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2012 GREEN INFRASTRUCTURE TECHNICAL ASSISTANCE PROGRAM
City of Atlanta
Atlanta, GA

Boone Boulevard
Green Infrastructure Conceptual Design

Photo: Street-side bioretention

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About the Green Infrastructure Technical Assistance Program

Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on our roofs, streets, and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby waterbodies. The stormwater carries trash, bacteria, heavy metals, and other pollutants from the urban landscape, polluting the receiving waters. Higher flows also can cause erosion and flooding in urban streams, damaging habitat, property, and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water. These neighborhood or site-scale green infrastructure approaches are often referred to as *low impact development*.

EPA encourages the use of green infrastructure to help manage stormwater runoff. In April 2011, EPA renewed its commitment to green infrastructure with the release of the *Strategic Agenda to Protect Waters and Build More Livable Communities through Green Infrastructure*. The agenda identifies technical assistance as a key activity that EPA will pursue to accelerate the implementation of green infrastructure.

In February 2012, EPA announced the availability of $950,000 in technical assistance to communities working to overcome common barriers to green infrastructure. EPA received letters of interest from over 150 communities across the country, and selected 17 of these communities to receive technical assistance. Selected communities received assistance with a range of projects aimed at addressing common barriers to green infrastructure, including code review, green infrastructure design, and cost-benefit assessments. Through the assistance provided to the City of Atlanta (City), EPA developed a concept design for a green infrastructure project to revitalize a distressed neighborhood and reduce flooding and combined sewer overflows (CSOs). The following report presents this concept design in detail, and is intended to provide a nationally applicable model for green infrastructure implementation in distressed neighborhoods.

For more information, visit *http://water.epa.gov/infrastructure/greeninfrastructure/gi_support.cfm*.

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Executive Summary

This report describes a green infrastructure conceptual plan developed for a portion of Boone Boulevard in the City of Atlanta. Located at the border of the English Avenue and Vine City neighborhoods, Boone Boulevard lies within the Proctor Creek Watershed, in an area designated by the EPA as an environmental justice community for watershed improvements. Like many environmental justice communities, the area confronts a range of environmental, social, and economic challenges:

- The area is served by both separate and combined sewer systems, leading to water quality impairments in Proctor Creek;
- Frequent and repeated flooding contributes to a significant number of abandoned properties;
- The area has a 20% housing vacancy rate and a foreclosure rate of 40%;
- 41% of the 9,000 residents of English Avenue and Vine City live below the poverty line;
- Nearly half of all households earn less than $22,355 per year;
- The crime rate in Vine City is more than twice the City of Atlanta average (Park Pride, 2011).

A local nonprofit, Park Pride, identified green infrastructure as a promising approach to addressing the community's challenges. In 2010 and 2011, Park Pride led a coalition of local and national partners—including residents, local, state and federal government agencies, impacted businesses and institutions of higher learning—in a Visioning Process to propose 200 acres of green infrastructure. The proposed green infrastructure would offer a connected series of green spaces to the community while also reducing the amount of combined sewer overflows, which contribute to the water quality impairments in Proctor Creek.[1] In the spring of 2011, Park Pride published the resulting plan, *Proctor Creek/North Avenue Watershed Basin: A Green Infrastructure Vision* (PNA Vision). The green infrastructure proposed for the PNA project includes parks, stormwater management greenways, community gardens and other vegetative areas, as well as constructed streams, rain gardens and bioretention ponds. In addition to the series of connected green spaces, the PNA Vision calls for the introduction of green streets—a design approach that uses natural systems to reduce stormwater runoff, improve water quality, enhance pedestrian safety, and beautify neighborhoods. The Boone Boulevard conceptual design and project prioritization presented in this report provide a site-specific green street design that complements the city's concept for this transportation corridor and could be integrated with several planned roadway improvements. The project also can serve as a template for additional green street retrofits elsewhere as the PNA Vision progresses.

Section 1 of this report presents the project process and local context and describes the benefits of green infrastructure. Site conditions and the proposed site design are found in Section 2, the goals of the project and design are discussed in Section 3, and the types of green infrastructure considered for the project are included in Section 4. The conceptual design is presented in Section 5, and green infrastructure technical specifications are included in Section 6. Section 7 provides information on proper operation and maintenance of green infrastructure, and Section 8 provides detailed capital cost estimates for the proposed conceptual design. References are found in Section 9. Appendix A is the Proctor Creek/North Avenue Needs Assessment and Appendix B is the Project Prioritization Summary. Conceptual design layouts are found in Appendix C.

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[1] In 2008, the City completed combined sewer separation of the Greensferry combined sewer overflow (CSO); however, the North Avenue CSO facility is still operational. Both facilities are located in the headwaters of the Proctor Creek Watershed.

1 Introduction

1.1 Project Process and Local Context

The Proctor Creek/North Avenue (PNA) watershed basin is an urban watershed immediately west of downtown Atlanta. Land use within the PNA consists of primarily low income residential and commercial uses that are supported by two wastewater treatment plants, one of which is a combined sewer treatment facility. The watershed has experienced frequent and repeated flooding in recent years resulting in a significant quantity of abandoned properties.

In 2011, Park Pride in conjunction with a coalition of local and national partners developed the *Proctor Creek/North Avenue Watershed Basin: A Green Infrastructure Vision* (PNA Vision). The PNA Vision proposed a series of green infrastructure projects within the PNA area that offer a network of green spaces to the community while providing capacity relief for the combined sewer system. Proposed green infrastructure features include parks, day-lighted streams, greenways, and community gardens.

EPA used the *PNA Vision* as a starting point for designing a green infrastructure project in the Proctor Creek watershed. The *PNA Vision* and other studies were reviewed to identify needs within the watershed (summarized in Appendix A). Needs include:

- Flood reduction and management to provide capacity relief for the combined sewer system;
- Cleaner surface and groundwater;
- Improved streets and sidewalks; and
- Economic revitalization.

Project team members, accompanied by Park Pride staff, conducted a field assessment of the watershed to collect additional information about potential green infrastructure sites identified in the PNA Vision. A meeting was held with City planners, stakeholders, and citizen representatives to discuss the preliminary field evaluation results and to help inform the selection and project prioritization criteria. Sites were then scored and ranked according to priority criteria. This process is summarized in Appendix B. The City used the information gleaned from this evaluation process to select a single green infrastructure project to develop into a conceptual plan. The selected project incorporates green infrastructure practices along the Boone Boulevard roadway corridor from Maple Street to James P. Brawley Drive.

Boone Boulevard is an east-west road that is located in the northwest quadrant of Atlanta. It passes through several neighborhoods and crosses the future path of the Atlanta BeltLine, a large-scale multi-use trail and greenway system. The City of Atlanta has been considering the redevelopment of Boone Boulevard (previously named Simpson Road) for several years. Plans for this corridor are detailed in the City's 1995 *Simpson Redevelopment Plan* and the City's 2006 *Simpson Road Corridor Redevelopment Plan Update*. The 2006 update presents a concept that involves concentrated mixed-use activity nodes linked by a continuous transportation corridor with streetscape and residential uses.

Implementing a green infrastructure project along Boone Boulevard would complement the city's concept for this corridor and could be integrated with several planned roadway improvements. This corridor is being reconstructed between Chappell Road and Northside Drive to reduce the road from four lanes to two lanes and to add improved bike lanes. In addition, Boone Boulevard is part of the Cycle Atlanta Phase 1 study conducted by the Atlanta Regional Commission Livable Centers Initiative (LCI). The Atlanta Regional Commission recently awarded the city $2.0M for installation of projects in the Phase 1 study. For Boone Boulevard, that includes resurfacing and restriping the current roadway surface. In April 2013, the City of Atlanta Department of Watershed Management was awarded a Section 319(h) grant in the amount of $387,747 to provide incremental funding for implementation of the green infrastructure components of the project. The City has made a further commitment to expand the scope of the green street to 1.2 linear miles along Boone Boulevard connecting downtown Atlanta to the west side of the BeltLine.

1.2 Benefits of Green Infrastructure

Urbanization and associated land cover change inhibit many of the processes that drive the natural hydrologic cycle, including infiltration, percolation to groundwater, and evapotranspiration. Traditional engineering approaches exacerbate these changes by rapidly conveying stormwater runoff into drainage systems, discharging higher flows and pollutant loads into receiving waters. As a result, stormwater runoff from urbanized areas is often a significant source of water quality impairments.

Green infrastructure is an important design strategy for protecting water quality that provides multiple community benefits. EPA defines green infrastructure as structural or non-structural practices that mimic or restore natural hydrologic processes within the built environment. Common green infrastructure practices include permeable pavement, bioretention facilities, and green roofs. These practices complement conventional stormwater management practices by enhancing infiltration, storage, and evapotranspiration throughout the built environment and managing runoff at its source.

Green infrastructure methods often offer greater versatility in design than conventional management practices, and can be incorporated into new urban development and redevelopment designs with relative ease. Green infrastructure practices have also been shown to cost-effectively reduce the impacts of stormwater runoff while reducing stormwater control measure (SCM) maintenance requirements (Chen and Hobbs, 2013). In addition, a key advantage of green infrastructure over conventional infrastructure is that green infrastructure provides multiple benefits to the surrounding community, including the following:

- **Increased property values:** Many aspects of green infrastructure can increase property values, including improved aesthetics, drainage, and recreational opportunities. Table 1-1 summarizes the recent studies that have estimated the effect that green infrastructure or related practices have on property values. The majority of these studies addressed urban areas, although some suburban studies are also included. The studies used statistical methods for estimating property value trends from observed data.
- **Increased enjoyment of surroundings:** A large study of inner-city Chicago found that one-third of the residents surveyed said they would use their courtyard more if trees were planted (Kuo, 2003). Residents living in greener, high-rise apartment buildings reported significantly more use of the area just outside their building than did residents living in buildings with less vegetation (Hastie, 2003; Kuo, 2003). Research has found that people make more walking trips when they are aware of natural features in the neighborhood and judge distances to be greater than they actually are in less green neighborhoods (Wolf 2008).
- **Increased safety and reduced crime:** Researchers examined the relationship between vegetation and crime for 98 apartment buildings in an inner city neighborhood and found the greener a building's surroundings are, the fewer total crimes (including violent crimes and property crimes), and that levels of nearby vegetation explained 7 to 8 percent of the variance in crimes reported by building (Kuo, 2001a). The stress reduction effects of trees are likely to also have the effect of reducing road rage and improving the attention of drivers (Wolf, 1998; Kuo, 2001a). Generally, if properly designed, narrower, green streets decrease vehicle speeds and make neighborhoods safer for pedestrians (Wolf, 1998; Kuo, 2001a).

- **Increased sense of well-being:** There is a large body of literature indicating that green space makes places more inviting and attractive and enhances people's sense of well-being. People living and working with a view of natural landscapes appreciate the various textures, colors, and shapes of native plants, and the progression of hues throughout the seasons (Northeastern Illinois Planning Commission, 2004). Birds, butterflies, and other wildlife attracted to the plants add to the aesthetic beauty and appeal of green spaces and natural landscaping. Attention restorative theory postulates that exposure to nature reduces mental fatigue, with the rejuvenating effects coming from a variety of natural settings, including community parks and views of nature through windows; in fact, desk workers who can see nature from their desks experience 23 percent less time off sick than those who cannot see any nature, and desk workers who can see nature also report a greater job satisfaction (Wolf, 1998).

Table 1-1. Studies estimating percent increase in property value from green infrastructure

Source	Percent increase in Property Value	Notes
Ward et al. (2008)	3.5 to 5%	Estimated effect of green infrastructure on adjacent properties relative to those farther away in King County (Seattle), WA.
Shultz and Schmitz (2008)	0.7 to 2.7%	Referred to effect of clustered open spaces, greenways and similar practices in Omaha, NE.
Wachter and Wong (2006)	2%	Estimated the effect of tree plantings on property values for select neighborhoods in Philadelphia.
Anderson and Cordell (1988)	3.5 to 4.5%	Estimated value of trees on residential property (differences between houses with five or more front yard trees and those that have fewer), Athens-Clarke County (GA).
Voicu and Been (2008)	9.4%	Refers to property within 1,000 feet of a park or garden and within 5 years of park opening; effect increases over time.
Espey and Owasu-Edusei (2001)	11%	Refers to small, attractive parks with playgrounds within 600 feet of houses.
Pincetl et al. (2003)	1.5%	Refers to the effect of an 11% increase in the amount of greenery (equivalent to a one-third acre garden or park) within a radius of 200 to 500 feet from the house.
Hobden, Laughton and Morgan (2004)	6.9%	Refers to greenway adjacent to property.
New Yorkers for Parks and Ernst & Young (2003)	8 to 30%	Refers to homes within a general proximity to parks.

2 Boone Boulevard Site

2.1 Existing Conditions

The proposed green street project on Boone Boulevard will treat an area of just over 2.5 acres between Brawley Drive and Maple Street, covering over 2,200 feet of roadway. The entire catchment area is approximately 92% impervious, and has an average slope of approximately 5%. The soils are predominantly classified as urban with a null Hydrologic Soil Group (HSG) value. There are no known potential soil contamination issues within the project area. The project area is not designated as a groundwater recharge area.

Most of the existing 4-lane roadway (two lanes each direction) is drained via a combined sewer system that intersects a main trunk line running north–south along Vine St. The block between Brawley Dr. and Griffin St. drains westward to a separate storm main at Brawley Drive. The City-owned right-of-way extends beyond the edges of the sidewalks located on both sides of the roadway. There are approximately 26 driveway entrances along the project area, although several of these connect to vacant lots. In addition, there are bus stops at the southwest and northeast corners of each of the seven intersections. Currently there is no designated on-street parking along Boone Boulevard.

A planned road diet will convert the existing 4-lane (2 lanes each direction) road to two, 10-foot travel lanes with a 12-foot left turn lane at selected intersections. According to the City of Atlanta, left-turn lanes will be required at Brawley Dr., Sunset Ave., and Vine St. (east-bound only). A 5-foot-wide bike lane will also be included on both sides of the street. Although the existing right-of-way is approximately 55 feet along Boone Boulevard, the road diet improvements will only extend between the inside edge of the sidewalk on both sides of the street, which is typically a 44-foot width.

The City provided GIS data layers for their storm and sanitary sewer network in the project area, which included locations, diameters, and material types for all of the pipe lines, and locations and rim elevations for the structures (e.g., catch basins, manholes, drop inlets, etc.). The GIS data also contained invert elevations for seven of the structures in the project area, which ranged in depth from 2.4 to 3.6 feet. Catch basins or drop inlets are located at every intersection within the project area. The storm drains along Boone Boulevard are reinforced concrete pipe with either 12- or 15-inch diameters. The combined sewer trunk line running under Vine St. is 12 feet in diameter according to the GIS layer, with unknown depth. The sewer line and associated laterals along Boone Boulevard, which were more critical to the green street implementation, were shown to have invert depths in excess of 5.2 feet and are not likely to conflict with proposed green street drainage features.

Boone Boulevard is also adjacent to the future site of a public park. Part of the City of Atlanta's approved proposals to restore the Vine City neighborhood involves the establishment of the 16-acre Historic Mims Park. The park will be located south of Boone Boulevard between Elm and Walnut Streets and will consolidate numerous vacant lots that are owned by the City. The park would be built in phases and include various monuments that salute Atlanta's historic figures, a retention pond to manage runoff from within the park, public art, educational activities, a museum, and an urban farm and greenhouses.

Figure 2-1 depicts the project catchment area, existing storm drainage network and topography, and parcel boundaries.

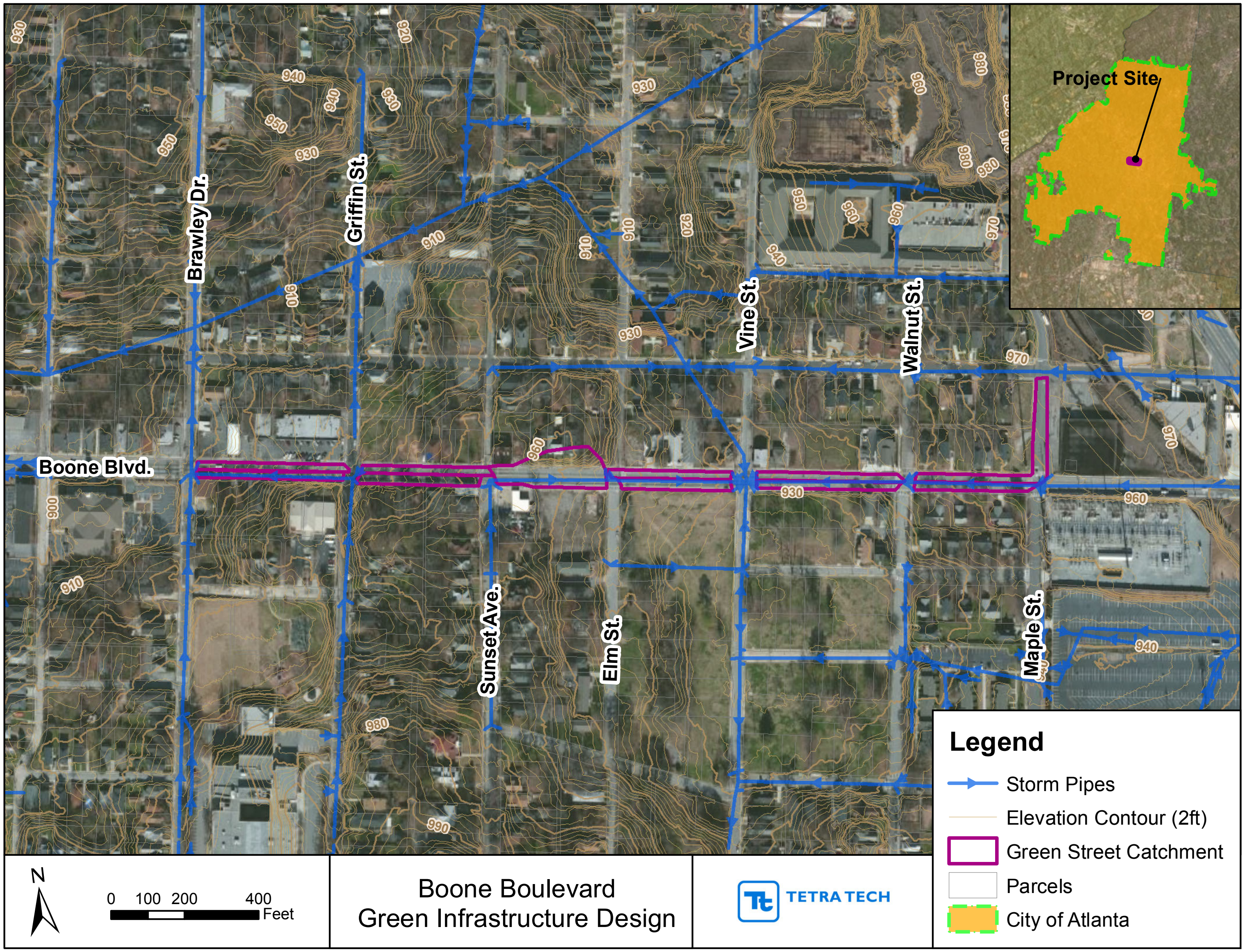


Figure 2-1. Boone Boulevard green infrastructure catchment area

Table 2-1 shows the drainage area properties for each catchment area. Catchment areas were delineated by block and road centerline. For example, drainage area “Vin-Wal N” represents the north side of Boone Boulevard between Vine St. and Walnut St. Offsite contributions from private driveways, curb cuts, etc. are also a factor in the green infrastructure design.

Table 2-1. Drainage area characteristics

Property	Wal-Map S	Wal-Map N	Vin-Wal S	Vin-Wal N	Elm-Vin S	Elm-Vin N	Sun-Elm N & S	Gri-Sun S	Gri-Sun N	Bra-Gri S	Bra-Gri N
Area (ac)	0.15	0.38	0.18	0.19	0.23	0.16	0.66	0.21	0.17	0.18	0.19
Slope (%)	4.5	4.4	4.5	4.5	5.0	4.8	3.0	5.9	5.2	6.4	6.2
Imperv. (%)	100	100	100	100	88	82	88	100	100	78	79

Example photographs of the study area are provided in Figure 2-2 and Figure 2-3.

Figure 2-2. Boone Boulevard from Brawley Dr., facing east

Figure 2-3. Boone Boulevard from Walnut St., facing west

2.2 Proposed Site Design

The overall vision for the Boone Boulevard green infrastructure project, provided in detail in Appendix C, is to implement “green street” infrastructure in conjunction with the planned road diet improvements. The proposed design includes a combination of planter box and permeable pavement features, in addition to several bioretention systems proposed outside of the road right-of-way in Mims Park. Each practice was designed to capture and treat the runoff from a 1.2 inch rainfall event. Several extended planting strips are also proposed along the roadway to reduce impervious area and take advantage of underutilized areas created by the road diet. Consistent with green street objectives, the extended planting strips help reduce overall runoff to downstream areas and receiving SCMs. The design and layout of the proposed green street was governed mostly by traffic and community needs, followed by water quality sizing criteria, as discussed in Section 4.

3 Goals

3.1 Project Goals

As stated in the Introduction, the goals for this project were largely shaped by the PNA Vision. The PNA Vision brought together a coalition of local and national stakeholders to identify community goals within the Proctor Creek/ North Avenue watershed and to propose alternative solutions. Among the goals identified in the PNA Vision were:

- Flood reduction and management to provide capacity relief for the combined sewer system;
- Cleaner surface and groundwater;
- Improved streets and sidewalks; and
- Economic revitalization.

By engaging a range of stakeholders, the PNA Vision was also able to propose innovative approaches to meeting multiple community goals. One proposed approach was the creation of a network of connected green spaces. Features such as parks, greenways, and community gardens could achieve watershed goals, while also improving aesthetics and quality of life. Green street projects, in particular, were highlighted as a holistic design option to serve the range of community goals.

3.2 Design Goals

Design guidance from the City's Transportation Planning Division took precedence since Boone Boulevard is slated to undergo a road diet project. As a result, the green street features were designed to comply with the road diet design criteria provided by the City's Transportation Planning Division, which is described in more detail in Chapter 5.

The Stormwater Control Measures (SCM) proposed for Boone Boulevard were designed using minimum standard #2 of the Unified Stormwater Sizing Criteria in Volume 2, Chapter 1.3.2.1 of the *Georgia Stormwater Management Manual* (Atlanta Regional Commission, 2001). One of the purposes of the sizing criteria is:

> ...to provide a framework for designing a stormwater management system to remove stormwater runoff pollutants and improve water quality

The Water Quality Criterion states that stormwater management facilities

> treat the runoff from 85% of the storms that occur in an average year. For Georgia, this equates to providing water quality treatment for the runoff resulting from a rainfall depth of 1.2 inches. Reduce average annual post-development total suspended solids loadings by 80%.

As specified, the sizing criteria will treat the runoff from 85% of storms in an average year and provide partial retention of larger storm events to reduce downstream flooding impacts. Specifically, a design rainfall depth of 1.2 inches was determined from the Georgia Stormwater Management Manual to calculate the water quality treatment volume (WQ_v).

4 Green Infrastructure Toolbox

Green infrastructure uses vegetation, soils, and natural processes to manage water within the context of the site design. A range of green infrastructure practices can be incorporated into the urban landscape to complement and enhance the layout of an existing or proposed site while also providing water quality treatment and volume reduction. The following sections describe common green infrastructure practices that are well suited for dense, urban areas and were identified as appropriate for consideration in the Boone Boulevard Green Street project.

4.1 Bioretention Facilities

Bioretention facilities are shallow, depressed areas with a fill soil and vegetation that infiltrate runoff and remove pollutants through a variety of physical, biological, and chemical treatment processes. The depressed area is planted with small to medium sized vegetation including trees, shrubs, grasses, and perennials, and may incorporate a vegetated groundcover or mulch that can withstand urban environments and tolerate periodic inundation and dry periods. Bioretention may be configured differently depending on the site context and design goals. This section summarizes general design considerations for bioretention facilities, and describes two configurations designed for dense urban areas: planter boxes and tree boxes.

Bioretention is well suited for removing stormwater pollutants from runoff, particularly for smaller (water quality) storm events, and can be used to partially or completely meet stormwater management requirements on smaller sites. Bioretention areas can be incorporated into a development site to capture roof runoff and parking lot runoff and within rights-of-way to capture sidewalk and street runoff (Figure 4-1 and Figure 4-2).

General guidelines for applying bioretention facilities are as follows:

- For unlined systems, maintain a minimum of 5 feet between the facility and a building and at least 10 feet from a building with a basement.
- A surface dewatering time of no greater than 72 hours either through infiltration with soils of sufficient percolation capacity or with an underdrain system and outlet to a drainage system. Use of an underdrain system is very effective in areas with low infiltration capacity soils.
- Planted with native and non-invasive plant species that have tolerance for urban environments, frequent inundation, and drought conditions.
- Inclusion of an overflow structure with a non-erosive overflow channel to safely pass flows that exceed the capacity of the facility or design the facility as an off-line system.
- Inclusion of a pretreatment mechanism such as a grass filter strip, sediment forebay, or grass swale upstream of the practice to enhance the treatment capacity of the unit.

Figure 4-1. Bioretention incorporated into a right-of-way

Figure 4-2. Bioretention incorporated into traditional parking lot design.

Planter Box: Planter boxes are bioretention facilities contained within a concrete box, allowing them to be incorporated into tighter areas with limited open space. Runoff from a street or parking lot typically enters a planter box through a curb cut, while runoff from a roof drain typically enters through a downspout. Planter boxes are often categorized either as flow-through planter boxes or infiltrating planter boxes. Infiltrating planter boxes have an open bottom to allow infiltration into the underlying soils. Flow-through planter boxes are completely lined and have an underdrain system to convey flow that is not taken up by plants to areas that are appropriate for drainage away from building foundations. Planter boxes are well suited to narrow areas adjacent to streets and buildings (Figures 4-3 and 4-4).

Figure 4-3. Planter box within street right-of-way

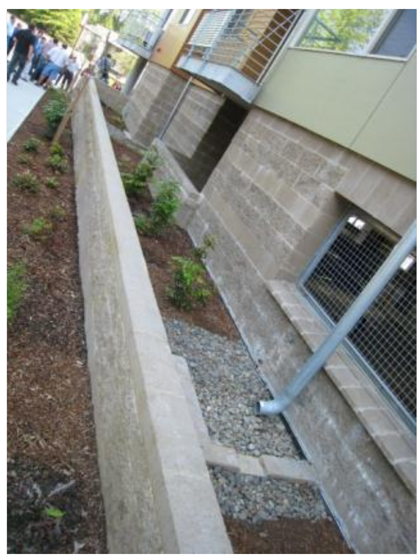


Figure 4-4. Flow-through planter box attached to building

Tree Box: Tree boxes are bioretention facilities configured for dense urban areas that use the water-uptake benefits of trees. They are generally installed along street corridors with curb inlets (Figure 4-5). Tree boxes can be incorporated immediately adjacent to street and sidewalks with the use of a structural soil, modular suspended pavement, or underground retaining wall to keep uncompacted soil in its place. Tree boxes typically contain a highly engineered soil media to enhance pollutant removal while retaining high infiltration rates. The uncompacted media allows urban trees to thrive, providing shade and an extensive root system for water uptake. For low to moderate flows, stormwater enters through the tree box inlet and filters through the soil. For high flows, stormwater will bypass the tree box if it is full and flow directly to the downstream curb inlet.

Figure 4-5. Tree box using grate inlets in street

4.2 Permeable Pavement

Conventional pavement results in increased surface runoff rates and volumes. Permeable pavements, in contrast, allow streets, parking lots, sidewalks, and other surfaces to retain the underlying soil's natural infiltration capacity while maintaining the structural and functional features of the materials they replace. Permeable pavements contain small voids that allow water to drain through the pavement to an aggregate reservoir and then infiltrate into the soil. If the native soils below the permeable pavements do not have enough percolation capacity, underdrains can be included to direct the stormwater to other downstream stormwater control systems. Permeable pavement can be developed using modular paving systems (e.g., concrete pavers, grass-pave, or gravel-pave) or poured-in-place solutions (e.g., pervious concrete or permeable asphalt).

Permeable pavement reduces the volume of stormwater runoff by converting an impervious area to a treatment unit. The aggregate sub-base can provide water quality improvements through filtering and enhance additional chemical and biological processes. The volume reduction and water treatment capabilities of permeable pavements are effective at reducing stormwater pollutant loads.

Permeable pavement can be used to replace traditional impervious pavement for most pedestrian and vehicular applications. Composite designs that use conventional asphalt or concrete in high-traffic areas adjacent to permeable pavements in lower-traffic areas along shoulders or in parking areas can be implemented to meet both transportation and stormwater management needs. Permeable pavements are most often used in constructing pedestrian walkways, sidewalks, driveways, low-volume roadways, and parking areas of office buildings, recreational facilities, and shopping centers (Figure 4-6 and Figure 4-7).

General guidelines for applying permeable pavements are as follows:

- Permeable pavements can be substituted for conventional pavements in parking areas, low-volume/low-speed roadways, pedestrian areas, and driveways if the grades, native soils, drainage characteristics, and groundwater conditions of the paved areas are suitable.
- Permeable pavement is not appropriate for stormwater hotspots where hazardous materials are loaded, unloaded, or stored, unless the sub-base layers are completely enclosed by an impermeable liner.
- The granular capping and sub-base layers should provide adequate construction platform and base for the overlying pavement layers.
- If permeable pavement is installed over low-permeability soils or temporary surface flooding is a concern, an underdrain should be installed to ensure water removal from the sub-base reservoir and pavement.
- The infiltration rate of the soils or an installed underdrain should drain the sub-base within 24 to 48 hours.
- An impermeable liner can be installed between the sub-base and the native soil to prevent water infiltration when clay soils have a high shrink-swell potential or if a high water table or bedrock layer exists.
- Measures should be taken to protect permeable pavements from high sediment loads, particularly fine sediment, to reduce maintenance. Typical maintenance includes removing sediment with a vacuum truck.

Figure 4-6. Permeable pavement one-way cycle track

Figure 4-7. Permeable interlocking concrete paver parking stalls

4.3 Impervious Area Conversion

In areas where existing impervious surfaces are unutilized or unwarranted, impervious paved areas can be converted to pervious landscaped areas. While impervious area conversion does not provide treatment to runoff from adjacent surfaces like other green infrastructure practices it does reduces the volume and pollutant load of stormwater as a result of land cover change. Impervious area conversion can be used to reduce the required size of downstream stormwater control measures. Two examples of impervious area conversion suitable for use in roadway corridors are vegetated medians (Figure 4-8) and extended planting strips.

Figure 4-8. Conversion of impervious roadway to vegetated center median

5 Green Infrastructure Conceptual Design

The selection of green infrastructure practices was informed by both the project goals for the site and the physical constraints posed by existing and future redevelopment conditions. The green infrastructure design goals identified by City of Atlanta staff primarily included improving the aesthetics of the roadway while simultaneously providing water quality and hydrologic benefits.

5.1 Conceptual Layout

Since Boone Boulevard is already planned to undergo a road diet project, the green street features were designed to comply with the road diet design criteria provided by the City's Transportation Planning Division.

Based on the aforementioned design requirements for the road diet, proposed green street features could be located along all sections of roadway that do not require an adjacent left turn lane. In these areas, up to 12 feet of road width is available to locate a curbside planter box, which is the City of Atlanta's preferred practice. Given the narrow footprint available for detention and treatment within the road corridor, planter boxes are generally limited to one side of the street. Since the existing road crest will be preserved during the planned street improvements, the planter boxes were designed to treat the water quality volume from one half of the roadway.

In areas where additional space is not available to treat the other half of the roadway with planter boxes, permeable pavement is proposed for the opposite bike lane to provide adequate treatment. Where implemented, the permeable pavement bike lanes are proposed to extend the entire block to connect to the down gradient catch basin and simplify the construction process. As a result, the permeable pavement infiltration capacity is typically oversized with respect to its catchment's water quality volume. In street sections where runoff is treated by planter boxes or off-line bioretention, impermeable asphalt is proposed for bike lanes in lieu of permeable pavement.

The City also expressed interest in installing stormwater treatment features adjacent to Boone Boulevard in Historic Mims Park. Separate bioretention systems were proposed for the area between Elm and Vine streets to treat runoff from the entire Sunset-Elm block, and south side of the Elm-Vine block. This approximate half-acre grassed open area is relatively flat, devoid of utilities, and up-gradient of existing storm sewers that connect back to the main trunk line along Vine St. Runoff from the Sunset-Elm block could be diverted via new culverts under Boone Boulevard and Elm Street, in addition to a new catch basin at the southwest corner of the Boone-Elm intersection. The Elm Street culvert would discharge into a stone settling basin in the park before overflowing into a series of two bioretention cells sized to treat the water quality volume. The second bioretention cell contains a grassed spillway that could discharge overflow to a shared outlet structure (i.e., concrete box riser with 4-sided weir) located in the other bioretention system treating the Elm-Vine-S drainage area. Runoff from the south side of the Elm-Vine block could be conveyed to the park area via a curb cut and recessed concrete flume through the sidewalk. Runoff could be conveyed through a pretreatment grass swale before entering the bioretention cell that contains the outlet structure. All of the bioretention cells would require perforated underdrains that connect to the outlet structure. A new reinforced concrete pipe culvert would convey flow from the outlet structure to the existing combined sewer system running along Vine St.

Figure 5-1 shows the proposed green street design for the Boone Boulevard project area.

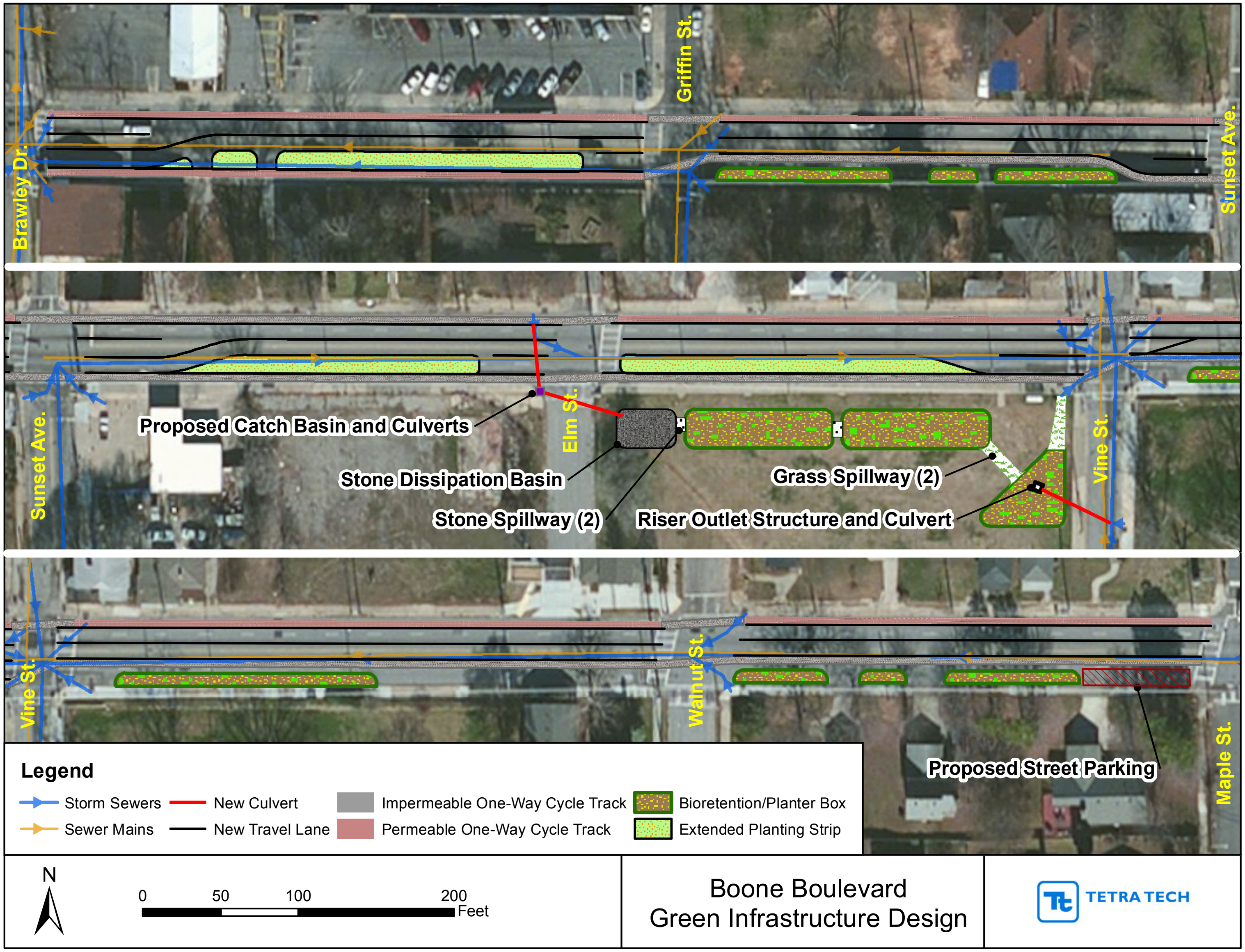


Figure 5-1. Conceptual layout for Boone Boulevard green infrastructure practices

5.2 Green Infrastructure Sizing

The Stormwater Control Measures (SCM) proposed for Boone Boulevard were designed using Minimum Standard #2 of the Unified Stormwater Sizing Criteria as described in Volume 2, Chapter 1.3.2.1 of the *Georgia Stormwater Management Manual* (Atlanta Regional Commission, 2001). One of the purposes of the sizing criteria is:

> ...to provide a framework for designing a stormwater management system to remove stormwater runoff pollutants and improve water quality

The Water Quality Criterion states that stormwater management facilities

> treat the runoff from 85% of the storms that occur in an average year. For Georgia, this equates to providing water quality treatment for the runoff resulting from a rainfall depth of 1.2 inches. Reduce average annual post-development total suspended solids loadings by 80%.

The sizing criteria will treat the runoff from 85% of storms in an average year and provide partial retention of larger storm events to reduce downstream flooding impacts. Specifically, a design rainfall depth of 1.2 inches was determined from the Georgia Stormwater Management Manual to calculate the water quality treatment volume (WQ_v), using the following equation:

$$WQv = \frac{1.2 * Rv * A}{12}$$

Where "A" equals the drainage area in acres and "Rv" is the volumetric runoff coefficient. Rv is calculated using the imperviousness of the drainage area:

$$Rv = 0.05 + 0.009 * I$$

Where "I" is imperviousness expressed as a percent.

Table 5-1 shows the calculated water quality treatment volumes for each of the sub-catchment areas. Table 5-2 shows the proposed sizing for the Boone Boulevard green street SCMs. All the planter boxes and bioretention cells were designed using the typical design standard for the City of Atlanta and use a 6-inch ponding depth underlain by a 2-foot-deep soil media and associated gravel underdrain system. All are adequately sized to treat the water quality volume. Permeable pavement bike lanes are designed to use interlocking concrete paver blocks underlain with an 18-inch drainage/storage layer and an associated underdrain system. As mentioned in Section 5.1, the permeable pavement bike lane locations are proposed to extend the entire way down each block, which yield subsurface storage volumes that exceed the targeted water quality treatment volume. The only undersized permeable pavement bike lane is the one for the Vine-Walnut block where the drainage area delineation includes a portion of Walnut street north of Boone Boulevard.

Table 5-1. Existing drainage area runoff volumes

Subcatchment	SCM Type	DA (ac)	WQ_v (ac-ft)	WQ_v (cu.ft.)
Wal-Map S	Planter Box	0.15	0.015	636
Wal-Map N	Permeable Pavement	0.38	0.036	1,560
Vin-Wal S	Planter Box	0.18	0.017	745
Vin-Wal N	Permeable Pavement	0.19	0.018	781
Elm-Vin S	Bioretention	0.23	0.019	830
Elm-Vin N	Permeable Pavement	0.16	0.012	543
Sun-Elm N & S	Bioretention	0.66	0.055	2,404
Gri-Sun S	Planter Box	0.21	0.020	859
Gri-Sun N	Permeable Pavement	0.17	0.016	690
Bra-Gri S	Permeable Pavement	0.18	0.014	601
Bra-Gri N	Permeable Pavement	0.19	0.015	636

Table 5-2. Proposed green street SCM sizing

SCM ID	SCM Type	Width (Ft)	Length (Ft)	Surface Area (Sq ft)	Storage Vol. (Cu ft)[1]	% of WQ Vol.
Wal-Map S	Planter Box	8	159	1,273	636	100%
Vin-Wal S	Permeable Pavement	5	299	1,496	718	46%
Vin-Wal N	Planter Box	8	186	1,489	745	100%
Wal-Map N	Permeable Pavement	5	377	1,886	905	116%
Elm-Vin S	Bioretention	55[2]	55[2]	1,660	830	100%
Elm-Vin N	Permeable Pavement	5	300	1,498	719	133%
Sun-Elm N & N	Bioretention	27	190	5,134	2,567	100%
Gri-Sun N	Planter Box	8	215	1,717	859	100%
Gri-Sun S	Permeable Pavement	5	317	1,583	760	110%
Bra-Gri S	Permeable Pavement	5	383	1,917	920	180%
Bra-Gri N	Permeable Pavement	5	386	1,929	926	120%

1. Does not include water storage in bioretention media
2. Triangular dimension; width and length are base and height dimensions

6 Green Infrastructure Technical Specifications

The purpose of this section is to provide guidance for designing the green infrastructure practices during final design. Design criteria for the planter boxes were derived from standard details provided by the City of Atlanta. Design of the bioretention cells and permeable pavement are based on criteria provided in Chapter 3.2.2 and Chapter 3.3.7 of the Georgia Stormwater Manual (Vol. 2), respectively. For the reader's benefit, design guidance for these three practices is consolidated into Table 6.1 and Table 6.2 at the end of this section.

6.1 Common Elements

a) Soil Media

Soil media is typically specified to meet the growth requirements of the selected vegetation while still meeting the hydraulic requirements of the system. The system must be designed to drain the surface storage volume in no more than 48 hours. The expected infiltration rate should be at least 0.5 in/hr.

Based on research from NC State, the engineered soil mixture shall be a blend of sandy loam, loamy sand, or loam texture with a content of fines (silt and clay) ranging from 8 to 12%. Organic matter should compose 1.5 to 3% of the mixture to help vegetation establish and increase sorption of pollutants. Organic material should not consist of manure or animal compost. Newspaper mulch has been shown to be an acceptable additive.

Gradation analyses of the blended material, including hydrometer testing for clay content and permeability testing of the soil filter material, should be performed by a qualified soil testing laboratory and submitted to the project engineer for review. Particle gradation tests should conform with ASTM C117/C136 (AASHTO T11/T27) and the blended material should have no less than 8% passing the 200 sieve and shall have a clay content of less than 2%. Other soil media design criteria include:

- pH should be between 5.5 and 6.5, cation exchange capacity (CEC) should be greater than 5 milliequivalent (meq)/100 g soil, and a maximum soluble salts concentration of 500 ppm.
- High levels of phosphorus in the media have been identified as the main cause of bioretention areas exporting nutrients. All bioretention media should be analyzed for background levels of nutrients. Total phosphorus should not exceed 15 ppm.
- Geotextile fabric of Mirafi 170n or equivalent may be placed between the sides of the filter layer and adjacent soil to prevent surrounding soil from migrating into the filter and clogging the outlet. Overlap seams must be a minimum of 12 inches.

b) Underdrain

An underdrain is required in areas where existing soils have an infiltration rate less than 0.5 in/hr and should meet the following criteria:

- The underdrain piping should be 6" (4" for planter boxes) rigid Schedule 40 PVC (AASHTO M252) and have 3/8-inch perforations spaced at 6-inch centers, with a maximum of 4 holes per row. The total opening area should exceed the expected flow capacity of the underdrain and does not limit infiltration through the soil media. Structure joints shall be sealed so they are watertight.

- Internal water storage zones can be created within the bottom of the bioretention cell by installing an upturned elbow on the underdrain where it discharges into the outlet structure.
- At least one line of underdrain should be spaced at a maximum of 10 feet on center on a minimum grade of 0.5%.
- Underdrain pipes must be bedded in 10 to 12 inches of clean, well-graded 1½" to ¾" washed stone.
- A choking layer composed of 2" of washed sand and 2" of #8 stone should be placed above the gravel layer to prevent the underdrain from clogging from migrating media particles.
- The underdrain must drain freely and discharge to the existing stormwater infrastructure.

c) Plant Selection

For the practice to function properly as stormwater treatment and blend into the landscape, vegetation selection is crucial. Appropriate vegetation will have the following characteristics:

1. Plant materials must be tolerant of drought, ponding fluctuations, and saturated soil conditions for 10 to 48 hours.
2. It is recommended that a minimum of three tree, three shrubs, and/or three herbaceous groundcover species be incorporated to protect against facility failure from disease and insect infestations of a single species.
3. Woody vegetation should not be specified at inflow locations.
4. Native plant species or tough/vigorous cultivars that are not invasive and do not require chemical inputs are recommended to be used to the maximum extent practicable.
5. Additional information and guidance on the appropriate woody and herbaceous species appropriate for bioretention in Georgia, and their planting and establishment, can be found in Appendix F (Landscaping and Aesthetics Guidance) of the Georgia Stormwater Management Manual, Vol. 2 (Atlanta Regional Commission, 2001).
6. After planting, the filter area should be mulched with 2-3 inches of triple-shredded hardwood mulch. A one-time spot fertilization is optional for first-year plantings.

d) Geotechnical Investigation

A full geotechnical investigation is recommended to characterize the soils prior to final design. Pertinent information includes permeability at each bioretention site, hydrologic soil group type, depth to water table, and the presence of expansive soils. If expansive soils are present, bioretention design should include an impermeable barrier since the proposed bioretention cell locations are adjacent to infrastructure such as roads and buildings.

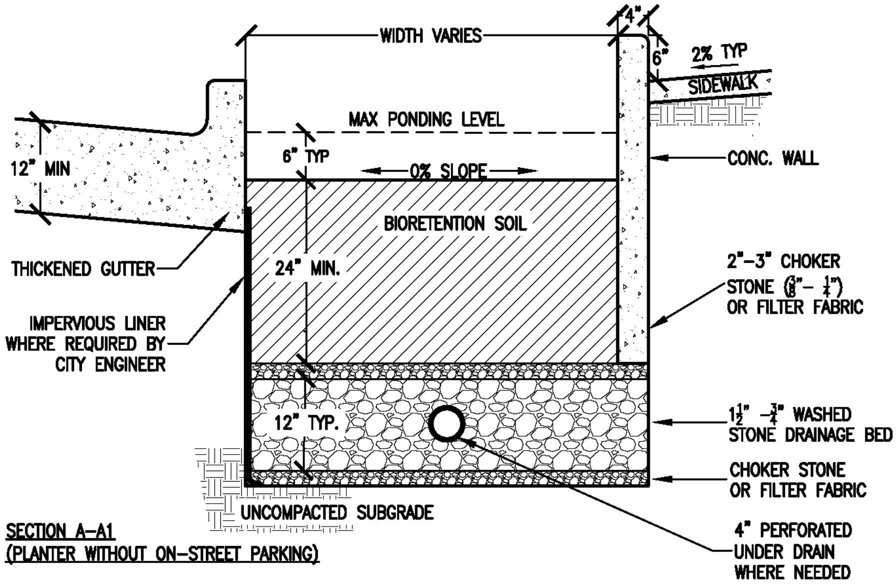
e) Maximizing Infiltration

SCMs implemented over soils with low permeability can be hydrologically connected to SCMs implemented over high permeability soils through the underdrain systems. Hydrologically connecting the SCMs where infiltration will be limited to locations where infiltration will be higher will maximize the treatment capacity of the site providing a greater overall infiltration capacity.

Table 6-1. Traditional bioretention/planter box specifications

1. Siting Setbacks	
Pavement	No requirement
Building	No requirement with lined bottom; otherwise,
	Basement: ≥ 10 feet
	No Basement: ≥ 5 feet
Property lines/ROW	≥ 2 feet / ≥0 feet
2. Volume	
Bottom slope	Flat
Side slopes	Bioretention: 2H:1V or flatter
	Planter Box: Vertical retaining wall
Freeboard	6 to 12 inches
3. Vertical Component	
Surface Storage	6 inches
Growing Layer	BR: ≥ 48 inches soil media;
	PB: ≥ 24 inches soil media;
	3 inches of mulch, max
Filter Layer	2 to 4 inches of clean medium sand (ASTM c-33) over 2 to 3 inches of #8 or #78 washed stone when drainage layer is used
Drainage Layer	Recommended 12 to 30 in. of clean coarse aggregate AASHTO #4, #5, or equivalent
Native Material	Test infiltration; ≥1/2 in/hr if designing with infiltration
4. Drainage	
Inlet	Curb inlet; sheet flow through grass filter strip downspout w/ energy dissipation
Underdrain	6-inch (BR) or 4-inch (PB) perforated PVC placed to meet dewatering requirement if needed; cleanout at terminal ends and every 250-300 feet
Outlet	Required to meet release rates
Overflow	Downstream inlet or catch basin set 6 to 12 inches above soil surface and connected to storm drainage network
Infiltration	Meet water quality volume requirement
Dewatering	Surface: ≤ 24 hours
	Sub-surface: ≤ 72 hours
5. Composition	
Surface Treatment	Vegetation and mulch
Soil Media	With or without an underdrain, meets dewatering requirement; supports plant growth
Side Slopes	Grass or mulch
Mulch	Triple-shredded hardwood
6. Pollutant	
Pretreatment	Required. May include grass filter strip, stone trench, forebay, sump inlets
7. Maintenance	
Access	Able to be accessed by a vehicle
Requirements	Designed and maintained to improve water quality; Maintenance plan should be in place

BR = bioretention; PB = planter boxes



Source: City of Atlanta

Figure 6-1. Typical planter box

Table 6-2. Permeable pavement

1. Siting Setbacks	
Pavement	No requirement
Building	No requirement with lined bottom; otherwise, Basement: ≥ 10 feet No Basement: ≥ 5 feet
Property lines/ROW	≥ 2 feet / ≥0 feet
2. Volume	
Slope	Less than 0.5 percent
Side slopes	Not applicable
Freeboard	Not applicable
3. Vertical Component	
Surface Layer	Interlocking Concrete Pavers; Concrete Grid Pavers; Plastic Grid Pavers; Concrete; Asphalt
Growing Layer	Not applicable
Bedding	1) Perm. Interlocking Conc. Pavers: 1.5 to 3 inches of #8 or #78 washed stone 2) Concrete and Plastic Grid Pavers: 1 to 1.5 inches of bedding sand 3) Permeable Concrete and Asphalt: None
Base Layer	12 to 30 in. of clean aggregate AASHTO #56 or equivalent; thickness depends on strength/storage needed; install 30 mil geotextile liner where aggregate meets soil
Native Material	Compacted as sub-base
4. Drainage	
Inlet	Pavement surface
Outlet	Required to meet release rates
Overflow	Downstream inlet
Infiltration	Meet water quality volume requirement
Dewatering	≤ 72 hours
5. Composition	
Surface Treatment	For interlocking or grid-type pavers use fine aggregate, coarse sand, or top soil & grass in openings
6. Pollutant	
Pretreatment	Divert runoff from sediment sources away from pavement
7. Installation and Maintenance	
Installation	Per manufacturer's recommendation
Load Bearing	Designed for projected traffic loads using AASHTO methods
Requirements	Designed and maintained to improve water quality; Maintenance plan should be in place

Notes: A reinforced concrete transition width (12 -18 inches) is required where permeable pavement meets adjacent non-concrete pavement or soil.

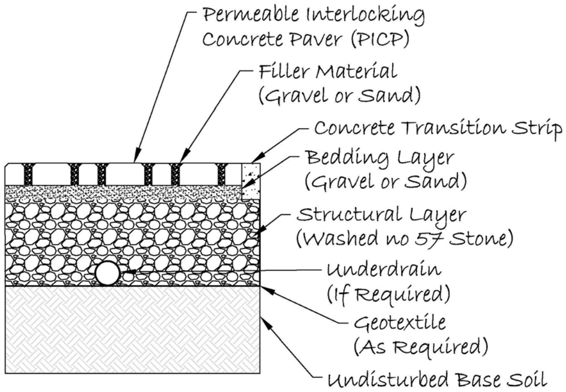


Figure 6-2. Permeable interlocking concrete pavers

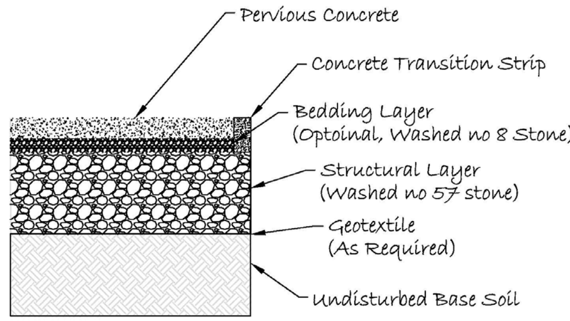


Figure 6-3. Pervious concrete

7 Operations and Maintenance

Maintenance activities should be focused on the major system components, especially landscaped areas and permeable pavement. Landscaped components should blend over time through plant and root growth, organic decomposition, and should develop a natural soil horizon (Table 7-1). The biological and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance. The primary maintenance requirement for permeable pavement consists of regular inspection for clogging and sweeping with a vacuum-powered street sweeper (Table 7-2).

Irrigation for the bioretention systems might be needed, especially during plant establishment periods or in periods of extended drought. Irrigation frequency will depend on the season and type of vegetation. Native plants will likely require less irrigation than nonnative plants.

The following tables outline the required maintenance tasks, their associated frequency, and notes to expand upon the requirements of each task.

Table 7-1. Bioretention operations and maintenance considerations

Task	Frequency	Maintenance notes
Monitor infiltration and drainage	1 time/year	Inspect drainage time (12–24 hours). Might have to determine infiltration rate (every 2–3 years). Turning over or replacing the media (top 2–3 inches) might be necessary to improve infiltration (at least 0.5 in/hr).
Pruning	1–2 times/year	Nutrients in runoff often cause bioretention vegetation to flourish.
Mowing	2–12 times/year	Frequency depends on the location, plant selection and desired aesthetic appeal.
Mulching	1–2 times/ year	Recommend maintaining 1”–3” uniform mulch layer.
Mulch removal	1 time/2–3 years	Mulch accumulation reduces available water storage volume. Removal of mulch also increases surface infiltration rate of fill soil.
Watering	1 time/2–3 days for first 1–2 months; sporadically after establishment	If drought conditions exist, watering after the initial year might be required.
Fertilization	1 time initially	One-time spot fertilization for first year vegetation (optional).
Remove replace dead plants	1 time/year	Within the first year, 10% of plants can die. Survival rates increase with time.
Inlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow into the retention area is as designed. Remove any accumulated sediment.
Outlet inspection	Once after first rain of the season, then monthly during the rainy season	Check for erosion at the outlet and remove any accumulated mulch or sediment.

Task	Frequency	Maintenance notes
Underdrain inspection	Once after first rain of the season, then yearly during the rainy season	Check for accumulated mulch or sediment. Flush if water is ponded in the bioretention area for more than 72 hours.
Miscellaneous upkeep	12 times/year	Tasks include trash collection, plant health, spot weeding, and removing mulch from the overflow device.

Table 7-2. Permeable pavement operations and maintenance considerations

Task	Frequency	Maintenance notes
Impervious to Pervious interface	Once after first rain of the season, then monthly during the rainy season	Check for sediment accumulation to ensure that flow onto the permeable pavement is not restricted. Remove any accumulated sediment. Stabilize any exposed soil.
Vacuum street sweeper	Twice per year as needed	Portions of pavement should be swept with a vacuum street sweeper at least twice per year or as needed to maintain infiltration rates.
Replace fill materials (applies to pervious pavers only)	1-2 times per year (and after any vac truck sweeping)	Fill materials will need to be replaced after each sweeping and as needed to keep voids with the paver surface.
Miscellaneous upkeep	4 times per year or as needed for aesthetics	Tasks include trash collection, sweeping, and spot weeding.

8 Capital Cost Estimates

The cost estimates for implementing the green street features along Boone Boulevard are found in Table 8-1.

Table 8-1. Cost estimate for implementation of Boone Boulevard green infrastructure

Item No	Description	Quantity	Unit	Unit Cost	Total
	Preparation				
1	Traffic Control	15	day	$1,000.00	$15,000
	Site Preparation				
2	Curb and Gutter Removal	560	LF	$6.00	$3,359
3	Excavation and Removal	2,312	CY	$22.00	$50,862
4	Remove Asphalt Pavement & Base	2,568	SY	$10.00	$25,678
5	Driveway Accommodation	4	EA	$700.00	$2,800
	Traditional Bioretention/Planter Box				
6	Fine Grading	21,583	SF	$0.72	$15,540
7	Soil Media - 2' Depth	835	CY	$40.00	$33,402
8	Filter Layer (sand and No. 8 stone)	139	CY	$45.00	$6,263
9	Drainage Layer - 14" Depth	489	CY	$45.00	$21,983
10	Grouted River Rock	314	SF	$15.00	$4,710
11	Baffles	51	EA	$125.00	$6,375
12	Vegetation	10,959	SF	$4.00	$43,837
13	Mulch	68	CY	$55.00	$3,721
14	Curb and Gutter	608	LF	$7.90	$4,802
15	Slotted 4" PVC Underdrain	983	LF	$8.00	$7,864
16	Underdrain Cleanouts	21	EA	$12.00	$246
	Permeable Pavement				
17	Permeable Pavement	10,310	SF	$8.00	$82,477
18	Structural Layer (washed no 57)	286	CY	$45.00	$12,887
19	Subbase Layer (washed no 2)	286	CY	$45.00	$12,887
20	Concrete Vertical Curb	2,062	LF	$8.50	$17,526
21	Slotted 4" PVC Underdrain	2,062	LF	$8.00	$16,495
22	Underdrain Cleanouts	52	EA	$12.00	$619
	Vegetated Medians				
23	Curb and Gutter	1,619	LF	$7.90	$12,790
24	Topsoil (1.5' Depth)	462	CY	$24.00	$11,096
25	Vegetation	8,322	SF	$4.00	$33,288
	Structures				
26	4'x4' Concrete Catch Basin	1	EA	$3,500.00	$3,500
27	12" RCP	145	LF	$31.26	$4,533
	Construction Subtotal				**$454,543**
28	Planning (20% of subtotal)				$90,909
29	Mobilization (10% of subtotal)				$45,454
30	Bond (5% of subtotal)				$4,545
31	Construction contingency (10% of subtotal)				$90,909
	Construction Total				**$686,359**
32	Design (40% of Construction Total)				$274,544
	Total Cost				**$960,903**

Costs are estimated based on the existing site conditions, account for the potential necessity of under-drains and are sized to capture 1.2 inches of runoff from impervious surfaces. The costs include both construction of the green infrastructure practices as well as site preparation, mobilization, etc., but do not implementation of the road diet plan including; roadway re-surfacing, re-striping, signage, and improvements to existing sidewalk to comply with the American Disabilities Act. Costs assume that no utility removal/rerouting will be required. In the event that detailed site survey and final design indicates the need for utility modification or other infrastructure improvements these costs may need revision.

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Appendix A Proctor Creek/North Avenue Needs Assessment

Several studies in the Proctor Creek/North Avenue (PNA) watershed basin have identified social, economic, and environmental needs along major road corridors. These studies include:

- 2004 *Vine City Redevelopment Plan*
- 2009 *Vine City/Washington Park Livable Centers Initiative (LCI)*
- 1998 and 2006 updates of the *English Avenue Community Redevelopment Plan*
- *Atlanta Beltline Redevelopment Pla*n
- *Northside Drive Corridor Plan*
- *Simpson Road Corridor Redevelopment Plan Update*
- 2012 *Proctor Creek Microbial Sampling Study*
- 2011 *Proctor Creek – Headwaters to Chattahoochee River – Watershed Improvement Plan* (Atlanta Regional Commission)

A document produced in 2010 by Park Pride, *Proctor Creek North Avenue Basin: A Green Infrastructure Vision* (PNA Vision), presents the highlights of most of these studies and presents concept plans for four demonstration sites and five catalyst sites, all based on green infrastructure. The needs addressed in these prior studies can help inform the selection of locations to implement green infrastructure projects. Some of these studies also identify improvement projects that are in the planning stages, which may help identify opportunities to complement existing plans, where feasible, or direct attention away from areas where planned projects will sufficiently meet the needs of the area.

Needs include:

1. Flood reduction and management/capacity relief for the combined sewer system
2. Cleaner surface and groundwater
3. Improved streets and sidewalks
4. Economic revitalization

The first two needs can be appropriately evaluated by subwatersheds identified in Figure 1. The last two needs are discussed in the prior studies in terms of neighborhoods and street corridors, and are more appropriately characterized and evaluated in these terms. The needs are discussed in detail in the following sections.

Flood Reduction and Management/Capacity Relief for the Combined Sewer System

Flood reduction and management is the primary need in the project area. Green infrastructure projects can alleviate flooding by directing runoff to bioswales, rain gardens, and other stormwater control features in the landscape. Directing flow away from homes and infrastructure will reduce nuisance flooding. Capturing large flows and releasing the water over an extended period of time will also provide relief to the combined sewer system.

The Vine City Livable Cities Initiative study notes that a flood following a major rainfall in September of 2002 resulted in the declaration of a state of emergency and the flooding of 169 homes in and around the study area. Some residents were evacuated by boat. As part of the response to the disaster, the city purchased land south of Joseph E. Boone Boulevard and demolished the houses in that area.

The area bounded by Simpson, Walnut, Thurmond, and Sunset Streets was designated as a Flood Recovery area by the City of Atlanta. This includes parts of subwatersheds 215 and 105. The blocks boarded by Simpson, Elm, Walnut and Thurmond Streets were identified for open space and residential development due to this area being prone to flooding. These areas were identified as projects H4 and P6 in the 2004 Vine City Redevelopment Plan, and are part of the Boone Park East demonstration project in the PNA Vision document. The City of Atlanta Department of Watershed Management owns two parcels (approximately 12 acres) that are included in this project area. This is a prime site for the green infrastructure improvements, as it typically floods and is already owned by a City agency (PNA Vision).

Much of the area to the immediate east of the Atlanta BeltLine, in subbasin 135, consists of underground streams, sewer overflows, and areas of chronic flooding. Many of the area's houses experience continued stormwater flooding and sewer backup issues (PNA Vision). The PNA Plan for the area named "Valley of Hawks" calls for a considerable amount of area immediately adjacent to the Atlanta Beltline to be developed as green space, green infrastructure, and marsh wetlands).

Subwatershed 105, which is known locally as The Gulch is the largest and most impervious sub-watershed in the PNA watershed. It is the source of is approximately 25% of all the flood runoff from the total project area *(assumes subwatershed 105 corresponds to subwatershed D in PNA Vision)*. The Gulch was a major source of water that flooded the Vine City and English Avenue neighborhoods in 2002 (PNA Vision).

Subwatershed 215, in the northeast corner of the project area has a highly impervious industrial base along the old rail lines and spurs, and south of Donald Lee Hollowell Drive/Bankhead Highway. This subwatershed needs storage for approximately 17 million gallons in cisterns or ponds (PNA Vision) *(assumes subwatershed 215 corresponds to subwatershed K in PNA Vision)*.

Cleaner Surface and Groundwater

The PNA study area needs cleaner surface and groundwater in order to improve the health and safety of the community (Park Pride, 2011). Water quality impairments in the study area are primarily due to urban runoff. Pollutants such as pesticides, herbicides, oils, grease, and sediment wash off of the landscape and into the stream system. A visual survey was conducted in 2009 to identify possible sources of pollution along Proctor Creek, from its headwaters to the Chattahoochee River (Proctor Creek Watershed Improvement Plan). The survey revealed potential non-point sources of pollution, including

- Urban runoff
- Aging or previously repaired sanitary sewer lines that cross the creek
- Signs of terrestrial and aquatic wildlife activity that can contribute fecal bacteria
- Domestic animals with access to or in close proximity of, the creek, which can be a source of fecal bacteria
- Areas where erosion control could be improved
- Excessive amounts of trash and debris that had either washed into the creek or been deliberately placed there

*Escherichia coli (*E. coli) and fecal coliform bacteria are pollutants of concern in parts of the Proctor Creek basin. Proctor Creek is an impaired stream, from its headwaters to the Chattahoochee River. The segment is listed for not meeting State water quality requirements for fecal coliform. A *Proctor Creek Microbial Sampling Study* was conducted by EPA in 2012 to determine if Proctor Creek and its tributaries are experiencing seasonal bacterial impairment and whether the source is human or animal. E. coli was chosen as the parameter of concern rather than the State's fecal coliform standard because studies have shown E. coli to be a better indicator of potential harmful pathogens in a waterbody. Results of the study showed very high levels of bacteria originating from human sources at monitoring station #3, which is outside of the project study area, and immediately downstream of a recently separated combined sewer overflow (CSO) facility. Further downstream, monitoring station #4 shows slightly lower concentrations of bacteria originating from human sources, but concentrations that are much higher than the other sample stations in the study. Station #4 is where Proctor Creek crosses North Avenue, and is within the PNA study area (Subbasins 135 and 209). It appears that elevated levels at station #4 are a result of the recently separated CSO facility upstream of station #3.

Green infrastructure measures that divert water into vegetated areas such as bioswales, tree boxes, or rain gardens allow pollutants to biodegrade or to be filtered to some extent before the water enters surface and groundwater. These measures can also reduce CSO events downstream by detaining storm flow volumes and providing relief to the combined sewer system.

Improved Streets and Sidewalks

Based on the lack of any recent redevelopment or revitalization, it is likely that streets and sidewalks are in need of repair throughout the study area (Park Pride, 2011). A thorough examination of these needs was made for the Vine City neighborhood. Green infrastructure can be used to improve drainage off of streets and sidewalks, and it can also improve the aesthetic appeal of a neighborhood and improve safety. Some of the measures that can be used to improve streets are curb cuts that direct water into bioswales, rain gardens, or street islands; permeable pavement that allows water to seep into the soil; and traffic calming devices to make neighborhoods more pedestrian-friendly.

Within the study area of the *2004 Vine City Redevelopment Plan* sidewalks were found to be missing in numerous locations, and a high number of pedestrians were observed in the neighborhood. The lack of sidewalks presents a challenge to school age children walking to Bethune Elementary and Kennedy Middle schools. In addition, there are numerous streets in the neighborhood in need of infrastructure improvements due to pot holes, poor drainage and lack of overall maintenance. The 2004 Plan identifies specific streets and sidewalks that are missing or in need of repair.

Economic Revitalization

Economic revitalization is needed throughout most of the project study area. An exception may be the area south of Martin Luther King Drive, which is largely occupied by a concentrated group of colleges and universities.

Downtown Atlanta is in need of greater connectivity options to the various transit services that exist today, as well as a hub for future transit. A multi-modal passenger terminal (MMPT) is proposed in the area known as the "gulch," just west of the Metropolitan Atlanta Rapid Transit Authority's (MARTA) Five Points station, and south of the downtown Atlanta Central Business District. It will be a hub for existing and proposed multi-modal transit networks. Green infrastructure in the area around the proposed hub would be a good way to build on this investment in the community, by encouraging economic growth and making the area an attractive destination.

The *Simpson Road Corridor Redevelopment Plan Update* discusses the demise of Simpson Road from its heyday of the 1950s and 1960s. It was a street that equaled Peachtree Street in Buckhead today with its thriving commercial activities, notable residential dwellings, and schools. Like other predominately African American streets, Simpson Road had many thriving African American businesses ranging from restaurants, inns and lounges, service stations, barber and beauty shops and tailor shops. Today the Simpson Road corridor has an abundance of abandoned and underutilized buildings and a perception of higher than average crime, as well as a high concentration of below-market rate housing and lower income characteristics. The Redevelopment Plan is a visionary yet achievable blueprint for revitalizing the corridor with respect to its historic context and physical character.

The *Northside Drive Corridor Plan* (1995) recognizes a need to accommodate and plan for future growth by improving the corridor to a six-lane boulevard, improving transit connections to downtown and Midtown, and supporting walkability through the corridor (referred to in the *Simpson Road Corridor Redevelopment Plan Update*).

Redevelopment is needed where the proposed Atlanta Beltline crosses Simpson Road near the existing MARTA alignment. The *Beltline Redevelopment Plan* (2005) calls for a redevelopment node at this location that will include significant medium density mixed-use redevelopment between Herndon Elementary School and Mayson Turner Road (northern section), a major expansion of Maddox Park, and the possibility of a new combined MARTA rail and Beltline transit station at the corner of Simpson Road and Mayson Turner Road (southern section). The Beltline plan also recommends a series of transportation improvement projects in and around the Simpson area to complement the goals of the Beltline project, address the physical changes required by the project, and mitigate potential adverse traffic impacts of the Beltline project.

The PNA Vision notes the largely vacant southeast corner of North Avenue and Northside Drive, vacant businesses along Boone Street, and vacant land in subwatershed J (subwatershed 215), where a large area of public housing was recently torn down.

Prioritization Criteria

The project team will conduct a field evaluation of potential sites for green infrastructure projects, focusing on the demonstration sites and catalyst sites identified in the PNA Vision document. Following the field evaluation, the sites will be prioritized based on the value they will provide and degree to which they meet the needs of the Proctor Creek. Criteria that may be used to prioritize sites include:

- Construction feasibility
- Property ownership (public or private)
- Flood reduction potential
- Potential to improve surface and groundwater quality
- Opportunity to improve streets or sidewalks
- Economic revitalization potential
- Project value (cost/benefit)

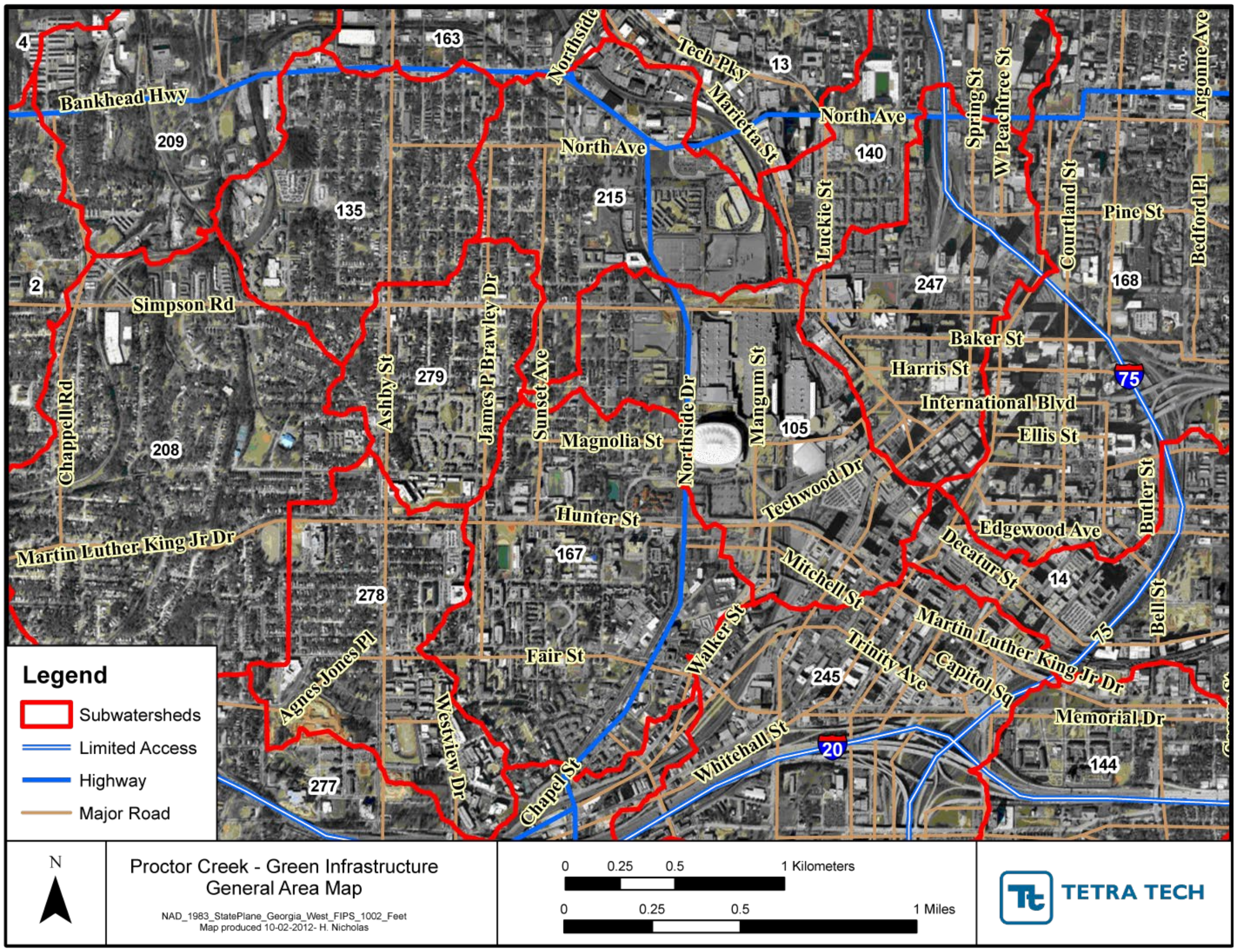

Figure A-1. PNA study area

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Appendix B Proctor Creek/ North Avenue Project Prioritization Summary

On October 15 and 16, 2012, the project team conducted a field evaluation of potential sites for green infrastructure projects within the Proctor Creek/North Avenue (PNA) watershed basin as a part of the Environmental Protection Agency (EPA) 2012 Green Infrastructure Technical Assistance Program. In addition, the project team hosted a public meeting with key stakeholders on October 16, 2012 to discuss the preliminary field evaluation results and to help inform the prioritization criteria for project selection. This memo summarizes the findings of the field evaluation, development of prioritization criteria, and subsequent prioritization of identified green infrastructure opportunities within the PNA.

Field Evaluation

The field evaluation primarily was focused on demonstration sites and catalyst sites identified in the PNA Vision document produced by Park Pride in 2010. However, two additional Green Infrastructure opportunities, (Joseph E. Lowery Boulevard and Lindsey Street) were identified by the field crew for consideration and were discussed during the stakeholder meeting. The project team worked with the City and Park Pride to define a set of field reconnaissance guidelines and field forms to assess each of the Green Infrastructure opportunities identified in the PNA Vision document. The field crew consisted of two technical experts (Jonathan Smith and Eric Byrne), Walt Ray with Park Pride, Susan Rutherford with the City of Atlanta, and many other stakeholder and expert advisors at various times during the field evaluation. The field crew located and assessed each of the Green Infrastructure opportunities identified in the PNA Vision document. During the field visit, the team evaluated each Green Infrastructure opportunity to define general site attributes, constraints, project understanding, and construction feasibility. For each site, the field crew took notes and collected photographic documentation.

Some of the sites were removed from consideration in the prioritization matrix upon the field assessment due to various site constraints, which included potential utility conflicts, insufficient drainage area, inadequate gradients, etc. Utility conflicts were evaluated based on GIS data layers or the observation of aboveground utility features such as power poles, catch basins, or manholes. In addition, some of the sites were removed from consideration because they were deemed to be outside the Green Infrastructure objectives of the study. Out of the initial 18 sites evaluated in the field, 6 were ultimately selected for consideration in the prioritization matrix. Two additional sites were added during the field evaluation, taking the total to 8 sites that were discussed during the stakeholder meeting and included in the final prioritization matrix. The final 8 sites are listed in Table B-1 along with a short project description.

Table B-1. 8 Projects for Consideration in the Prioritization Matrix

Project ID	Project Location	Project Description(s)
C	Boone Street: Green Street Demonstration	Green street retrofit between beltline and Northside Drive.
D	Boone Park East: Demonstration Project	Pond: water storage feature and park with community garden(s) and open play space for recreation. Project may incorporate bypass of runoff from large parking lot to the north into the project area for storage and treatment.

Project ID	Project Location	Project Description(s)
E	Vine City Park Extension	Expansion of Vine City Park and implementation of a water storage feature
G	Boone Park West: Demonstration Site	Pond: water storage feature and park
H	Bone Park West	Pond: water storage feature between Cairo Street and Joseph Lowery Boulevard
I	English Avenue School: Demonstration Site	Community garden, rainwater harvesting, porous concrete parking, recreation (playground and basketball court)
New-O	Joseph Lowery Boulevard	Green street retrofit of portion of Lowery Boulevard
New-P	Lindsey St.	Park and water storage feature between Lindsay St. and Oliver St. Project will implement several off-street bioretention facilities in a planned community park.

Stakeholder Meeting

The project team coordinated a stakeholder meeting on October 16, 2012 at the Fulton County Neighborhood Union Health Center in the PNA watershed basin. The meeting was well attended and included city officials, community leaders, and representation from organizations such as Park Pride, Atlanta Beltline, City of Atlanta Planning and Community Development, and others. The meeting consisted of a short presentation about each of the project opportunities, followed by a discussion to promote an exchange of ideas and concepts, and finished with a list of priorities and weighting factors developed by the meeting participants.

One of the primary goals of the stakeholder meeting was to develop a list of prioritization criteria based on input from stakeholders and project team members. Meeting attendees initially identified a list of over twenty criteria. Following several iterations of attributes considered for inclusion, the final list was narrowed to 12 priority criteria. Each of the prioritization criteria that made the final list are described below in no particular order.

Drainage Area/Stormwater Storage Potential	Evaluates the potential for the proposed project to reduce runoff volume discharging to the downstream stormwater system.
Community Acceptability/Partnerships	Evaluates the likelihood that the project will be embraced or accepted by the local community and utilize existing or potential partnerships with existing community groups or initiatives.
Operations & Maintenance	Evaluates the level of operations and maintenance that would be required for the project long term.
Greenspace/Recreation	Evaluates the green space or recreational opportunities provided by or incorporated into the project.

Implementation Timeline	Evaluates the potential for the project to be implemented in a short timeframe.
Water Quality Treatment Potential	Evaluates the potential of the project to reduce pollutant loading to Proctor Creek.
Project Value	Represents the cost-benefit of the project to address overall project goals. This criteria relies heavily on the professional judgment of the evaluation team in estimating the
Existing Infrastructure Connection/Ongoing Public Initiatives	Represents the potential for the project to be integrated into current infrastructure or public initiatives.
Aesthetics	Evaluates the potential impact of the project to improve or enhance community aesthetics
Displacement Minimization	Evaluates the potential impact of the project on existing residents and community activities. An example of displacement is the removal of a recreational amenity such as a playground or sports court for the purpose of constructing a stormwater BMP.
Streets and Sidewalks	Evaluates how the project integrates into planned street and sidewalk improvements.
National/Regional Showcase/ Destination/Visibility	Potential for the project to become a showcase site

Upon selection of the 12 prioritization criteria, meeting attendees identified the six criteria of greatest importance for the selection of a green infrastructure project to proceed to conceptual design phase within the PNA. These factors were ranked and are incorporated into the prioritization and ranking system described below.

Results and Discussion

After the prioritization attributes were selected, a scoring and ranking system was determined based on input from stakeholders, team members, and the twelve prioritization attributes. Some of these attributes, like “Streets and Sidewalks Improvements” are qualitative and thus involve only a “yes” and “no” scoring criteria while attributes like “Drainage Area/Stormwater Storage Potential” are quantitative. It should be noted however, that for the quantitative attributes, professional judgment and experience were used in lieu of engineering calculations due to time, budget, and scope constraints.

Scoring the project opportunities for the attributes also required threshold criteria (ranges of values) developed from all the site attribute values. Thresholds were selected to assign scores to ranges of attribute values based on a weighted ranking of the attribute values. For each project opportunity, total scoring was based on a total maximum score of 100 points with each attribute receiving a possible score between 0 and 10. Since there are twelve prioritization attributes and some attributes have more importance for implementation than others, the project team applied weighting factors to each attribute to ensure that the maximum possible score equals 100. The weightings were based on the relative importance of the attribute to overall achievement of the goals and objectives. Each prioritization attribute and its associated scoring criteria are shown in the tables below, and the final weighted scoring matrix is shown in Table B-2.

It is important to note that the project scoring results are heavily dependent on the prioritization criteria and weighting developed as a part of the stakeholder meeting. While the Boone Park East Demonstration project achieved the highest ranking of the 8 green infrastructure projects evaluated during this process, it is the project team's assessment that the project may not be the best candidate project to meet the objectives of the EPA Green Infrastructure Partners Program.

Scoring factors for the twelve priority criteria

Drainage Area/ Stormwater Storage Potential	Score
None	0
Interception	1
Infiltration/Bioretention	2.5
Small Storage	5
Medium Storage	7.5
Large Storage	10

Community Acceptability	Partnerships	Score
No	No	0
Yes	No	5
No	Yes	5
Yes	Yes	10

Operations & Maintenance	Score
Intensive	0
Moderate	5
Minimal	10

Water Quality Treatment Potential	Score
Minimal	0
Moderate	5
Intensive	10

Existing Infrastructure Connection	Ongoing Public Initiatives	Score
No	No	0
Yes	No	5
No	Yes	5
Yes	Yes	10

Nat'l/Reg. Showcase/ Destination/Visibility	Score
Low	0
Medium	5
High	10

Street & Sidewalk Improvements	Score
No	0
Yes	10

Greenspace	Recreation	Score
No	No	0
Yes	No	5
No	Yes	5
Yes	Yes	10

Implementation Timeline	Score
Long	0
Medium	5
Short	10

Project Value	Score
High	10
Medium	7.5
Low	5

Aesthetics	Score
Low	0
Medium	5
High	10

Displacement Required	Score
Yes	0
No	10

Table B-2. Weighted rankings

		Priorities												
	Weighting	**2**	**1**	**1.5**	**1**	**1**	**0.5**	**0.5**	**1.5**	**0.25**	**0.25**	**0.25**	**0.25**	
Project ID	**Project Location**	**Drainage Area/ Stormwater Storage Potential**	**Community Acceptability/ Partnerships**	**Operations & Maintenance**	**Greenspace/ Recreation**	**Implementation Timeline**	**Water Quality Treatment Potential**	**Project Value**	**Existing infrastructure Connection/Ongoing Public Initiatives**	**Aesthetics**	**Displacement Minimization**	**Streets & Sidewalks improvements**	**Nat'l/Reg. Showcase/ Destination/Visibility**	**Total Score (max= 100)**
C	Boone Street: Green Street Demonstration	10	10	7.5	0	10	2.5	5	15	2.5	2.5	2.5	1.25	68.75
D	Boone Park East: Demonstration Project	20	10	7.5	10	10	5	5	7.5	2.5	2.5	0	2.5	82.5
E	Vine City Park Extension	10	5	7.5	0	10	2.5	2.5	7.5	1.25	2.5	0	0	48.75
G	Boone Park West: Demonstration Site	10	5	7.5	5	5	5	2.5	0	2.5	2.5	0	0	45
H	Boone Park West	10	5	7.5	5	5	5	2.5	0	2.5	2.5	0	0	45
I	English Avenue School: Demonstration Site	5	10	7.5	5	10	0	2.5	15	1.25	2.5	0	1.25	60
New-O	Joseph Lowery Boulevard	5	5	7.5	0	5	2.5	3.75	7.5	2.5	2.5	2.5	1.25	45
New-P	Lindsey St.	10	10	7.5	5	10	5	5	7.5	1.25	2.5	0	0	63.75

Appendix C Conceptual Design Layouts

Site Location			
MBL	NA	Latitude	33° 45' 48" N
Date of Field Visit	10/15/2012	Longitude	84° 24' 28" W
Field Visit Personnel	JS, EB, WR	Street Address	NW Boone Blvd.
Major Watershed	Proctor Cr.	Landowner	City of Atlanta

Existing Site Description: The proposed project site includes the Boone Blvd. roadway corridor between Brawley Dr. and Maple St. Boone Blvd is an existing 4-lane roadway (two lanes each direction) with adjacent sidewalks. The project site is served by a combined sewer system with feeder lines under the roadway intersecting main trunk lines at Vine St and Brawley Dr. Boone Blvd is currently slated to undergo improvements within the next few years. Improvements will include the reduction from four lanes to two, the addition of 2 five-foot wide one-way cycle tracks, and new center turn lanes at select intersections.

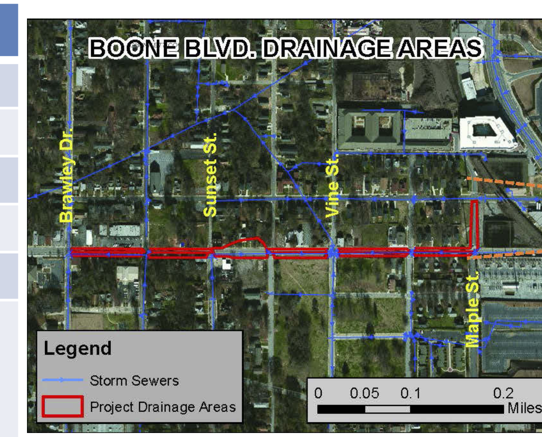
Watershed Characteristics	
Watershed Area, acres	2.56
Hydrologic Soil Group	Urban
Total Impervious, %	91.6
Design Storm Event, in	1.2
Proposed SCMs	PB, BR, PP

* Proposed Characteristics	
Total Detention Volume, ft^3	10,585
Planter Box Area, ft^2	4,479
Bioretention Area , ft^2	6,794
Perm. Pavement Area, ft^2	10,310
Ext. Planting Strip Area, ft^2	8,322

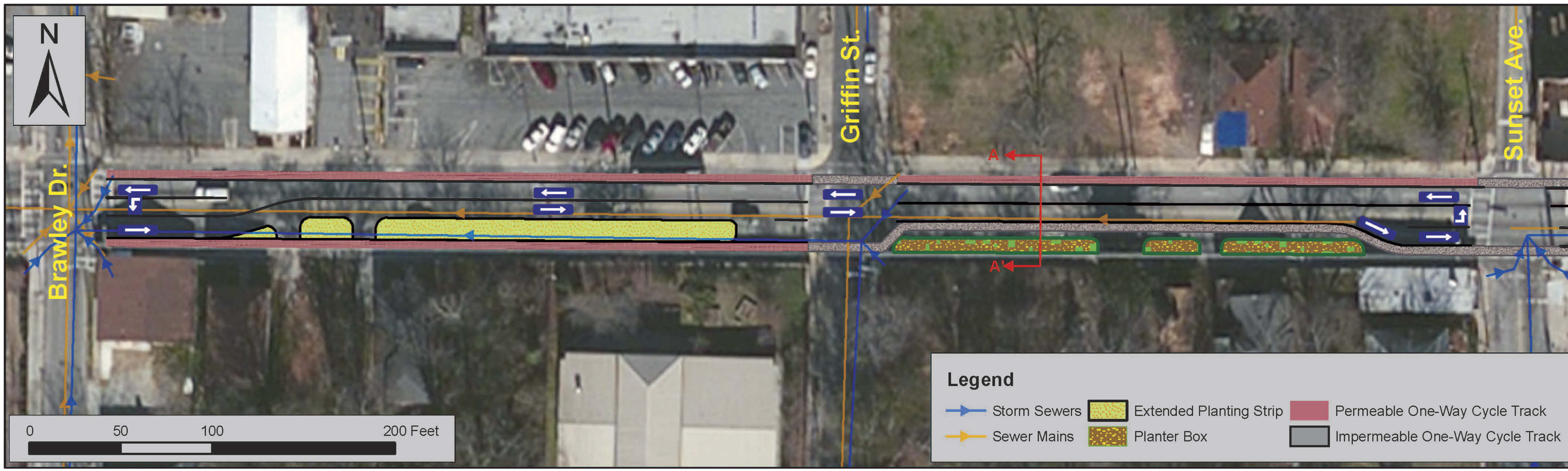
Proposed Green Infrastructure Description: Proposed SCMs within the right of way include planter boxes along three blocks and permeable pavement bike paths along five blocks . Two off-line bioretention systems (located in Mims Park) will treat runoff from 1.5 blocks. All SCMs will contain under-drains that connect to existing or proposed storm mains. In addition extended planting strips will be incorporated along three blocks.

PB= Planter Box, BR = Bioretention, PP = Permeable Pavement

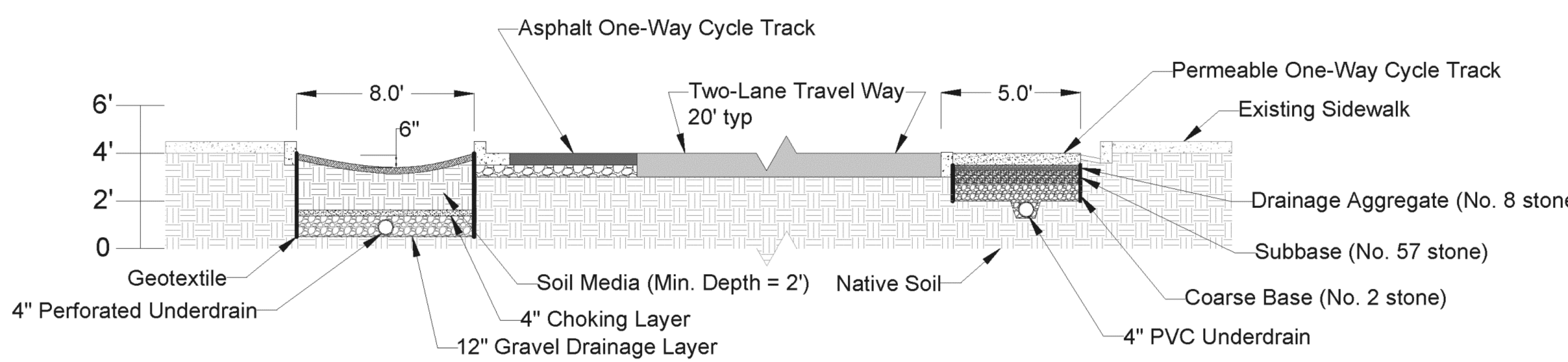
*Green Infrastructure characteristics are based on field observations and GIS data resources available at the time of conceptual design analysis. Note that final design characteristics will be dependent on a detailed site survey and could vary slightly from conceptual design characteristics.



ATLANTA, GEORGIA GREEN INFRASTRUCTURE CONCEPTUAL PLAN
SITE: JOSEPH E. BOONE BLVD.

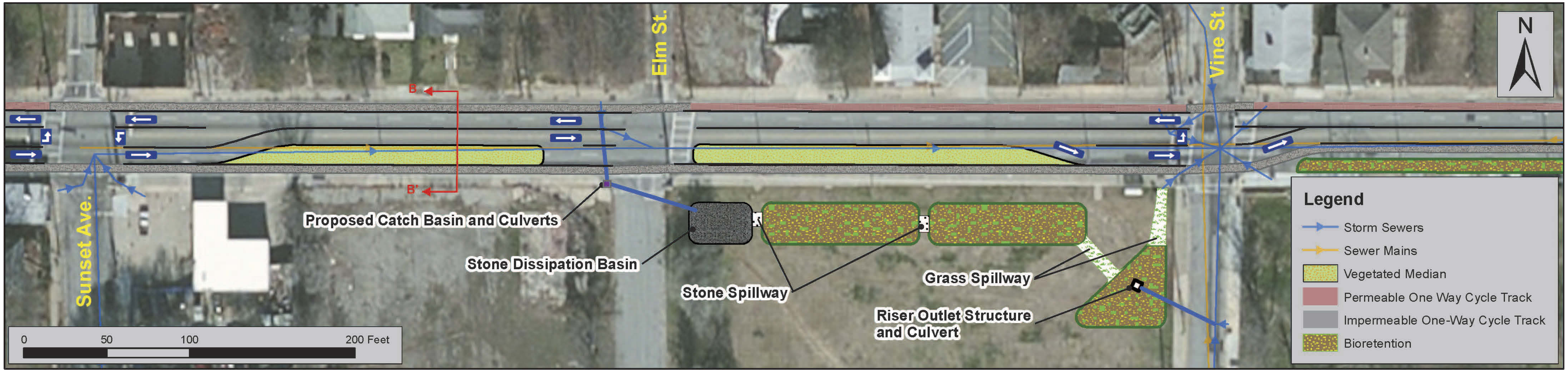


775 Joseph E. Boone Blvd, facing east



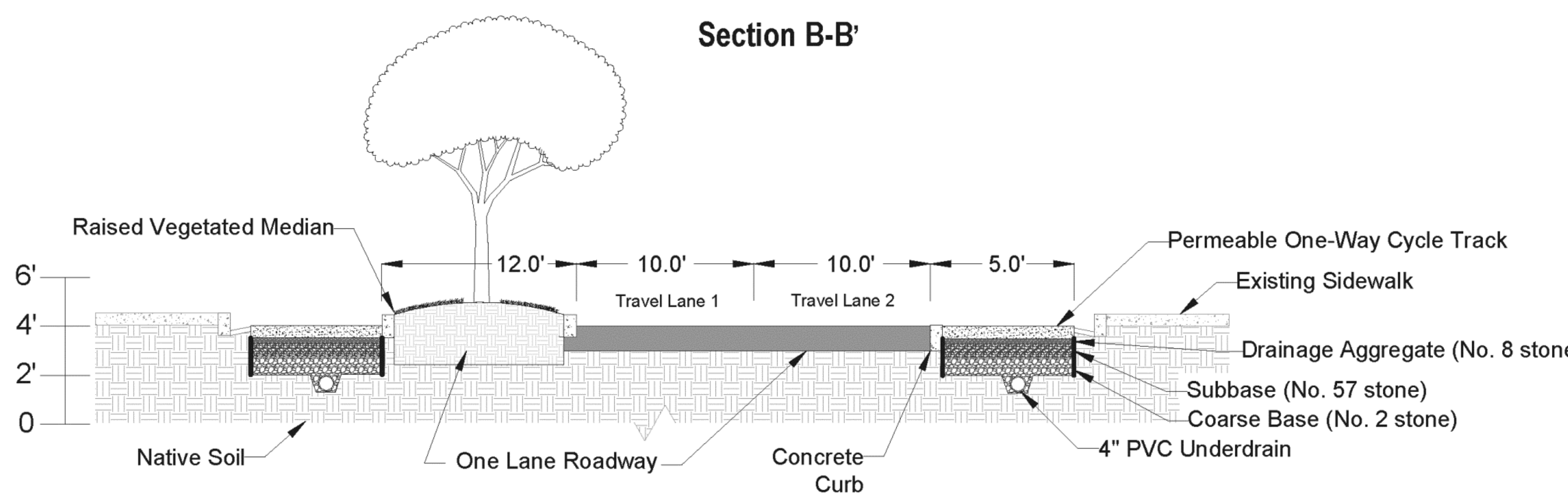
Section A-A'

ATLANTA, GEORGIA GREEN INFRASTRUCTURE
CONCEPTUAL PLAN
SITE: JOSEPH E. BOONE BLVD.



785 Joseph E. Boone Blvd NW, facing west

Section B-B'



DEPARTMENT OF WATERSHED MANAGEMENT