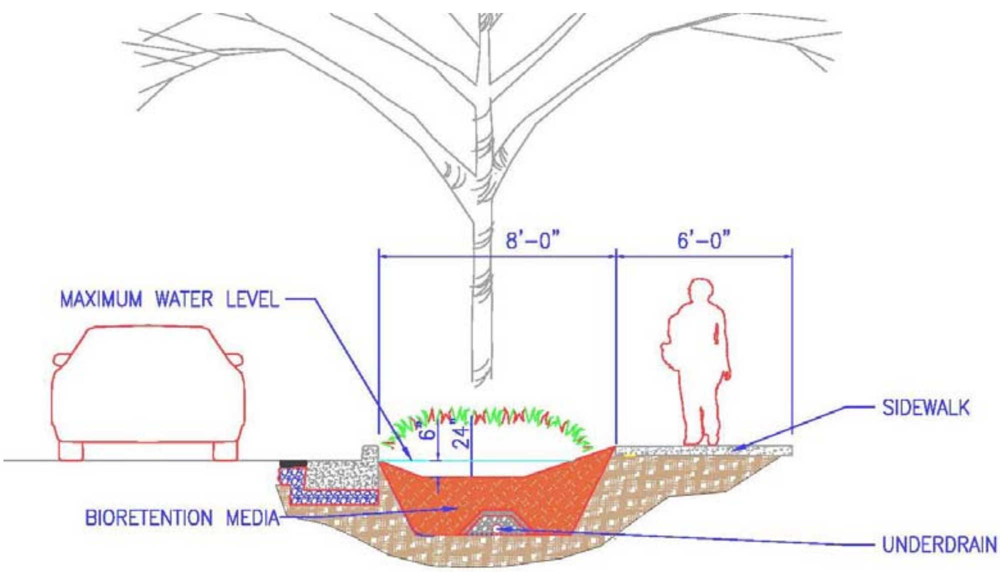
Greening of Decatur Street
Edmonston, MD

Green Street Design Options and Benefits Analysis

July 2010



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EXECUTIVE SUMMARY

The Town of Edmonston (Edmonston) is taking a leadership role by initiating the evaluation of a broad scope of alternative energy, transportation, and stormwater management approaches that address the community's sustainability objectives. Edmonston (population - 1,400; total area - 0.9 square miles) straddles the Northeast Branch of the Anacostia River, 2.5 miles from Washington, D.C. The Anacostia is one of the nation's most polluted rivers, and stormwater is a large source of pollution. To improve stormwater management and spur green development, the town is pursuing green infrastructure alternatives. With a $25,000 grant from the Chesapeake Bay Trust, the Town of Edmonston and the Low Impact Development (LID) Center, Inc. developed a Green Street design for Decatur Street, the town's main street.

This report provides detail on the Decatur Street design opportunities and constraints, specifics on recommended design components of curbside bioretention, and an analysis of the three (3) design options. While this document is intended for a technical audience, the information will also assist the community[1] by promoting further discussion and additional insight for their planning efforts. The Decatur Street model demonstrates a multi-benefit infrastructure approach that was derived from discussions with the community and project engineers. The design integrates green practices directly into the right-of-way to treat rain where it falls and reduce the flow of stormwater pollution to the Anacostia. The new green infrastructure practices are sized to treat 90 percent of the annual total rainfall and provide improved air quality and other environmental benefits. The three (3) design options summarized in the report represent increasing levels of treatment. They are summarized in table below.

Table: Bioretention and Street Tree Options for Decatur Street

Option	# of Bioretention Cells	Total Bioretention Area (sf)	% Street Area Treated	Average Water Quality Volume (in)	# of New Trees
1	4	870	29	1.27	43
2	9	1,928	62	1.33	38
3	14	3,533	62	2.45	25

At the end of the report, a discussion of the cost, complexity, and benefits associated with the green strategies are provided to guide design option decision making.[2] Plan sheets depicting the locations of bioretention and street trees for each of the three (3) options are provided in Appendix A. In addition, the following elements of curbside bioretention maintenance are provided in Appendix B:

- Design elements to ease maintenance and prolong the life of bioretention facilities
- Routine and remedial maintenance activities

[1] A separate report entitled, *Edmonston: A Great Green Town, Integrating Main Streets with Green Streets* provides the Town of Edmonston with the initial framework of a Green Master Plan to assist in devising strategies to improve stormwater management and encourage green development by pursuing green infrastructure alternatives.
[2] After the presentation of the bioretention and street tree design options to the Town of Edmonston, an opportunity arose to include a shared bike lane and permeable pavement in the street design. An addendum to this report provides information on a permeable pavement option and suggested locations for permeable pavement bike lanes.

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1.0 INTRODUCTION

The Town of Edmonston, as a historical port town and now as a “bridging” community, has strong connections to the Anacostia River. While the river presents a flooding threat to Edmonston, it is also considered a great asset as an open space and a green corridor. The Anacostia River, which has a mostly urban watershed, has been severely degraded by urban runoff pollution and high runoff flow rates. The land area of Edmonston is only a very small part of the Anacostia watershed. Through the greening of Decatur Street, Edmonston can take the first step and demonstrate sustainable redevelopment to the rest of the towns and cities in the Anacostia watershed. The following report presents the green street design options and benefits analysis for Decatur Street.

1.1 Project Goals

The Town of Edmonston requested that Decatur Street, which has no on-street parking, be narrowed in order to slow traffic, shorten pedestrian crossing distance, and reduce imperviousness. The project goals, derived from discussions with the community and project engineers, are as follows:

- Capture stormwater pollution before it enters the Anacostia River
- Reduce flooding along Decatur Street
- Encourage green economic development in Edmonston
- Incorporate large canopy street trees
- Slow traffic along Decatur Street
- Create a safe and pleasant environment for pedestrians and bicyclists

1.2 Project Constraints

A determination of the project constraints was made by evaluating survey plans created by G&C Consulting, Inc., site visits, and feedback from residents and city officials. While water and sewer utilities run down the center of the street, gas and telephone utilities run along the sides of the street. The Verizon telephone lines are deep and will not likely be impacted by the construction of the bioretention cells. The available information on the gas lines is not accurate enough for design and may or may not conflict with some of the bioretention cells proposed in the options. Potential solutions for addressing utility conflicts are provided in section 3.0, Design Options.

Other project constraints include:

- Narrow 50’ right-of-way
- Flat topography
- Truck use of the street
- High groundwater
- Underground and overhead utilities
- Driveway access

1.3 LID Practices

There are many green or low impact development (LID) practices that can be incorporated into the right-of-way, including permeable pavement, bioretention, swales, and trees. The goals of these practices are to reduce runoff through retention and detention, and to reduce pollutants by encouraging stormwater contact with the vegetation and soils. Based on the design goals and site constraints, the LID Center chose bioretention and improved tree planting areas as the chief green strategies for Decatur Street.[4]

1.3.1 Bioretention Cells

Table 1. Pollutant Removal by Bioretention[3]

Parameter	Pollutant Removal
Copper	43 – 97%
Lead	70 – 95%
Zinc	64 – 95%
Phosphorus	65 – 87%
Total Kjeldahl Nitrogen (TKN)	52 – 67%
Ammonium (NH4+)	92%
Nitrate (NO3-)	15 – 16%

Bioretention is a versatile and valuable green streets tool. Bioretention cells are small landscaped basins that reduce stormwater runoff through storage, infiltration, and evapotranspiration, and treat stormwater through physical, chemical, and biological processes. They can be adapted to many settings, from a high-density urban street to a quiet low-density residential street. Bioretention is one of the most effective tools for retaining and treating stormwater. Table 1 lists pollutant removals from a University of Maryland, College Park study of bioretention in the lab and pilot projects. The level of stormwater retained depends on a number of design factors, but most importantly the infiltration rate of the native soils. In addition to the stormwater benefits, bioretention offers many ancillary benefits, like improved aesthetics and urban heat island reduction.

1.3.2 Street Trees

Street trees provide many community benefits such as intercepting rainfall before it becomes polluted runoff, reducing the urban heat island effect, and making walking space more comfortable. While street trees are not a new green street concept, the planting requirements for a healthy, large canopy tree are often overlooked. Many urban trees have been planted too close together or in a soil area that is too small to allow the tree to reach a mature size and provide the desired community benefits. Tree roots require an uncompacted soil area where water and air will reach them. Casey Trees, a nonprofit organization whose mission is to restore, protect, and enhance Washington, D.C.'s tree canopy, published the *Tree Space Design Guide*[5] in 2008. The guide emphasizes soil volume as the main factor in determining a tree's size and health. Figure 1 illustrates the increase of canopy size with soil volume.

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[3] Allen P. Davis, et al., *Water Quality Improvement Through Bioretention: Lead, Copper, and Zinc Removal*, Water Environment Research, 75, 73-82, January/February 2003.

[4] After the presentation of the bioretention and street tree design options to the Town of Edmonston, an opportunity arose to include a shared bike lane and permeable pavement in the street design. An addendum to this report provides information on a permeable pavement option and suggested locations for permeable pavement bike lanes.

[5] Casey Trees. 2008. *Tree Space Design Guide*. Washington, D.C.

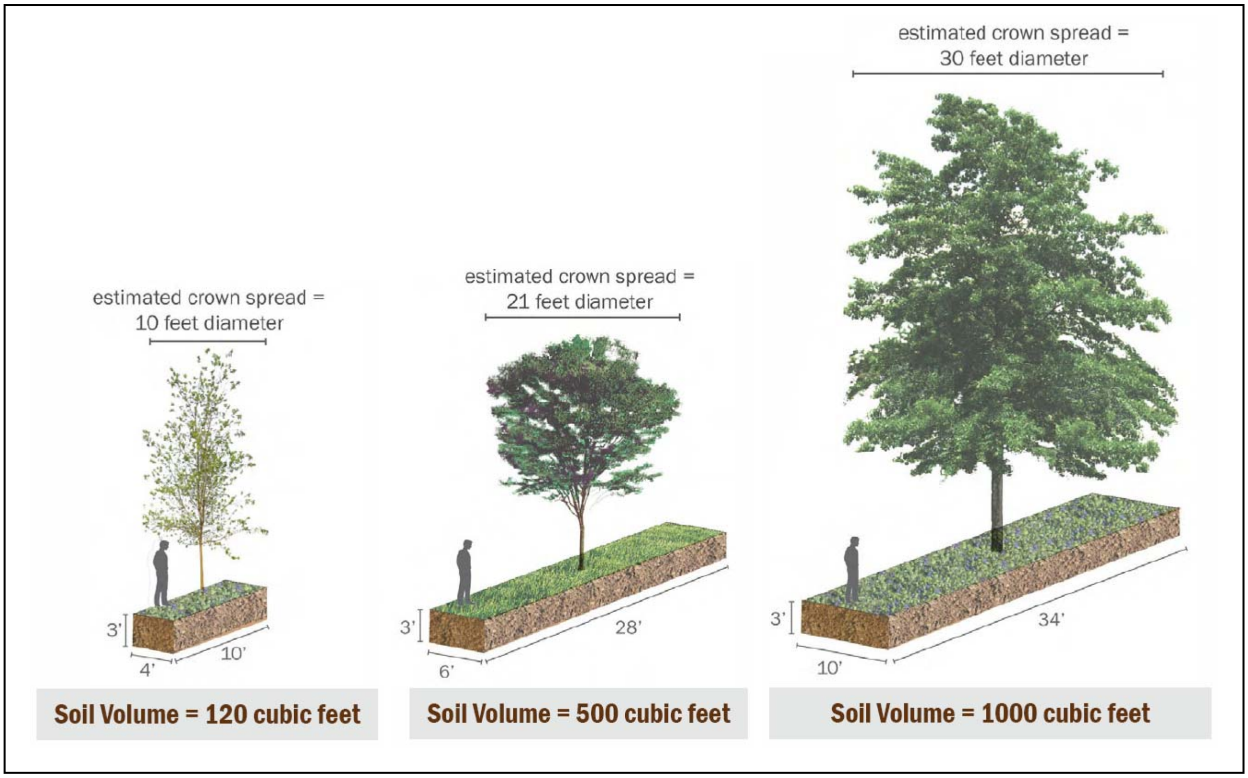


Figure 1. Tree canopy size increasing with increased soil volume.
Source: Tree Space Design Guide, Casey Trees

2.0 STORMWATER DESIGN GOAL

The stormwater goals of the Decatur Street LID project are to reduce stormwater pollution and flooding along Decatur Street. Different levels of treatment can be achieved for the areas serviced by the LID practices. For instance, the area of bioretention can be increased to capture a larger storm or greater water quality volume (WQ_v). The WQ_v is the storage volume necessary to capture stormwater pollutants from most small storms and the "first flush" of larger storms. The WQ_v required by the *Maryland Stormwater Design Manual* (2000) is 1.0 inches of rainfall. The Chesapeake Bay Trust and Town of Edmonston set a 1-year 24-hour storm (that is a 24-hour storm that occurs, on average, once a year) capture goal. The rainfall volume for the 1-year 24-hour storm in Prince George's County, Maryland is 2.7 inches. Table 2 lists the volumes for design storms in Prince George's County. These storms, while significant, represent a small portion of the total yearly rainfall volume, which averages 39 inches. This is supported by Hirschman and Kosco (2008), who analyzed storm events in an average year and found that 90 percent of all storm volumes were below 1.2 inches (Figure 2). Volume capture beyond 1.2 inches will result in diminishing returns of stormwater treatment per cost of added stormwater storage. The design options for Decatur Street present several levels of WQ_v treatment.

Table 2. Precipitation Volume Frequency Estimates[6]

Storm Frequency	Storm Volume (in)
1 yr – 24 hr	2.65
2 yr – 24 hr	3.20
5 yr – 24 hr	4.11
10 yr – 24 hr	4.92
25 yr – 24 hr	6.15

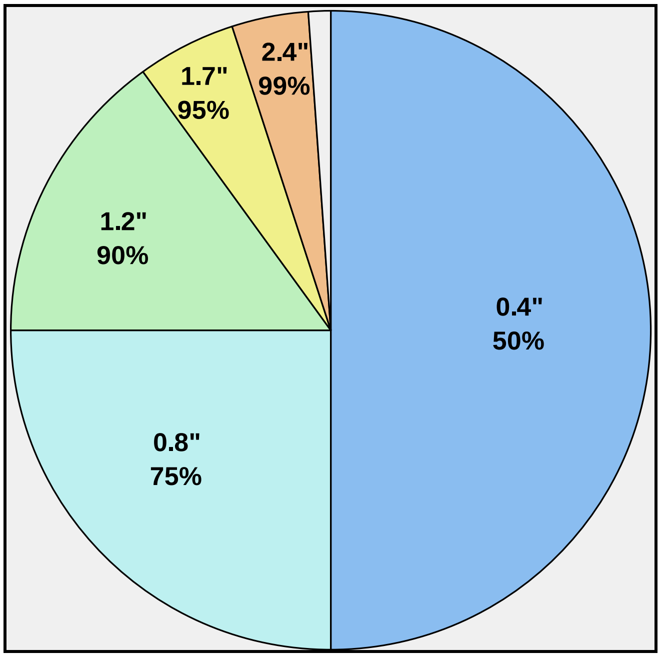


Figure 2. Analysis of Annual Rainfall Volumes and capture for Washington, D.C.[7]

3.0 DESIGN OPTIONS

Narrowing Decatur Street will meet the community goals of slowing traffic, shortening pedestrian crossing distance, and reducing impervious area. The reduction in impervious area makes the street more sustainable by reducing runoff and providing more open soil area for rainfall to infiltrate. G & C Consultants, Inc. produced two street layout options with a reduced street width. The Town of Edmonston chose the option that will narrow the driving lane and create a traffic-calming meander in the street (see Figure 3). Planting strips will be placed on one side of the street, alternating sides on each block. The width of the planting strips will increase by 4–6 feet while the total width of the planting strip available for LID practices is 8–9 feet. The expanded planting strip areas provide adequate space for the placement of bioretention and healthy tree plantings.

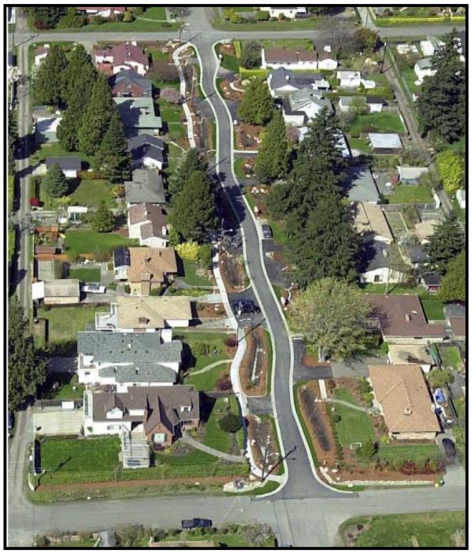


Figure 3. Street Edge Alternatives (SEA) Street reconstruction in Seattle, WA. Includes narrower driving lane and traffic-calming meander.
Source: Seattle Public Utilities

[6] From NOAA *Precipitation-Frequency Atlas of the United States* (2004).
[7] Hirschman and Kosco, 2008, *Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program*, Center for Watershed Protection.

A cross section of the curbside bioretention design proposed for the expanded planting strip areas is shown in Figure 4. Images of other green street projects where bioretention are used in the planting strip are shown in Figure 5. Note that these are only examples and that the cells designed for Decatur Street will be slightly different. The cells should have the following features:

- **Offline –** The bioretention cells will be offline, meaning that once they are filled to capacity, stormwater will bypass the bioretention and continue to flow along the gutter to the storm sewer inlet.
- **Underdrains –** Due to shallow groundwater and potentially poor infiltration soils, the bioretention cells will have underdrains. The underdrains will prevent water from standing on the surface of the bioretention cells for more than 48 hours. In addition, the underdrain will prevent groundwater from rising into the bioretention cell, which would reduce storage capacity for incoming stormwater. The underdrains will connect to the storm sewer system at inlet structures or manholes.
- **Underdrain Cleanout –** Underdrain cleanouts are standpipes which typically have locking caps and are connected to the end of the underdrain opposite the storm sewer connection. They provide maintenance access for the underdrain and a port for monitoring the water levels in the cell or collecting filtered stormwater samples.
- **2.5 Feet Total Bioretention Cell Depth –** The recommended design of the bioretention cell is 6 inches of surface storage over 2 feet of bioretention media (see cross section in Figure 4**)**. This design is less deep than typical bioretention cells due to the shallow storm drain system. The underdrain, which is at the bottom of the cell, must have positive flow to the storm sewer and must therefore be at an elevation above the invert of the storm sewer. The depths of storm sewer inlets noted on the plans are 3–5 feet from the top of the curb.
- **Curb Cut Inlets with Depressed Gutter Pans –** Curbside bioretention cells typically have simple curb openings or curb cuts to allow water in the gutter to enter the cells. The curb cuts need to be wide enough and have a depressed gutter to ensure street runoff enters the inlet and does not bypass it.
- **Flow Dissipation –** To prevent scour at the inlets, flow dissipation needs to be installed at the cell inlets. Flow dissipation typically consists of river rock. Concrete splash pads have also been used.
- **Side Slopes –** The design used for calculations consists of a vertical 1 foot curb wall on the street side of the bioretention and a 3:1 slope on the sidewalk side of the bioretention. The 9 foot planting strip will allow for a design consisting of a 5 foot bottom width for the bioretention cell, a 3 foot wide slope, and a 1 foot wide buffer with the sidewalk.

Given the limitations of the underground utility survey described in the project constraints section, some conflicts with the bioretention cell and gas lines may arise during construction. Solutions to gas lines conflicting with the bioretention cells include:

- *Moving the gas line.*
- *Narrowing the bioretention cell.* The bioretention cell can be narrowed 1–2 feet if the gas line is on the edge; however, the overall storage capacity needs to stay the same. Narrowing the cell too much could impede the flow of stormwater in the cell or lead to scour and unhealthy vegetation.
- *Installing a protective cover.* A protective cover or "doghouse" can be installed over or around the gas line to protect it from stormwater contact.

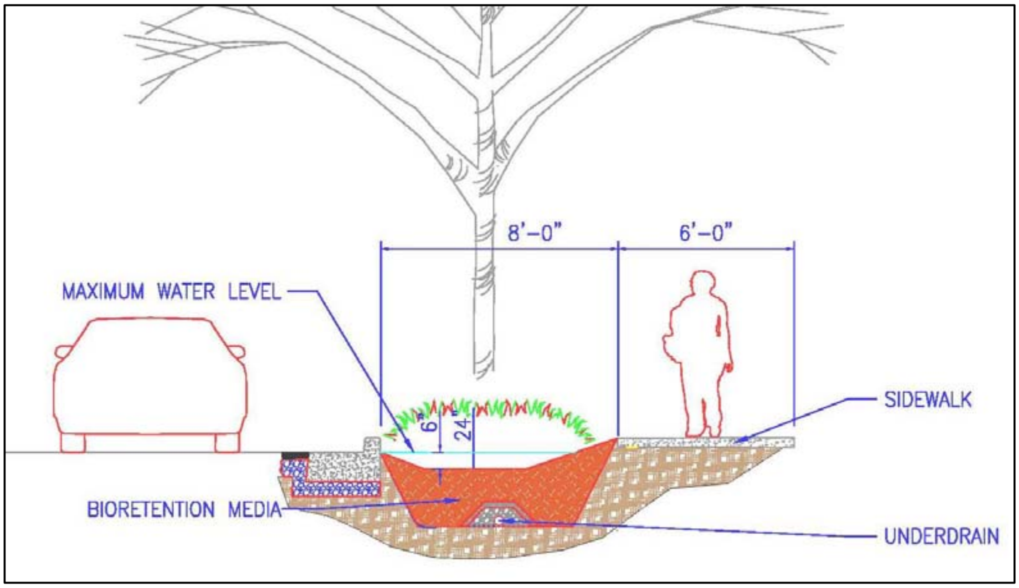


Figure 4. Proposed cross-section for Decatur Street curb-side bioretention cells.
Source: Low Impact Development Center, Inc.

Figure 5. Examples of bioretention cells between the curb and sidewalk.
Source: Portland, Oregon Bureau of Environmental Services

The design options summarized in Table 3 and described below represent increasing levels of treatment, complexity, and cost.

Table 3. Bioretention and Street Tree Options for Decatur Street

Option	# of Bioretention Cells	Total Bioretention Area (sf)	% Street Area Treated	Average Water Quality Volume (in)	# of New Trees
1	4	870	29	1.27	43
1A	4	964	29	1.41	43
2	9	1,928	62	1.33	38
2A	9	2,116	62	1.47	38
3	14	3,533	62	2.45	25

Constraints of the right-of-way width and the need to support truck traffic limited our ability to treat runoff from the entire street at a reasonable cost. The side of Decatur Street that will not have the planting strip cannot be treated by bioretention. A maximum of 62 percent of the street can be treated by bioretention.

The new street trees are located in all planting strip areas where there is no bioretention. Small trees can be planted in the bioretention cells, but they are not good locations for large canopy trees. Large trees in bioretention cells can take up volume for stormwater runoff storage and block flow within the cell. The recommended spacing of the street trees is based on guidance provided in the Casey Trees 2008 *Tree Space Design Guide*. The soil volume goal for each tree on Decatur Street was 1,000 cubic feet. The soil volume was estimated by assuming a 3 foot root depth, 8 foot wide planting strip, and 40 foot spacing length along the street. Due to available space, utilities, and driveways, some spacings are smaller than the desired 40 foot goal. The smallest tree spacing along the street is 30 feet, giving the tree a 720 cubic feet soil volume.

Each of the design options are described in more detail below. Plans illustrating the location of bioretention, the street drainage area, and the new trees for each of the options can be found in Appendix A.

3.1 Option 1 (4 Bioretention Cells and 43 New Street Trees)

Option 1 consists of two bioretention cells at the intersection of 49th Avenue, two bioretention cells at the 51st Avenue intersection, and 43 new street trees. This option minimizes cost and design obstacles and treats 29 percent of the street area, capturing a WQ_v of 1.27 inches for those areas. The 49th Avenue and 51st Avenue intersections already have storm sewer inlets and drain pipes available to connect the bioretention cell underdrains.

Option 1A enlarges two bioretention cells by extending them all the way to the corner. The other two bioretention cells can not be extended due to utilities. The size increase provides some additional WQ_v storage. The extension to the corner changes the aesthetic of the bioretention cell and eliminates space at the corner that might be used for a planting, signs, or trash cans.

Table 4. Option 1

Option	# of Bioretention Cells	Total Bioretention Area (sf)	% Street Area Treated	Average Water Quality Volume (in)	# of New Trees
1	4	870	29	1.27	43
1A	4	964	29	1.41	43

3.2 Option 2 (9 Bioretention Cells and 38 New Street Trees)

Option 2 consists of two bioretention cells at intersections 47th Avenue, 49th Avenue, 51st Avenue, and 52nd Avenue, one bioretention cell at 51st Place, and 38 new street trees. This option maximizes the area that can be treated by bioretention and can capture a WQ_v of up to 1.33 inches. The intersections of 47th Ave., 52nd Ave., and 51st Pl. do not have immediate access to the storm sewer system, which will result in higher construction costs for connecting bioretention underdrains.

Option 2A enlarges five bioretention cells by extending them to the corner. The other four bioretention cells cannot be extended due to utilities. The size increase provides some additional WQ_v storage. As with Option 1A, the extension to the corner changes the street corner aesthetic and eliminates space at the corner that might be used for a planting, signs, or trash cans.

Table 5. Option 2

Option	# of Bioretention Cells	Total Bioretention Area (sf)	% Street Area Treated	Average Water Quality Volume (in)	# of New Trees
2	9	1,928	62	1.33	38
2A	9	2,116	62	1.47	38

3.3 Option 3 (14 Bioretention Cells and 25 New Street Trees)

Option 3 consists of the Option 2 bioretention cells plus an additional 1,605 square feet of bioretention, and 25 new street trees. This option, which maximizes bioretention along the street, would bring the WQ_v capture up to 2.45 inches, but will still be short of the 1-yr 24-hr storm volume goal of 2.7 inches. Option 3 would provide the largest WQ_v capture but will yield increased costs and fewer canopy street trees.

Table 6. Option 3

Option	# of Bioretention Cells	Total Bioretention Area (sf)	% Street Area Treated	Average Water Quality Volume (in)	# of New Trees
3	14	3,533	62	2.45	25

4.0 DISCUSSION OF DESIGN OPTIONS

The most effective green street strategy for Decatur Street maximizes benefits of stormwater treatment, reduces urban heat island effect, and improves aesthetics while meeting the community needs of safety and comfort. Based on input from the community and project constraints, the recommended green strategies for Decatur Street are curbside bioretention and improved tree planting areas. All three of the design options will integrate green practices directly into the right-of-way to treat rain where it falls and reduce the flow of stormwater pollution to the Anacostia. The discussion below provides guidance to the Town of Edmonston on which design option will work best for them.

Option 3 increases stormwater treatment at the cost of other green street benefits. Option 3, like option 2, treats runoff from 62 percent of drainage area. However, Option 3 will capture 99 percent of the average annual rainfall from that drainage area. In comparison to option 2 with 90 percent capture, the increase of 9 percent capture comes at the cost of 1,417 square feet of additional bioretention area and 13 fewer large canopy trees along the street. This option will produce large gaps between sets of street trees.

Option 1 includes bioretention cells (4) at the most suitable spots along Decatur Street. Those are locations with adequate space in the planting strip, drainage area, and nearby access to the storm sewer system. This option will only treat 29 percent of the runoff from the street.

Option 2 increases the street area treated to 62 percent and includes bioretention cells (9) wherever there is adequate space and drainage area. However, there are no nearby storm sewers for connecting the underdrains from five of the bioretention cells. In some cases, there might be storm sewer access on side streets off Decatur Street. In other cases, it may be more cost effective to extend the storm sewer down Decatur Street. Choosing option 2 will require additional engineering investigation and likely higher construction costs to connect underdrains over a longer distance to the storm sewer system.

Whichever design option is chosen, Edmonston will be the first town in the Anacostia watershed with a green street and will be a model for green infrastructure practices incorporated into a small town main street. The green strategies implemented on Decatur Street will provide a starting place for creating a more sustainable Edmonston.

5.0 APPENDIX A: Design Options 1 – 3 Diagrams

Figure A1. Plan Sheet: Option 1, Decatur East

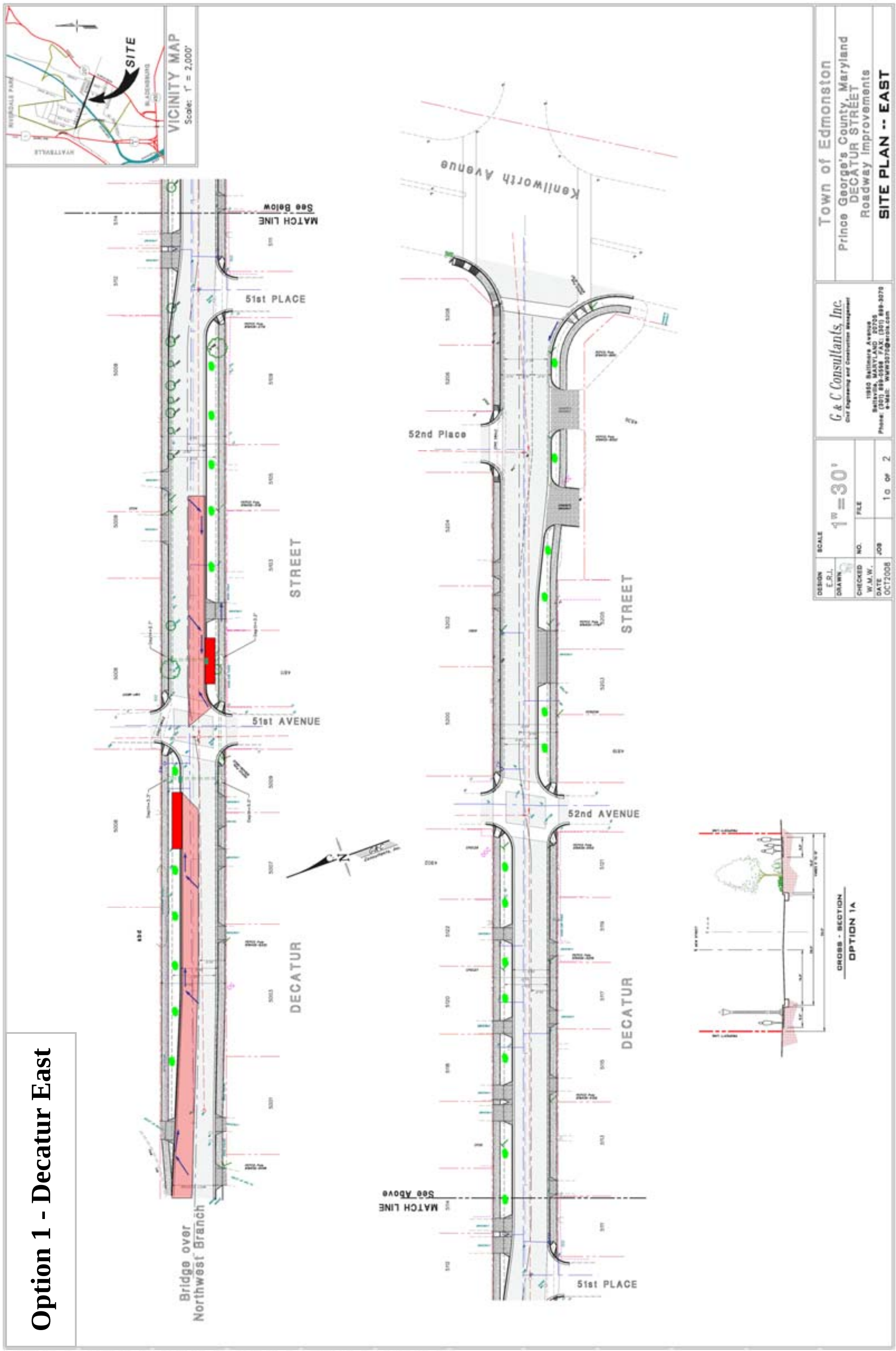


Figure A2. Plan Sheet: Option 1, Decatur West

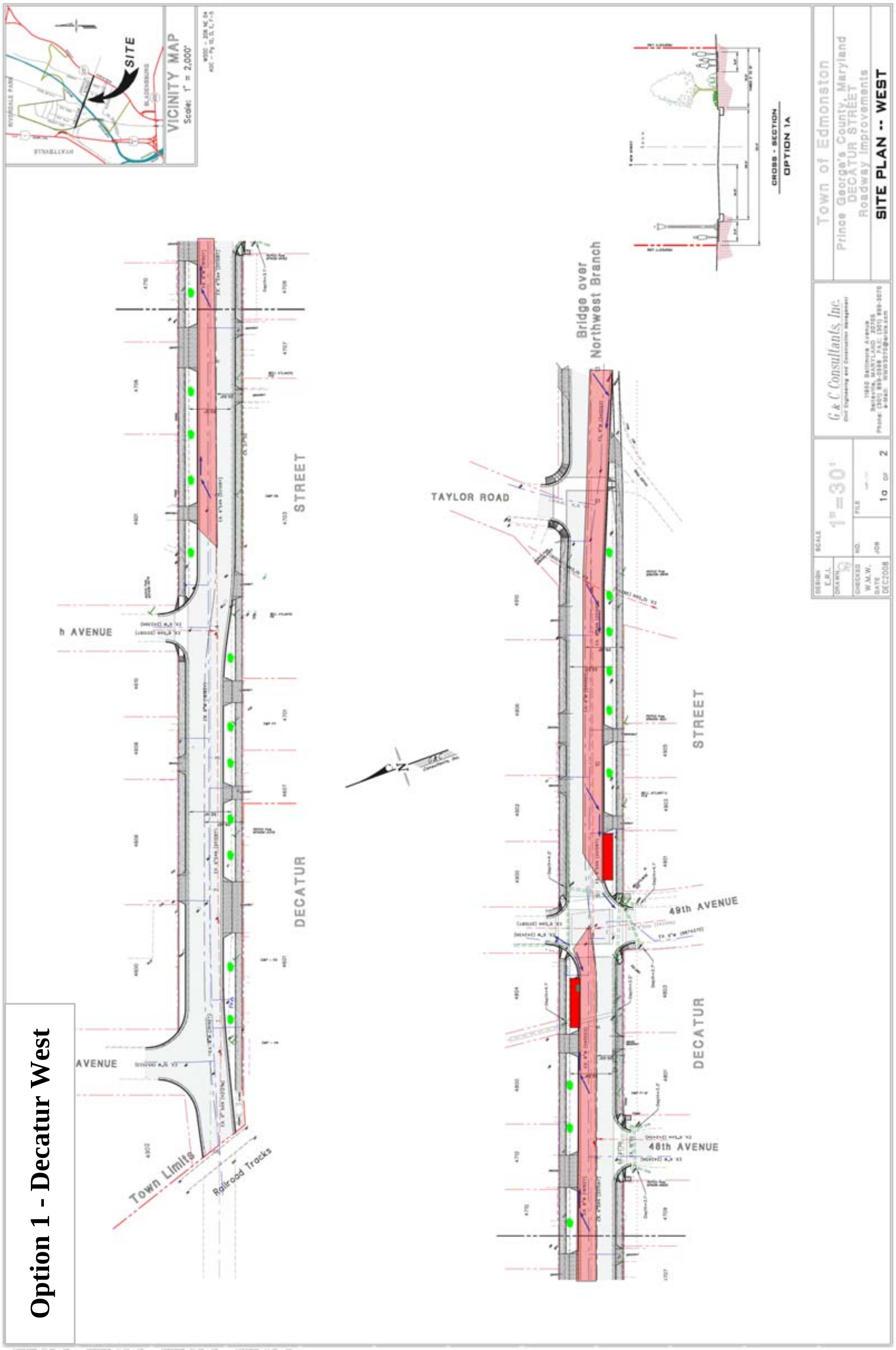


Figure A3. Plan Sheet: Option 2, Decatur East

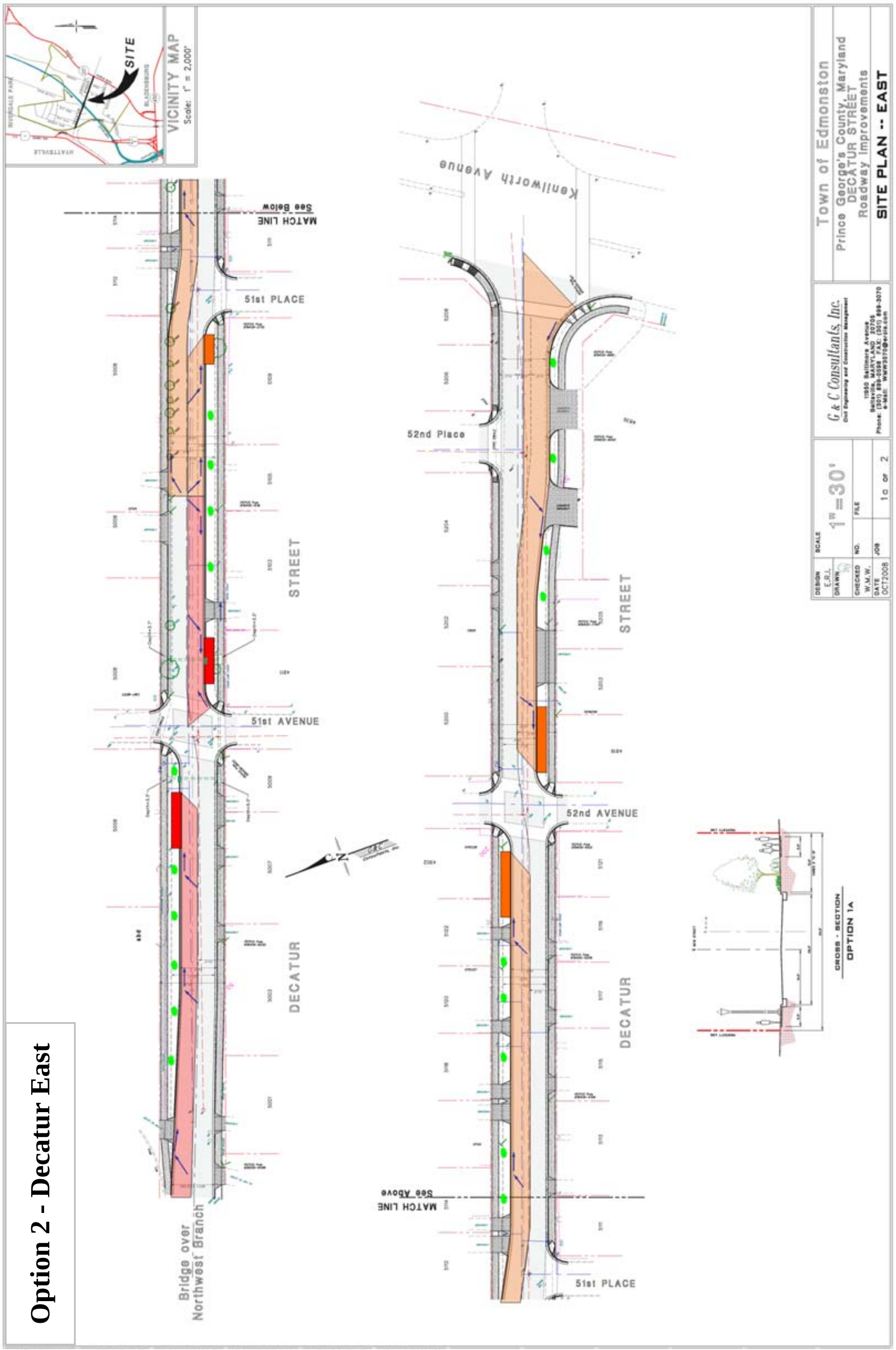


Figure A4. Plan Sheet: Option 2, Decatur West

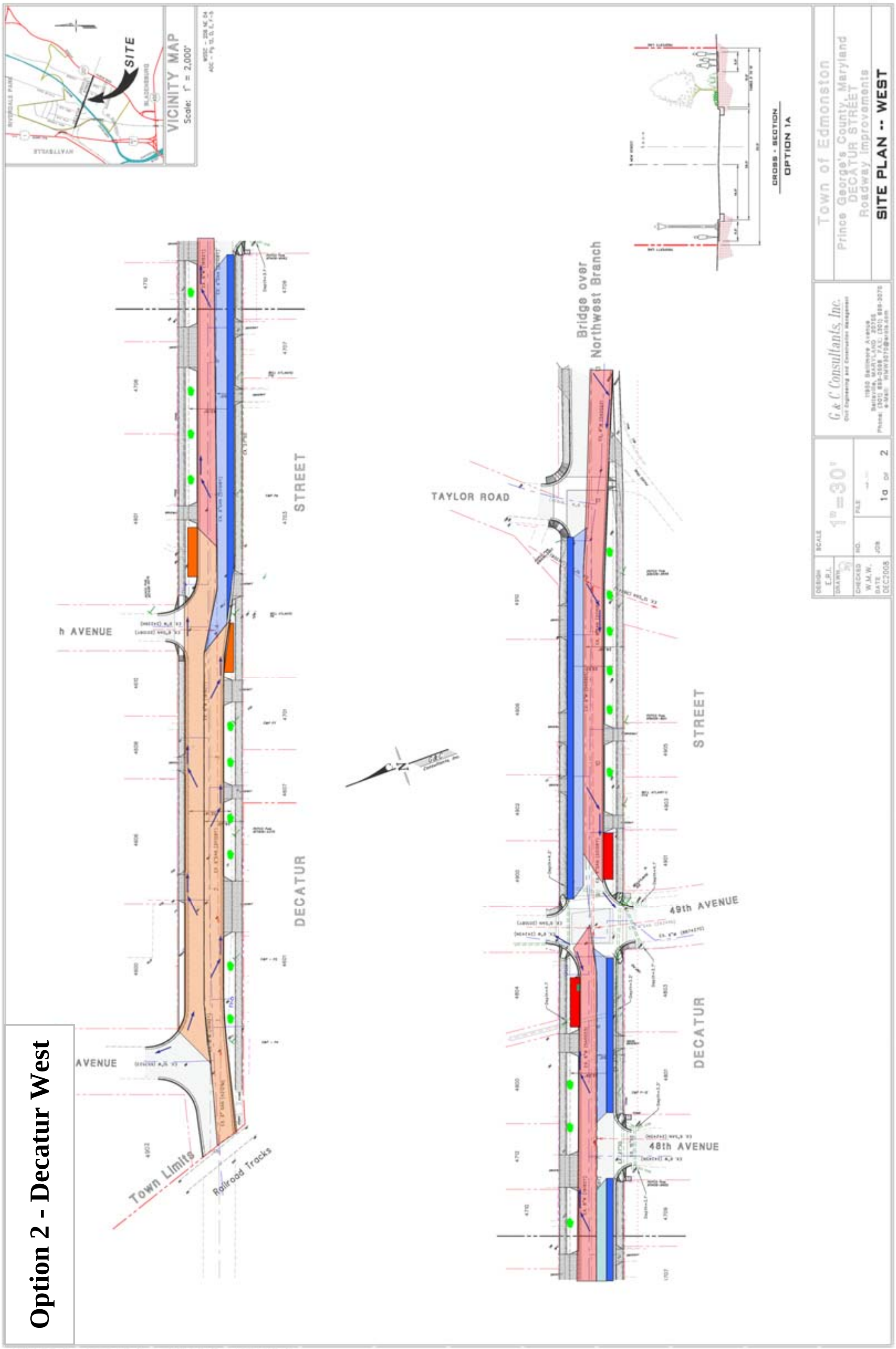


Figure A5. Plan Sheet: Option 3, Decatur East

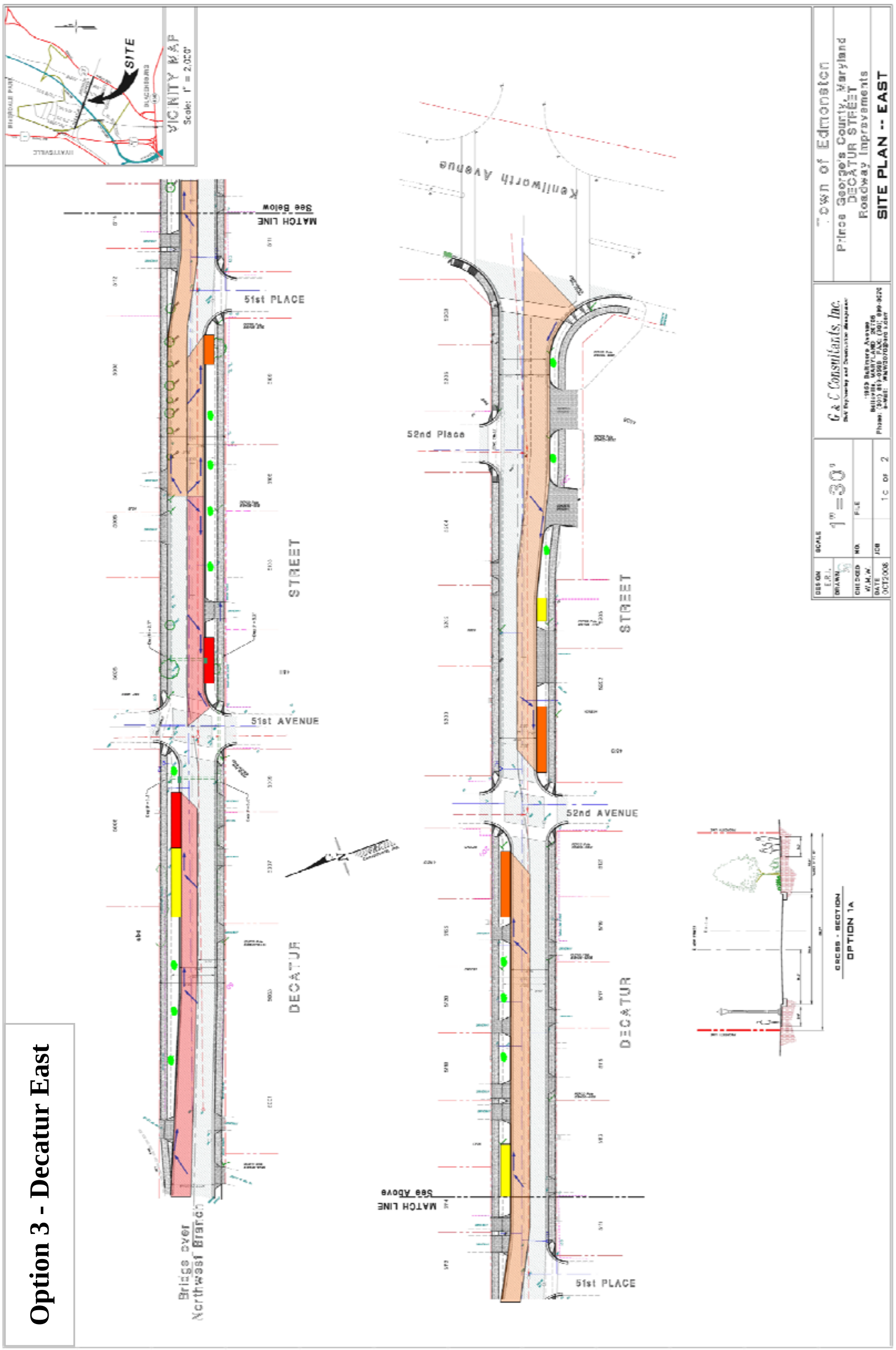
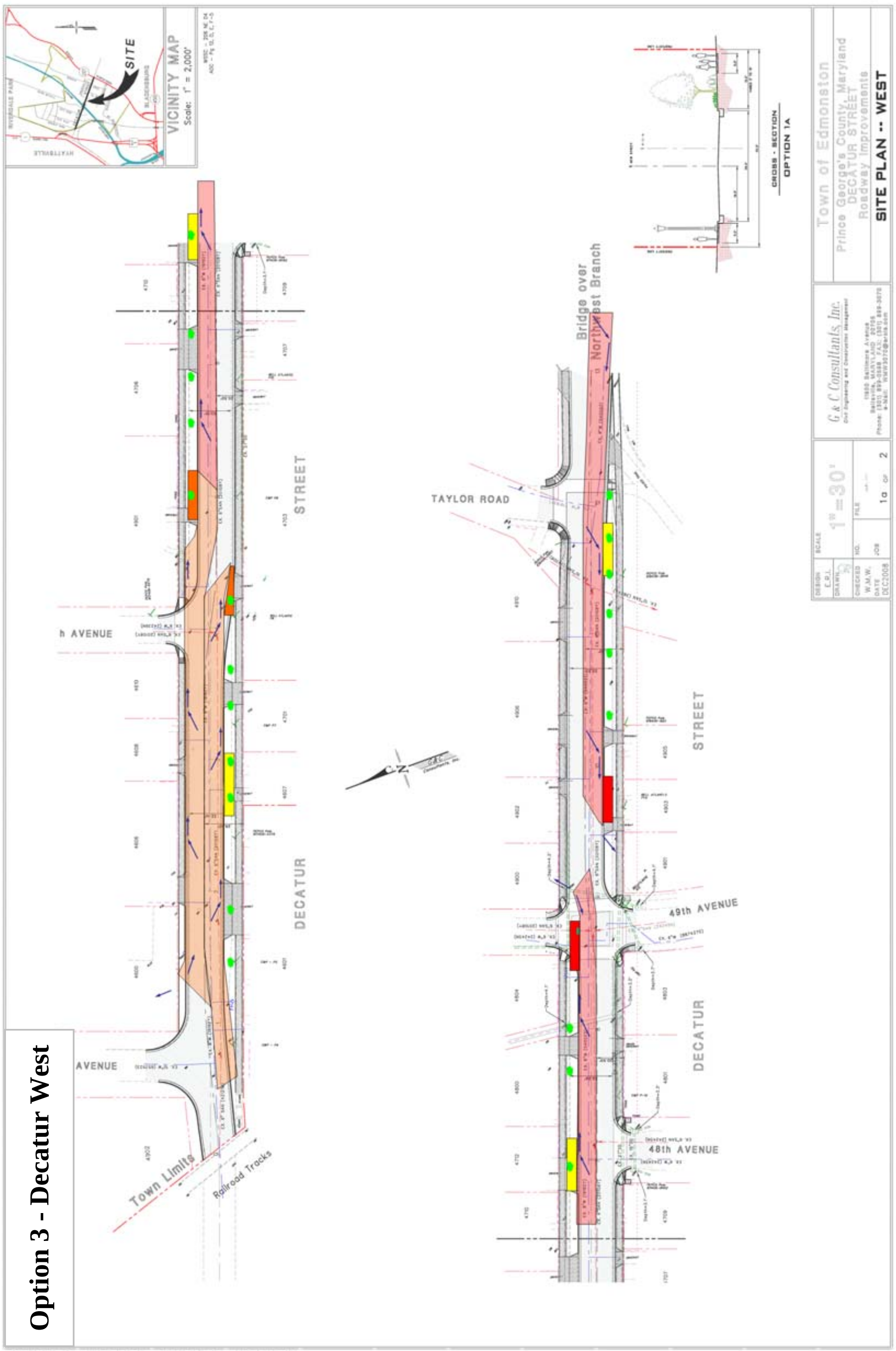


Figure A6. Plan Sheet: Option 3, Decatur West



6.0 APPENDIX B: Maintenance of Curbside Bioretention

6.1 Description

As described in section 1.3.1, bioretention cells are small landscaped basins that reduce stormwater runoff through storage, infiltration, and evapotranspiration, and treat stormwater through physical, chemical, and biological processes. The type of bioretention facility along Decatur Street is curbside bioretention, which is a bioretention cell between the curb and sidewalk. Essentially, there are three elements to bioretention cells that must be maintained: vegetation health, soil media infiltration and treatment capacity, and the overflow and/or underdrain functions.

6.2 Design Elements

Certain design elements will ease maintenance and prolong the life of the bioretention facilities. Table B1 lists design elements that should be included and maintained.

Table B1. Bioretention Design Elements for Maintenance

Access	All of the curbside bioretention needs to have adequate access for routine maintenance and remedial maintenance requiring large equipment.
Inflow Dissipation	Riprap (large river rock) or concrete pads at the inlets to the curbside bioretention will dissipate inflow energy and capture most large litter and leaf debris. The dissipation of flow energy will also prevent or reduce erosion near the inlet.
Native Vegetation	Deeply rooted native vegetation will tolerate wet and dry cycles and require less care and maintenance. The plants recommended in LID Center 2009 *Greening the Streets of Edmonston, Maryland: A Green Master Plan for the Community* will fulfill this function and are well suited for the curbside bioretention.
Underdrain Cleanout	Each of the curbside bioretention cells will have an underdrain and underdrain cleanout. The cleanout will allow the pipe to be cleared and for monitoring to occur.

6.3 Maintenance Activities

Maintenance Activities can be split into two categories: routine maintenance and remedial maintenance.

6.3.1 Routine Maintenance

The routine maintenance for bioretention facilities will be typical of any landscaped area. These types of activities can be performed by volunteers, contractors, or city staff without specialized training. They are done on a weekly, biweekly, or as needed basis.

Vegetation is the focus of routine maintenance activities. The plants chosen for the bioretention planting plan are native plants or dry and wet cycle tolerant plants. These plant types will require more attention to establish, such as regular watering and weeding, but once established they will require less attention than many non-native ornamental plants. The goal for the bioretention should be thick lush vegetation that requires no fertilizer, pesticides, or watering in the long-term. The application of fertilizers and pesticides might be a detriment to native plants, because they encourage the growth of invasive species more than the growth of native plants. Bioretention will still function quite well with invasive plants, which can grow quickly and densely, but they may detract from the aesthetic goal.

During the first growing season and until establishment, vegetation health should be inspected biweekly. Watering and weeding should be done on an as needed basis. Vegetation maintenance such as pesticide application or mechanical treatment must not compromise the function of the bioretention basin.

Finally, debris and litter should be removed on a regular basis. In an urban area such as Decatur Street, the curbside bioretention needs to be cleared of litter on a monthly basis and after major storm events. Inlets should be inspected and cleared of accumulated sediment on a yearly basis. The schedule for removals of debris, litter, and accumulated sediment will need to be updated as experience dictates.

Table B2. Routine Maintenance Schedule for Bioretention

Description	Frequency	Time of Year
Soil		
Inspect and repair erosion; clean up trash and debris	Monthly	Monthly
Mulch Layer		
Re-mulch any void areas	As needed	As needed
Remove previous mulch layer before applying new layer (optional)	Once every 2 years	Spring
Add any additional mulch if necessary	Twice a year	Spring and Fall
Plants		
Remove and replace all dead and diseased vegetation considered beyond treatment	Twice a year	Spring and Fall
Treat all diseased trees and shrubs	As needed	Varies, but will depend on insect or disease infestation
Water plant material at the end of each day for 14 consecutive days after planting	Initial installation period	Initial installation period
Replace support stakes	After 1st year	As needed
Replace any deficient stakes or wires	As needed	As needed
Remove mulch from outlets and cleanouts	Monthly or as needed	Monthly

6.3.2 Remedial Maintenance

Remedial maintenance activities are measures taken in response to abnormal conditions and gradual deterioration. The following components should be inspected following major storms in the first year and then annually after the first year. Table B3 includes inspection items and, if necessary, the appropriate corrective measures.

Table B3. Remedial Maintenance Schedule for Bioretention

Inspection Item	Corrective Action
Vegetation • Health, diversity, and density	• Remove noxious weeds and invasive plants. • Reseed or replant bare/unvegetated areas with appropriate seed mix or plants. • Adjust maintenance cycle to avoid recurring problems.
Hydraulic Rate • Water ponding for 24 hrs may indicate an operational problem	• Clear the underdrain through the cleanout. • Core aeration of soil media. • Add soil amendments. • Cultivation of unvegetated areas may be required to add root infiltration. • Remove and replace the top few inches of soil. • Replace all filtering media.
Sediment accumulation • Usually collects along the upstream edge	• Remove deposited sediment and maintain original contours and grading. The basin must be completely dry for sediment removal. The potential for downstream re-suspension must be minimized. • If there is no commercial or industrial landuse in the basin drainage area, then the sediment can be disposed onsite by land application or landfilled; sediments from watersheds with commercial or industrial land uses may need to be tested to determine proper disposal. • Upstream watershed stabilization and additional pretreatment will slow sedimentation in the bioretention basin.
Erosion • Usually occurs where flow is concentrating	• Repair gullies and rills, reseed or replant, and regrade slopes. • Temporarily add erosion netting or vegetation mats if necessary.
Structures • Concrete inlet, outlet structures, and underdrains (and curbing around bioretention planters) will deteriorate over time	• Record and continually monitor minor wear which will not impact function. • Patch concrete deterioration if possible. • Replace structure.

ADDENDUM: Permeable Pavement Options for Decatur Street

PERMEABLE PAVEMENT OPTIONS FOR DECATUR STREET

Purpose of Addendum

The bioretention and street tree design options described in the *Greening of Decatur Street* report were presented at the Town of Edmonston public meeting on March 5, 2009. The design options presented in the report summarize recommendations based on information gathered during the grant period. Although the *Greening of Decatur Street* report was complete, the mayor of Edmonston, Mr. Adam Ortiz, learned of new street layout information, prompting consideration for another design option. During the public meeting, Mayor Ortiz indicated that truck traffic would be routed off of Decatur Street, allowing the project engineer to narrow traffic lanes and include shared bike lanes. This new information allowed the Low Impact Development (LID) Center to consider the use of permeable pavement in the roadway, which will increase the area of street treated with LID practices. This addendum describes the addition of permeable pavement to the bioretention and street tree Design Options 1 and 2.

Permeable Pavement Design

Decatur Street will have two 14 feet wide shared bicycle and motorist lanes. The minimum width of a travel lane for motor vehicles is 11 feet, which leaves 3 feet near the curb for bicyclists. The area of roadway treated can be increased by using permeable pavement in this 3 foot wide space along sections of the street that are not treated by bioretention. Because permeable pavement is more expensive than conventional pavement, it is not cost-effective to use it along the entire length of the road. The permeable pavement strips should be used only where there is no space for the bioretention option. Therefore, all of the permeable pavement strips will be located on the sides of the street without a planting strip. The strips of permeable pavement will act as infiltration trenches, intercepting street runoff before it enters the gutter.

There are three types of permeable pavement: pervious concrete, porous asphalt, and permeable interlocking concrete pavers. Pervious concrete and porous asphalt are similar to their impervious counterparts but with reduced or no fines, leaving pores in the material for water to infiltrate. Permeable interlocking concrete pavers are not porous themselves, but have spacers built into them that allow stormwater to flow between them. Table 1 lists the advantages and disadvantages of using each of the three (3) pavement types recommended for this application.

Table 1. Comparison of Permeable Pavement Options

Type	Advantages	Disadvantages
Pervious Concrete	• Having a different (lighter) color strip will help to slow motorists and help separate bike and motor vehicle traffic • Less likely to be accidentally sealed when asphalt portion of the lanes are slurry[1] seal coated	• Constructability issues, for example, the wrong water/cement ratio can result in the clogging of the lower part of the pavement and accelerated deterioration; experienced contractors needed
Porous Asphalt	• Most inexpensive of the three options • Can be poured with the same equipment and methods as conventional asphalt	• Looks similar to conventional asphalt and could be mistakenly sealed when the conventional asphalt is slurry[1] seal coated
Permeable Interlocking Concrete Pavers	• Durable, attractive, easy to install and maintain • Not likely to be mistakenly paved or sealed over	• Most expensive permeable pavement option • May require a concrete edge between the asphalt and pavers • Unless a smooth paver design is used, then the surface might be uncomfortable for bicyclists, and they may choose to ride on adjacent asphalt surface

The underlying pavement structure, comprised of the aggregate base and subbase, will be the same for all three pavement types. The aggregate base and subbase provide a level surface for the pavement, support for traffic loads, and storage space for stormwater until it infiltrates into the soil or enters the underdrain.

Due to the area soils and high groundwater table, the permeable pavement trenches will require underdrains. The underdrains can be located at the bottom of the trench, as shown in Figure 1, or they can be raised from the bottom of the trench to allow for a minimum infiltration volume.

[1] Slurry coat seal consists of sand, asphalt emulsion, water, and other additives and is used to fill in cracks and smooth out wear in asphalt.

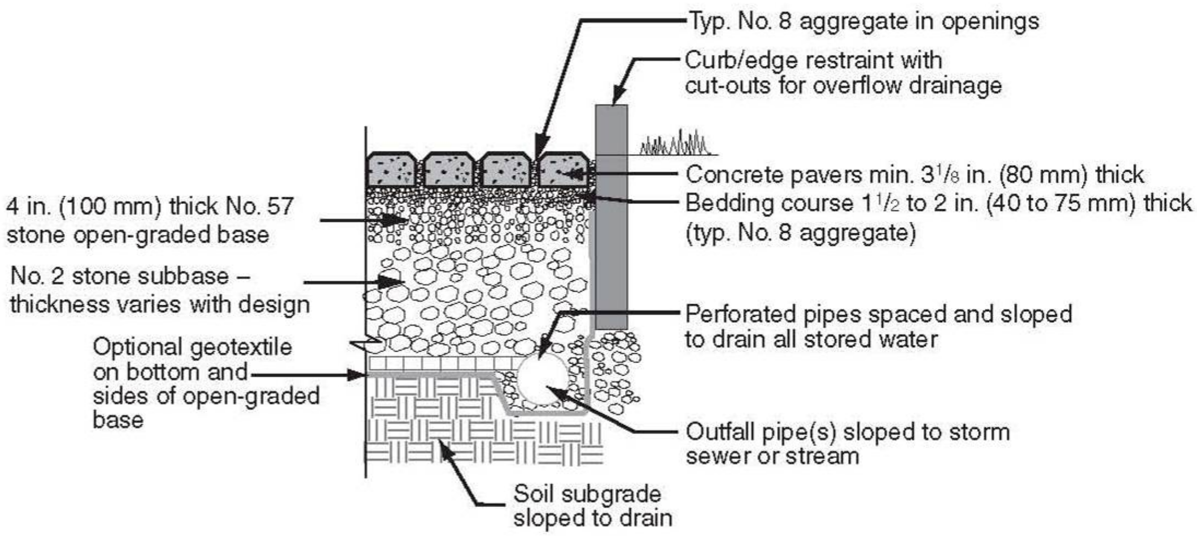


Figure 1. Permeable Interlocking Concrete Pavement Structure with Underdrain.
Source: Permeable Interlocking Concrete Pavements Manual, Interlocking Concrete Pavement Institute (ICPI)[2]

Permeable Pavement Design Options

Design Options 1 and 2 with permeable pavement are shown on the plan sheets in the Addendum Appendix and summarized in Table 2. Since options 2 and 3 have the same bioretention treatment area, the permeable pavement layout will be the same for option 3 as option 2.

Table 2. Permeable Pavement Additions to the Decatur Street LID Design Options

Option	# of Strips of Pervious Pavement	Approximate Area of Pervious Pavement (sf)	Approximate % of Street Area Treated
1	5	3,720	60%
2	7	5,250	90%

For option 1, as with the bioretention cells, permeable pavement strips were sited only along blocks where the underdrains could be conveniently tied into the storm sewer system. For option 2, permeable pavement strips were sited along all street sections that are not treated by bioretention regardless of storm sewer access. Option 2 captures runoff from the greatest percentage of the street, which is 90 percent. Capturing 100 percent is not attainable, because not all the runoff from the intersections can be intercepted by permeable pavement or the curbside bioretention cells.

[2] David Smith, 2006. *Permeable Interlocking Concrete Pavements, 3rd ed.*, Interlocking Concrete Pavement Institute (ICPI), Washington, DC, 2006.

ADDENDUM APPENDIX:

Design Options 1 and 2 with Permeable Pavement

Figure A1. Plan Sheet: Option 1, Decatur East

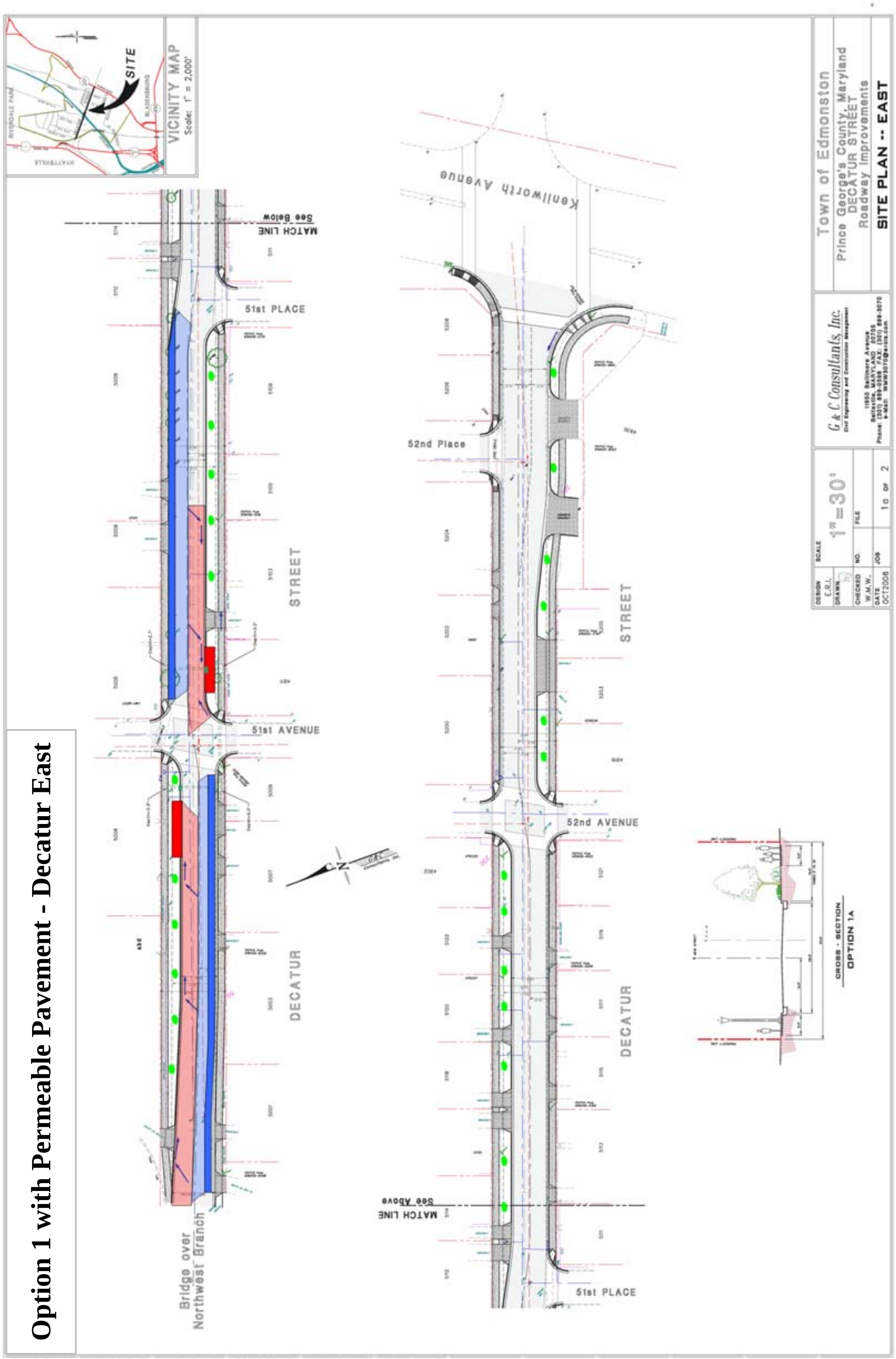


Figure A2. Plan Sheet: Option 1, Decatur West

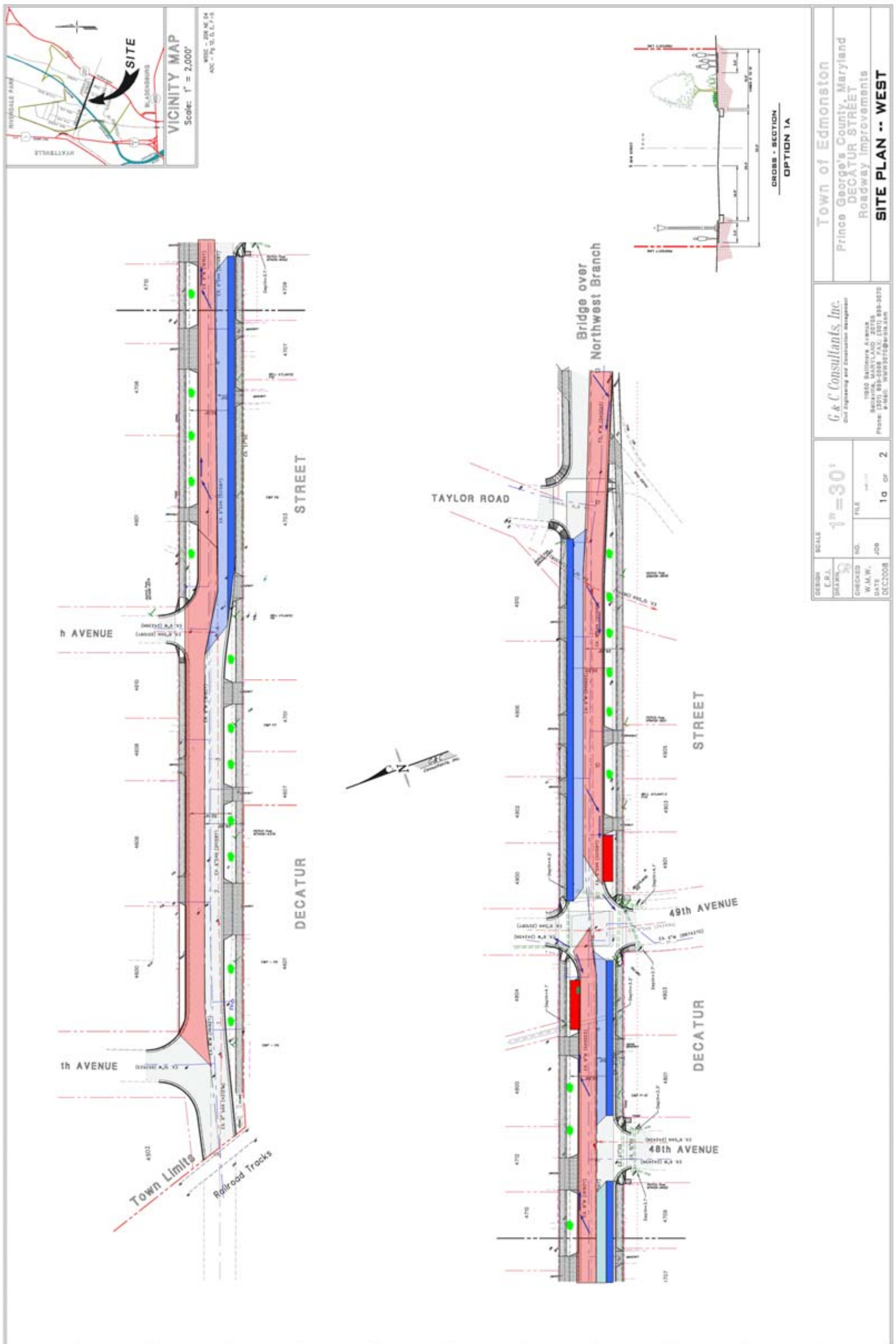


Figure A3. Plan Sheet: Option 2, Decatur East

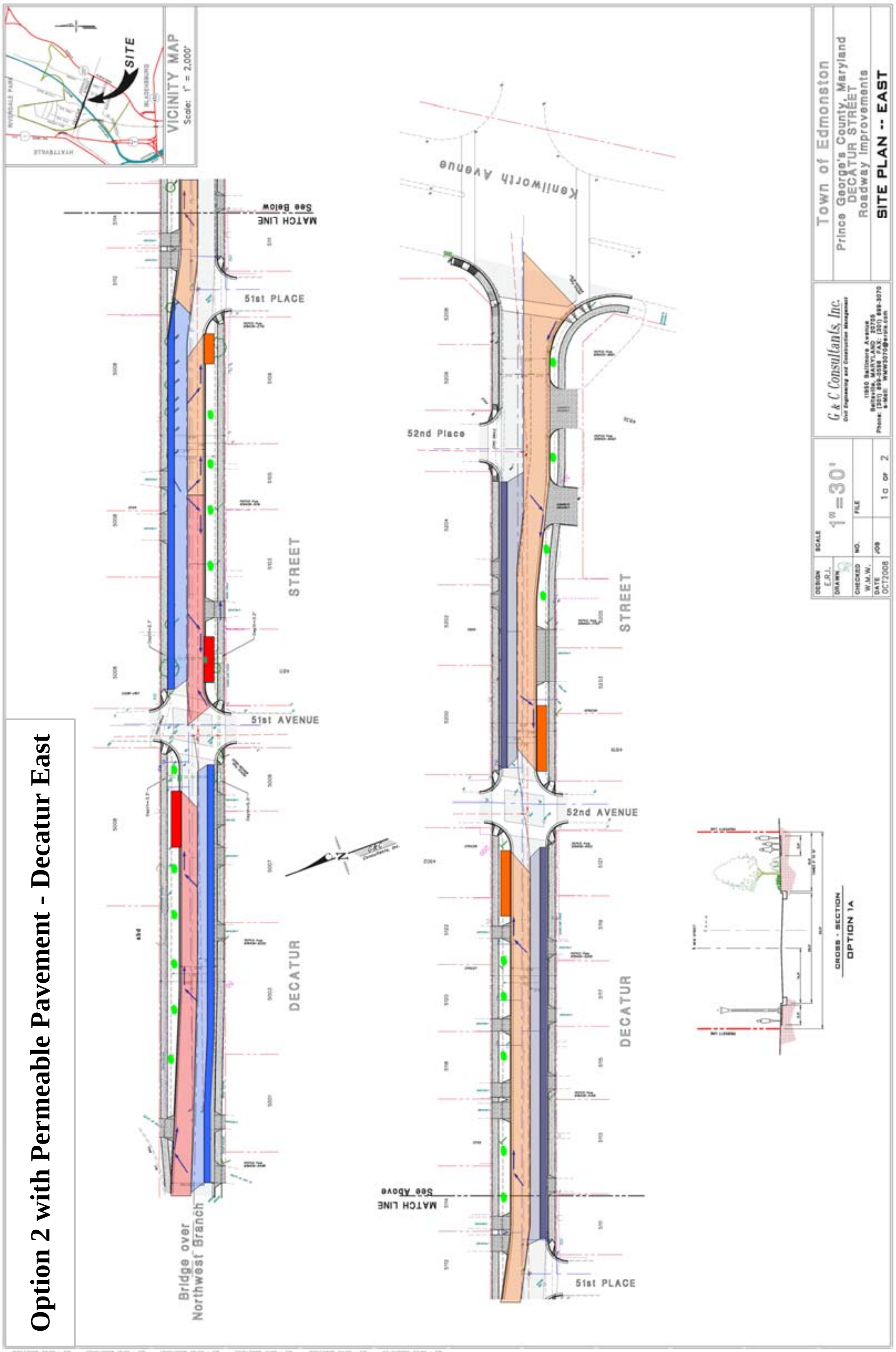

Option 2 with Permeable Pavement - Decatur East
VICINITY MAP
Scale: 1" = 2,000'
SITE
Town of Edmonston
Prince George's County, Maryland
DECATUR STREET
Roadway Improvements
SITE PLAN -- EAST
G & C Consultants, Inc.
1" = 30'
1 of 2
MATCH LINE
See Below
See Above
51st PLACE
51st AVENUE
52nd Place
52nd AVENUE
Kenilworth Avenue
DECATUR
STREET
Bridge over
Northwest Branch
CROSS - SECTION
OPTION 1A

Figure A4. Plan Sheet: Option 2, Decatur West