CITY OF FALLS CHURCH, VIRGINIA

Watershed Management Plan

City of Falls Church
Department of Public Works

Adopted February 27, 2012

Prepared with assistance from
AMEC Environment & Infrastructure, Inc.

5. Watershed Management Strategies

5.1 Introduction

This section presents the process used to identify and prioritize projects to solve locally-identified problems, such as flooding and degradation of stream habitats, or to help achieve larger regional goals such as restoring the health of the Potomac River and the Chesapeake Bay. Specifically, the City will need to implement projects between 2013 and 2018 to meet 5% of the overall pollutant reduction assigned to Falls Church. While long-term planning and costs are discussed in Section 6, the WAC believed that it was important to assure that projects identified in the Watershed Management Plan at least be sufficient to meet the City's commitments over the life of the five-year CIP. At the end of this section are "Project Data Sheets" for the top 10 priority projects.

5.2. Watershed Management Techniques

Falls Church, unlike more recently developed areas of Northern Virginia, was largely developed without the benefit of a comprehensive approach to managing stormwater or stringent stormwater management requirements. Many areas of the City are served by undersized stormwater pipes and inlets, if they are served at all. Additionally, there are relatively few stormwater management facilities to mitigate flooding, improve water quality, or both. The result is twofold. First, several areas of the City experience localized flooding after relatively routine storm events. This localized flooding is the most frequent subject of complaints by City residents. Second, Falls Church has a greater impact per acre on water quality in the Chesapeake Bay than more recently or less intensely developed areas in the region.

Most flooding problems in the City can be solved through more effective management of the volume/quantity of stormwater. Solutions are site-specific, but can include:

- upgrading undersized pipes, culverts, and inlets;
- stormwater diversion;
- implementing techniques such as rooftop or underground detention to temporarily store and slowly release stormwater; and,
- flood proofing.

Example of a street with too few inlets to adequately handle stormwater volume.

One common problem identified in the City is that many streets do not have an adequate number of inlets for the volume of water being handled. In those cases, new inlets need to be added and the system enhanced to deal with the added volume.

While new drainage infrastructure is relatively easy to incorporate into the urban environment, implementing techniques to control the quantity and quality of stormwater presents a much greater challenge. Traditional stormwater management techniques such as "extended detention dry ponds," "wet ponds," and "constructed wetlands" operate by detaining or retaining stormwater in an impoundment so that pollutants can settle out before the water is slowly released into the receiving stream. Although these

techniques are relatively common in more suburban areas, particularly those developed in the 1980s and 1990s, they have historically been avoided in the City because they consume too much space.

Low Impact Development/Urban Stormwater Controls

More recently, a diverse toolbox of techniques better suited to the urban environment has emerged. These techniques tend to be smaller than traditional controls. Many are designed to mimic the natural hydrology by slowing stormwater runoff and/or by promoting infiltration into the soil. Some techniques, such as cisterns and rain barrels, collect stormwater for later use as irrigation water – thereby reducing stormwater volume, improving water quality, and saving money. Techniques such as street sweeping and public education are designed to prevent pollutants from entering stormwater in the first place. Finally, stream restoration and day-lighting can be employed to repair the damage caused to streams from inadequate stormwater controls.

Traditional stormwater management techniques, such as the "wet pond" above, are not well suited for the City's more urban environment.

The major limitation in the City with regard to LID is that they often rely on the ability of the underlying soil to quickly infiltrate stormwater into the ground. Because most soil in the City is highly compacted, careful consideration needs to be given to the type of technique selected for a particular site. In some cases, the soil can be amended or removed and replaced with more porous soil. In other cases, techniques such as green roofs and "tree box filters" should be considered over techniques that rely primarily on infiltration.

Table 5-1 provides an overview of LID tools and other urban stormwater management techniques that are applicable in the City of Falls Church.

Table 5-1. Low Impact Development and Other Applicable Stormwater Management Techniques

Practice	Description	Advantages	Disadvantages	Picture
Cisterns and Rain Barrels	Large containers used to catch rainwater for reuse. Rain barrels are used for residential and smaller commercial applications. Cisterns are used for larger applications. Health Department restrictions may apply. Typically, rainwater is used for irrigation.	1. Water conservation and reuse. 2. Reduce load on storm drain system. 3. Small area required. 4. Use for landscape irrigation. 5. Low maintenance.	1. Highly variable benefits that are difficult to track for regulatory compliance purposes. 2. Requires large scale use to make significant difference. 3. Treats only a small area.	
Tree Box Filters and Manufactured BMPs	Precast concrete box with engineered media at curb line. In many cases, trees or other small vegetation are incorporated to promote nutrient uptake.	1. Easy to incorporate and can be used to retrofit streets and parking areas. 2. Small area needed for installation. 3. Aesthetically pleasing. 4. Pollutant removal efficiencies are relatively well documented.	1. Small drainage area. 2. Requires consistent maintenance program, including replacement of vegetation. 3. Does not provide flood control.	
Permeable Pavers	Open-jointed block system that infiltrates water through openings.	1. Does not take up additional land space. 2. Reduces impervious area of site. 3. Good for places of worship and secondary parking areas that are not used frequently.	1. Can clog and requires consistent maintenance. 2. Inappropriate for high traffic areas. 3. Requires permeable soils or installation of an under-drain. 4. If technique uses vegetation, sun/shade may be an issue.	

Practice	Description	Advantages	Disadvantages	Picture
Permeable Asphalt	Standard hot-mix asphalt with reduced sand or fines that allows water to drain through it.	1. Same as Permeable Pavers.	1. Same as Permeable Pavers.	
Green Roofs	Vegetated roof system. Rainwater filters through special soil medium. Specially selected plants promote nutrient uptake and evapo-transpiration.	1. Secondary benefits include improved air quality and reduced heating/cooling bills. 2. Aesthetically pleasing. 3. Can be installed in any urban area. Does not take up land space.	1. More expensive than a traditional roof. 2. Possibility of leakage. 3. Best for new construction or replacement of entire roof system. 4. Vegetation requires maintenance while being established.	
Grassed Swales	Earthen swale that is broad and shallow with vegetation. Check dams are usually installed to pond water and promote infiltration into the soil.	1. Easy to incorporate into site design. 2. Used for water quality by infiltration. 3. Can be used instead of curb and gutter in residential areas.	1. Water quality benefit requires permeable soils. 2. Not for use in steep terrain. 3. Relatively low pollutant removal. 4. Takes up more space than other techniques. 5. Requires periodic mowing.	
Sand Filter	Above or underground vault filled with sand and other materials. Water slowly infiltrates through the sand, where pollutants are trapped.	1. May be used in highly urban areas. 2. May be located under parking areas. 3. May be used to treat up to 20 acres of drainage area.	1. Subject to more intense maintenance than other facilities.	

Practice	Description	Advantages	Disadvantages	Picture
Bioretention/Rain Gardens	Planted area with engineered media beneath that infiltrates into the surrounding soil.	1. Aesthetically pleasing. 2. Minimal maintenance. 3. May be used as a landscaping feature. 4. May be used in a variety of situations.	1. Treats only a small drainage area. 2. Not to be used near marine clays. 3. Minimum size of approx 150 sq ft. 4. Important to install correct plants.	
Infiltration Trench	Stone filled trench that captures water and slowly infiltrates into soil.	1. Achieves high pollutant removal. 2. Can be located in tight spaces or along the edge of parking lots. 3. Can be used in place of gutter system along roads.	1. Must have permeable soils. 2. Subject to clogging and maintenance intensive. 3. Less aesthetically appealing than other techniques.	
Stream and Headwaters Restoration	Various techniques used to restore degraded streams or headwaters damaged by excessive volume and velocity of stormwater.	1. Can restore the biological integrity of stream segments. 2. Can be aesthetically pleasing.	1. Space limitations can make impractical. 2. Often requires extensive grading and the removal of trees. 3. May experience failure if volume/velocity issues are not addressed.	

In addition to the above structural techniques are several non-structural techniques that can be used to prevent pollutants from entering stormwater in the first place. Examples include:

- public education and outreach,
- street sweeping,
- storm drain clean out, and
- fertilizer management.

Under the terms of the City's MS4 stormwater permit, the City already engages in a rigorous public education program, conducts street sweeping on public roads, and cleans out storm drain inlets and catch-basins. In FY2011, street sweeping prevented 250 tons of sediment and debris from entering the storm sewer system. Likewise, storm drain inlet and catch-basin cleaning removed 200 tons of sediment and debris. Encouraging private property owners to engage in street sweeping and inlet cleaning is a potential BMP for the City's consideration.

A strategy contained in the Virginia WIP is to require the development of nutrient management plans for all public property where fertilizers are stored or applied. While fertilizer application is generally limited in the City to places such as Thomas Jefferson Elementary and Madison Park, these facilities and any future facilities where fertilizers are applied will likely need to develop nutrient management plans.

Additional ordinances, policies, and protocols that can be used to minimize impervious surface cover and promote infiltration of stormwater into the soil (such as reduced parking space standards, policies to promote shared parking, street with standards, etc.) are found in Section 3.

5.3. Problem/Opportunity Identification and Initial Prioritization

AMEC and City staff employed a three-tiered approach to identify problem areas and/or opportunities for improvements to water quality and aquatic habitats. These included (1) staff interviews (July 20-21, 2009), (2) an analysis of City complaint records, and (3) reviewing recommendations from previous watershed management and stormwater-related studies. Previous studies include:

- 2009 Stream Assessment Report
- 2007 Stormwater System Performance Assessment
- 2007 City Facility Assessment
- 2005 Evaluation of Daylighting Opportunities Report
- 2003 Stormwater Utility and Infrastructure Plan
- 1996 Watershed Management Plan

Based on this approach, AMEC and City staff compiled a draft list of problem areas/opportunities and used a desktop map exercise to eliminate initiatives that were clearly impractical. This resulted in 45 problem areas/opportunities for further prioritization.

5.3.1 Initial Problem/Opportunity Prioritization

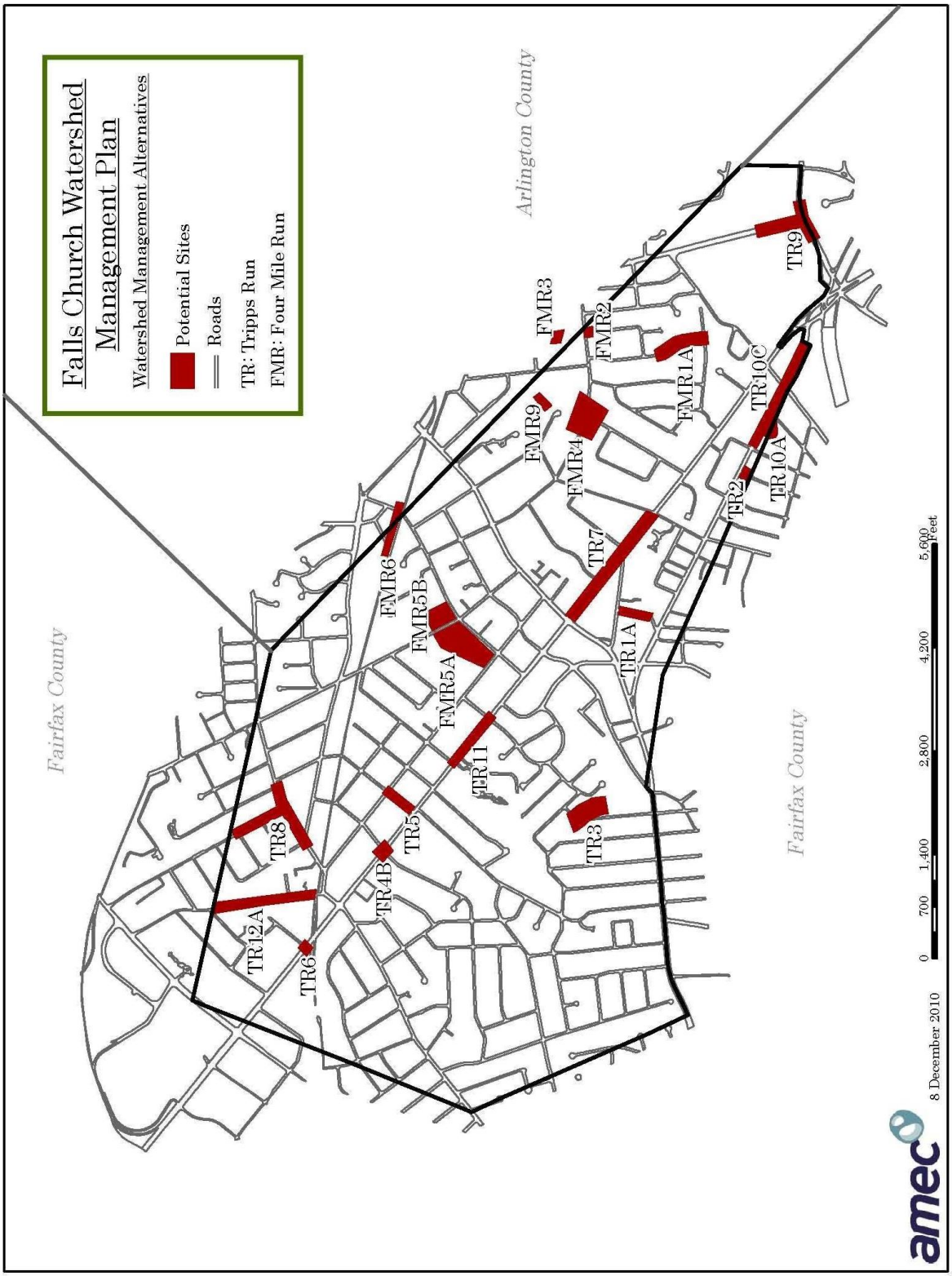
The next step was to develop prioritization criteria for use by the City and AMEC to narrow the list of problem areas/opportunities. These problem areas/opportunities would then be subject to additional analysis, including a field investigation. Table 5-2 presents the initial prioritization criteria. Priorities reflect those situations that present a threat to public safety (such as road flooding) or a threat to private property where the source of the problem is from a public right-of-way or public facility. Based on the Chesapeake Bay TMDL, where a flooding problem could potentially be solved in combination with an improvement to water quality, those projects are ranked higher. Flooding in parks, which represents a nuisance but not a threat to infrastructure or safety, and flooding on private property with no public source were ranked lower.

Table 5-2. Watershed Management Alternatives Initial Prioritization Criteria

Rank	Prioritization Criteria
1	Flooding on Road Right-of-Way/Public Safety Issue w/ Potential Water Quality Benefit
2	Flooding on Road Right-of-Way/Public Safety Issue
3	Home Flooding w/ Public Source w/ Potential Water Quality Benefit
4	Home Flooding w/ Public Source
5	Yard Flooding w/ Public Source w/ Potential Water Quality Benefit
6	Yard Flooding w/ Public Source
7	Stream Restoration/Daylighting w/ Water Quality Benefit
8	Water Quality Improvement Only
9	Stream Restoration/Daylighting Only
10	Flooding – Parks and Open Space
11	Flooding – Private Drainage Issues

Using the criteria in Table 5-2, the prioritization process resulted in 21 problem/opportunity areas for further field investigation and final prioritization. Figure 5-1 shows the potential project locations, while Table 5-3 provides a brief description, of each project, including potential benefits and conflicts. Appendix F includes the full list of prioritized problem/opportunity areas.

Figure 5-1. Problem/Opportunity Areas Identified for Field Investigation

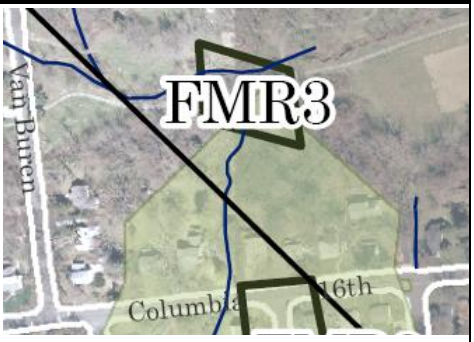


FMR-1A Van Buren Street Between Villa Ridge and Underwood	
Drainage Area: ≈4.5 Acres Percent Impervious: 25% Planning Level Cost: $120,000	
Problem/Opportunity: Water from City ROW. Flooding in yards of 209, 210, 211, and 212 Van Buren Street reported due to undersized pipes and poor layout. Wren Branch Daylighting at FMR-1B could help. Should be examined in tandem.	
Project and Benefits: Improvements to existing infrastructure should be based on a full drainage study of the area. The drainage study will help determine issues with the system and lead to possible retrofit solutions.	
Conflicts: Significant access, utility, and construction issues. Land acquisition involved.	

FMR-2 Columbia and Underwood Streets	
Drainage Area: ≈8.0 Acres Percent Impervious: 32% Planning Level Cost: $550,000	
Problem/Opportunity: Flooding in the intersection; one inlet reported in poor condition.	
Project and Benefits: The inlet along Columbia Street is in poor condition and needs to be replaced as per design capacity. Additional inlets need to be installed on Underwood Street to alleviate flooding. All inlets can be retrofitted with tree box filters to improve water quality from this relatively large drainage shed.	
Conflicts: Minor conflict with existing utilities.	

FMR-3 Four Mile Run Stream Culvert at Van Buren

Drainage Area: ≈46.8 Acres
Percent Impervious: 29%
Planning Level Cost: $210,000



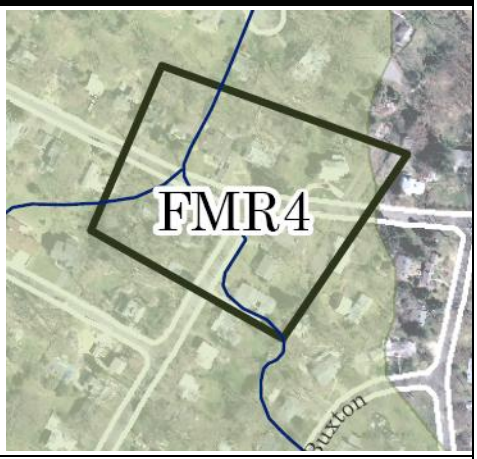
Problem/Opportunity: Undersized culvert causes backwater into East Falls Church Park.

Project and Benefits: The project would involve day-lighting of storm sewer and bank stabilization to alleviate the flooding issue around East Falls Church Park. The channel stabilization would include design of step pool system and stabilize banks using grade control for approximate 250 feet of headwater stream. The project would require coordination with Arlington County.

Conflicts: Significant construction access issues and potential impact on trees. Coordination required with Arlington County.

FMR-4 Columbia and Noland Streets

Drainage Area: ≈1.6 Acres
Percept Impervious: 69%
Planning Level Cost: $300,000



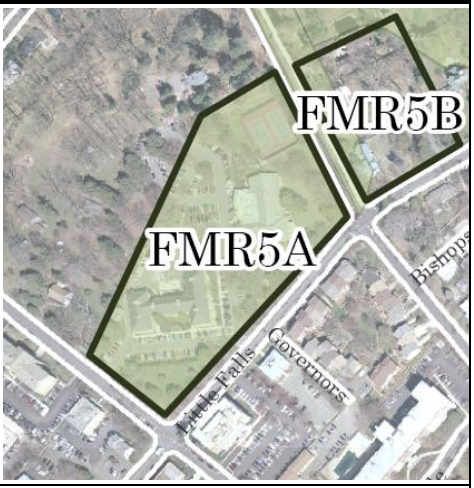
Problem/Opportunity: Drainage issues for individual homes (431, 432, and 434 Columbia Street). Potential capacity issue. Possible retrofit opportunity for water quality. Along Noland Street and Columbia Street, there is a lack of storm sewer inlets, and the water eventually collects and overtops the inlet in front of 431 Columbia Street. The water flows down the property line and onto the patio and in the basement.

Project: Additional storm sewer infrastructure consisting of inlets, storm sewers, and tree box filters are required along Noland Street and Columbia Street. The existing inlets are overwhelmed by the amount of sheet flow resulting from the paved surfaces. Tree box filters will provide water quality improvements.

Conflicts: Minor conflict with existing utilities. Lots of mature trees.

FMR-5A City Hall Campus

Drainage Area: ≈7.4 Acres
Percent Impervious: 35%
Planning Level Cost: $480,000



Problem/Opportunity: Potential to improve water quality from large area of uncontrolled impervious surface cover. The site already has some permeable pavement and a bioretention facility to promote infiltration and improve water quality.

Project and Benefits:

The project will help promote stormwater runoff infiltration and provide water quality benefits to a highly impervious area. The project may help reduce flooding issues along Great Falls Street (see right for inlet overwhelmed by drainage).

Specific project components include:

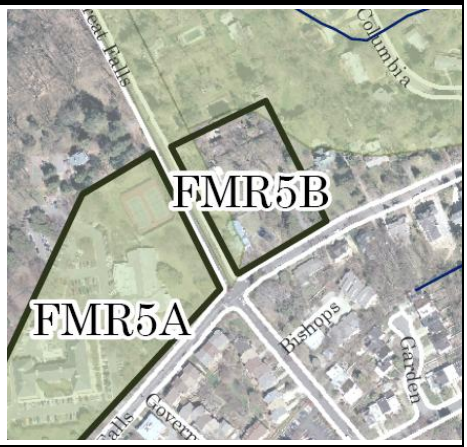
- Retrofit medians in the parking lot and the open area near the tennis court with bioretention facilities.
- Retrofit the buildings near the tennis courts with a cistern for rainwater harvesting to reduce the flow of runoff.
- Space may be available for tree box filters or additional bioretention along the perimeter of the employee lot.
- Integrate permeable pavers in several areas of the parking lot to promote infiltration.

Conflicts: Potential for minor impact to trees. Minor conflict with existing utilities.

Note: Improvements at the City Hall site may help the drainage problem on Great Falls Street and backyard drainage issues in the northeastern quadrant of the intersection of Great Falls Street and Little Falls Street (FMR-5B). As a result, it is recommended that FMR-5A and FMR-5B be considered in tandem so that the impact of any proposed improvements at FMR-5A on base conditions at FM- 5B can be better understood.

FMR-5B North Quadrant Little Falls Street and Great Falls Street

Drainage Area: ≈3.7 Acres
Percent Impervious: 39%
Planning Level Cost: $270,000



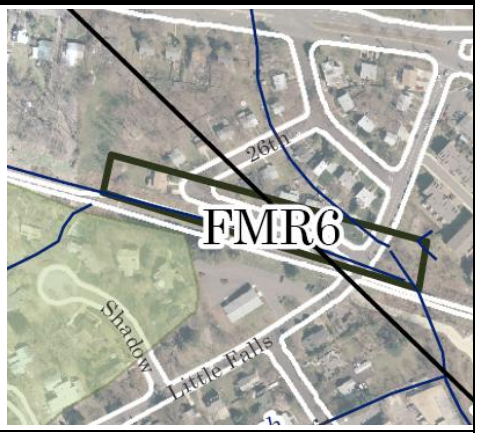
Problem/Opportunity: Significant water in backyards, with some from the street. 304 Great Falls Street and 307 Little Falls Street specifically noted by staff. Some of these problems could be reduced through the use of bioretention or on-site storage at FMR-5A.

Project and Benefits: Recommend adding more inlets along Great Falls Street. The existing inlet pipe can be retrofitted by increasing the diameter or using a horizontal elliptical pipe. New inlets can be added in combination with tree box filters. It is recommended that a drainage study be performed on the pipe system.

Conflicts: Impact to mature trees and significant conflict with existing utilities. Land acquisition and/or easements on private property required.

FMR-6 Trammel Branch Daylighing Between W&OD Trail and 26th Street

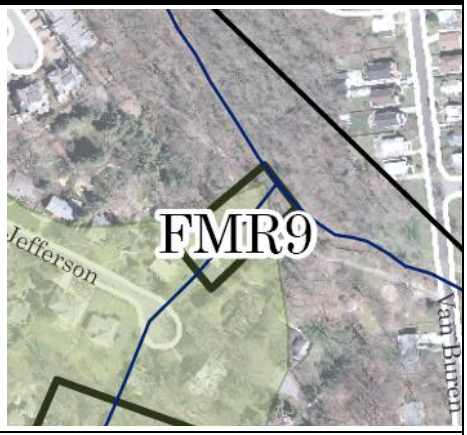
Drainage Area: ≈20.5 Acres
Percent Impervious: 25%
Planning Level Cost: $1,220,000



Problem/Opportunity: This site was given an "A" ranking for possible stream day-lighting in the 2005 Evaluation of Daylighting Opportunities Report. Individual home flooding is reported as an issue in this area

Project and Benefits: The project would provide grade control for the stream in the vicinity of homes. The culvert crossing at W&OD Trail would be removed and daylighted. The trail would be connected by a bridge over the stream. Since the stream would be linear, a step pool morphology with grade control boulders would be implemented. Since the project is along the City boundary, coordination with Arlington County will be required.

Conflicts: Significant access, utility, and construction issues. Coordination required with Arlington County and the Northern Virginia Regional Park Authority.

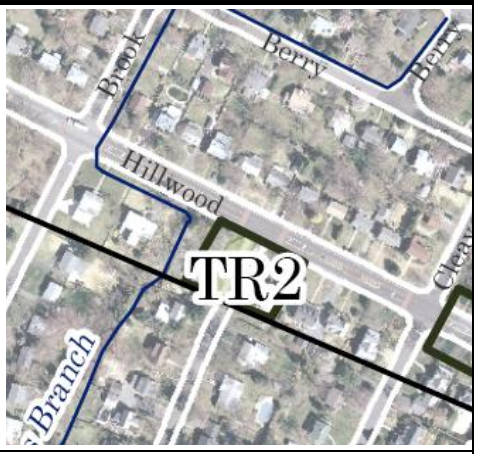
FMR-9 Harrison Branch Outfall and Four Mile Run	
Drainage Area: ≈73 Acres Percent Impervious: 32% Planning Level Cost: $180,000	
Problem/Opportunity: Blowout where 48" pipe containing Harrison Branch enters Four Mile Run. Potential for daylighting small portion and stabilizing outfall. Relatively easy project. Will reduce TSS from streambank erosion.	
Project and Benefits: The proposed project would day-light approximately 150 feet of pipe and create a step pool system with grade control. The project fixes the cantilevered culvert and excessive scour at the outlet.	
Conflicts: Impact to mature trees, floodplain, and Resource Protection Area. Potential need for land acquisition.	

TR-1A Douglass and Hillwood Avenues – Eastern Side of Shopping Center	
Drainage Area: ≈1.1 Acres Percent Impervious: 87% Planning Level Cost: $130,000	
Problem/Opportunity: Capacity issue, stormwater runoff jumps curb and floods office space. Potential for box filter to improve water quality.	
Project: Retrofit existing inlet and add new drainage inlets in combination with tree box filters along Douglass Avenue. New drainage inlets will help alleviate flooding issue around the office building. The addition of tree box filters will serve to improve water quality in this highly impervious area.	
Conflicts: Potential for minor impact to trees. Minor conflict with existing utilities.	

TR-2 Hillwood Avenue and Linden Lane

Drainage Area: ≈0.2 Acres
Percent Impervious: 55%
Planning Level Cost: $30,000

Problem/Opportunity: Flooding reported on street and in yards near this intersection. Potential opportunity for box filters to improve water quality.



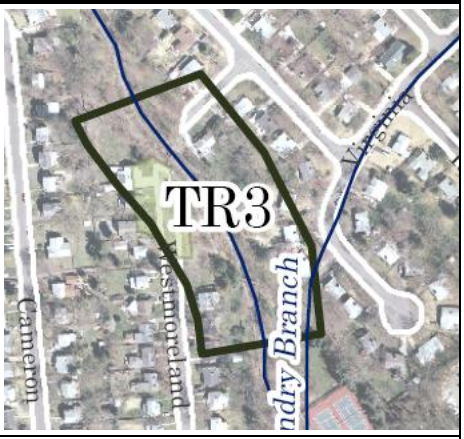
Project and Benefits: The addition of a drainage inlet along Linden Lane in combination with a tree box filter will help resolve the flooding issue and improve water quality.

Conflicts: Minor conflicts with existing utilities. Requires coordination with Fairfax County.

TR-3 Drainage at West Westmoreland Road and Tripp's Run Restoration

Drainage Area: ≈0.8 Acres
Percent Impervious: 38%
Planning Level Cost: $30,000

Problem/Opportunity: Water in street due to poor grading and no inlet. Contributes to drainage issues identified at 207 West Westmoreland Road. Tripp's Run in this area, which is a concrete trapezoidal channel, has high potential for stream restoration. Potential installation of bioretention at Cavalier Trail Park.



Project and Benefits: The project consists of diverting flow from the northwest side of West Westmoreland Street using a rock lined channel that would flow to a proposed rain garden/biofiltration facility. The entrance channel will alleviate the ponding that is occurring due to the build-up of leaves and debris at the end of West Westmoreland Street.

Conflicts: Some impact to mature trees. No utility conflicts. Involves land disturbance in floodplain and Resource Protection Area.

TR-4B West Broad and North Spring Streets

Drainage Area: ≈0.3 Acres
Percent Impervious: 83%
Planning Level Cost: $65,000

Problem/Opportunity: Standing water in the intersection.

Project and Benefits: Recommend raising the grade near handicap ramp at the intersection of West Broad Street and North Spring Street to divert flow downstream and prevent ponding water. Also need to add a drainage inlet along North Spring Street to divert the flow. A tree box filter can provide water quality benefits.

Conflicts: Likely significant utility conflicts. Minimal other conflicts.

TR-5 N. Oak Street Between Broad and Park

Drainage Area: ≈0.2 Acres
Percent Imperious: 89%
Planning Level Cost: $240,000

Problem/Opportunity: Flooding on N. Oak Street between Park Avenue and Broad Street possibly due to undersized pipes. Stormwater enters parking garage in the north-west quadrant of Oak and Broad. Potential for water quality improvement.

Project and Benefits: Add new drainage inlet in combination with tree box filters. Retrofit the sidewalk with permeable pavers. Replace compacted grass area in sidewalk with bioretention facility. The addition of a new drainage inlet will help reduce flooding and the potential for automobiles to hydroplane. It will also reduce the amount of runoff entering the parking garage (see right). The tree box filters, permeable pavers, and bioretention will improve water quality from this highly impervious area.

Conflicts: Potential for minor impact to trees. Minor conflict with existing utilities.

TR-6 West Broad and Falls Avenue

Drainage Area: ≈7.3 Acres
Percent Impervious: 38%
Planning Level Cost: $540,000

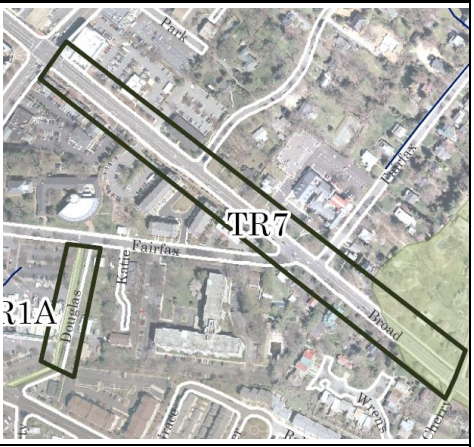
Problem/Opportunity: Standing water in the intersection.

Project and Benefits: The addition of a drainage inlet near the West Broad and Falls Avenue intersection will help resolve standing water issues. Inclusion of a tree box filter will provide water quality benefit.

Conflicts: Minor conflicts with existing utilities.

TR-7 East Broad Between Washington and Cherry Streets

Drainage Area: ≈4.0 Acres
Percent Impervious: 50%
Planning Level Cost: $400,000

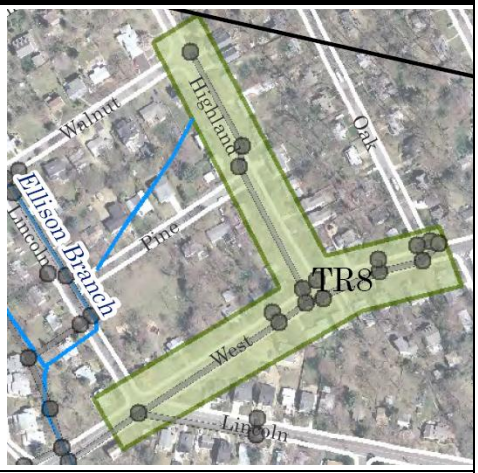


Problem/Opportunity: Standing water at low spot on Lawton Street. Entire area between Washington and Cherry is subject to excess sheet flow due to lack of inlets.

Project and Benefits: The East Broad Street intersection problem can be fixed by adding more drainage inlets along the road and the low spot location. The addition of drainage inlets will reduce flooding and spread and prevent vehicle hydroplaning (see picture to the right at the intersection at Lawton Street).

In order to provide water quality improvement, the proposed drainage inlets can be added in combination with tree box filters. The sidewalks along the streets can also be replaced with permeable pavers to provide stormwater infiltration.

Conflicts: Impact to trees. Significant access issues and conflict with existing utilities.

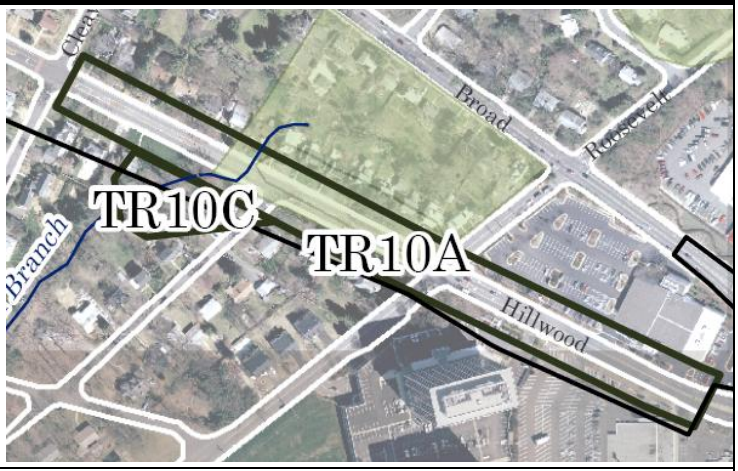
TR-8 Highland Avenue and West Street Drainage	
Drainage Area: ≈8.2 Acres Percent Impervious: 24% Planning Level Cost: $470,000	
Problem/Opportunity: Flooding issues were identified in the Stormwater System Performance Assessment conducted in 2007.	
Project: In order to alleviate the flooding at the intersection of Highland Avenue and West Street, this project proposes the addition of storm sewer inlets and pipes accompanied with tree box filters in order to provide added water quality benefit.	
Conflicts: Impact to mature trees. Minor conflicts with existing utilities.	

TR-9 Roosevelt and Wilson Boulevard	
Drainage Area: ≈0.7 Acres Percent Impervious: 91% Planning Level Cost: $110,000	
Problem/Opportunity: Capacity issue next to BJs commercial building. Inlet opening is partially collapsed. A quarter of the intersection goes under water during major storm events. Slope of pipe that causes clogging may also be a contributing factor. Highly impervious area.	
Project and Benefits: The focus of this project is to improve safety by reducing roadway flooding (see right for photo of intersection flooding). A secondary benefit is to improve water quality in a highly impervious area with large amounts of vehicular traffic and parking: Specific project components include: • Replace existing failed pipe at the intersection of Wilson Blvd and Roosevelt Blvd. • Replace existing sidewalk with permeable pavers. • Add curb cut inlets and cascade bioretention in existing median along Roosevelt Blvd. • Add storm sewer inlets and tree box filters along the eastern side of Roosevelt Blvd.	
Conflicts: Potential for minor impact to trees. Major conflict with existing utilities – some relocation may be required.	

TR-10A Hillwood Avenue Between Cleave Drive and East Broad

Drainage Area: ≈0.6 Acres
Percent Impervious: 60%
Planning Level Cost: $171,000

Problem/Opportunity: Excess sheet flow during storms. Not enough inlets. Tree box inlets could improve water quality.



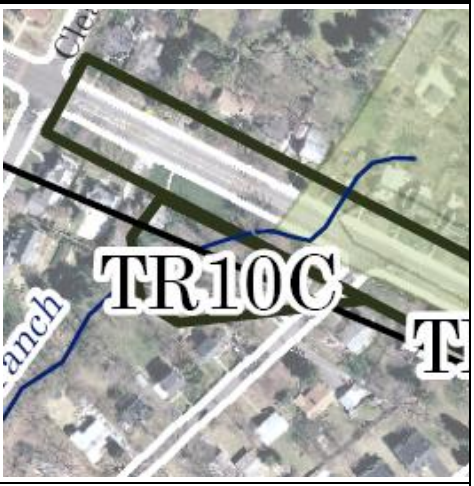
Project and Benefits: Add drainage inlets in combination with tree box filters along Hillwood Avenue. Retrofit sidewalks with permeable pavers. The addition of drainage inlet will help reduce flooding and hydroplaning. The permeable pavers will help improve water quality.

Conflicts: Minor impact to mature trees. Major conflict with existing utilities.

TR-10C Hillwood Avenue Outfall Stabilization

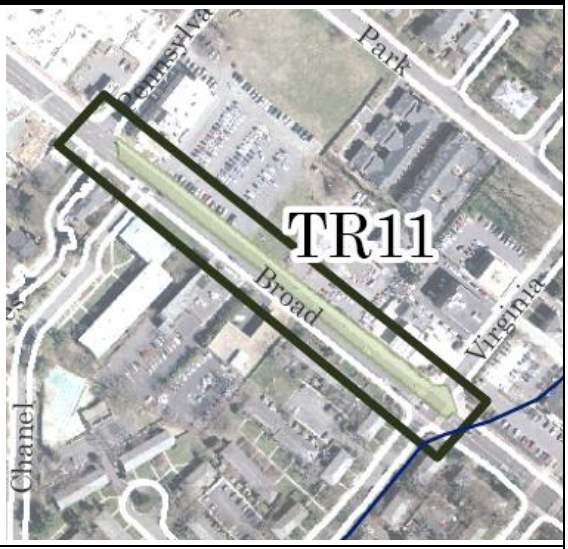
Drainage Area: ≈5.9 Acres
Percent Impervious: 31%
Planning Level Cost: $180,000

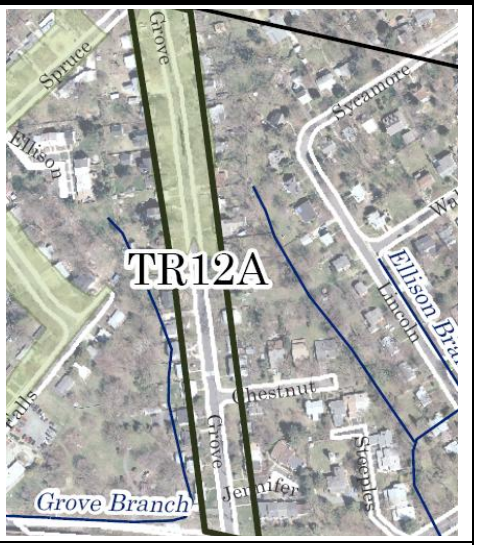
Problem/Opportunity: Outfall stabilization.



Project and Benefits: The project would involve fixing the stormwater outfall and headwater stream by using step pool system with boulders as grade control. The outfall would be stabilized by filling and cutting of a two-stage channel.

Conflicts: Significant access, utility, and construction issues. Coordination required with Fairfax County.

TR-11 West Broad Street Between Virginia and Pennslyvania	
Drainage Area: ≈2.0 Acres Percent Impervious: 91% Planning Level Cost: $380,000	
Problem/Opportunity: Excess sheet flow during storms on Broad Street due to lack of inlets. There are no inlets from Virginia Avenue to the intersection at Pennsylvania Avenue. Some of the inlets further upstream need to be larger.	
Project and Benefits: Reduce flooding and improve water quality by adding drainage inlets in combination with tree box filters. Replace sidewalk pavement with permeable pavers. Retrofit existing island with cascade bioretention (see picture to right of cascading bioretention incorporated into area between street and sidewalk).	
Conflicts: Potential for minor impact to trees. Major conflict with existing utilities.	

TR-12A Grove Avenue Between City Line and W&OD Trail	
Drainage Area: ≈17.7 Acres Percent Impervious: 22% Planning Level Cost: $660,000	
Problem/Opportunity: Several downspouts and sump pumps drain to Grove Avenue creating icy conditions in the winter. Neighbors complain about high groundwater table and poor yard drainage. Restoration or better drainage in Grove Branch and Ellison Branch might be potential solutions.	
Project and Benefits: This project consists of adding inlets along Grove Avenue in combination with tree box filters to collect water from sump pumps. The sump pump water draining to the ditch in the backyard of houses along the Grove Street can be implemented with two stage channel and step pools to provide grade control. This project was given extra weight due to the problem with icy road conditions.	
Conflicts: Impact to trees. Requires additional easements from private property owners for backyard ditch work.	

5.3.2 Field Evaluation Process

AMEC conducted two days of field visits (November 12 and 15, 2010) to gather site-specific information on the 21 problem/opportunity areas identified during the initial prioritization process. A standardized Candidate Watershed Management Project Investigation Form was used to ensure a consistent approach to each site. The form includes:

- Identified Issues
- Treatment Options
- Ownership Status
- Drainage Area and Land Use
- Site Characteristics
- Site Constraints
- Site Drawing
- Construction Considerations
- Recommendations

Visiting a potential project site. Pictured – Potential bioretention area at City Hall.

During the field investigation, particular attention was given to issues such as construction access and land acquisition, potential conflicts with utilities, impacts on mature trees, and other site-specific issues and complicating factors. All complete project investigation forms, including site sketches and pictures, are found in Appendix G.

5.4 Project Rankings

Projects were ranked based on three methodologies to assist the WAC in its process of selecting 10 projects for further development and recommendation for inclusion in the CIP. These included a composite ranking, a safety ranking, and a water quality ranking.

5.4.1 Composite Ranking

The composite ranking criteria used to score individual projects included the type of management practice(s) involved, site parameters and constraints, treatment potential (impervious area treated), and mitigating factors. These category scores were then added to arrive at a total score for each proposed project. A higher score correlates to a more effective and feasible project. Table 5-3 presents a summary of the composite ranking criteria.

5.4.2 Safety and Water Quality Ranking

Safety Ranking

Determining the severity of the safety concern addressed by any particular project is necessarily subjective. However, applying best professional judgment, City staff assessed each project and assigned it a safety ranking. The main factor considered was the potential for the project to solve a defined threat to human safety. For instance, several projects deal with flooding in the main travel lanes of major roads. These outranked projects that address nuisance flooding concentrated outside of the travel lanes. In addition, the potential for a problem to impact and cause damage to structures was also a primary consideration. City staff assigned each project a ranking from 1 to 5, with 1 being the highest severity.

Water Quality Ranking

While individual techniques will have some variation in their pollutant removal efficiencies, for comparative purposes the amount of impervious area treated is the most straight forward way of determining a project's potential to improve water quality. As part of this analysis, AMEC further refined estimates of the impervious area treated by proposed projects based on an analysis of site topography and aerial photographs.

A complicating factor is that stream restoration and outfall stabilization do not "treat" a particular area. Rather, they achieve a reduction in pollutants typically measured by pounds per linear foot restored. As a result, it is not appropriate to use impervious cover for comparing the pollutant removal ability of these types of projects (FMR-6, FMR-9, FMR-3, TR-12A, and TR-10C). To make an apples-to-apples comparison, AMEC determined an "average" number of pounds of phosphorus removed from an impervious acre of urban land using tree box filters. Phosphorus is considered by Virginia to be the "keystone" pollutant from which compliance is measured. An average urban acre generates approximately 7.6 pounds of phosphorus per year.[14] A tree box filter, which has a 60% removal efficiency, will therefore remove approximately 4.6 pounds of phosphorus per acre per year. The Chesapeake Bay Model currently gives stream restoration credit for removing 0.0035 pounds/linear foot/year. As a result, it takes approximately 1,300 linear feet of restoration to equal the reduction from one acre treated by a tree box filter. It should be noted that the Chesapeake Bay Program is in the process of reassessing the amount of credit that can be applied to stream restoration; however, those figures were not available before adoption of this plan.

[14] Calculated using the "Chesapeake Bay Method" in the *Northern Virginia BMP Handbook*. Assumes a phosphorus pollutant concentration of 1.08 mg/l.

Table 5-3. Composite Ranking Scoring Criteria

Management Practice(s)	Points[1]	Parameters/ Constraints	Points	Treatment Potential	Points	Mitigating Factors	Points
Infiltration Trench	19.5	Construction Access	Easy = 30 Mod. = 10 Difficult = 0	Percent Impervious	100% = 5 0% = 0	Large Drainage Area on Public Land	20
Porous Pavement	21	Land Acquisition/ Easement	No = 30 Yes = 0			ROW Safety Issue	15 to 25
Vegetated Swale	18.25	Potential Utility Conflicts	None= 30 Few = 15 Many = 0			Stormwater Impacts Structure	10
Tree Box Filter	18.5	Tree Removal	None = 30 Few = 15 Many = 0			Multi-Jurisdiction Cooperatio n Required	-10
Sand Filter	17					Extremely Difficult Site Access	-20
Green Roof	22.125						
Rainwater Harvesting	17.125						
Bioretention	21.125						
Pipes/Drainage	11.5						
Category Total	Cumulative up to four projects.	**Category Total**	Points are added for each sub category and averaged.	**Category Total**	Number of points.	**Category Total**	Cumulative number of points.

[1]REFERENCE DATA FOR MANAGEMENT PRACTICE PERFORMANCE

Virginia's Stormwater Impact Evaluation: Developing and Optimization Tool for Improved Site Development, Selection and Placement of Stormwater Runoff BMPS – Virginia Polytechnic Institute and State University, Blacksburg, VA, January 2009.

Galli, John. 1982. *Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland.*

Georgia Stormwater Management Manual Volume 2 Technical Handbook First Edition August 2001.

Fairfax County – LID BMP Fact Sheet – Tree Box Filters February 28, 2005.

Updated BMP Removal Efficiencies from the National Pollutant Removal Database and Acceptable BMP Table for Virginia.

East Baton Rouge Parish Stormwater BMPs – BMP Selection August 2007.

Handbook for Developing Watershed Plans to Restore and Protect Our Waters, Environmental Protection Agency, March 2008.

Cost Methodology

To establish a base for cost comparison, unit costs are based on information provided in the *County of Fairfax DPWES Land Development Services 2010 Comprehensive Unit Price Schedule* and the *Fairfax County Cost Templates for 2010 Watershed Management Plans*. Specific unit cost information is provided in Table 5-4.

Table 5-4. Project Component Unit Cost Summary

CATEGORY	UNIT	UNIT PRICE
Storm sewer inlet	EACH	$5,000
Tree box filter	EACH	$10,000
Pervious pavement	SY	$100
Bioretention	SY	$150
Rain barrels	GALLON	$1.50
15” Class IV RCP	LF	$49
18” Class IV RCP	LF	$60
24” Class IV RCP	LF	$87
30” Class IV RCP	LF	$107
Stream restoration	LF	$300
Clear and grub (stream rest)	ACRE	$10,000
Plantings (stream rest)	ACRE	$25,000

For each individual project, a base construction cost was computed. Percentages for the items shown in Table 5-5 were then added into the base construction cost and rounded to the nearest ten thousand dollars to determine the estimated planning level project cost. The cost estimates for each of the projects are pre-conceptual estimates for general budgeting purposes only. The planning level estimates are not engineering estimates. Stream restoration costs do not include 5% of base cost for plantings since planting cost is based on acreage.

Table 5-5. Summary of Project Cost Factors[15]

1	**Base Cost**	**Base Cost**
2	Mobilization	+ 5% of Base Cost
3	Plantings	+ 5% of Base Cost
4	Ancillary Items	+ 5% of Base Cost
5	Erosion and Sediment Control	+ 10% of Base Cost
6		**= Subtotal 1 (Sum 1-5)**
7	Contingency	+ 25% of Subtotal 1
8		**= Subtotal 2 (Sum of 6 & 7)**
9	Engineering Design, Surveys, Land Acquisition, Utility Relocations and Permits	+ 45% of Subtotal 2
10		**= Total (Sum of 8 & 9)**
11	**Total Cost**	**Estimated Planning Level Project Cost (Item 10 Rounded to Nearest $10,000)**

[15] Assumptions
1. Existing inlets capture 100% of the runoff and there is no bypass flow.
2. Estimate of storm sewer inlets placement based on 0.5 acres per inlet.
3. Tree box filters are determined based on drainage area and percent impervious: highly impervious areas (streets, C=0.90) placed every 0.5 acres; residential areas (yards and streets, C=0.50) placed every 1 acre.

Table 5-6 shows each project and its associated safety rank, impervious acres treated, total cost, cost per acre treated, and water quality ranking.

Table 5-6. Summary of Safety and Water Quality Rankings

Site ID#	Safety Rank	Impervious Acres Treated	Cost	Cost Per Acre Treated	Water Quality Rank
FMR-1A	**4**	1.1	$120,000	$106,195	2
FMR-2	**2**	2.6	$550,000	$214,008	10
FMR-3	**5**	0.2	$210,000	$1,094,400	18
FMR-4	**3**	1.1	$300,000	$272,727	12
FMR-5A and FMR-5B[16]	**2**	4.0	$750,000	$186,567	6
FMR-6	**5**	1.2	$1,220,000	$1,059,657	17
FMR-9	**2**	0.2	$180,000	$1,172,571	19
TR-1A	**3**	1.0	$130,000	$136,842	4
TR-2	**4**	0.1	$30,000	$272,727	13
TR-3	**4**	0.3	$30,000	$98,684	1
TR-4B	**1**	0.2	$65,000	$276,596	14
TR-5	**4**	2.2	$240,000	$110,092	3
TR-6	**1**	2.8	$540,000	$191,489	7
TR-7	**1**	2.0	$400,000	$200,000	8
TR-8	**3**	2.0	$470,000	$235,000	11
TR-9	**1**	0.8	$110,000	$141,753	5
TR-10A	**3**	0.4	$171,000	$488,571	16
TR-10C	**5**	0.2	$180,000	$1,172,571	20
TR-11	**2**	1.8	$380,000	$208,791	9
TR-12A	**3**	1.4	$660,000	$486,455	15

[16] FMR-5A and FMR-5B are combined for ranking purposes since they were considered by the WAC to represent different phases of a larger project.

5.4.2 Safety and Water Quality Ranking

Using the three scoring systems, the WAC discussed each project. Where water quality, safety, and composite ranks were all either high or mid-level, the WAC agreed to include these projects in the final top 10 priority projects. Likewise, those projects that scored low or mid-level across the board were removed from consideration. The WAC then voted on the remaining projects for ranking purposes. Table 5-7 shows the ranking results as recommended by the WAC.

Table 5-7. Final Project Ranking Summary*

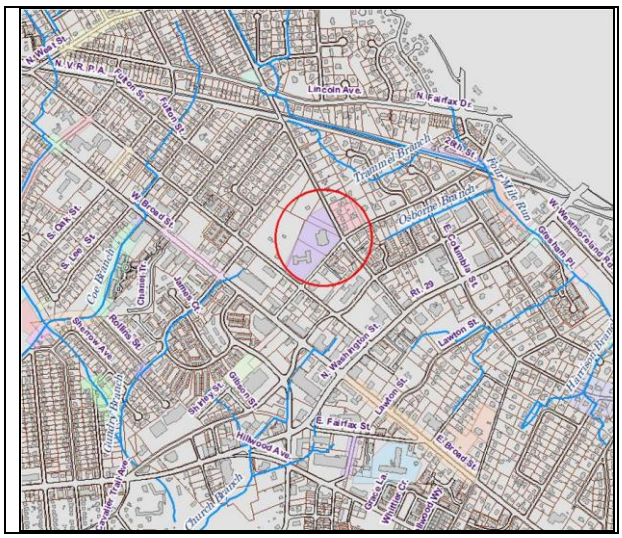
Site ID#	Description	Water Quality Rank	Safety Rank	Composite Rank	Const. Issues	Land Acquisition	Utility Conflicts	Tree Removal	WAC
FMR-5A	CITY HALL CAMPUS	6	Mid	126	Easy	No	Few	None/ Low	**Top Rank Concurred by WAC**
AND									
FMR-5B	NORTH QUADRANT LITTLE FALLS ST AND GREAT FALLS ST		Top	67	Moderate		Many	Few	**FMR-5A and 5B Planned Concurrently**
FMR-2	COLUMBIA AND UNDERWOOD STREETS	10	Mid	104	Easy	No	Few	None/ Low	**Top Rank Concurred by WAC**
TR-11	WEST BROAD ST BEWTEEN VIRGINIA AND PENNSYLVANIA	9	Top	96	Easy	No	Many	None/ Low	**Top Rank Concurred by WAC**
TR-1A	DOUGLASS AVE AND HILLWOOD AVE-EASTERN SIDE OF SHOPPING CENTER	4	Mid	92	Easy	No	Few	None/ Low	**Top Rank Concurred by WAC**
TR-7	EAST BROAD BETWEEN WASHINGTON AND CHERRY STREETS	8	Top	89	Easy	No	Many	Few	**Top Rank Concurred by WAC**
TR-6	WEST BROAD AND FALLS AVE	7	Mid	83	Easy	No	Few	None/ Low	**Top Rank Concurred by WAC**
TR-3	DRAINAGE AT WESTMORELAND ROAD AND TRIPPS RUN RESTORATION	1	Low	79	Easy	No	None/Low	None/ Low	**Top Rank by WAC Vote (9)**

Site ID#	Description	Water Quality Rank	Safety Rank	Composite Rank	Const. Issues	Land Acquisition	Utility Conflicts	Tree Removal	WAC
TR-4B	WEST BROAD ST AND NORTH SPRING ST	15	Top	79	Easy	No	None/Low	None/ Low	**Top Rank by WAC Vote (6)**
FMR-9	HARRISON BRANCH OUTFALL AND FOUR MILE RUN	20	Top	54	Easy	No	Few	Few	**Top Rank by WAC Vote (6)**
FMR-4	COLUMBIA AND NOLAND STREETS	13	Mid	91	Easy	No	Few	None/ Low	**Top Rank by WAC Vote (2)**
TR-10A	HILLWOOD AVE BETWEEN CLEAVE DR AND EAST BROAD ST	17	Mid	77	Easy	No	Many	None/ Low	**Top Rank by WAC Vote (2)**
TR-8	HIGHLAND AVE AND WEST ST INTERSECTION DRAINAGE	11	Low	76	Easy	No	None/Low	None/ Low	**Low Rank by WAC Vote (1)**
TR-5	OAK ST BETWEEN BROAD AND PARK	3	Low	92	Easy	No	Few	None/ Low	**Low Rank by WAC Vote (1)**
TR-12A	GROVE AVE BETWEEN CITY LINE AND W&OD TRAIL	16	Low	86	Easy	Yes	Few	Few	**Low Rank by WAC Vote (None)**
TR-9	ROOSEVELT BLVD AND WILSON BLVD	5	Top	120	Easy	No	Many	Few	**Low Rank by WAC Vote (None)**
TR-2	HILLWOOD AVE AND LINDEN LANE	14	Low	49	Easy	No	Few	None/ Low	**Removal from Consideration Concurred by WAC**
FMR-1A	VAN BUREN ST DRAINAGE BETWEEN VILLA RIDGE AND UNDERWOOD	2	Low	38	Moderate	Yes	Many	Few	**Removal from Consideration Concurred by WAC**
FMR-6	TRAMMEL BRANCH DAYLIGHTING BETWEEN W&OD TRAIL AND 26TH ST	18	Low	26	Moderate	Yes	Many	Few	**Removal from Consideration Concurred by WAC**

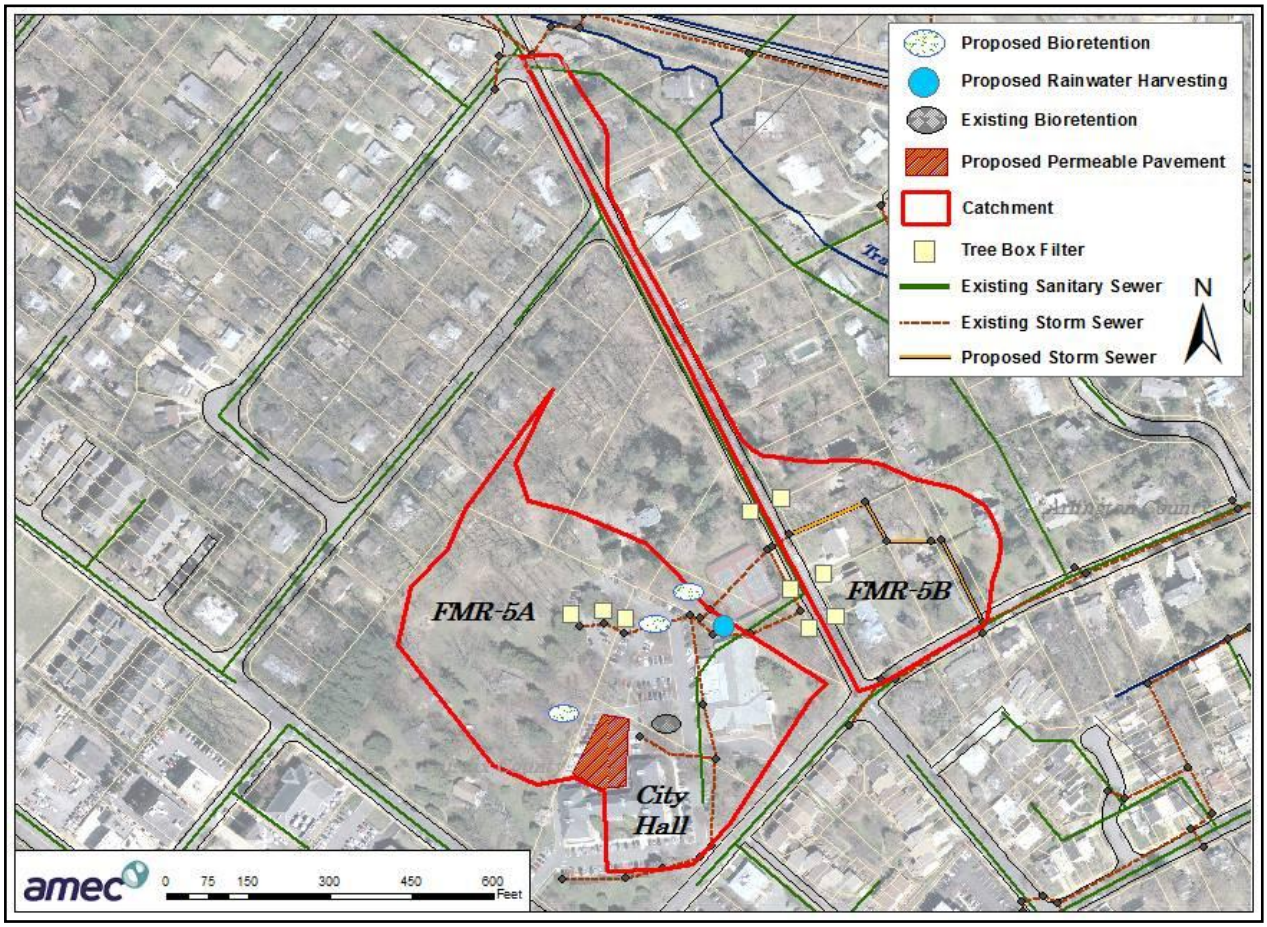
Site ID#	Description	Water Quality Rank	Safety Rank	Composite Rank	Const. Issues	Land Acquisition	Utility Conflicts	Tree Removal	WAC
FMR-3	FOUR MILE RUN STREAM CULVERT AT VAN BUREN	19	Low	25	Difficult	Yes	Few	Many	**Removal from Consideration Concurred by WAC**
TR-10C	HILLWOOD AVE OUTFALL STABILIZATION	21	Low	15	Difficult	Yes	Few	Many	**Removal from Consideration Concurred by WAC**

5.5 Project Data Sheets

PROJECT DATA SHEET
FMR-5A AND 5B



Address	300 Park Avenue 300-306 Great Falls Street 307 Little Falls Street
Location	City Hall Campus; Northeast Quadrant Great Falls and Little Falls Street
Land Owner	City of Falls Church (FMR-5A); Private Property (FMR-5B)
Parcel ID	1440, 1332, 1307, 1220
Control Type	Water quality and quantity control
Drainage Area	≈7.42 acres (FMR-5A) ≈3.72 acres (FMR-5B)
Impervious Area	≈2.57 acres (35%) ≈1.45 acres (39%)



Description: This project is designed to improve water quality from a large area of uncontrolled impervious surface cover by promoting stormwater infiltration and to mitigate roadway and backyard flooding in the northeast quadrant of the intersection of Great Falls Street and Little Falls Street caused by large volumes of water from City Hall campus and Great Falls Street. FMR-5A already has an area of permeable pavement and a bioretention facility to promote infiltration and improve water quality. Further improvements at City Hall may help reduce localized drainage and flooding problems. As a result, it is recommended that the projects be planned together so that the impact of any improvements at FMR-5A on baseline conditions at FMR-5B can be assessed.

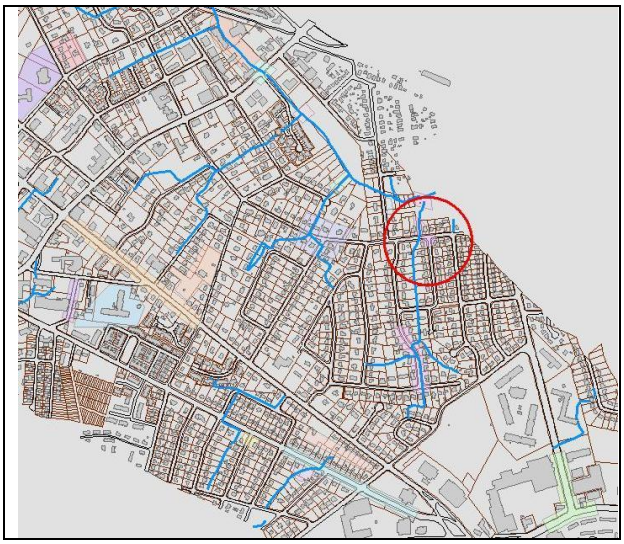
Specific project components include:

- Retrofit medians in the parking lot and the open area near the tennis court with bioretention facilities.
- Retrofit the buildings near the tennis courts with a cistern for rainwater harvesting to reduce the flow of runoff.
- Locate tree box filters and additional bioretention along the perimeter of the employee lot.
- Integrate permeable pavers in several areas of the parking lot to promote infiltration.
- Locate tree box filters along Great Falls Street.
- Replace and increase the capacity of storm sewers located in the northeast quadrant of Great Falls Street and Little Falls Street.

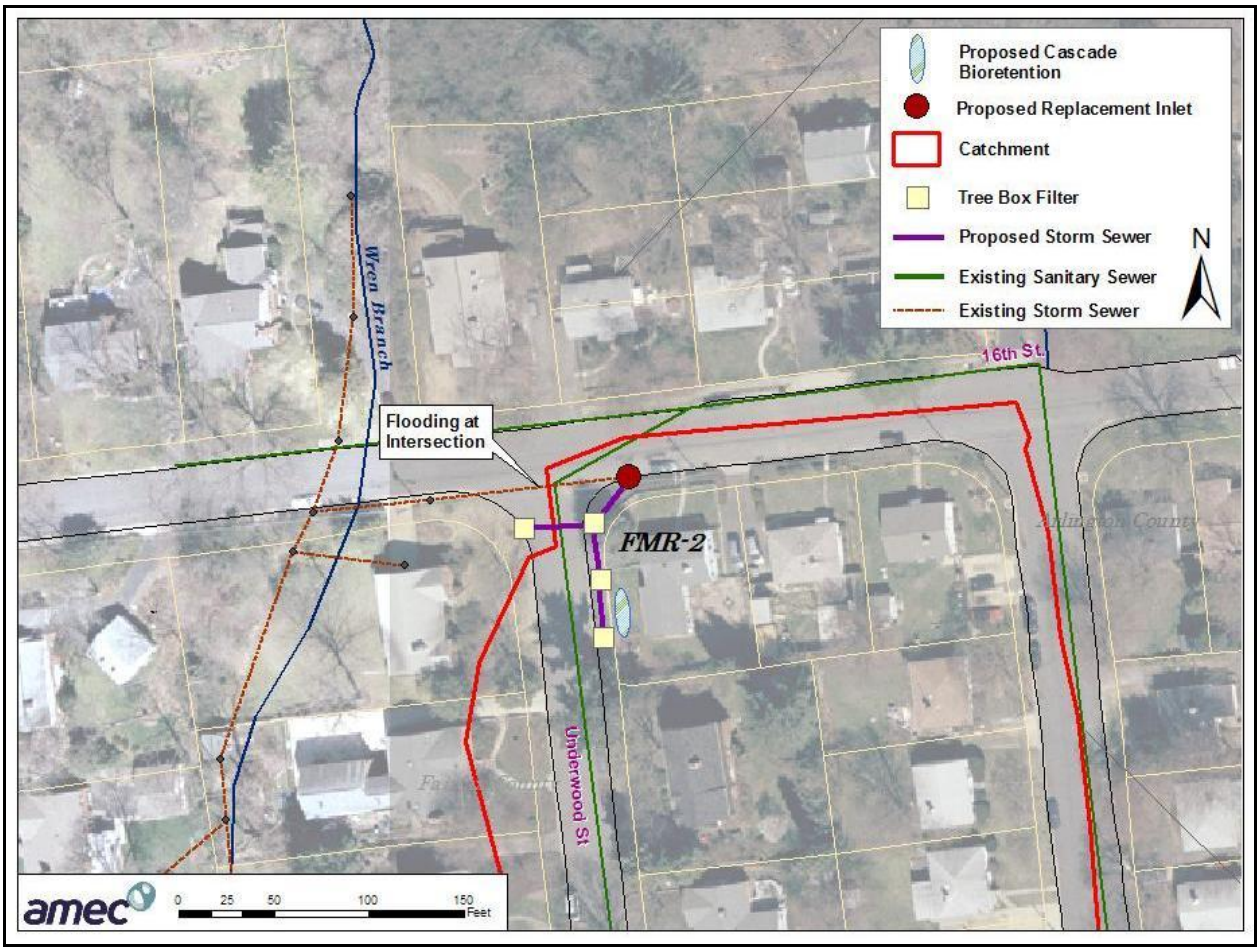
FMR-5A and 5B Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
FMR-5A				
Storm sewer length (15”)	100	Ft	$49	$4,900
# of Inlets	0	EA	$5,000	$0
# of Tree Box Filters	4	EA	$10,000	$40,000
Bioretention	750	SY	$150	$112,500
Rainwater Harvesting	1	EA	$4,000	$4,000
Permeable Pavement	500	SY	$100	$50,000
FMR-5B				
Storm sewer length (18”)	1000	Ft	$60	$60,000
# of Inlets	4	EA	$5,000	$20,000
# of Tree Box Filters	4	EA	$10,000	$40,000
Base Construction Cost FMR 5A/5B (Subtotal 1)				**$331,400**
Mobilization (5%)				$16,570
Plantings (5%)				$16,570
Ancillary Items (5%)				$16,570
Erosion and Sediment Controls (10%)				$33,140
Subtotal 2				**$414,250**
Contingency (25%)				$103,562.50
Subtotal 3				**$517,812.50**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$233,015.63
Total				**$750,828.13**
Estimated Planning Level Project Cost				**$750,000**

PROJECT DATA SHEET
FMR-2



Address	6608 16th St. & 323 N Underwood St
Location	Columbia and Underwood Streets
Landowner	City of Falls Church
Parcel ID	2771, 2784
Control Type	Water quality and quantity control
Drainage Area	≈8 acres
Impervious Area	≈2.57 acres (32%)

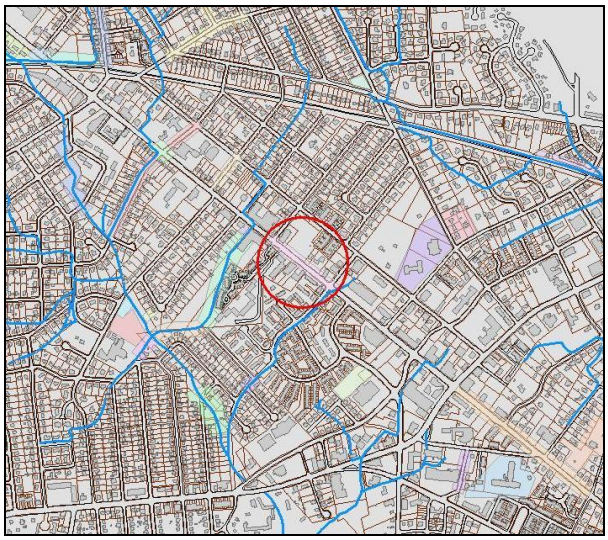


Description: This project is designed to control flooding at the intersection of Columbia Street and Underwood Street. The existing inlet along Columbia Street is in poor condition and needs to be replaced as per design capacity. Additional inlets need to be installed on Underwood Street to alleviate flooding. All inlets can be retrofitted with tree box filters to improve water quality from this relatively large drainage shed.

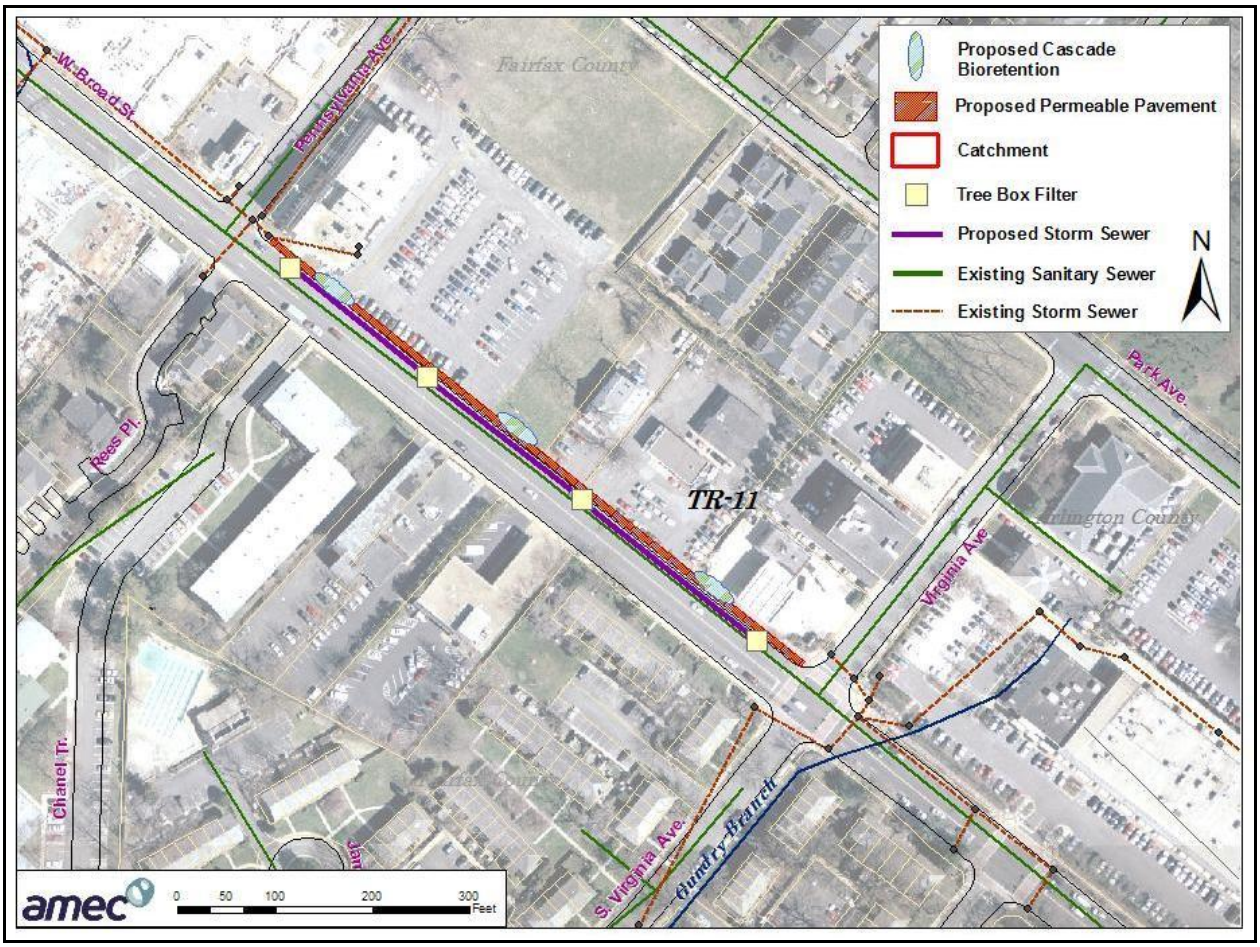
FMR-2 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	1650	Ft	$49	$80,850
# of Inlets	16	EA	$5,000	$80,000
# of Tree Box Filters	8	EA	$10,000	$80,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	0	SY	$100	$0
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$240,850**
Mobilization (5%)				$12,043
Plantings (5%)				$12,043
Ancillary Items (5%)				$12,043
Erosion and Sediment Controls (10%)				$24,085
Subtotal 2				**$301,062.50**
Contingency (25%)				$75,265.63
Subtotal 3				**$376,328.13**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$169,347.66
Total				**$545,675.78**
Estimated Planning Level Project Cost				**$550,000**

PROJECT DATA SHEET
TR-11



Address	400, 402, 412, 444 & 450 West Broad Street
Location	West Broad Street between Virginia and Pennsylvania
Land Owner	City of Falls Church
Parcel ID	1553, 1456, 1431, 1242
Control Type	Water quality and quantity control
Drainage Area	≈2.0 acres
Impervious Area	≈1.82 acres (91%)



Description: This project is designed to reduce sheet flow during storms on Broad Street due to lack of stormwater inlets. There are no inlets from Virginia Avenue to the intersection at Pennsylvania Avenue. In addition, some existing inlets are undersized. The project is an opportunity to improve water quality from a highly impervious area.

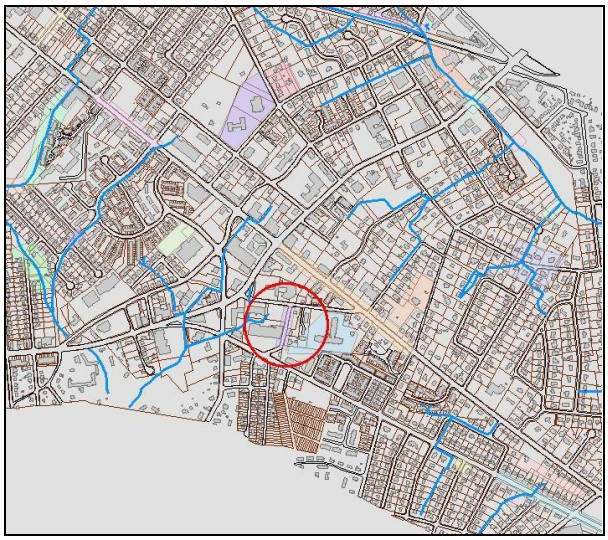
Specific project components include:

- Reduce flooding and improve water quality by adding drainage inlets in combination with tree box filters.
- Replace sidewalk pavement with permeable pavers.
- Retrofit existing island with cascade bioretention (see page 5-20 for an example).

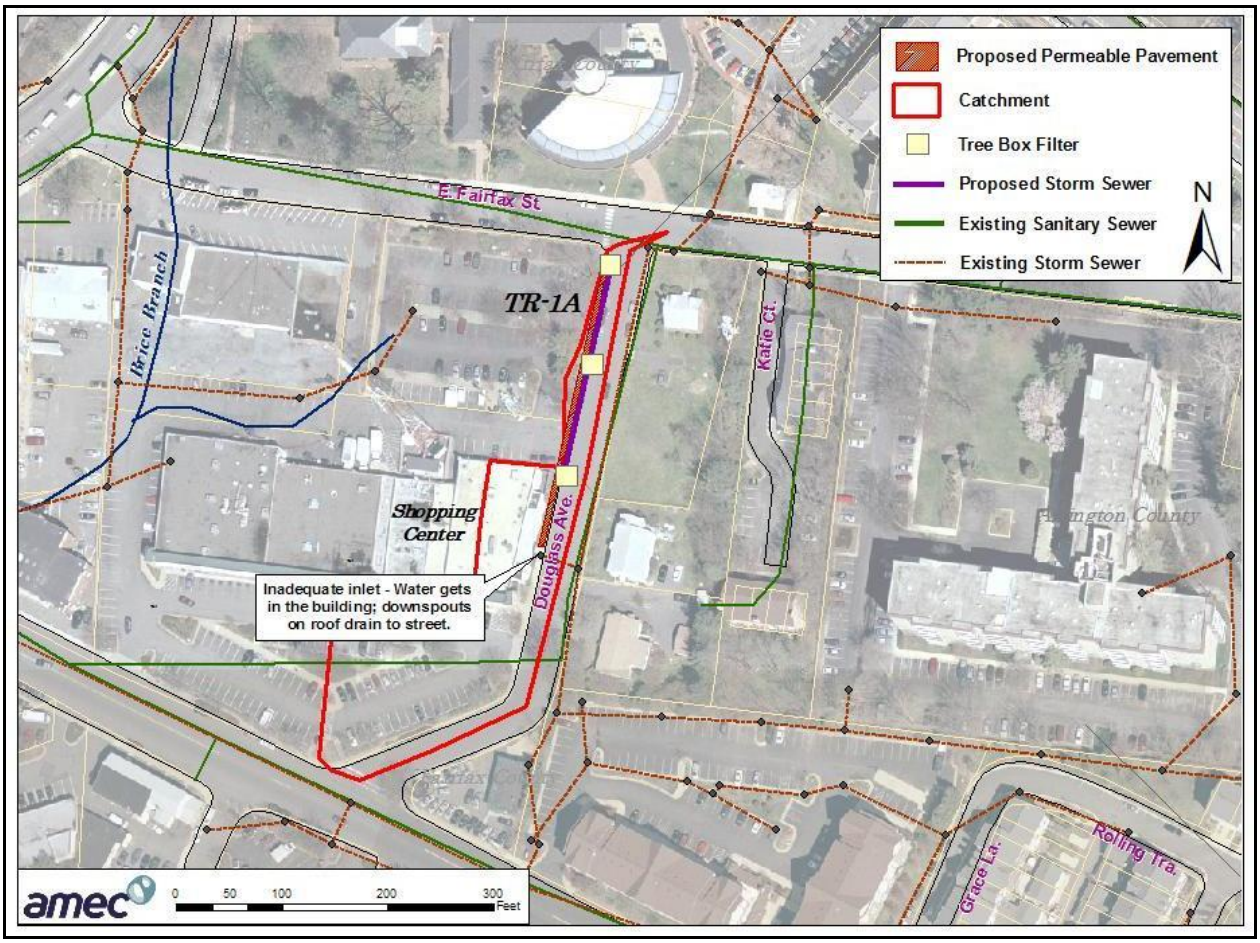
TR-11 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	600	Ft	$87	$52,200
# of Inlets	4	EA	$5,000	$20,000
# of Tree Box Filters	4	EA	$10,000	$40,000
Bioretention	100	SY	$150	$15,000
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	400	SY	$100	$40,000
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$167,200**
Mobilization (5%)				$8,360
Plantings (5%)				$8,360
Ancillary Items (5%)				$8,360
Erosion and Sediment Controls (10%)				$16,720
Subtotal 2				**$209,000**
Contingency (25%)				$52,250
Subtotal 3				**$261,250**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$117,562.50
Total				**$378,812.50**
Estimated Planning Level Project Cost				**$380,000**

PROJECT DATA SHEET
TR-1A



Address	155 Hillwood Avenue
Location	Douglass and Hillwood Avenues – Eastern side of Shopping Center
Land Owner	City of Falls Church
Parcel ID	3076, 3098, 3106, 3207, 3320, 3392
Control Type	Water quality and quantity control
Drainage Area	≈1.09 acres
Impervious Area	≈0.95 acres (87%)



Description: This project is designed to address a capacity issue where stormwater runoff jumps the curb and floods neighboring properties. The project also presents an opportunity to improve water quality in this highly impervious area.

Specific project components include:

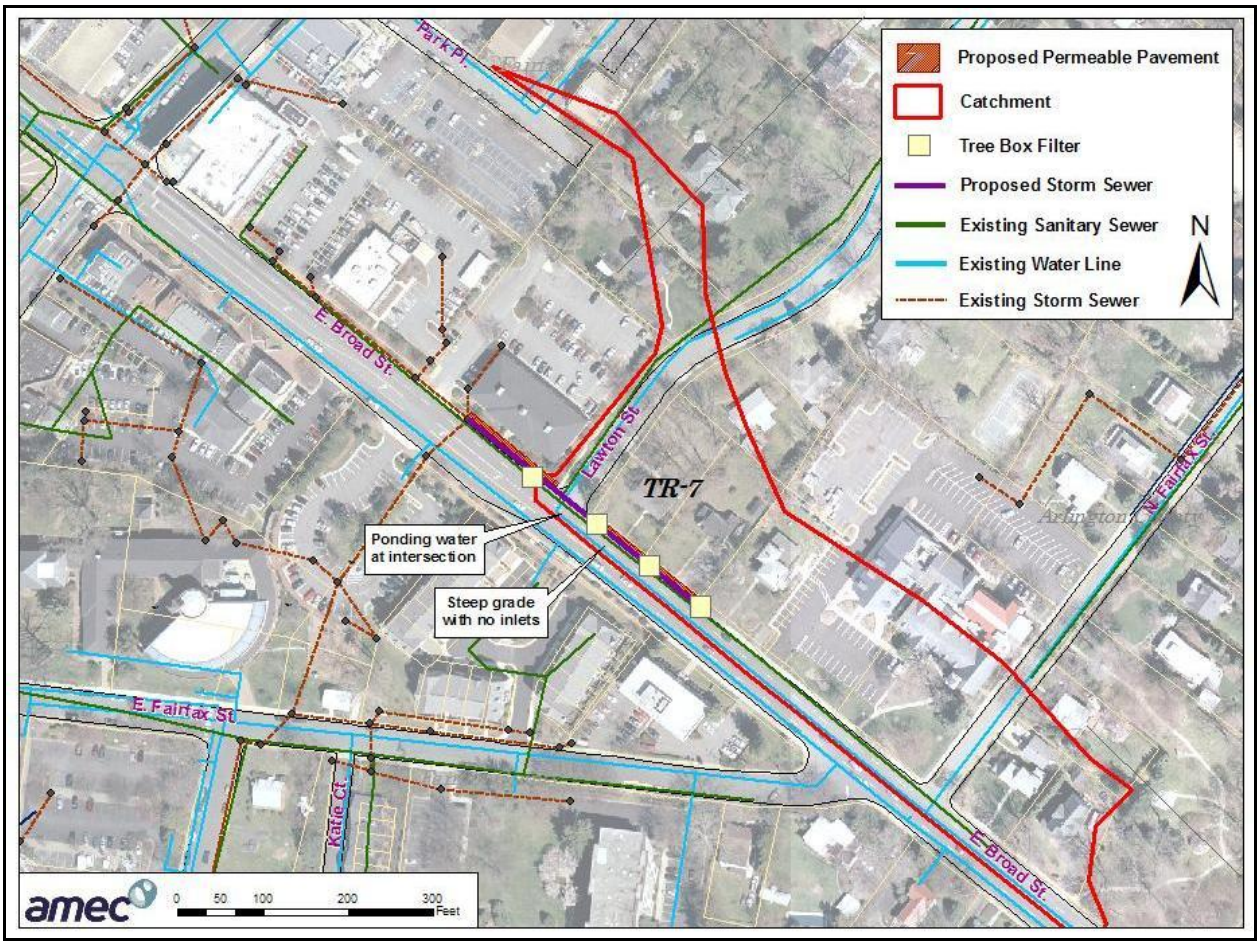
- New storm drain and inlets along Douglass Avenue.
- Retrofit of existing inlets and outfitting of new inlets with tree box filters to improve water quality.
- Integration of permeable pavers in sidewalk area along the west side of Douglass Avenue to reduce runoff.

TR-1A Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	300	Ft	$49	$14,700
# of Inlets	2	EA	$5,000	$10,000
# of Tree Box Filters	2	EA	$10,000	$20,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	130	SY	$100	$13,000
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$57,700**
Mobilization (5%)				$2,885
Plantings (5%)				$2,885
Ancillary Items (5%)				$2,885
Erosion and Sediment Controls (10%)				$5,770
Subtotal 2				**$72,125**
Contingency (25%)				$18,031.25
Subtotal 3				**$90,156.25**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$40,570.31
Total				**$130,726.56**
Estimated Planning Level Project Cost				**$130,000**

PROJECT DATA SHEET
TR-7

Address	131, 201 – 303 East Broad Street
Location	East Broad between Washington and Cherry Streets
Land Owner	City of Falls Church
Parcel ID	3112, 3070, 2907, 2809, 2872, 2830, 2791, 2628
Control Type	Water quality and quantity control
Drainage Area	≈4.02 acres
Impervious Area	≈2 acres (50 %)

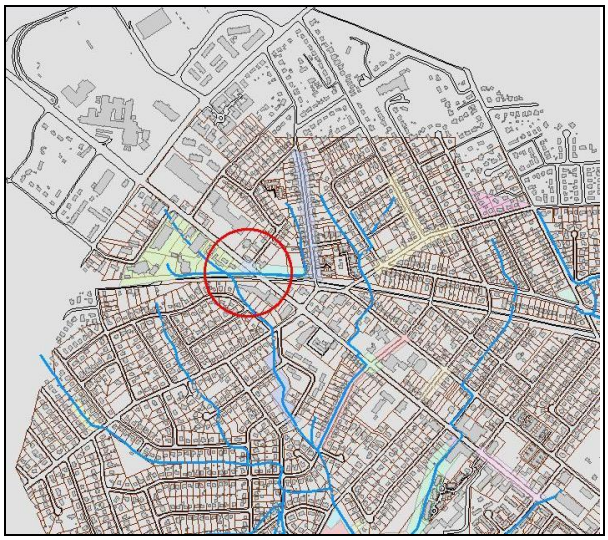


Description: This project is designed to address standing water issues at the low spot on Lawton Street. The entire area between Washington and Cherry is subject to excess sheet flow due to lack of inlets. The East Broad Street intersection problem will be fixed by adding more drainage inlets along the road and the low spot location. The addition of drainage inlets will reduce flooding and the spread causing hydroplane for vehicles. To provide water quality improvement, the drainage inlets can be combined with tree box filters. The sidewalks along the streets can also be replaced with permeable pavers to provide stormwater infiltration.

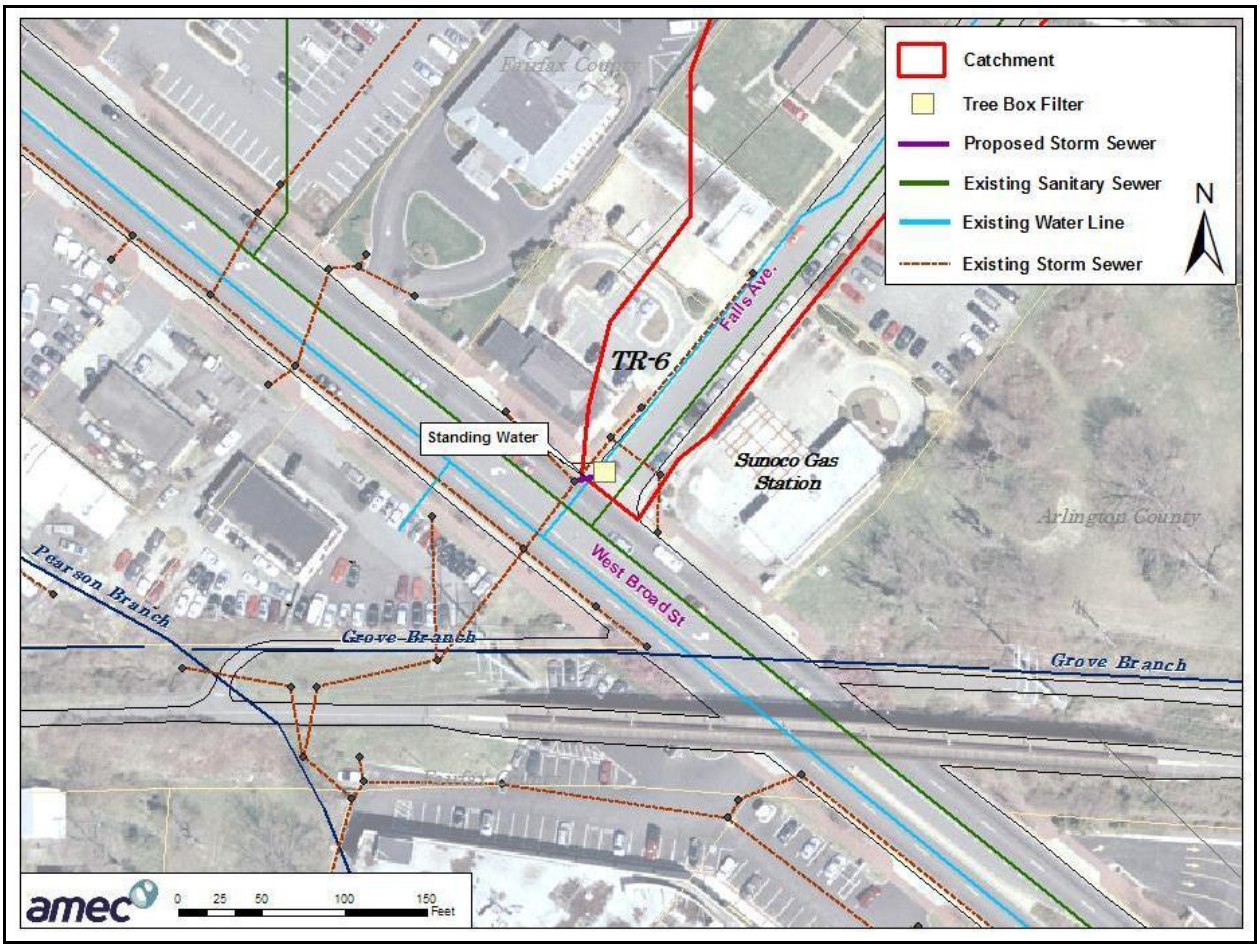
TR-7 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	1000	Ft	$60	$60,000
# of Inlets	8	EA	$5,000	$40,000
# of Tree Box Filters	4	EA	$10,000	$40,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	350	SY	$100	$35,000
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$175,000**
Mobilization (5%)				$8,750
Plantings (5%)				$8,750
Ancillary Items (5%)				$8,750
Erosion and Sediment Controls (10%)				$17,500
Subtotal 2				**$218,750**
Contingency (25%)				$54,687.50
Subtotal 3				**$273,437.50**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$123,046.88
Total				**$396,484.38**
Estimated Planning Level Project Cost				**$400,000**

PROJECT DATA SHEET
TR-6



Address	1050, 1100 & 1103 West Broad Street
Location	West Broad and Falls Avenue
Land Owner	City of Falls Church
Parcel ID	402, 424, 454
Control Type	Water quality and quantity control
Drainage Area	≈7.3 acres
Impervious Area	≈2.8 acres (38%)

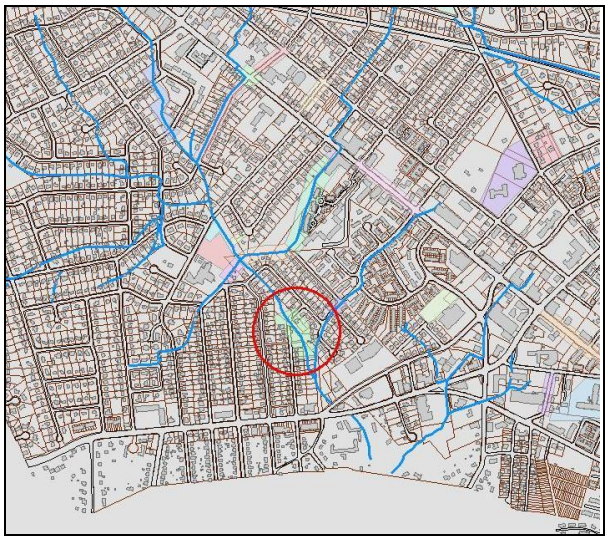


Description: This project is designed to address standing water in the intersection of West Broad Street and Falls Avenue. The addition of a drainage inlet near the West Broad and Falls Avenue intersection will help resolve standing water issues. In addition, inclusion of a tree box filter will provide water quality benefit for this highly impervious area.

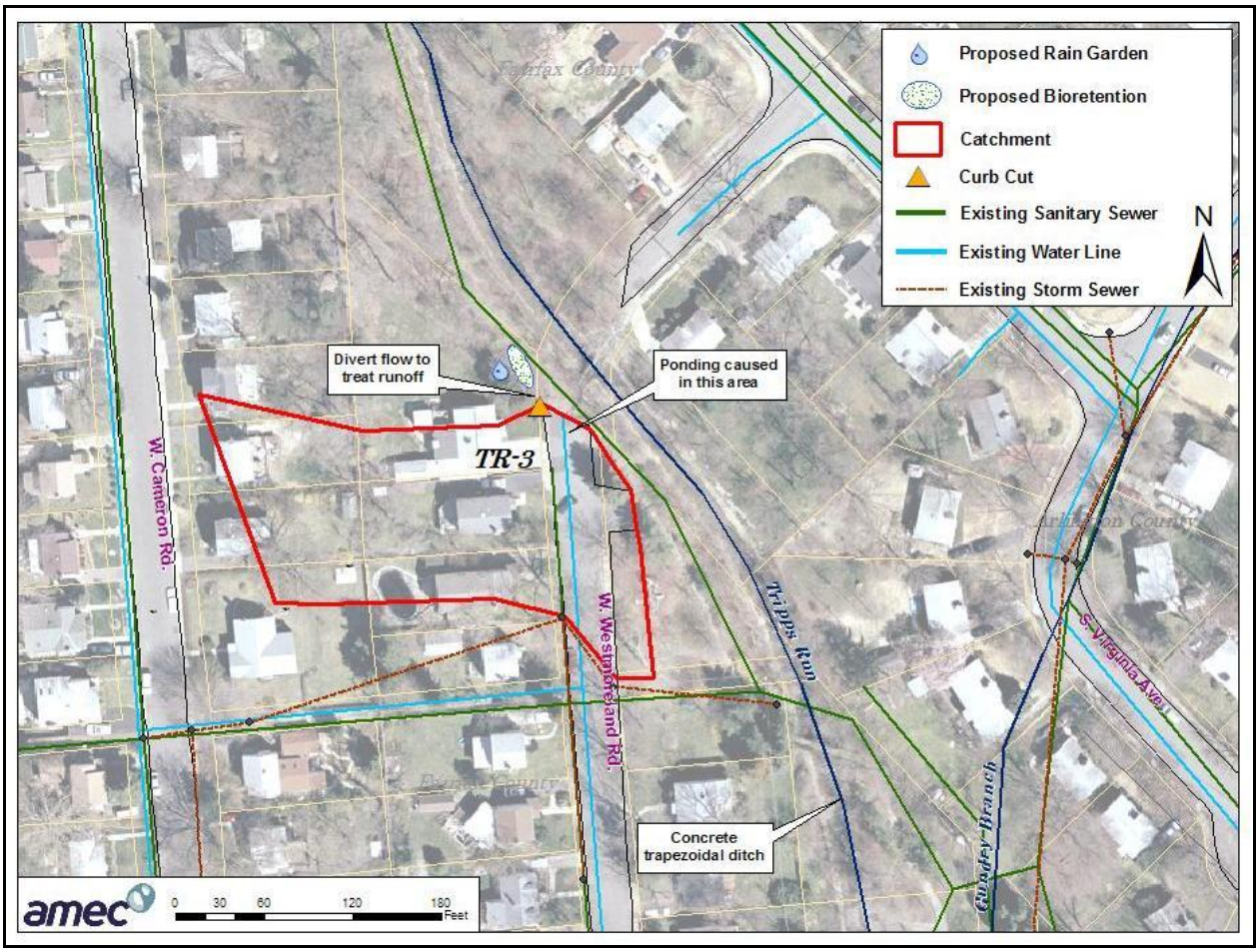
TR-6 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	1300	Ft	$60	$78,000
# of Inlets	16	EA	$5,000	$80,000
# of Tree Box Filters	8	EA	$10,000	$80,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	0	SY	$100	$0
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$238,000**
Mobilization (5%)				$11,900
Plantings (5%)				$11,900
Ancillary Items (5%)				$11,900
Erosion and Sediment Controls (10%)				$23,800
Subtotal 2				**$297,500**
Contingency (25%)				$74,375
Subtotal 3				**$371,875**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$167,343.75
Total				**$539,218.75**
Estimated Planning Level Project Cost				**$540,000**

PROJECT DATA SHEET
TR-3



Address	207 W Westmoreland Road
Location	Drainage at West Westmoreland Road
Land Owner	City of Falls Church
Parcel ID	2571
Control Type	Water quality and quantity control
Drainage Area	≈0.8 acres
Impervious Area	≈0.3 acres (38%)

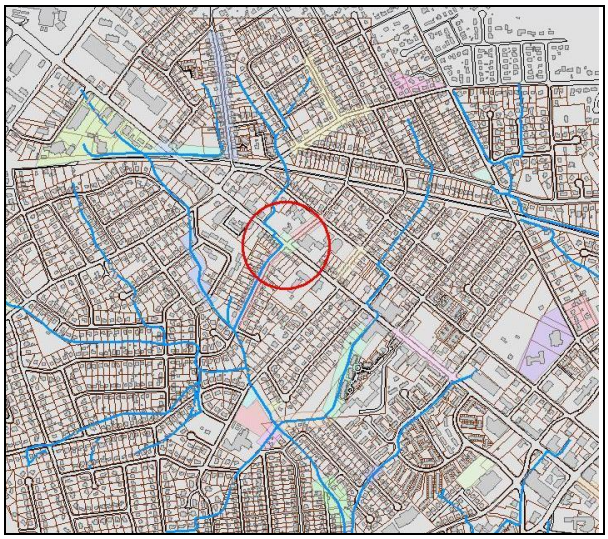


Description: This project is designed to address flooding in the street due to poor grading and no inlet. The project will also help address drainage issues identified at 207 West Westmoreland Road. Finally, the project will provide water quality benefits to this area. The project consists of diverting flow from the northwest side of West Westmoreland Road using a rock lined channel that would flow to a proposed rain garden/biofiltration facility. The entrance channel will alleviate the ponding that is occurring due to the build-up of leaves and debris at the end of West Westmoreland Road.

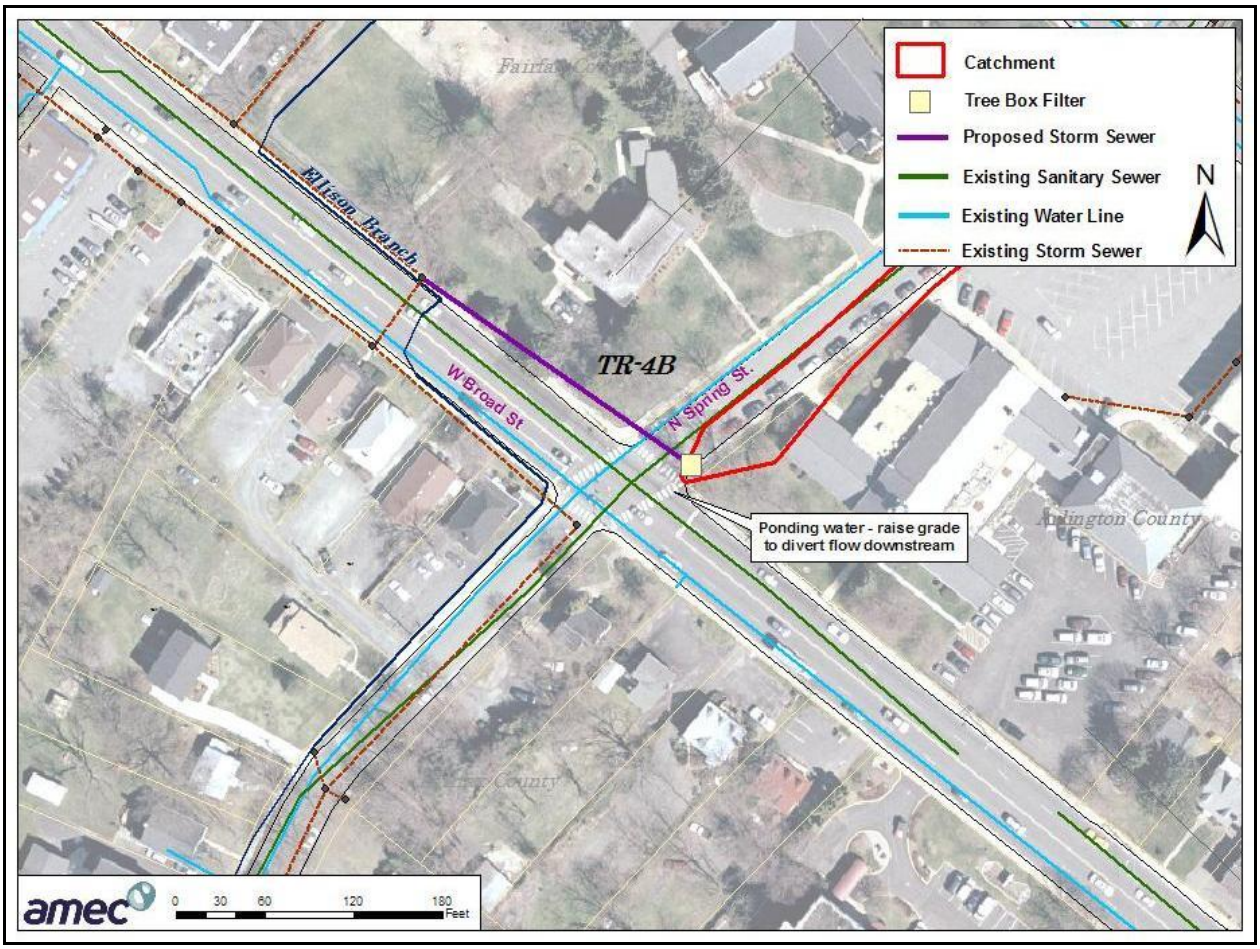
TR-3 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	0	Ft	$49	$0
# of Inlets	0	EA	$5,000	$0
# of Tree Box Filters	0	EA	$10,000	$0
Bioretention	75	SY	$150	$11,250
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	0	SY	$100	$0
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$11,250**
Mobilization (5%)				$562.50
Plantings (5%)				$562.50
Ancillary Items (5%)				$562.50
Erosion and Sediment Controls (10%)				$1,125
Subtotal 2				**$14,062.50**
Contingency (25%)				$3,515.63
Subtotal 3				**$17,578.13**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$7,910.16
Total				**$25,488.28**
Estimated Planning Level Project Cost				**$30,000**

PROJECT DATA SHEET
TR-4B



Address	905 Park Avenue
Location	West Broad and North Spring Streets
Land Owner	City of Falls Church
Parcel ID	700, 799, 887, 902, 917, 949, 966
Control Type	Water quality and quantity control
Drainage Area	≈0.29 acres
Impervious Area	≈0.24 acres (83%)

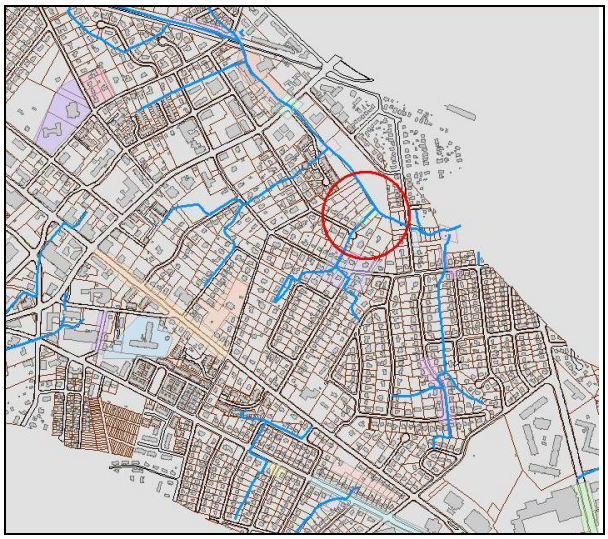


Description: This project is designed to address standing water in the intersection of West Broad Street and North Spring Street. Improvements can also be coupled with techniques to improve water quality from this highly impervious area. The project includes raising the grade near the handicap ramp at the intersection of West Broad Street and North Spring Street to divert flow downstream and prevent ponding. A drainage inlet with a tree box filter will also be added along North Spring Street to divert the flow and provide water quality benefits.

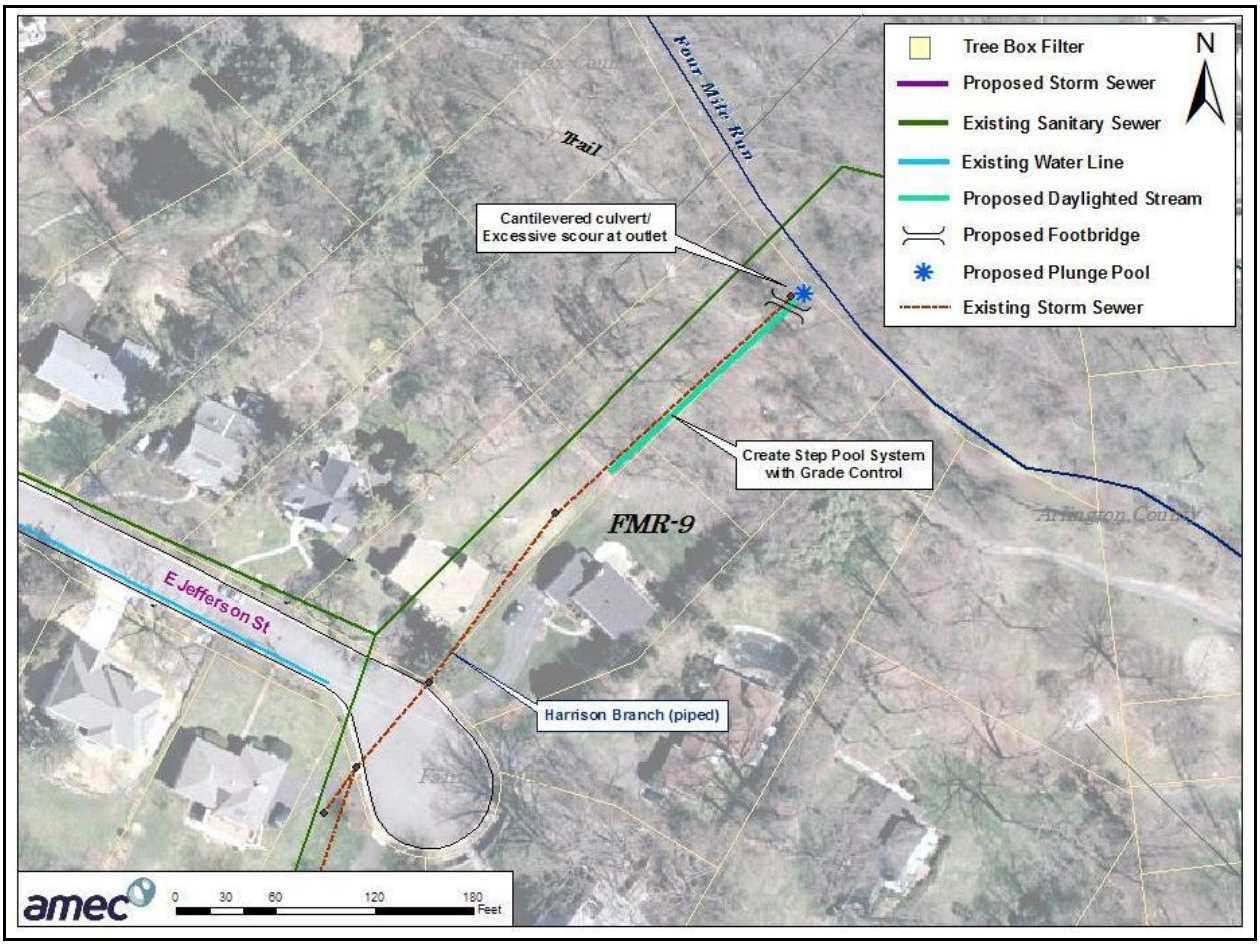
TR-4B Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	225	Ft	$60	$13,500
# of Inlets	1	EA	$5,000	$5,000
# of Tree Box Filters	1	EA	$10,000	$10,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	0	SY	$100	$0
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$28,500**
Mobilization (5%)				$1,425
Plantings (5%)				$1,425
Ancillary Items (5%)				$1,425
Erosion and Sediment Controls (10%)				$2,850
Subtotal 2				**$35,625**
Contingency (25%)				$8,906.25
Subtotal 3				**$44,531.25**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$20,039.06
Total				**$64,570.31**
Estimated Planning Level Project Cost				**$65,000**

PROJECT DATA SHEET
FMR-9



Address	419 East Jefferson Street
Location	Harrison Branch Outfall and Four Mile Run
Land Owner	City of Falls Church
Parcel ID	4141, 4152, 4217, 4258, 4265, 4273
Control Type	Water quality and quantity control
Drainage Area	≈73 acres
Impervious Area	≈23 acres (32%)

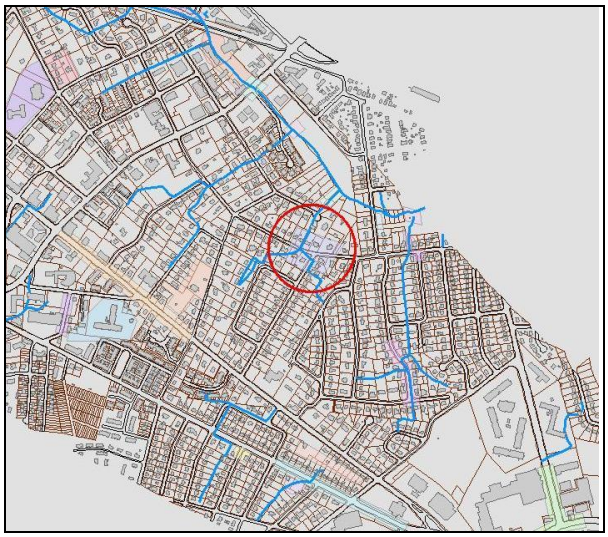


Description: This project is designed to improve water quality and habitat by remediating a blowout where the 48" pipe containing Harrison Branch enters Four Mile Run. The blowout contributes to total suspended solids in the water through erosion of the stream bank and outfall area. The project will day-light approximately 150 feet of pipe and will create a step pool system with grade control. The project will fix the cantilevered culvert and excessive scour at the outlet.

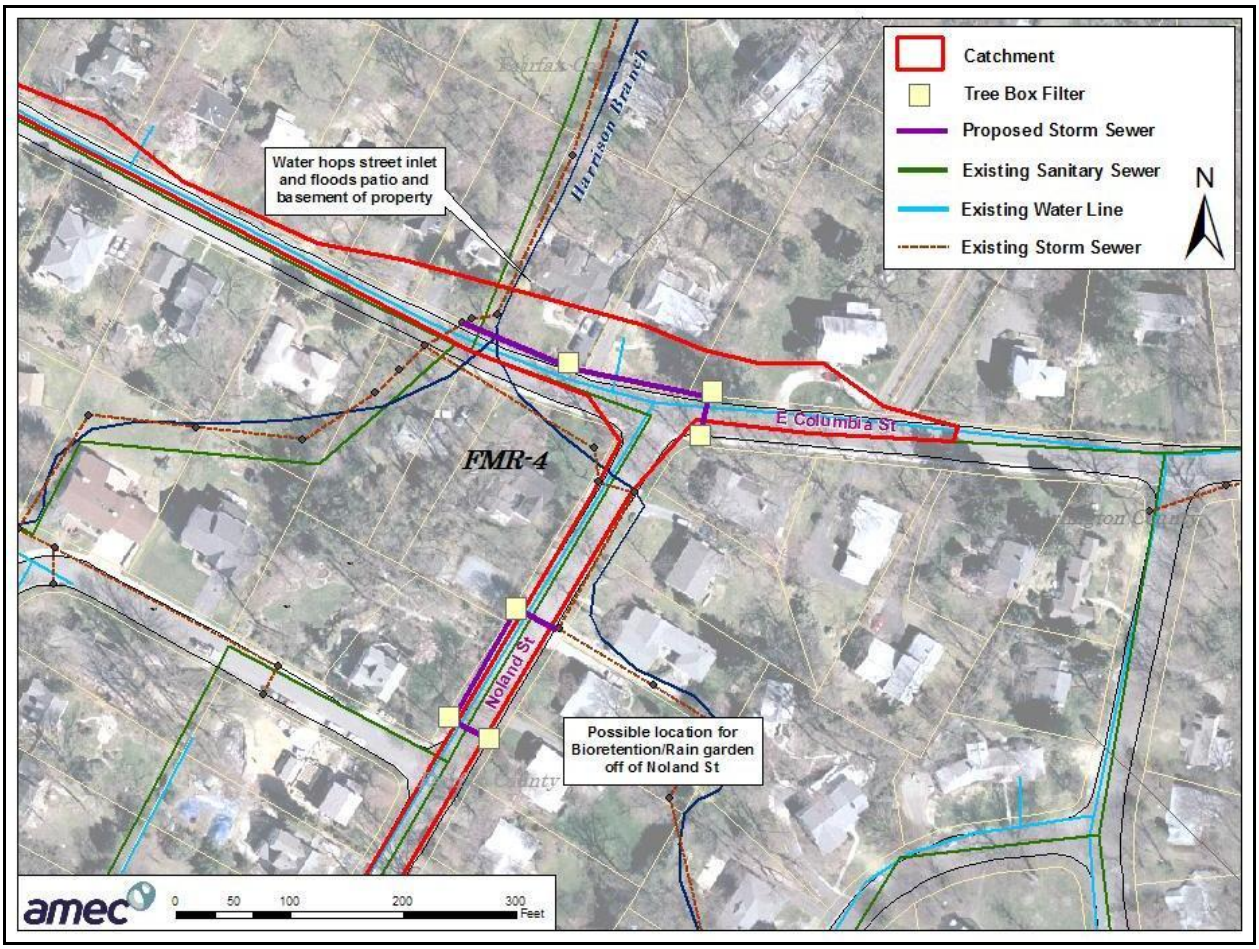
FMR-9 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	0	Ft	$49	$0
# of Inlets	0	EA	$5,000	$0
# of Tree Box Filters	0	EA	$10,000	$0
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	0	SY	$100	$0
Stream Restoration	200	LF	$300	$60,000
Planting (stream restoration only)	0.5	AC	$25,000	$12,500
Clear and Grub	0.5	AC	$10,000	$5,000
Base Construction Cost (Subtotal 1)				**$77,500**
Mobilization (5%)				$3,875
Plantings (5%)				$3,875
Ancillary Items (5%)				$3,875
Erosion and Sediment Controls (10%)				$7,750
Subtotal 2				**$96,875**
Contingency (25%)				$24,218.75
Subtotal 3				**$121,093.75**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$54,492.19
Total				**$175,585.94**
Estimated Planning Level Project Cost				**$180,000**

PROJECT DATA SHEET
FMR-4



Address	Multiple addresses near the intersection of Columbia and Noland Streets
Location	Columbia and Noland Streets
Land Owner	City of Falls Church
Parcel ID	2611, 2771, 2798, 2881, 2756
Control Type	Water quality and quantity control
Drainage Area	≈1.62 acres
Impervious Area	≈1.1 acres (69%)

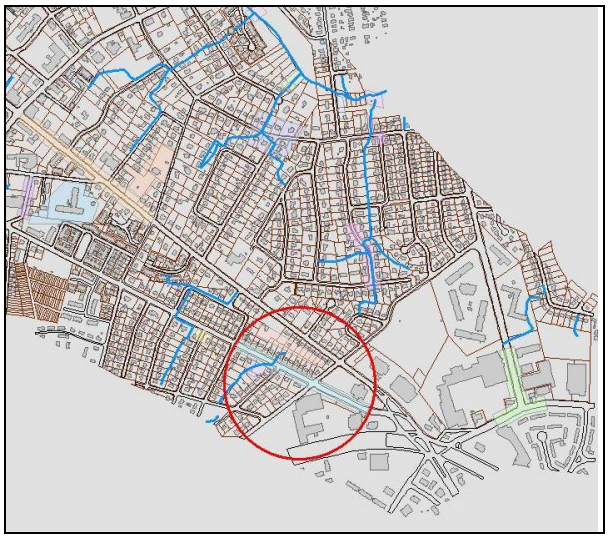


Description: This project is designed to address flooding and drainage issues for individual homes (431, 432, and 434 Columbia Street). The project will also improve water quality for this highly impervious area. The primary issue is a lack of storm sewer inlets along Noland Street and Columbia Street where the water eventually collects and overtops the inlet in front of 431 Columbia Street. This project involves the addition of new storm sewer infrastructure consisting of inlets, storm sewers, and tree box filters (to improve water quality).

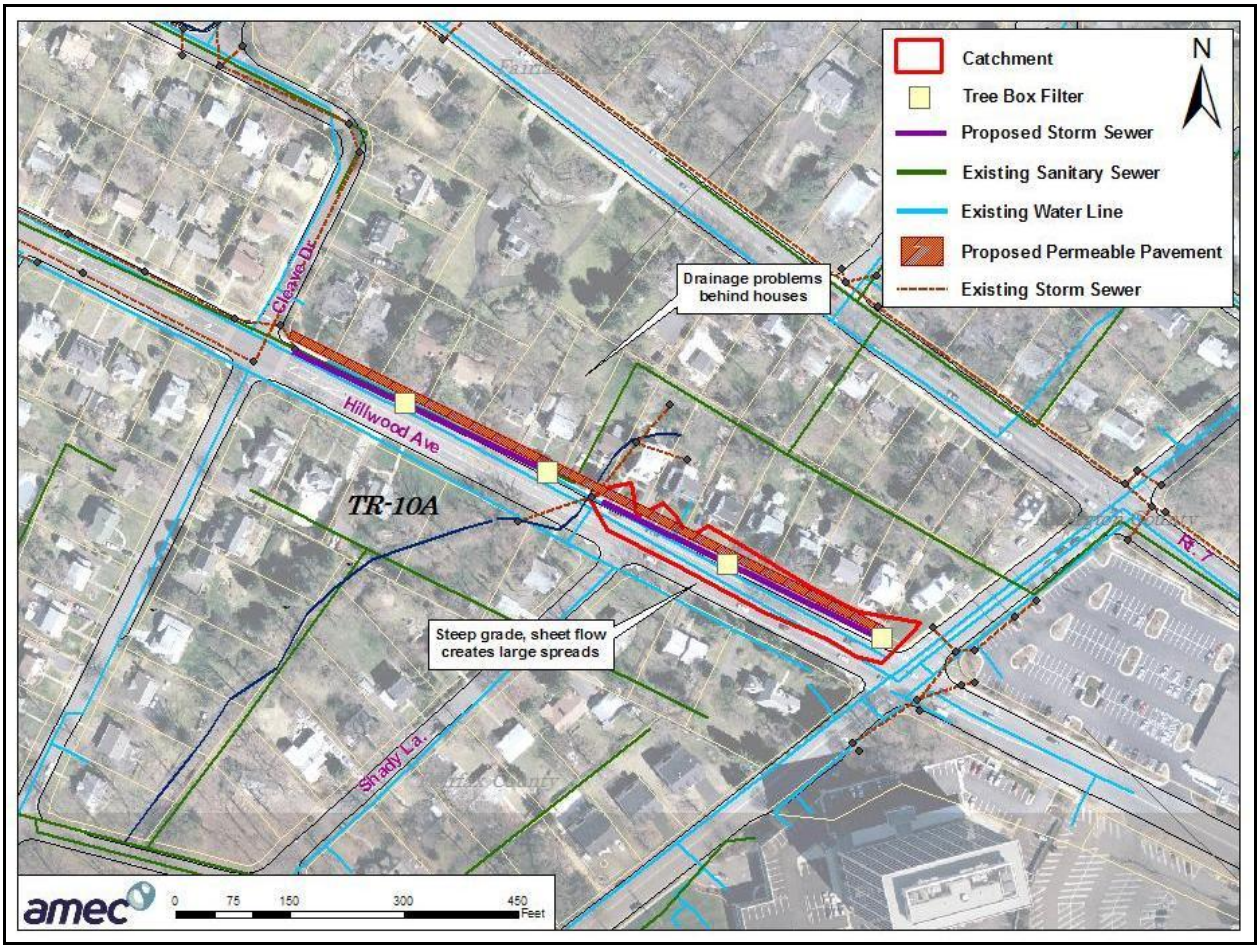
FMR-4 Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	1200	Ft	$60	$72,000
# of Inlets	4	EA	$5,000	$20,000
# of Tree Box Filters	4	EA	$10,000	$40,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	0	SY	$100	$0
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$132,000**
Mobilization (5%)				$6,600
Plantings (5%)				$6,600
Ancillary Items (5%)				$6,600
Erosion and Sediment Controls (10%)				$13,200
Subtotal 2				**$165,000**
Contingency (25%)				$41,250
Subtotal 3				**$206,250**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$92,812.50
Total				**$299,062.50**
Estimated Planning Level Project Cost				**$300,000**

PROJECT DATA SHEET
TR-10A



Address	Multiple addresses along Hillwood Avenue
Location	Hillwood Avenue between Cleave Drive and East Broad Street
Land Owner	City of Falls Church
Parcel ID	4140, 4147, 4154, 4162, 4159, 4165, 4174, 4179, 4187, 4193, 4200, 4207, 4216, 4221, 4228
Control Type	Water quality and quantity control
Drainage Area	≈0.58 acres
Impervious Area	≈0.35 acres (60%)



Description: This project is designed to reduce excess sheet flow during storms, which causes flooding and hydroplaning along Hillwood Avenue. The project is also an opportunity to improve water quality in this highly impervious area.

Specific project components include:

- New storm sewer line and inlets on the north side of Hillwood Avenue.
- Outfit new inlets with tree box filters to improve water quality.
- Retrofit sidewalks with permeable pavers to improve water qualtiy.

TR-10A Planning Level Cost

Items	Quantity	Quantity Units	Unit Cost	Total
Storm sewer length	300	Ft	$60	$18,000
# of Inlets	2	EA	$5,000	$10,000
# of Tree Box Filters	2	EA	$10,000	$20,000
Bioretention	0	SY	$150	$0
Rainwater Harvesting	0	EA	$4,000	$0
Permeable Pavement	275	SY	$100	$27,500
Stream Restoration	0	LF	$300	$0
Planting (stream restoration only)	0	AC	$25,000	$0
Clear and Grub	0	AC	$10,000	$0
Base Construction Cost (Subtotal 1)				**$75,500**
Mobilization (5%)				$3,775
Plantings (5%)				$3,775
Ancillary Items (5%)				$3,775
Erosion and Sediment Controls (10%)				$7,550
Subtotal 2				**$94,375**
Contingency (25%)				$23,593.75
Subtotal 3				**$117,968.75**
Engineering, Design, Surveys, Utility Relocation and Permits (45%)				$53,085.94
Total				**$171,054.69**
Estimated Planning Level Project Cost				**$171,000**