific stormwater management improvements to a more logical “regional” drainage basin view of stormwater. Through efficiencies in project configurations, cost effectiveness of the recommended projects, and the potential for rainwater harvesting, a Stormwater Master Plan was developed that was comparable in cost to traditional stormwater methods for Basin A and its anticipated future development. However, the benefits to the larger community and the advancement of Georgia Tech’s sustainability mission far exceed ordinance compliance with the implementation of the Stormwater Master Plan for Basin A. The benefits of the Stormwater Master Plan include:

- Reduces the volume of stormwater runoff contributing to the City’s combined sewer system; therefore, assists in the City’s goal of reducing the frequency and volume of combined sewer overflows. The reduction in stormwater volume reaching the wastewater treatment plant will save the City the treatment cost of the unbilled stormwater (\$120,000 annually).
- Reduces the demand of potable water for non-potable purposes by almost 27 MG per year (11 MG for toilet flushing and 16 MG for irrigation), which is preserving a valuable resource and saving Georgia Tech operating expenses
- Returns stormwater to natural processes through infiltration, irrigation, and evaporation rather than quickly running off into the collection system as is typical in urban environments
- Provides a stormwater infrastructure plan for the development of the Basin A Eco-Commons
- Maintains water surface levels in the proposed Eco-Commons Glade Pond during peak evaporation periods
- Provides a sustainable supply for a flowing surface water feature on campus after rainfall events for over 60 percent of the year during an average year with currently proposed cistern sizes, which can be expanded to provide more resilient flow
- Strongly promotes Georgia Tech’s sustainability mission and strategic plan
- Exceeds the requirements of the recently adopted City of Atlanta’s stormwater ordinance with over four times the volume reduction and twice the peak reduction as the minimal performance criteria that would be required of the redevelopment within Basin A
- Provides a valuable research and educational opportunity for Georgia Tech if the school chooses to take advantage of the resource

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Inman, Earnest J. *Lagtime Relations for Urban Streams in Georgia: Water-Resources Investigations Report 00-4049*. U.S. Geological Survey, Atlanta, GA: 2000.

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APPENDIX A

Basin A Model Results Summary

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A. BASIN A MODEL RESULTS SUMMARY

Scenario	Event	1.2-Inch	1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
	24-Hr Rainfall (inches)	1.2	3.4	4.1	4.8	5.5	6.5	7.2	7.9
Undeveloped	Peak (cfs)	0	16	44	84	133	208	234	336
	Volume (MG)	0	1.2	2.3	3.6	5.0	7.3	9.1	11.0
Baseline (1950)	Peak (cfs)	45	227	251	297	331	341	355	407
	Volume (MG)	1.2	5.6	6.5	7.8	9.0	10.1	11.6	12.4
Existing (2012) - No Action	Peak (cfs)	50	271	296	346	367	376	381	427
	Volume (MG)	1.6	6.7	7.5	8.9	9.9	11.0	12.4	13.2
Existing (2012)	Peak (cfs)	44	271	295	340	357	363	357	408
	Volume (MG)	1.4	6.5	7.3	8.7	9.7	10.8	12.2	13.0
Future (Master Plan) - No Action	Peak (cfs)	40	247	271	311	331	342	339	370
	Volume (MG)	1.2	6.1	6.9	8.2	9.1	10.2	11.6	12.4

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APPENDIX B

City of Atlanta Stormwater Ordinance Compliance

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B. CITY OF ATLANTA STORMWATER ORDINANCE COMPLIANCE

At a minimum, the stormwater management criteria for the future Basin A are to meet the recently (February 2013) adopted City of Atlanta stormwater ordinance standards for redevelopment sites within Basin A. The general nature of the updated ordinance is to better define the guidelines and minimum stormwater performance criteria for new construction and re-development, while not suppressing development by making the requirements attainable. Specifically, it is correcting a requirement that made many projects financially impractical due to the cost of meeting the existing stormwater criteria (i.e. 30 percent peak flow reduction for up to the 100-year event).

B.1 PERFORMANCE CRITERIA

The performance criteria defined by the City of Atlanta stormwater ordinance is defined as:

- Stormwater Runoff Reduction: the stormwater runoff volume generated by the first 1.0 inch of rainfall shall be retained on-site
- Water Quality Protection: if due to site constraints, the entire volume of runoff from the 1.0-inch event cannot be retained, the remaining volume shall be increased by a 1.2 multiplier and treated with stormwater management practices that provide at least an 80 percent reduction in total suspended solids
- Stream Channel Protection: 24-hour extended detention of the one-year, 24-hour event
- Overbank Flooding Protection: reduce the peak runoff rate up to the 25-year, 24-hour event by half of the pre-development impervious percentage
- Additional Measures: no increase in peak discharge rates for any event compared to pre-development conditions and compliance with guidelines outlined in the Georgia Stormwater Management Manual

B.1.1 Basin A Redevelopment Areas

In Basin A, the areas of redevelopment would be required to comply with the stormwater ordinance. These areas were delineated according to the Engineered BioSystems Building (EBB) Sector and South Central Sector Plans as well as the 2004 Campus Master Plan Update, where applicable, and are summarized in Table B-1 and illustrated in Figure B-1.

Table B-1: Basin A Redevelopment Areas Summary

SUBBASIN	AREA (acre)	2012		Future	
		CN	IMP (%)	CN	IMP (%)
MP01	4.44	83	37%	88	59%
MP02	4.79	88	61%	84	56%
MP03	0.91	80	23%	90	67%
MP04	1.25	89	63%	84	58%
MP05	1.45	84	44%	88	66%
MP06	1.78	86	55%	89	66%
MP07	2.86	89	67%	92	80%
MP08	1.95	94	83%	91	78%
MP09	2.04	88	60%	81	42%
MP10	2.80	93	82%	87	66%
MP11	17.70	88	59%	82	46%
TOTALS	41.97	88	59%	85	56%

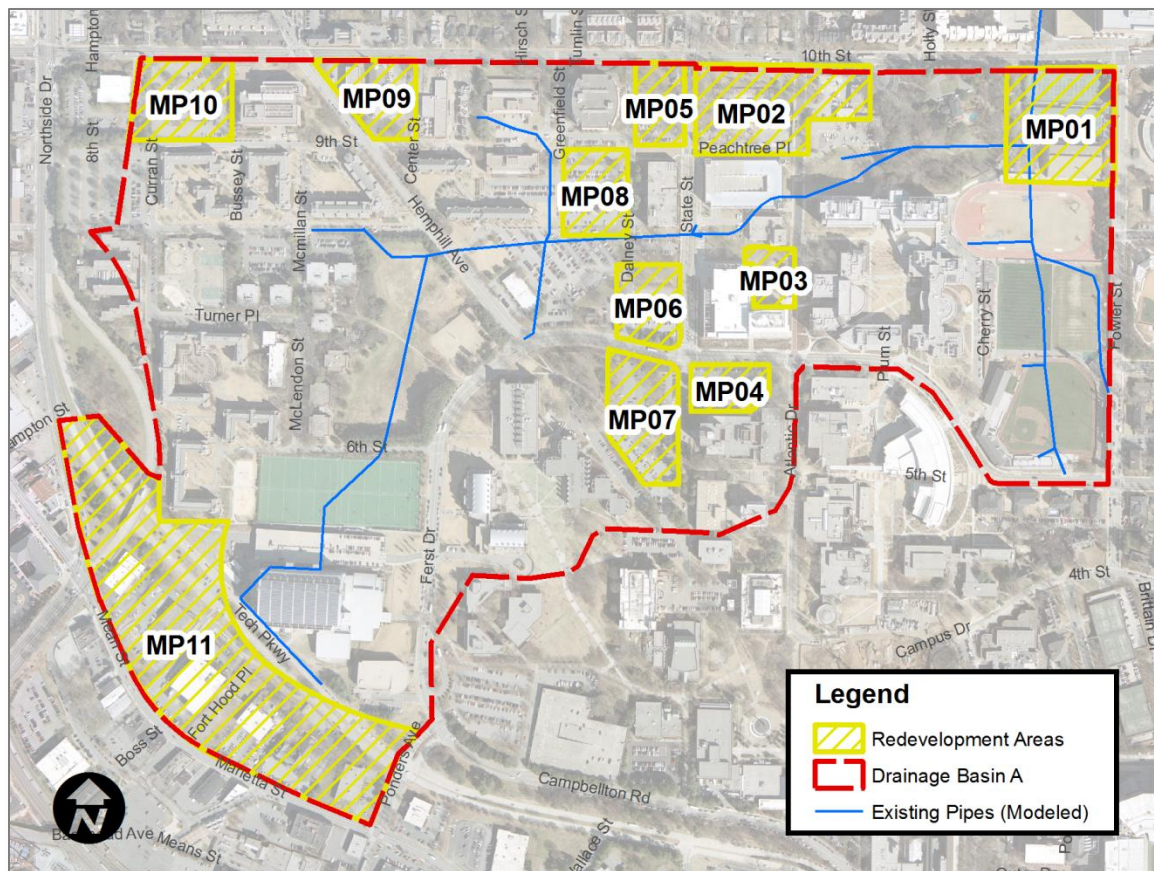


Figure B-1: Basin A Redevelopment Areas Overview

B.1.2 Stormwater Model Results

The 2012 and future stormwater runoff characteristics of the redevelopment areas were input into the model as reflected by the hydrologic curve number (Table B-1), and the results are summarized in Table B-2.

Table B-2: Basin A Redevelopment Areas Runoff Results

SUBBASIN	A	B	C	D	E
	Future 1-Inch Runoff Volume (MG)	Future 1-Yr, 24-Hr Runoff Volume (MG)	Existing (2012) 25-Yr, 24-Hr Hour Peak Runoff (cfs)	Future 25-Yr, 24-Hr Hour Peak Runoff (cfs)	% Change 25-Yr, 24-Hr Peak Runoff (Future vs. Existing)
MP01	0.02	0.16	30	33	8%
MP02	0.01	0.09	35	33	-6%
MP03	0.01	0.08	6	7	16%
MP04	0.02	0.24	9	9	-7%
MP05	0.03	0.26	10	11	6%
MP06	0.01	0.06	13	13	4%
MP07	0.01	0.11	21	22	3%
MP08	0.03	0.20	15	15	-3%
MP09	0.01	0.06	15	13	-10%
MP10	0.06	0.81	22	20	-6%
MP11	0.02	0.13	131	119	-9%
TOTALS	0.21	2.18	307	295	-4%

B.1.3 Required Stormwater Management Storage

To meet the stormwater management performance criteria summarized in Subsection B.1, each of the 11 redevelopment areas must:

- Retain on-site the runoff volume from the 1-inch event (Column A, Table B-2)
- Detain for 24 hours the 1-Year, 24-Hr runoff volume (Column B, Table B-2)
- Provide the storage volume necessary to reduce the peak runoff rate up to the 25-Year, 24-Hour event as summarized in Table B-3

Table B-3: Required Storage for Peak Runoff Reduction

SUBBASIN	Existing (2012) 25-Year, 24-Hr Hour Peak Runoff (cfs)	Pre-Development Impervious Cover (%)	Required Peak Reduction (Imp% ÷ 2)	25-Year, 24-Hr Peak Runoff Goal (cfs)	Storage Volume ¹ Required to Meet Goal (CF)	Storage Volume ¹ Required to Meet Goal (MG)
MP01	30	37%	18%	25	14,000	0.10
MP02	35	61%	30%	25	14,000	0.10
MP03	6	23%	12%	5	4,000	0.03
MP04	9	63%	32%	6	4,000	0.03
MP05	10	44%	22%	8	5,000	0.04
MP06	13	55%	28%	9	6,000	0.04
MP07	21	67%	33%	14	11,000	0.08
MP08	15	83%	42%	9	8,000	0.06
MP09	15	60%	30%	11	6,000	0.04
MP10	22	82%	41%	13	10,000	0.07
MP11	131	59%	29%	92	38,000	0.28
TOTALS	307	59%	30%	217	120,000	0.90

¹ – Volume estimate obtained by setting maximum outflow from hypothetical detention storage in stormwater model to runoff goal and recording the resulting maximum volume

In summary, to meet the City of Atlanta’s stormwater ordinance the following volumes of stormwater storage (Table B-4) must be provided by traditional methods or by using “green” infrastructure practices:

Table B-4: Basin A Redevelopment Storage Requirements

SUBBASIN	Future 1-Inch Runoff Volume (MG)	Future 1-Year, 24-Hr Runoff Volume (MG)	Storage Volume Required to Meet 25-Yr, 24-Hr Peak Reduction Goal (MG)	Maximum Stormwater Storage Volume Required (MG)	Maximum Stormwater Storage Volume Required (CF)
MP01	0.02	0.16	0.10	0.16	21,400
MP02	0.01	0.09	0.10	0.10	13,400
MP03	0.01	0.08	0.03	0.08	10,700
MP04	0.02	0.24	0.03	0.24	32,100
MP05	0.03	0.26	0.04	0.26	34,800
MP06	0.01	0.06	0.04	0.06	8,000
MP07	0.01	0.11	0.08	0.11	14,700
MP08	0.03	0.20	0.06	0.20	26,700
MP09	0.01	0.06	0.04	0.06	8,000
MP10	0.06	0.81	0.07	0.81	108,300
MP11	0.02	0.13	0.28	0.28	37,400
TOTALS	0.21	2.18	0.90	2.35	314,100

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APPENDIX C

Stormwater Project Log Template

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