
team #16039

# Streamline Broad Street

City of Chattanooga LID Design Competition

June 20, 2014

## Design Narrative

*Streamline Broad Street* reimagines a new pedestrian and commercial district that emphasizes safety, sustainability and quality of urban design in downtown Chattanooga. For the overall circulation, we redistributed parking and traffic flow to optimize car travel lanes, protect cyclists, and most importantly create pedestrian dedicated spaces with shade and welcoming sidewalks. The redesigned streetscape showcases sustainability and environmental responsibility through the integration of multiple green infrastructure improvements such as uncompacted soils to support large canopy trees and street-side rain gardens. Complete street concepts are integrated to provide safe use for all modes of transportation, including automobiles, bikes, pedestrians and mass transit. Elements of *Streamline Broad Street* serves a dual purpose, such as intersection bump-outs that improve pedestrian safety and absorb stormwater, so that capital investment is maximized for both social and environmental benefits.

The concept begins with the reduction of travel lanes and removal of the center landscape and parking median, which inherently created pedestrian/auto conflicts and limited pedestrian space. The total amount of parking is retained; however, the parking spaces are concentrated in front of businesses and adjacent to expanded sidewalk areas. The redistributed parking spaces are pervious to infiltrate, slow, and cool polluted stormwater flows and include bioretention planting islands for stormwater management.

To grow large, successful trees that Broad Street is known for, the street tree planters are interconnected beneath suspended pavement to enhance the growth potential of both new and, where possible, relocated existing trees. The additional sidewalk space opens up to provide for secondary uses such as outdoor cafes, benches, bike parking, newspaper boxes, street fairs and other special events. Clear sidewalk space is located at building facades to allow for unobstructed walking and views of businesses. All secondary activities are provided for between street trees and outside the flow of pedestrian walking and vary based on the needs of adjacent businesses. This increase and improvement of pedestrian space aims to create a new streetscape standard with a flexibility of uses through simplicity, comfort and thoughtful use of materials.

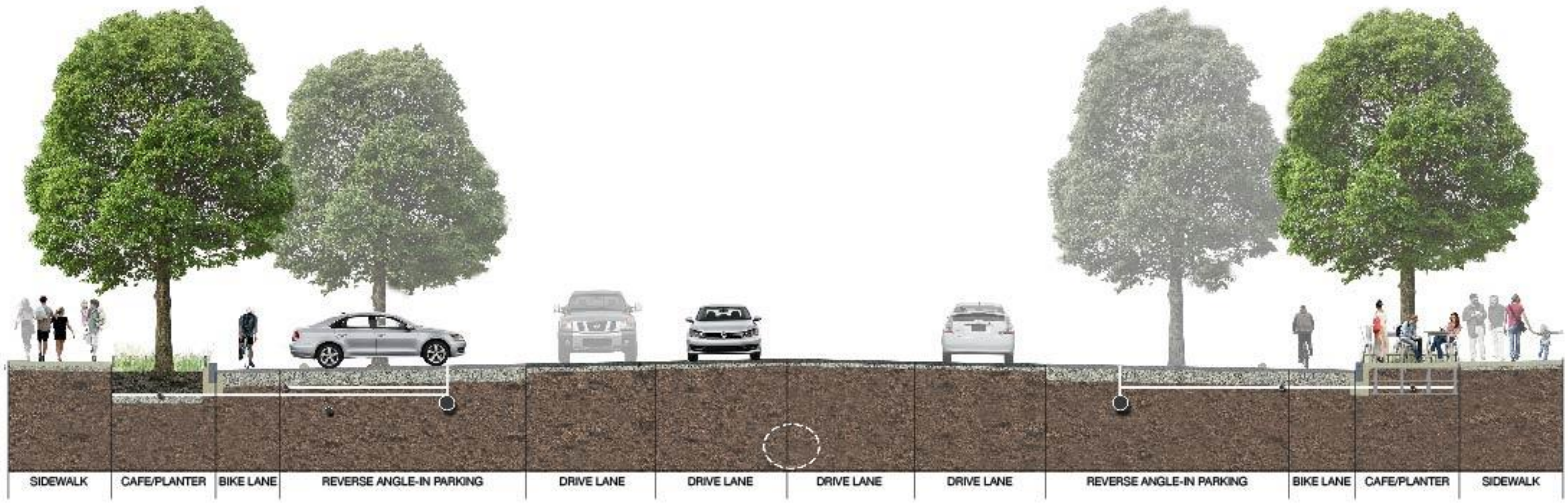
Supporting multimodal transportation, bikers have dedicated and protected bike lanes separated from traffic at intersections. At intersections, bicyclists cue in front of stopped traffic to keep them in view and provide them with a safe start. As a continuation of these safe intersection concepts, curb extensions are provided at crosswalks to increase pedestrian and planting areas at intersections. This shortens the exposure and distance pedestrians must traverse when they cross streets, slows traffic and reduces unnecessary paving at large intersections. The intersection of Broad Street and M.L. King Boulevard acts as the gateway to City Center with Broad Street terminating at the Tennessee Aquarium. To strengthen these vital intersections, the pedestrian scramble concept proposes that all lights remain red for a separate pedestrian cycle, allowing for comfortable pedestrian crossing while vehicular and bicycle traffic waits. This ensures there is never pedestrians crossing while vehicles are in motion, eliminating pedestrians hurried by waiting vehicles and any other potential pedestrian conflict.

A greater amount of healthy planting areas allow for both a celebration of seasonal changes as well as more canopy trees to welcome the pedestrian by significantly reducing temperatures on hot summer days. The healthy canopies work to relieve stress on the combined sewer system reducing stormwater volumes and peak flows through beneficial interception, infiltration, evapotranspiration, and distributed pocket storage. The planters and their vegetation serve a dual function as stormwater bioretention. These planted areas capture and filter polluted street and sidewalk rain water through porous planting soils that remove dangerous hydrocarbons and nutrients often found in roadway runoff. The resulting run-off volumes and peak flows are reduced as water is retained in the canopy and held in planting soils for plant uptake and groundwater recharge. Throughout the *Streamline Broad Street* area, primarily native plants and large canopy tree species are proposed. By providing large planters with adequate room for tree roots to grow, we celebrate trees that will flourish in their native climate, celebrate our native ecology all while making a beautiful new Broad Street for the residents and visitors to our city and the generations ahead.

## Plant List

- Street Trees:
  - Willow Oak – *Quercus phellos*
  - Swamp White Oak – *Quercus bicolor*
  - Water Oak – *Quercus nigra*
  - Swamp Chestnut Oak – *Quercus michauxii*
  - Plane Tree –*Platanus xacerifolia*
  - Black Gum – *Nyssa sylvatica*
  - Overcup Oak – *Quercus lyrata*
- Bioretention Plants:
  - Switchgrass – *Panicum virgatum*
  - Soft Rush – *Juncus effusus*
  - Purple Coneflower – *Echinacea purpurea*
  - Virginia Sweetspire – *Itea virginica*
  - Prairie Dropseed – *Sporobolus heterolepis*
  - Pennsylvania Sedge – *Carex pensylvanica*
  - Dwarf Tickseed – Coreopsis auriculata ‘Nana’

## Four Lanes Back-In Parking Both Sides

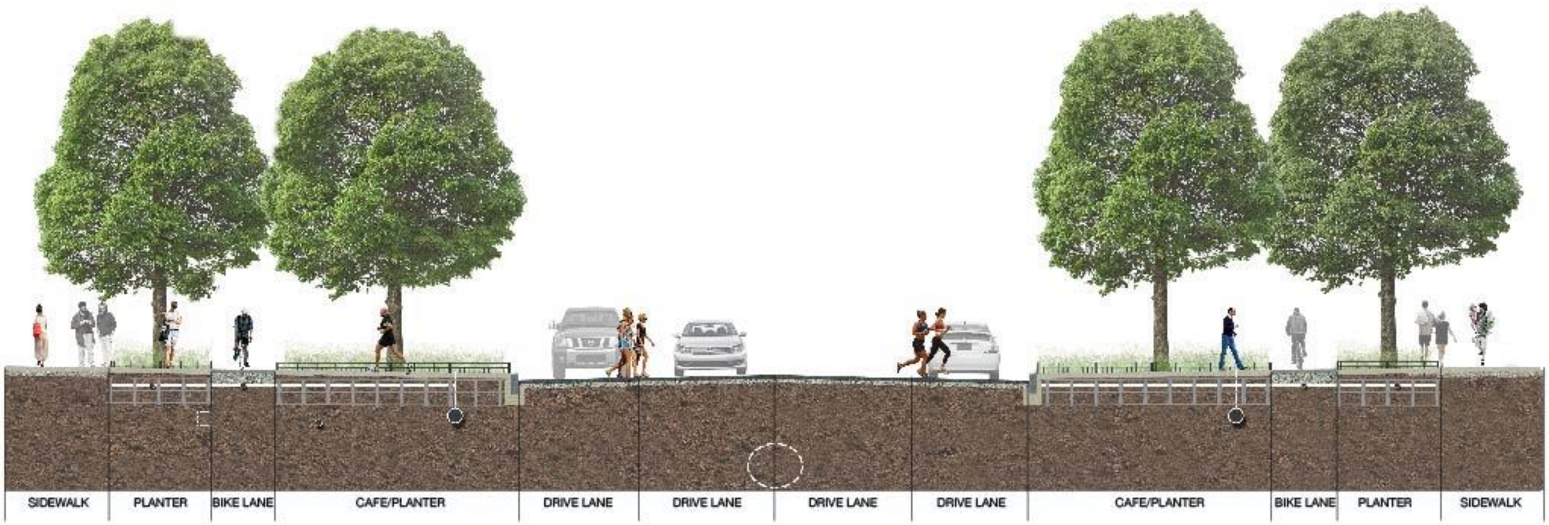



The elimination of the center island and reduction from six lanes of traffic to four lanes of traffic concentrates vehicular traffic while allowing ample parking, planter space and pedestrian areas near the businesses along Broad Street. Available research suggests Broad Street can accommodate the reduction in traffice lanes. This section highlights how the stormwater practices function below grade. Water is infiltrated and cleaned through the use of porous paving and bioretention facilites. Overflow from large storm events is directed to piping for removal from the site. See attached details for additional information.

## Two Lanes Back-In Parking Both Sides

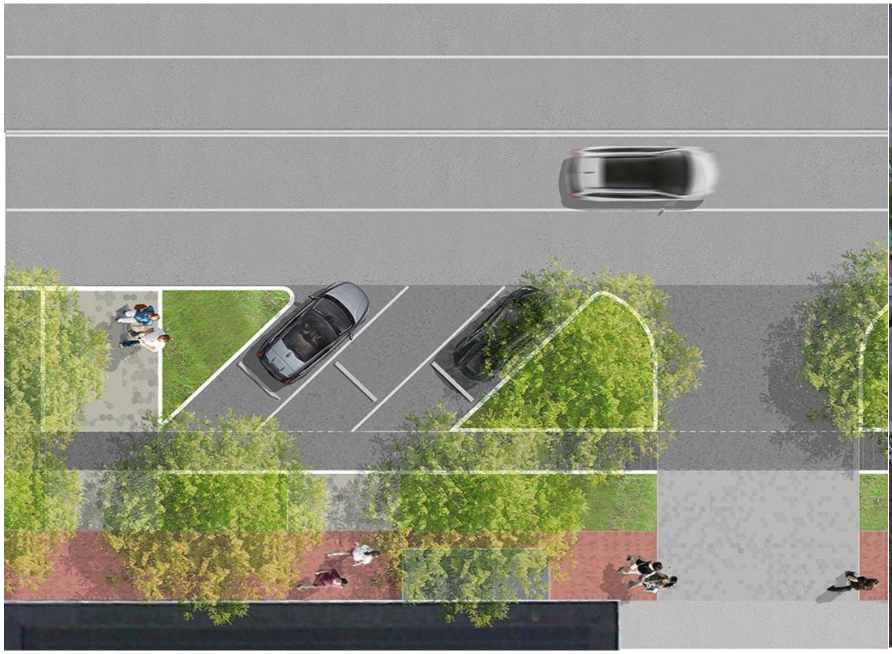

Moving north on Broad Street, the last two blocks approaching the Tennessee Aquarium are heavy in pedestrian activity. A further reduction to two traffic lanes will slow vehicle speed while creating larger sidewalk and pedestrian areas for increased café, shopping, landscape and stormwater opportunities. This concept of providing space for pedestrian activity compounds when the last blocks are closed off to vehicular traffic, providing an unobstructed walking area for special events and markets or potentially every weekend during high tourist seasons. Special paving of the drive lanes and parking area will reflect the City's character and make the north end of Broad Street a true destination for living, dining and shopping all year long. See attached details for more information.

Crosswalk at Four Lanes of Traffic



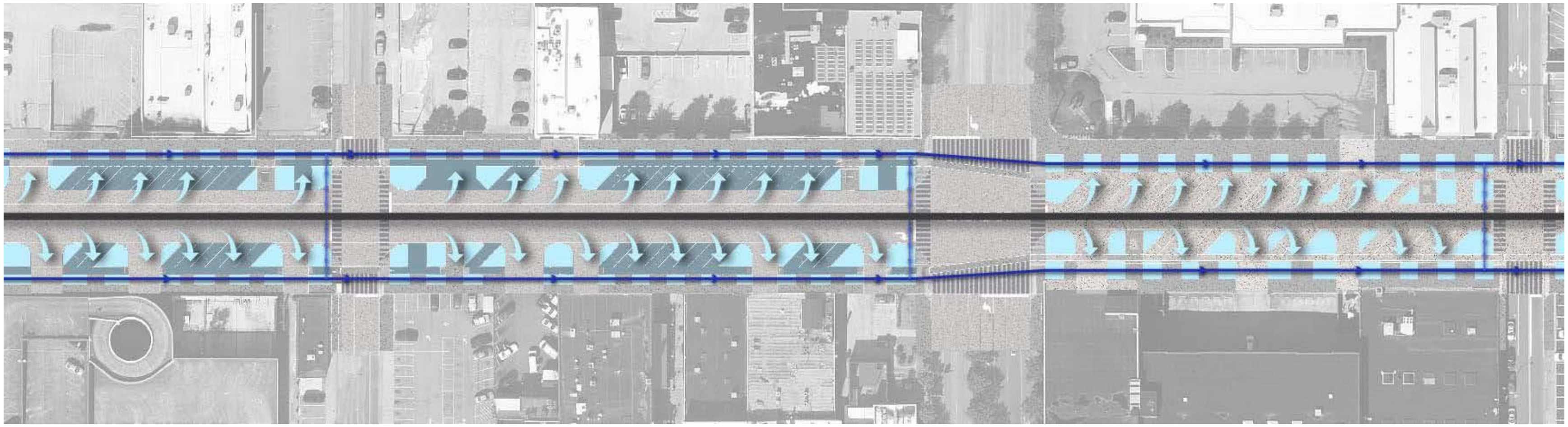

Safety for all modes of transportation is paramount in creating a complete streetscape. This section shows how vehicles, bicycles and pedestrians can navigate with ease while remaining safe at all times. The sidewalks adjacent to businesses remain free and clear from vehicle and bicycle traffic for easy strolling. Bike lanes are protected from vehicular traffic while separated from pedestrian conflicts. Curb extensions at crosswalks minimize the distance pedestrians have to cross the street while incorporating additional tree canopy and landscaping, making the intersections less expansive with cooler temperatures. Connecting both sides of the street is essential for a thriving social district. See attached details for more information.

## Dual Purpose



The complete street with low impact design serves two ever present demands of any successful urban center. The image on the left provides a detailed look at how the streetscape functions. Varied paving patterns and materials delineate the intended use and guide users in safe mobility. The red clay brick pattern provides a thoroughfare for walkers while different color and material for driveways alert pedestrians of turning vehicles. Concrete pavers suggest areas for stopping, dining, parking bicycles and waiting for the bus. Different colors of street paving clearly direct drivers and cyclists while different colors and materials alert pedestrians of the potential for vehicles turning into driveways. In addition to providing essential urban mobility, the image on the right shows the hidden side of the complete street benefit – the environmental side. During rain events, the water is infiltrated, slowed and cleaned to prevent damage to receiving waters, including the Tennessee River and proximal overland areas down-gradient. Sediment and pollutant removal, as well as the minimal and slow release of stormwater, ensures that the City of Chattanooga remains a steward of the dynamic and sensitive environment she inhabits.

## Proposed Drainage Pattern

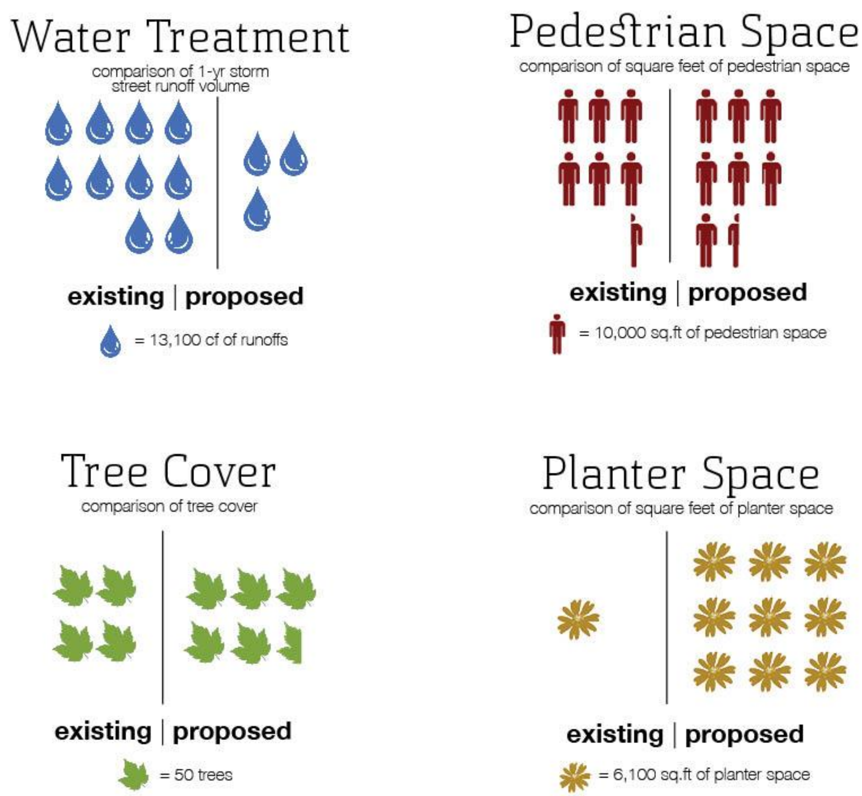


In order for stormwater practices to function properly, rainwater must flow toward and into each facility. The proposed drainage patterns mimic the current drainage on Broad Street. Instead of flowing directly into the combined sewer system, stormwater will flow into facilities that collect, cool and clean the water. The center of the street will be crowned, creating a drainage divide down the middle of the traffic lanes. Rain will sheet flow to the east and west into bioretention planters and the pervious pavement occupied by parking areas and bike lanes. Rain falling on the sidewalk will flow toward the street and into bioretention planters spaced along the full length of the project area.

Once the water is cleaned and infiltrated and groundwater is recharged, slow release of rainwater and overflow from large storm events will enter pipes that run the length of Broad Street to be discharged safely. An option to discharge overflow from each block into the combined sewer system is demonstrated in the drainage pattern diagram.

There is opportunity to include area outside of the right-of-way by rerouting rooftop downspouts into the bioretention areas. Increasing the storage area alongside bioretention planters beneath the suspended pavement will accommodate rainfall from a larger drainage area into stormwater practices within the project limits.

## Existing Conditions Versus Proposed Benefits

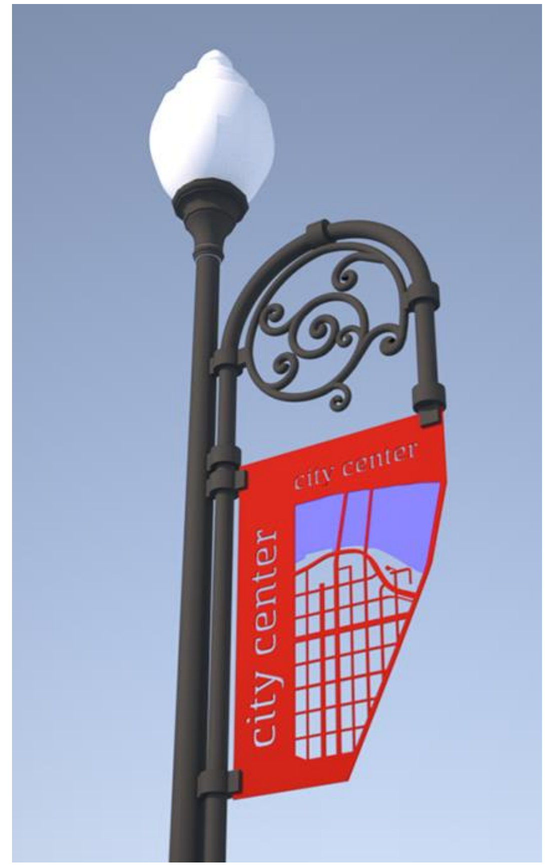



The intent of *Streamline Broad Street* is to improve the City Center for its inhabitants and its environment. The images here provide a glimpse of the potential a complete streetscape could provide in meeting both goals. Stormwater runoff is greatly reduced, while tree cover and planter space/bioretention are additionally significantly increased. Active pedestrian space increases, and the effect of the additional green space will contribute to a much greater sense of the pedestrian experience.

Educational Signage


Throughout the *Streamline Broad Street* area, interpretive signs educate citizens and visitors about the function and value of green infrastructure to reduce the cost of stormwater management while enhancing both user experiences and protecting the Tennessee River. Given the focus of activity within this area of Chattanooga, the educational signs and personal observations of users will serve to accelerate the acceptance and adoption of green infrastructure practices in the region. All of this is done with attention to materials and the site's natural and cultural history to create a unique and unified streetscape to serve as a City Center standard.

## Historic Context


One of Chattanooga's most appealing assets is her history. In the early 20th century, Broad Street served as the main thoroughfare between the the train station and the Tennesse River. This image serves as the historical precedent for the angled parking as a way to accommodate the high volume of visitors to the City Center. Details from the drinking fountain inspire a new look for the City Center, calling upon images from the not too distant past.

## Hydrology Narrative

The *Streamline Broad Street* project area is served by an existing combined sewer system (CSS) and the proposed improvements provide flexibility for many options to help the City of Chattanooga reduce instances of combined sewer overflows. Green infrastructure practices are proven and recognized effective measures for reducing combined sewer overflows; by reducing wet weather runoff volumes and delaying peak flows, the capacity of the CSS can be maintained so that costly measures such as large control tunnels can be avoided. Rather than separating the storm and sanitary sewer system entirely, the *Streamline Broad Street* stormwater concept relies on runoff reduction and peak flow delay through the integration of green infrastructure practices to "free up" CSS capacity and reduce overflow occurrences. However, the storm drain layout has been designed to allow for the flexibility of a fully separated system should one be desired; both scenarios have been modeled and the results are described in detail below.

Chattanooga has recently adopted new stormwater regulations which focus on and incentivize the use of runoff reducing, or green infrastructure, practices for stormwater management. Chattanooga's Resource Rain - *Rainwater Management Guide* provides a compliance tracking methodology, which for the *Streamline Broad Street* project includes retention of the 1-inch volume.

Infiltration storage in permeable parking stalls, permeable bike lanes, and micro-bioretention landscape islands easily achieve greater than 1-inch minimum Stay on Volume (SOV); SOV is the volume of runoff that is retained or "stays on" site. The adjacent summary lists only the volumes lost through infiltration (per PCSWMM modeling described below); when SOV in the bioretention media and pervious pavement stone is included, the proposed strategy captures more than 3 watershed inches in BMPs Based on NRCS TR-55 Runoff Curve Number adjustments, this design mimics the hydrologic function of open space in well drained soils

### Resource Rain

Rainwater Management Guide

"the first inch of rainfall must be managed with no discharge to surface waters"

| | |
|---|---|
| **targeted/required** | |
| SOV Design Rainfall | 1" |
| SOV Design Volume | 41,288 cf |
| Design Project Area | 12.10 acres |
| Hydrology Coefficient (Rv) | 0.94 |
| **design results** | |
| Tree Restorative SOV | 1,230 cf |
| Pervious Pavement SOV | 20,550 cf |
| Bioretention SOV | 30,840 cf |
| SOV Rainfall | 1.2" |

Design summary of infiltration volumes (not including SOV in bioretention media and pavement stone)

The significant volume reduction of the proposed strategy provides the City of Chattanooga with an extremely flexible schematic concept which can be adjusted to meet project budgets; optimized to maximize volume reduction (as shown) or minimized to meet only minimum 1-inch SOV goal; and can be integrated with untreated roof and parking lot retrofits.

**Project Name:** Streamline Broad St
**Date Prepared:** 6/20/2014
**Prepared by:** WaterLove

**WORKSHEET 4: CN Adjustment**

=> Denotes input by user

| Point of Interest | Area ($ft^2$) | Weighted CN | Storm Frequency | Rainfall (in) | S | Q (in) | BMP Capture Volume ($ft^3$) | Infiltration Volume ($ft^3$) | Total BMP Volume Reduction ($ft^3$) | Q minus Total Volume Reduction (in) | Adjusted CN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Downstream CSS | 527,076 | 98.00 | 10 | 5.10 | | 4.86 | | | | 0.20 | 38 |
| | | | 25 | 6.00 | 0.20 | 5.76 | 153,606 | 51,390 | 204996 | 1.09 | 49 |
| | | | 100 | 7.40 | | 7.16 | | | | 2.49 | 56 |

NRCS TR-55 methodology considers the project area, area captured and treated by BMPs, and infiltrated volume to determine an appropriate RCN

In addition to SOV, the benefits of these practices include filtering of total suspended solids and nutrients, peak flow reduction and delay, and evapotranspiration from vegetated areas. The following design parameters and measures are proposed:

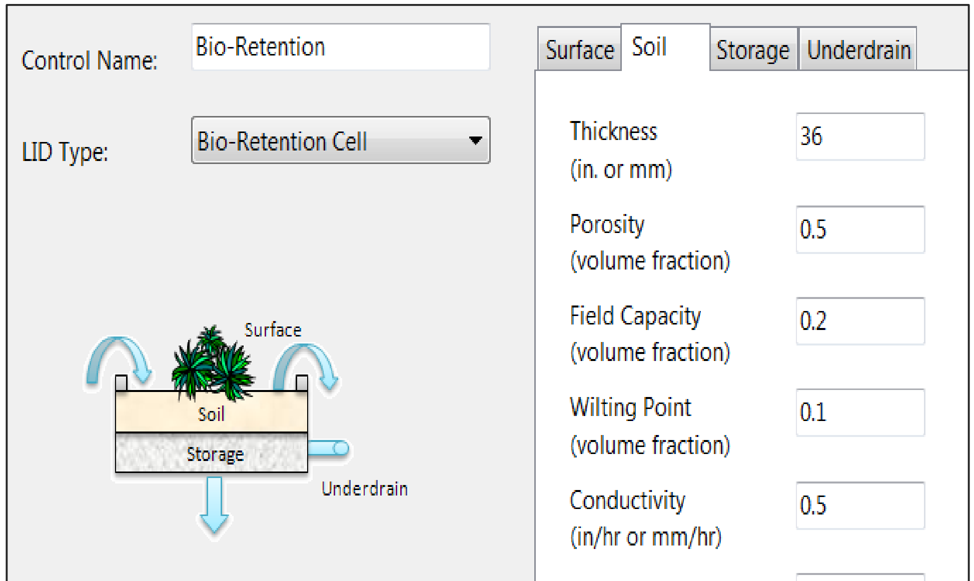
- Tree Canopy: tree planting will increase the number of street trees as a restorative practice.
- Bioretention: 6-inch typical/12-inch maximum surface ponding; 36-inch media to support tree plantings; and 12-inch gravel. Underdrains are included based on anticipated infiltration rates, and overflow inlets or curb cuts will collect larger storm drainage.
- Pervious pavement: 4-inch pervious surface (interlocking paver blocks and asphalt) over 18-inch stone storage with underdrains. Surface inlets provide a large storm overflow/bypass.

The street trees will be planted in structural soils that connect in a continuous trench beneath the sidewalk pavement. Known as suspended pavement, these structural soils allow for improved tree growth and health in urban environments, reduce pavement heaving due to tree roots, and provide an opportunity for stormwater reduction similar to bioretention. It should be noted that the *Streamline Broad Street* stormwater compliance strategy does not include the runoff reduction benefits of this innovative practice, and will show even greater volume reduction benefits than modeled.

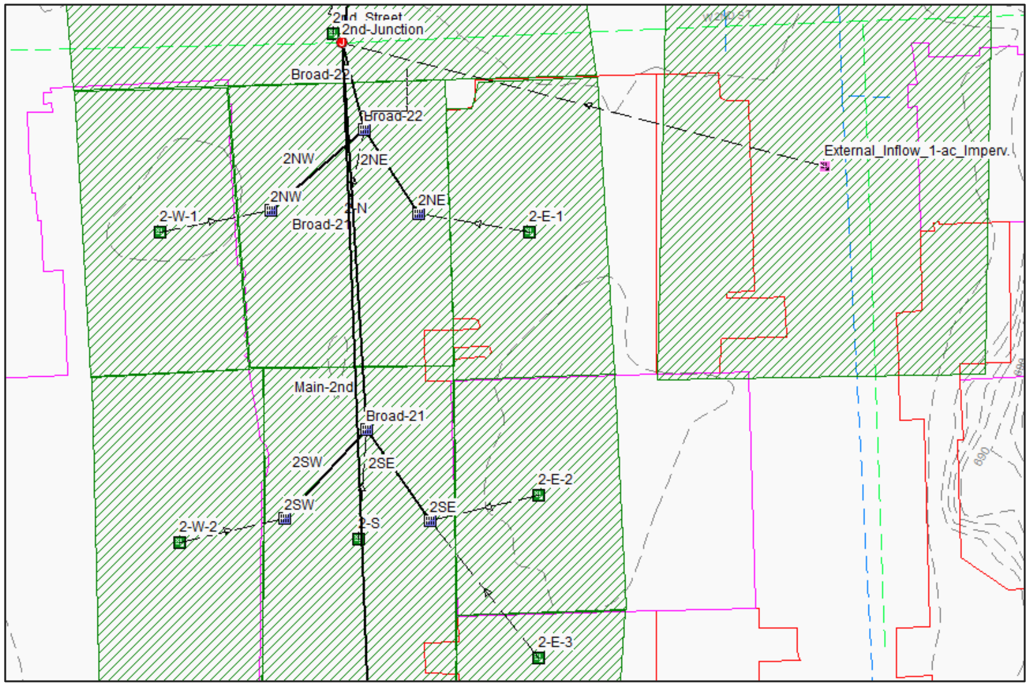
Maintenance of the distributed green infrastructure practices will be necessary to maintain their optimum function. Permeable pavements should be vacuum-swept monthly for the first year; following, the frequency should be evaluated based on the observations and results of the sweeping activities. Interlocking Concrete Pavers are proposed for the parking stalls based on aesthetics, longevity, and ability to access underground utilities without patching. Porous asphalt is recommended for the bike lane based on a poll of design team bike enthusiasts, which incorporates the importance of a smooth ride, with very low anticipated pollutants loads. Bioretention maintenance includes weed control, mulch, and plant establishment for the first year, followed by inspections and weed pruning every six months following establishment. Signs of erosion or standing water may be addressed by removing/replacing mulch and aeration; built up sediment from pre-treatment areas should be removed at least annually; and trash removal should be an on-going activity to maintain the City Center image.

## Stormwater Model and Results

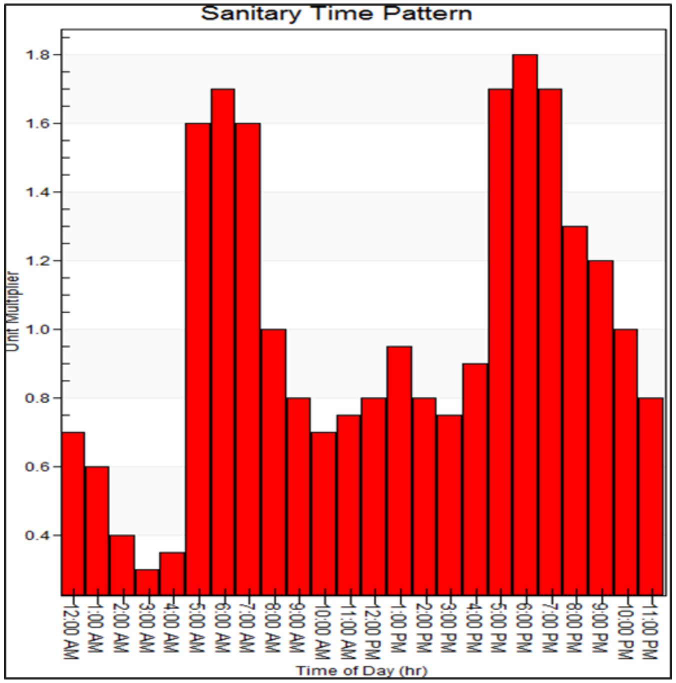
The Resource Rain - *Rainwater Management Guide* allows for Runoff Curve Number reductions based on the volume lost in green infrastructure practices; this provides a simplified method for modeling the benefits of green infrastructure practices without having to model each practice individually. However, PCSWMM has an integrated low impact development controls feature which allows for the easy input of LID design parameters (e.g. soil depth, stone depth and porosity, infiltration rates, etc.) and a more accurate representation of LID function; therefore, PCSWMM was chosen as the project modeling tool. In addition to the LID dialog boxes, CAD and GIS information can be referenced into PCSWMM for pipe network and drainage area population. The PCSWMM user interface is intuitive, and models can be run for design storms or continuous simulations of historic rainfall events.




PCSWMM has LID Controls Dialog Boxes for easy modeling input




Example of the PCSWMM model configuration for block between 2nd Street/Aquarium Way and 3rd Street

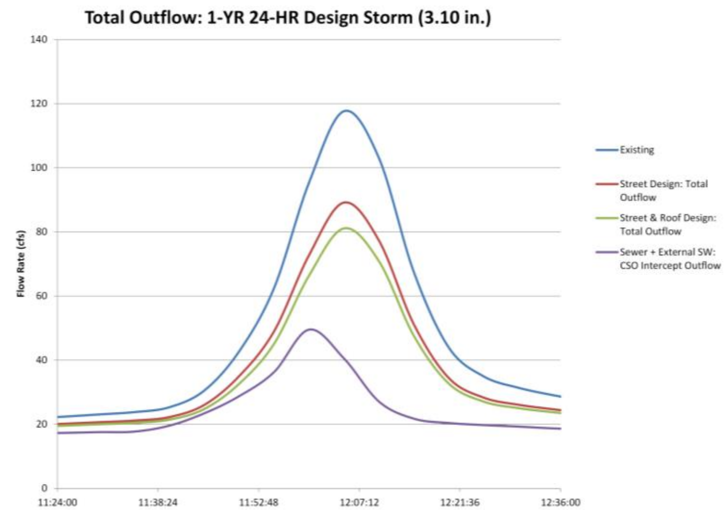



Sanitary time frame analysis

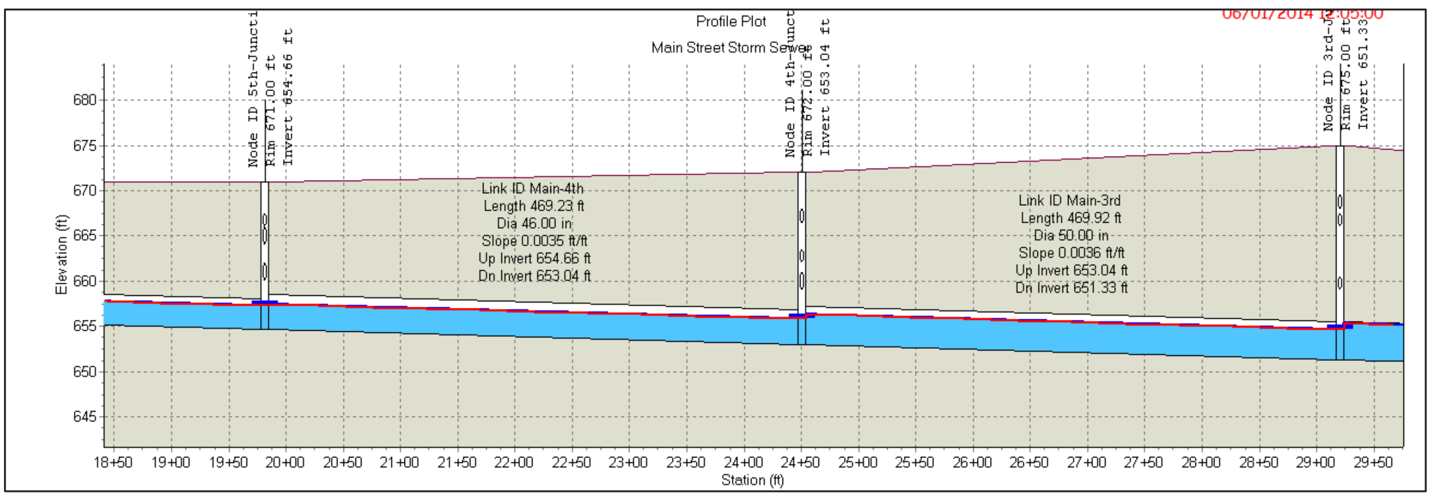
For each of the following model scenarios, a sanitary sewer average flow of 20 cfs was included based on a sanitary time frame analysis (see figure), as well as an estimated 8 acres of upstream impervious surface (one acre contributing to the CSS at junction of each intersection). During the peak flow of design storm events the CSS discharge was 16 cfs. The 12.1 acre project area is the Broad Street right-of-way (ROW) and the adjacent roofs and parking lots contribute an additional 10.3 acres of drainage. The point of analysis for each scenario is in the CSS at the furthest point downstream within the project area (2nd Street/Aquarium Way).

- Existing conditions scenario
- Proposed scenario 1 provides stormwater management only for the project area
- Proposed scenario 2 assumes that the adjacent roofs and parking lots can be disconnected and directed into green infrastructure stormwater practices as well

The fourth scenario shown on the adjacent hydrograph demonstrates the hydrograph results if Broad Street ROW and the adjacent roofs and parking lots are disconnected from the CSS and discharged directly to a stormwater outfall. However, a schematic capacity analysis of the existing CSS indicates that complete disconnection may not be necessary with the reduction of wet weather volumes.




Hydrographs for 1-Year, 24-Hour Storm Event




Existing CSS Interceptor Profile - 10-Year Event Peak

As expected, the peak flow reduction benefits of green infrastructure practices decrease as storm events get larger. Volume reduction benefits remain significant, even in large storm events, because the green infrastructure hydrographs mimic pre-development conditions more closely than traditional development hydrographs. The reduced volumes coupled with reduced peak flows will mitigate CSS wet weather capacity problems without fully separating the storm and sanitary systems.

| Volume of Runoff in Acre-feet | | | | | |
|---|---|---|---|---|---|
| ***Event*** | ***Existing*** | ***Proposed 1*** | ***Volume Reduction*** | ***Proposed 2*** | ***Volume Reduction*** |
| 1-YR | 7.6 | 5.3 | 31% | 4.6 | 40% |
| 2-YR | 9.0 | 6.3 | 29% | 5.7 | 37% |
| 5-YR | 11.1 | 7.8 | 30% | 7.2 | 36% |
| 10-YR | 12.6 | 9.2 | 28% | 8.1 | 36% |
| 25-YR | 15.0 | 10.9 | 27% | 10.0 | 33% |
| 100-YR | 18.5 | 13.8 | 25% | 12.9 | 30% |

| Peak Flow in CFS (CSS Outlet) | | | | | |
|---|---|---|---|---|---|
| ***Event*** | ***Existing*** | ***Proposed 1*** | ***Flow Reduction*** | ***Proposed 2*** | ***Flow Reduction*** |
| 1-YR | 119.5 | 91.0 | 24% | 83.0 | 31% |
| 2-YR | 140.4 | 107.2 | 24% | 98.1 | 30% |
| 5-YR | 165.0 | 128.3 | 22% | 117.3 | 29% |
| 10-YR | 175.7 | 143.3 | 18% | 130.7 | 26% |
| 25-YR | 185.6 | 165.7 | 11% | 157.7 | 15% |
| 100-YR | 206.9 | 188.8 | 9% | 185.4 | 10% |

## Explanation of project costs and an economic comparison with the same project if developed using traditional methods

Project costs were developed based on both the proposed design concept, which maximizes the amount of stormwater treatment provided in the space available, and a "bioretention only" design concept, which still provides greater than a 1" SOV to meet the new stormwater regulations. This comparison was prepared to demonstrate that the new regulations can be achieved in a cost-effective manner for less than traditional practices while also providing an upper bound price to maximize the volume and peak flow reductions possible within the public right-of-way. The schematic probable costs below were compared to similar complete street project bids in North Carolina, Virginia, Pennsylvania, Texas and California on a per-linear-foot basis; relevant portions of the costs were also compared to CSS separation projects and urban street revitalization projects. The budget prices below fall within the expected range of construction costs based on these comparisons.

| | Maximized LID Project | | | | | Bioretention Only LID Project | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Unit Price | Total | Item | Quantity | Unit | Unit Price | Total |
| Mobilization, SUE, Stakeout | 1 | LS | $25,000 | $25,000 | Mobilization, SUE, Stakeout | 1 | LS | $25,000 | $25,000 |
| Erosion & Sediment Control | 1 | LS | $9,000 | $9,000 | Erosion & Sediment Control | 1 | LS | $9,000 | $9,000 |
| Pvt/Median Demolition/Disposal | 175,000 | SF | $0.75 | $131,250 | Pvt/Median Demolition/Disposal | 88,500 | SF | $0.75 | $66,375 |
| Bioretention (mulch, soil, gravel) | 54,889 | SF | $6.00 | $329,334 | Bioretention (mulch, soil, gravel) | 54,889 | SF | $6.00 | $329,334 |
| Sidewalk Brick & Pavers | 73,650 | SF | $4.50 | $331,425 | Sidewalk Brick & Pavers | 73,650 | SF | $4.50 | $331,425 |
| Pervious Pvt Stalls (pavers & stone) | 39,068 | SF | $14.00 | $546,952 | Mill & Overlay | 1,447 | SY | $3.00 | $4,341 |
| Pervious Pvt Plaza (pavers & stone) | 38,000 | SF | $14.00 | $532,000 | Pervious Pvt Plaza (pavers & stone) | 38,000 | SF | $14.00 | $532,000 |
| Pervious Bike Path (asphalt & stone) | 32,200 | SF | $8.50 | $273,700 | Mill & Overlay | 1,193 | SY | $3.00 | $3,578 |
| Excavation | 17,653 | CY | $10.00 | $176,528 | Excavation | 11,650 | CY | $10.00 | $116,502 |
| | | | | | | | | | |
| Structural Soils | 3,000 | CY | $45.00 | $135,000 | Structural Soils | 3,000 | CY | $45.00 | $135,000 |
| 6-inch underdrains | 2,000 | LF | $12.00 | $24,000 | 6-inch underdrains | 2,000 | LF | $12.00 | $24,000 |
| 12-inch pipe | 5,600 | LF | $18.00 | $100,800 | 12-inch pipe | 5,600 | LF | $18.00 | $100,800 |
| | | | | | | | | | |
| | | | | | | | | | |
| Yard Inlets | 75 | Ea. | $500.00 | $37,500 | Yard Inlets | 75 | Ea. | $500.00 | $37,500 |
| Curb | 10,000 | LF | $25.00 | $250,000 | Curb | 10,000 | LF | $25.00 | $250,000 |
| Asphalt (Surface & Base Coarse) | 912 | tons | $80.00 | $72,960 | Asphalt (Surface & Base Coarse) | 912 | tons | $80.00 | $72,960 |
| Coarse Aggregate | 1,150 | tons | $29.00 | $33,350 | Coarse Aggregate | 1,150 | tons | $29.00 | $33,350 |
| Wheel Stops | 330 | Ea. | $62.00 | $20,460 | Wheel Stops | 330 | Ea. | $62.00 | $20,460 |
| Landscape (Bioretention & Trees) | 1 | LS | $300,000 | $300,000 | Landscape (Bioretention & Trees) | 1 | LS | $300,000 | $300,000 |
| Striping | 13100 | LF | $0.12 | $1,572 | Striping | 13100 | LF | $0.12 | $1,572 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | Subtotal | $3,330,831 | | | | Subtotal | $2,393,197 |
| | | 20% Contingency | | $666,166 | | | 20% Contingency | | $478,639 |
| | | **Schematic Budget** | | **$3,996,997** | | | **Schematic Budget** | | **$2,871,836** |

Schematic budget comparison between maximized LID and minimized LID

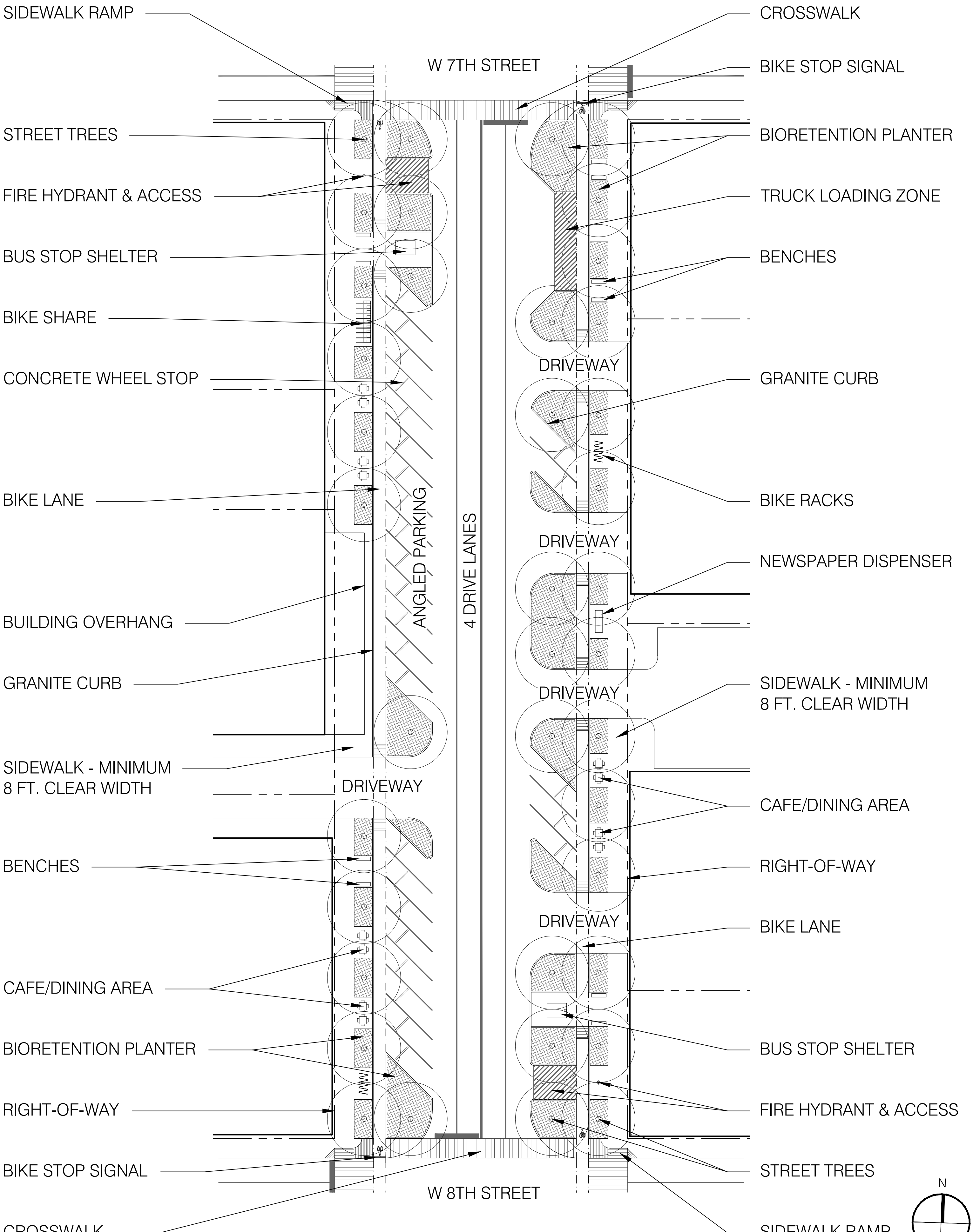
Because the areas of the pervious parking stalls and bike lanes are predominantly existing asphalt, the cost savings are realized in pavement costs, demolition, and excavation. The event plaza is still proposed to be pervious pavement based more on its drainage benefits than its stormwater treatment benefits.

In order to achieve the same result in wet weather peak flow controls by traditional methods, a 2.5 acre-feet underground vault would be required to detain and slowly release CSS flows. The vault size was calculated using the NRCS TR-55 storage estimate method and Figure 6-1. The following costs assume that the design aesthetic of increased vegetated areas, suspended pavements for optimized tree canopy growth, reduced traffic travel lanes, and pavers in the event spaces remain the same for both scenarios.

| | Bioretention Only LID Project | | | | | Traditional | | | |
|---|---|---|---|---|---|---|---|---|---|
| Item | Quantity | Unit | Unit Price | Total | Alt. Item | Quantity | Unit | Unit Price | Total |
| Mobilization, SUE, Stakeout | 1 | LS | $25,000 | $25,000 | Mobilization, SUE, Stakeout | 1 | LS | $25,000 | $25,000 |
| Erosion & Sediment Control | 1 | LS | $9,000 | $9,000 | Erosion & Sediment Control | 1 | LS | $9,000 | $9,000 |
| Pvt/Median Demolition/Disposal | 88,500 | SF | $0.75 | $66,375 | Pvt/Median Demolition/Disposal | 88,500 | SF | $0.75 | $66,375 |
| Bioretention (mulch, soil, gravel) | 54,889 | SF | $6.00 | $329,334 | Planting Area | 54,889 | SF | $1.50 | $82,334 |
| Sidewalk Brick & Pavers | 73,650 | SF | $4.50 | $331,425 | Sidewalk Brick & Pavers | 73,650 | SF | $4.50 | $331,425 |
| Mill & Overlay | 1,447 | SY | $3.00 | $4,341 | Mill & Overlay | 1,447 | SY | $3.00 | $4,341 |
| Pervious Pvt Plaza (pavers & stone) | 38,000 | SF | $14.00 | $532,000 | Paver Plaza | 38,000 | SF | $4.50 | $171,000 |
| Mill & Overlay | 1,193 | SY | $3.00 | $3,578 | Mill & Overlay | 1,193 | SY | $3.00 | $3,578 |
| Excavation | 11,650 | CY | $10.00 | $116,502 | Excavation | 6,066 | CY | $10.00 | $60,663 |
| | | | | | **Concrete Vault (installation, access)** | **108,900** | **CF** | **$11.50** | **$1,252,350** |
| Structural Soils | 3,000 | CY | $45.00 | $135,000 | Structural Soils | 3,000 | CY | $45.00 | $135,000 |
| 6-inch underdrains | 2,000 | LF | $12.00 | $24,000 | 6-inch underdrains | 4,000 | LF | $12.00 | $48,000 |
| 12-inch pipe | 5,600 | LF | $18.00 | $100,800 | | | | | |
| | | | | | 24" RCP | 3,000 | LF | $48.00 | $144,000 |
| | | | | | 36" RCP | 3,750 | LF | $60.00 | $225,000 |
| Yard Inlets | 75 | Ea. | $500.00 | $37,500 | SD Inlets & Inlet Adjustments | 1 | LS | $42,000 | $42,000 |
| Curb | 10,000 | LF | $25.00 | $250,000 | Curb | 10,000 | LF | $25.00 | $250,000 |
| Asphalt (Surface & Base Coarse) | 912 | tons | $80.00 | $72,960 | Asphalt (Surface & Base Coarse) | 912 | tons | $80.00 | $72,960 |
| Coarse Aggregate | 1,150 | tons | $29.00 | $33,350 | Coarse Aggregate | 1,150 | tons | $29.00 | $33,350 |
| Wheel Stops | 330 | Ea. | $62.00 | $20,460 | Wheel Stops | 330 | Ea. | $62.00 | $20,460 |
| Landscape (Bioretention & Trees) | 1 | LS | $300,000 | $300,000 | Landscape (Planting Areas & Trees) | 1 | LS | $300,000 | $300,000 |
| Striping | 13100 | LF | $0.12 | $1,572 | Striping | 13100 | LF | $0.12 | $1,572 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | Subtotal | $2,393,197 | | | | Subtotal | $3,278,407 |
| | | 20% Contingency | | $478,639 | | | 20% Contingency | | $655,681 |
| | | **Schematic Budget** | | **$2,871,836** | | | **Schematic Budget** | | **$3,934,088** |

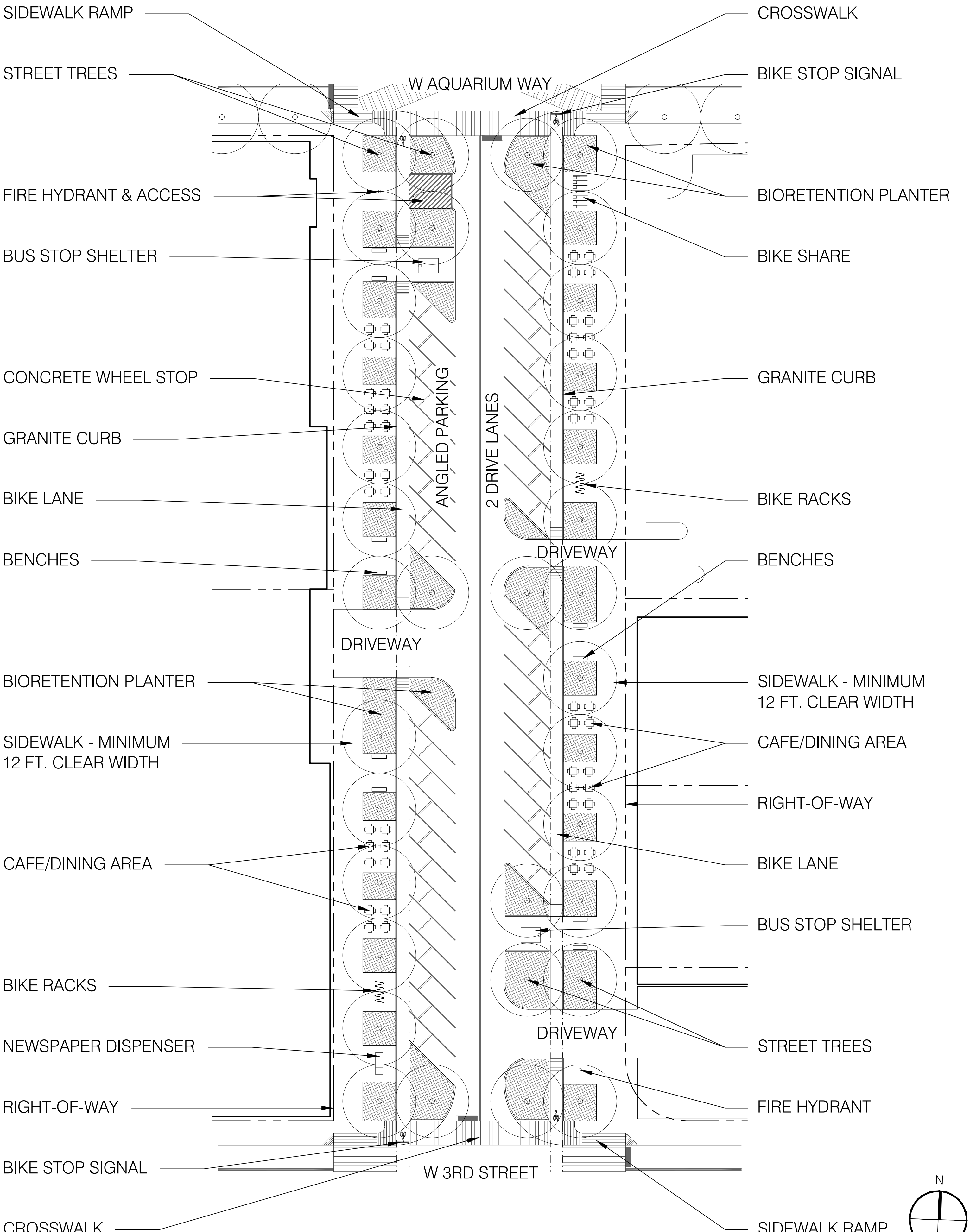
Schematic Budget comparison including a traditional, grey infrastructure solution

The traditional solution is cost-comparable with a maxed out LID option that reduces stormwater volumes by 25% - 31%; the peak flow reductions would be the same. Flexibility exists to forego the pervious parking stalls and bike lanes and still achieve better than the minimum 1-inch SOV for a cost savings of roughly 25% compared to a traditional approach. This project will epitomize the ease with which green infrastructure can be used to either maximize results for a set budget or minimize the budget needed for minimum compliance.



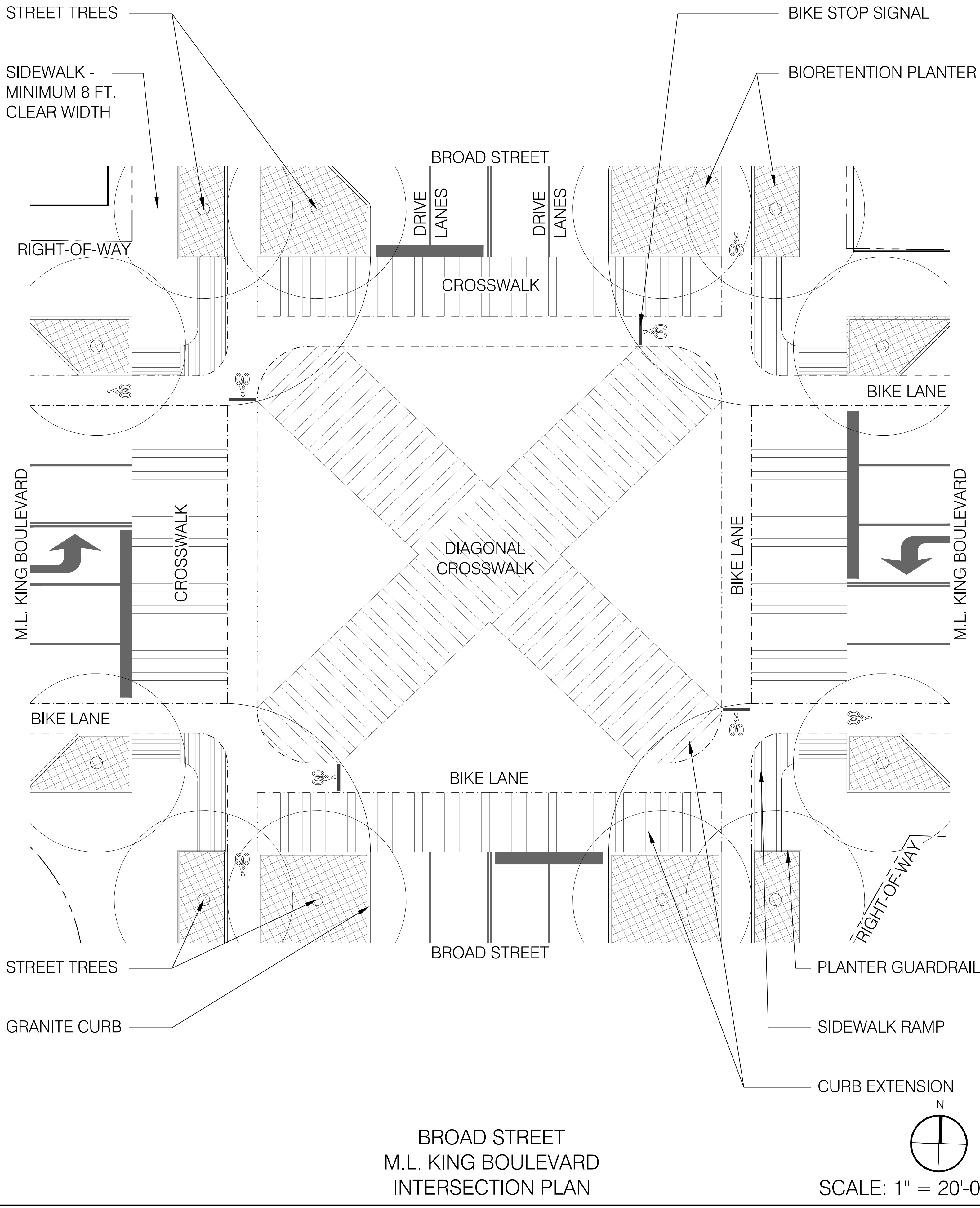

BROAD STREET
TYPICAL 4 DRIVE LANE PLAN

SCALE: 1" = 50'-0"

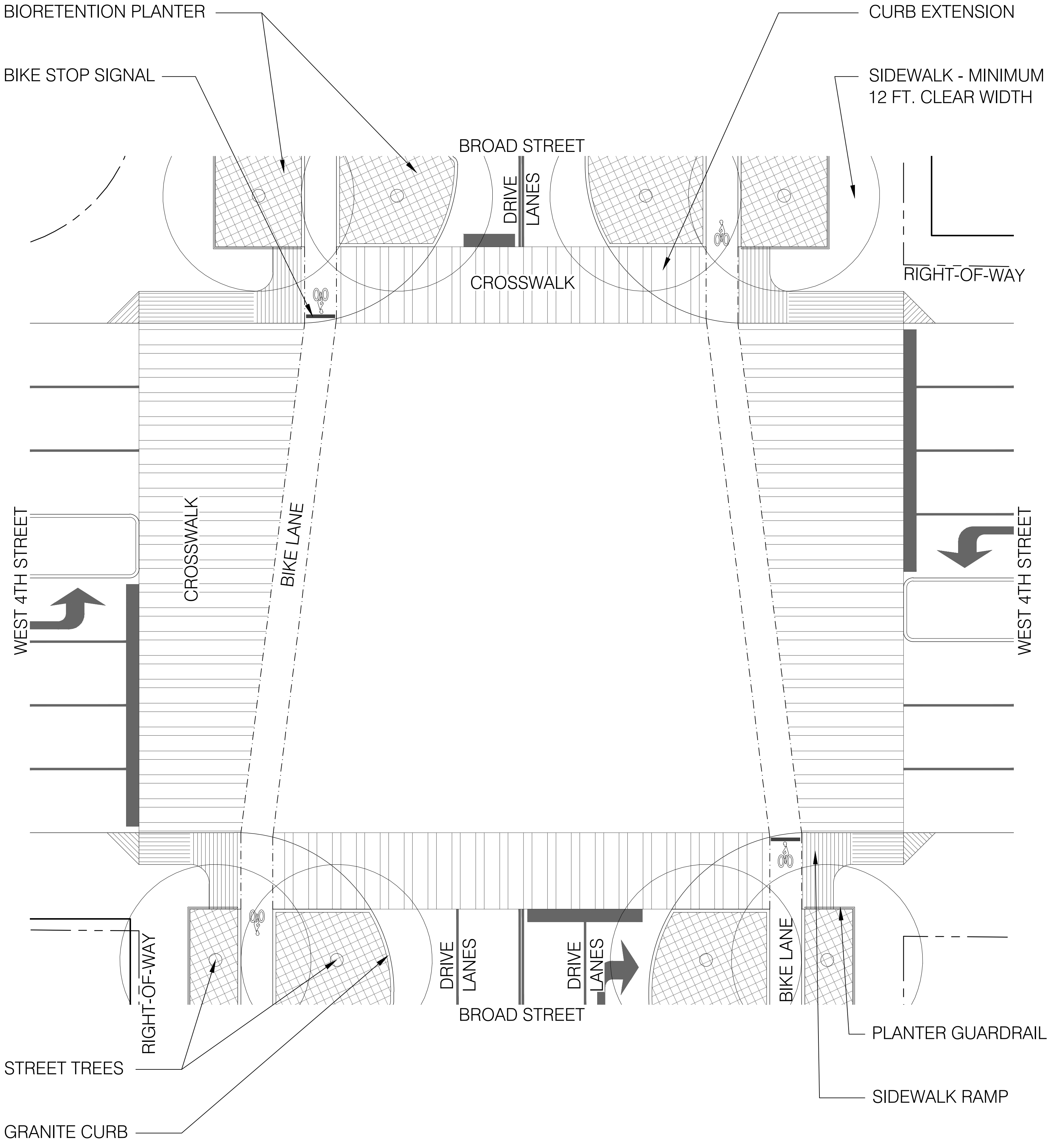



BROAD STREET
TYPICAL 2 DRIVE LANE PLAN

SCALE: 1" = 50'-0"

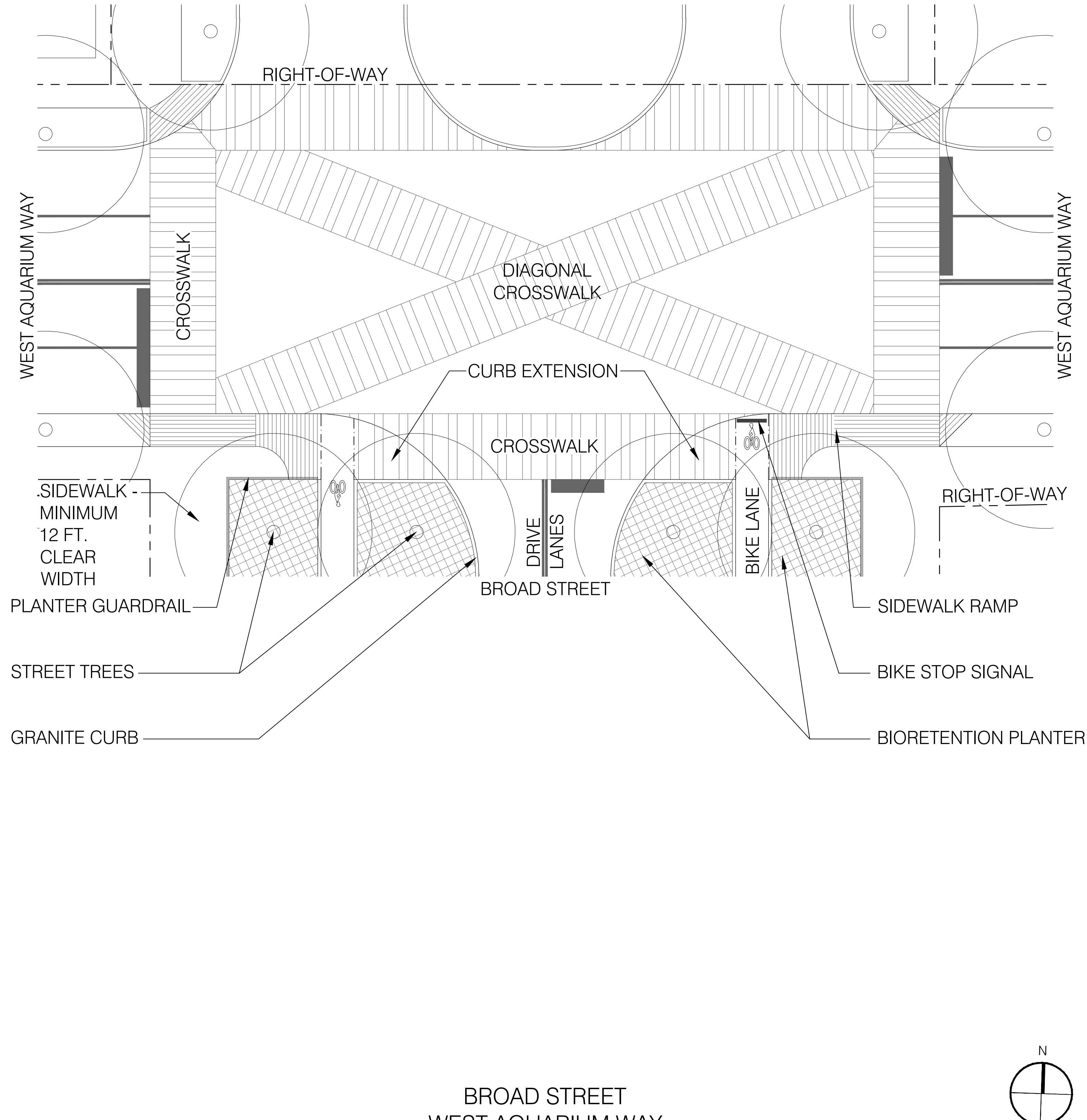



BROAD STREET
M.L. KING BOULEVARD
INTERSECTION PLAN



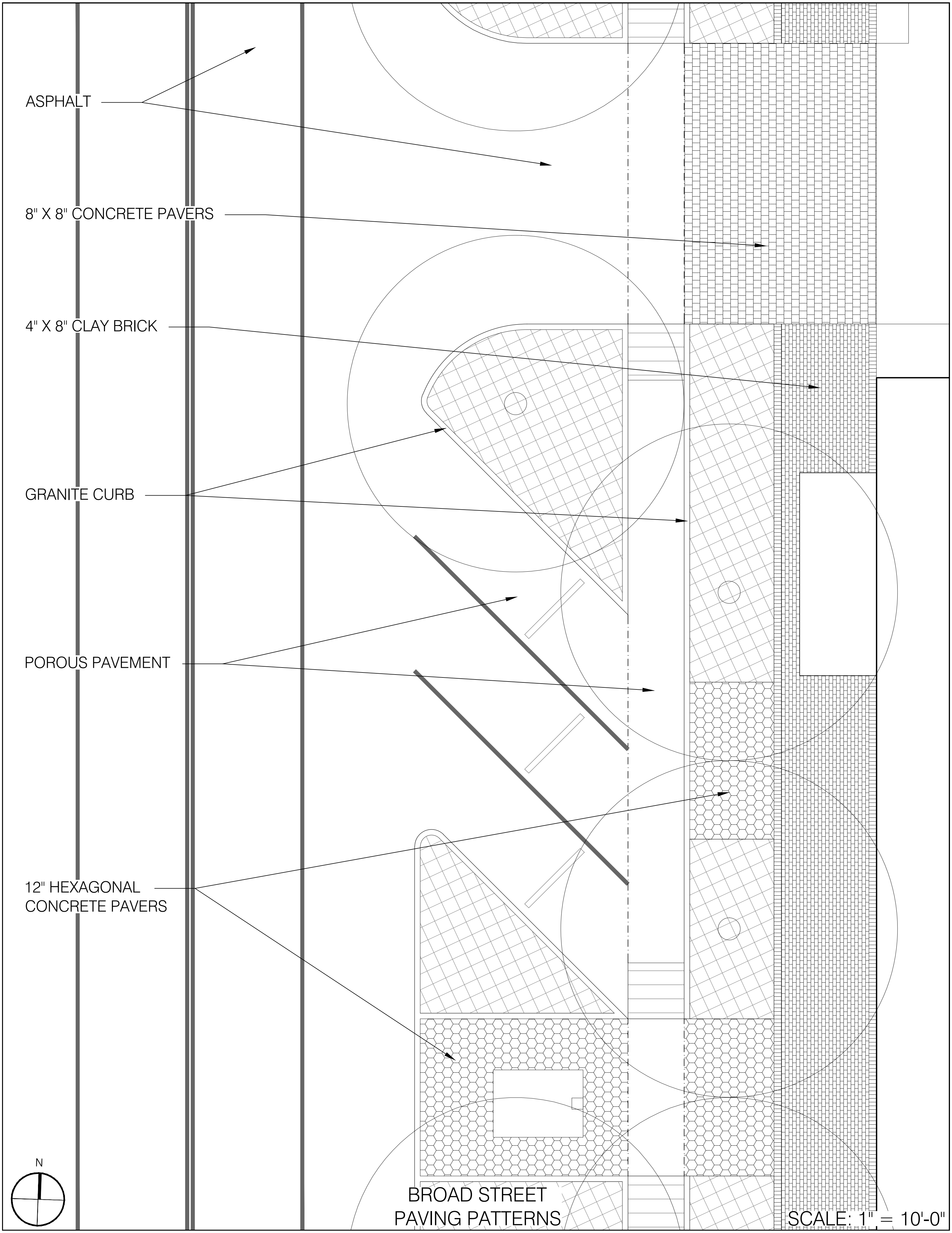

BROAD STREET
WEST 4TH STREET
INTERSECTION PLAN

SCALE: 1" = 20'-0"

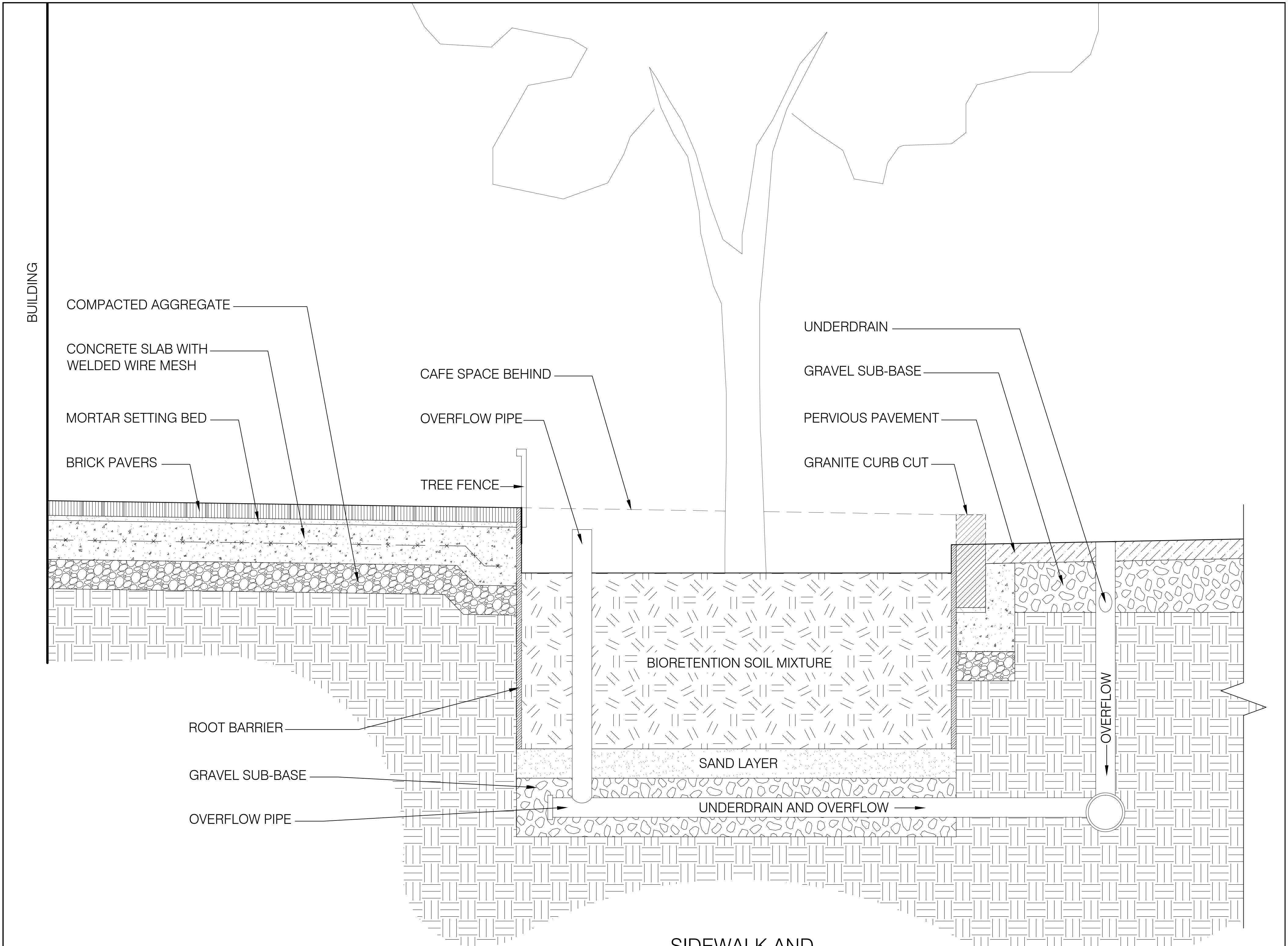



BROAD STREET
WEST AQUARIUM WAY
INTERSECTION PLAN

SCALE: 1" = 20'-0"

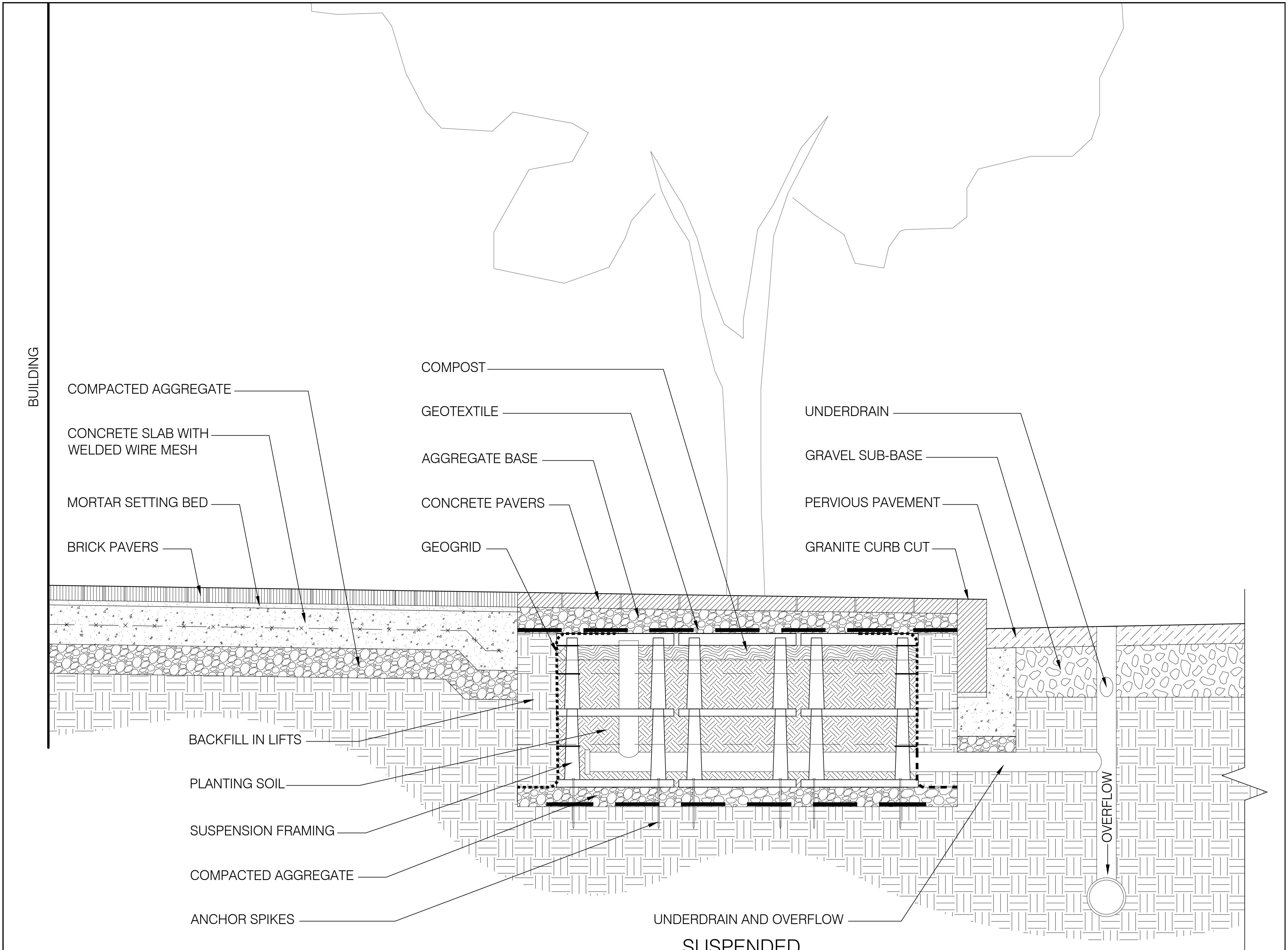



BROAD STREET
PAVING PATTERNS




SIDEWALK AND
BIORETENTION DETAIL

SCALE: ½" = 1'-0"




SUSPENDED
PAVEMENT DETAIL

SCALE: ½" = 1'-0"