SOLTESZ LLC

STRATEGIES FOR TODAY. INSIGHT FOR TOMORROW.

<u>Town of Washington Grove</u>

Stormwater Management Assessment

Date August 23, 2023

Prepared For: Town of Washington Grove
300 Grove Ave Washington Grove MD

STATE OF MARYLAND
ANDREW P. BOFTO
No. 53214
PROFESSIONAL ENGINEER

08/23/2023

<u>PROFESSIONAL CERTIFICATION</u>
I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland,
License No. 53214
Expiration Date: 06/14/2023

Table of Contents

I. Chapter I – Stormwater Management Proposal Summary 1
II. Chapter II – Assessment of Existing Facilities 1
III. Chapter III – Recommendations........ 5
IV. Chapter IV – The Woods 7
Appendix A – Supplemental Drainage Areas. 9

I. Chapter I – Stormwater Management Proposal Summary

Soltesz and the Town of Washington Grove Mayor and Town Residents meet to confirm the scope of the study for the “Storm Drain Storm Water Management”. The following is a summary of the goals of the RFP:

1) Review the limited town infrastructure and determine if it is acceptable to convey a reasonable storm event.
2) The “site” for review is considered to be from the high point within the town park to the conveyance across Washington Grove Lane into West Woods.
3) Review the possible Storm Water Device locations device.
4) Look at what could be done with in the public right of way which could enhance the quality and quantity of the downstream discharge into the West Woods.
5) A 100 year storm event is generally looked at to evaluate if there are flooding issues. The generally accepted criteria to review at a site such as Washington Grove is; are structures being flooded, can you generally access the site, lastly is there a future condition such as erosion which may lead to a future problem.
6) A 10 year storm is generally used to determine if a storm drain system is able to convey a proper amount of water.

II. Chapter II – Assessment of Existing Facilities

Soltesz performed an infrastructure assessment on various days throughout the month of June. The assessment included visual inspection of roadway condition, pipe capacity, inlet capacity overall drainage pattern.

Please see appendix A for supporting hydrology as obtained from MCATLAS, a web based GIS database provided by Montgomery County. Based on our walk we found the data to be consistent with what was observed in the field.

Our study found three major observations which need to need to be addressed for the conveyance of stormwater:

1. Maintenance of existing system required.
2. Inlet and pipe capacity does not meet 10 year requirements.
    a. Addressed maintenance and existing and inlet capacity the swales and ditches didn't address.
3. Swales and Ditches do not convey a 10 year storm.

Note:

1. A ten year storm is a typical Montgomery County design parameter for storm drain systems.
2. A 100 year storm event is a typical design parameter for flood conveyance.

100 year conveyance was looked at and discussed with community representatives Although overland flow is required to convey the 100 year storm our observations indicate that no significant structural damage is occurring in flood conditions only low through road ways and swales.

The existing storm infrastructure at Washington grove is in need of maintenance, repair and in some cases replacement. The existing infrastructure appears to be undersized, cluttered and rusted through. As Shown in Figure 1 the existing road conveyance pipes are undersized and made of old material.

Figure 1. Undersized CMP.

As Shown in Figure 2, the asphalt swales on the side of the roads provide no infiltration are old and a drainage analysis needs to be done to see if they are adequately sized. Many of the inlets onsite are inefficient, undersized, and filled with clogging debris. As Figure 3 shows some of the structures are buried and others are just too small.

Figure 2. Asphalt swales need to be replaced with bio swales to treat water before it hits storm drain and reaches West Woods.

Figure 3. Varying types of structures onsite could be replaced with more efficient structures that can handle a larger capacity and further prevent overland flow from bypassing structure and creating runoff in west woods.

III. Chapter III – Recommendations

The Recommendations for design are as follows. First the existing facilities need to be inspected and maintained. Second the asphalt swales need upgraded to bio swales and more efficient inlets. Third surface drainage easements would be recorded to ensure adequate drainage across yards. Fourth a submerged gravel wetland could be placed onsite that will capture a portion of the runoff and treat the water quality issues. Fifth a Regenerative step pool storm conveyance system could be installed to maintain the

The structures that were observed to be clogged with debris and filled in will need to be cleaned out. Some structures will be filled in worse than others with some needing to be un buried after years of being heavily filled in.

Having bioswales at the locations of the asphalt swales would encourage infiltration and reduce the amount of runoff that is delivered to West Woods. A soils investigation is needed to determine the effectiveness of these devices however any amount of infiltration will enhance the capabilities of the system. The increase in infiltration will reduce stormwater runoff and reduce erosive flows in the west woods stream. The larger swale section will convey a larger volume of water and route it through a system that will control the flow so that it does not erode out the stream in west woods. The increased size in bioswales can be accomplished through grading within public right of way, minor roadway width reduction and grading easements from adjacent property owners.

Soltesz observed Storm Drain structures on site that if replaced with more efficiently designed structures that incorporate more modern technology would increase inlet capacity and reduce bypass and sump ponding at inlets. This increase in capacity would route the water to ESD devices that would reduce direct runoff from being delivered to the West woods. In addition easements could be placed onsite to prevent the current stable flow paths from being disrupted. The design rule of thumb from the County manual states that when flow exceeds 2.5 acres, 3 cfs or after flow crosses a third property line a surface drainage easement is required. This would decrease the chance of someone building something on their property that will obstruct the flow path and reduce the chances of erosion or flooding.

As seen in Figure 4. below the typical bioswale will have a flat bottom width with side slopes of 3:1 at a depth between 1 and 2 feet. Below the surface at the bottom is a layer of gravel sand and biomaterial.

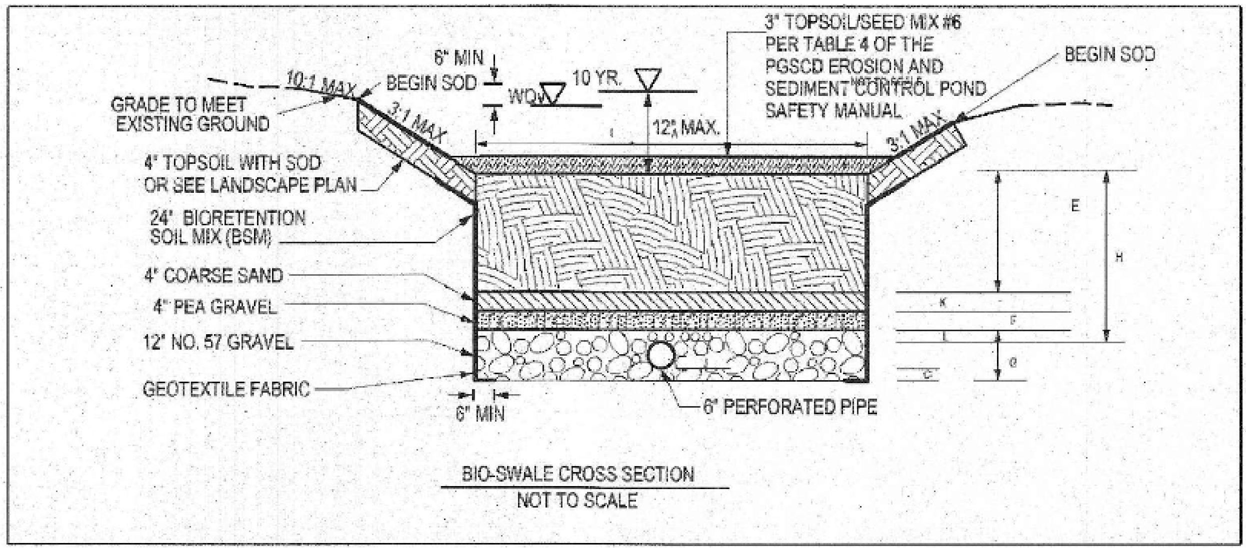


Figure 4. Bioswale typical section. As can be seen there is a bottom width that is flat then side slopes at 3:1. Below the surface is multiple layers of soil mix, sand and gravel.

A potential stormwater management strategy would be to place a submerged gravel wetland to be placed at the location at Center street on site that facilitates ease of drainage of water that would otherwise contaminate the west woods with water that is nutrient laden. As seen in Figure 5. Below the submerged gravel wetlands' plug flow reactor design allows for water to be treated and also allows a reduction in peak discharge without infiltration into the native soil material. An underdrain will tap into the existing storm drain system that will receive the subsurface effluent that is treated water that will be delivered to the stream across from. Washington Grove Lane. The installation of this device would provide water quality treatment and quantity control and could assist in reducing flooding on Washington grove lane. Since the water will be stored in the subsurface and discharged slowly through a low flow underdrain, and the device will be able to store a volume of water, the peak flow will be reduced during rain events and will decrease flooding on Washington Grove lane as well as decrease erosive discharges at the direct discharge point on Washington Grove Lane where the stream headwater channel begins.

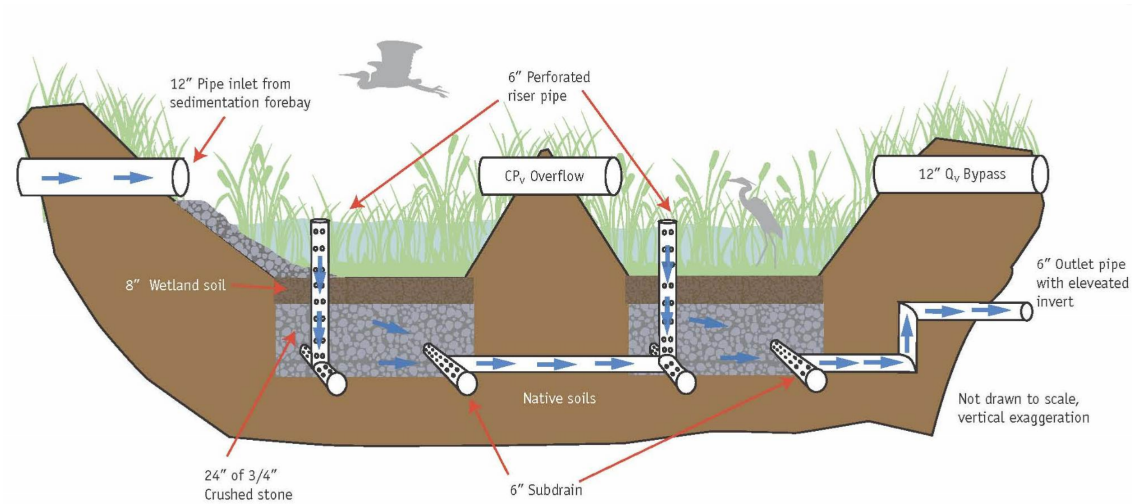


Figure 5. Submerged Gravel Wetland cross section. As seen the water has two points of discharge. One is a low flow 6" outlet pipe that lets water outslowly after it has had time to infiltrate through the wetland stone. Second is a bypass which is shown here as a pipe but could also be a weir outfall.

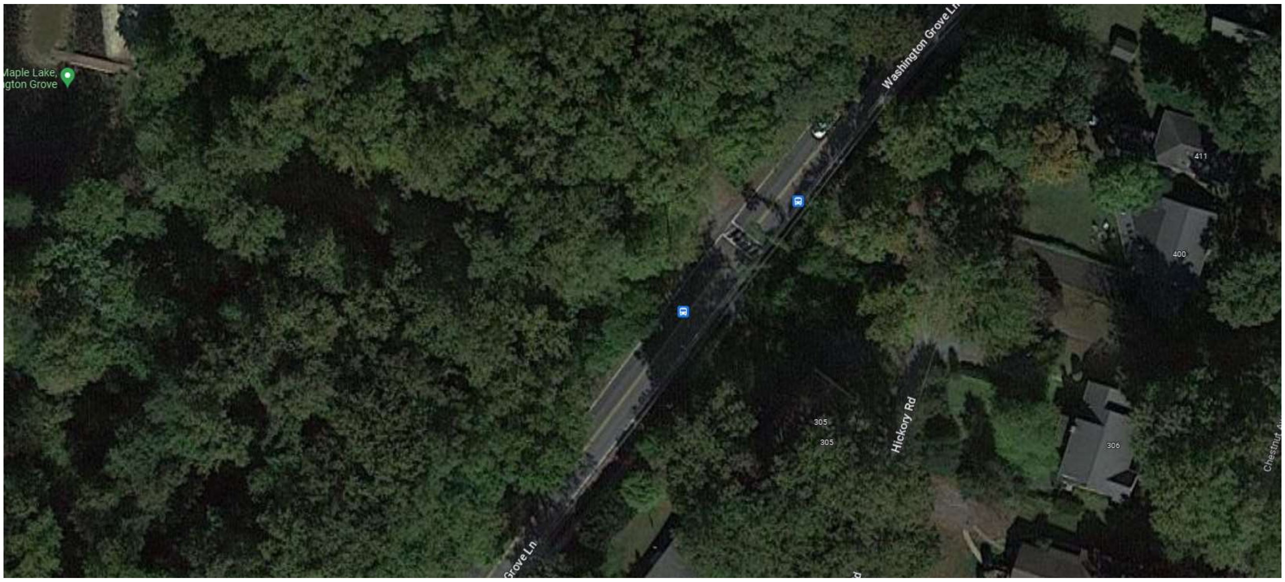
IV. Chapter IV – The Woods

As Stated in the *"Stream Assessment and Recommendations"* dated October of 2022, one possible strategy to restore the stream in the West woods is using a Regenerative step pool storm conveyance system that will both stabilize the channel an provide abundant water quality. The Regenerative step pool storm conveyance system works best in a ephemeral storm drain system which is what is observed near maple lake and on the north west side of Washington Grove lane and confirmed to be the most appropriate restoration on the site walk in May of 2023. The Flow regime of ephemeral storm drain receiving channel will complement the sand and woodchip mixture to receive the water from Washington grove which can be added to the submerged gravel wetland to make a treatment train that will both leave the water nutrient free and un-erosive. A conveyance assessment would be done on two separate areas that can be thought of as two separate projects. One project would be the town of Washington Grove to the south east of Washington Grove lane and the second would be the stream to the north west. The two projects could either be dependent on each other or completely independent of each other depending on what approach was taken to restore the stream. If the channel adjacent to maple lake in West woods was fixed with minimal stabilization or a natural channel design approach then the stream would need to be done after the South east portion was completed. Since the natural channel design and channel stabilization do not factor in water quality, only quantity control and stabilization, then the water would still need to be treated through subsurface infiltration before it reached the discharge point on the northeast side of Washington Grove Road. If a regenerative step pool storm conveyance approach used for the stream restoration the treatment, and quantity control would be built into the facility thus decreasing the need for work within the community and also making the two projects independent of each other. If this approach were used without increasing pipe and swale sizes as well as adding a Submerged Gravel Wetland then the Flooding on Washington Grove Road will remain as is.

Appendix A – Supplemental Pictures, Drainage Areas and Stormwater Calculations.

Study Point 1:

Washington Grove Lane



Inlet

Inlet

Outfall

1	**Washington Grove Lane Crossing**				
	Q = ciA				
	c	0.4			
	i	7.07	in/hr	0.000164	ft/sec
	Area	1589580	sf		
	q=	104.0586	cfs		

Study Point 1

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.02000	ft/ft
Normal Depth	3.92	ft
Diameter	3.92	ft
Discharge	104.06	ft³/s

Results

Diameter	3.92	ft
Normal Depth	3.92	ft
Flow Area	12.05	ft²
Wetted Perimeter	12.31	ft
Hydraulic Radius	0.98	ft
Top Width	0.00	ft
Critical Depth	3.10	ft
Percent Full	100.0	%
Critical Slope	0.02138	ft/ft
Velocity	8.63	ft/s
Velocity Head	1.16	ft
Specific Energy	5.08	ft
Froude Number	0.00	
Maximum Discharge	111.94	ft³/s
Discharge Full	104.06	ft³/s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

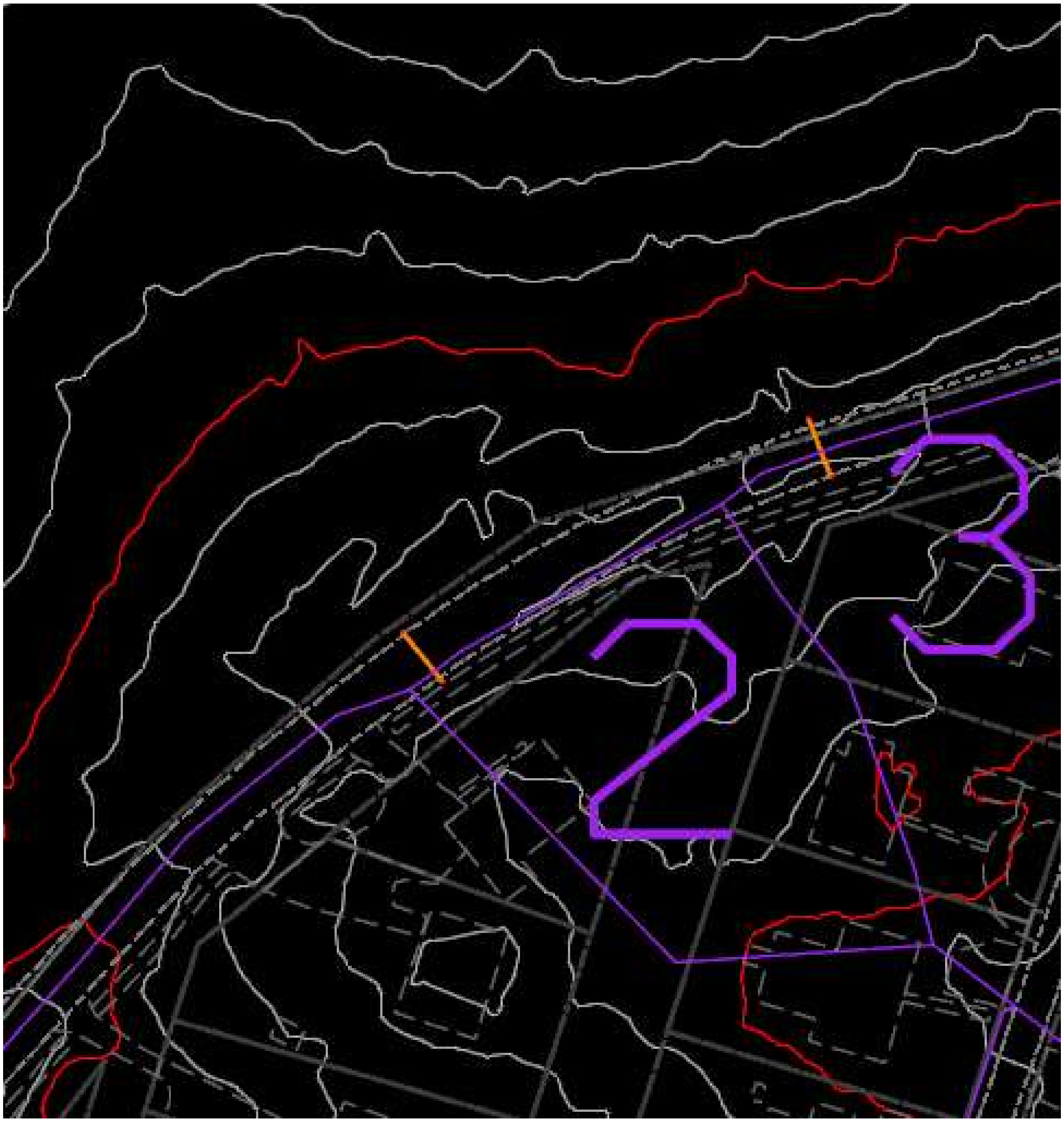
GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Study Point 2



SD in place unable to be identified assumed to be CMP

*Could not be found in field or via google maps

2	**Washington Grove Lane Crossing**				
	Q = ciA				
	c	0.4			
	i	7.07	in/hr	0.000164	ft/sec
	Area	30737	sf		
	q=	2.012135	cfs		

Study Point2

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.02000	ft/ft
Normal Depth	0.89	ft
Diameter	0.89	ft
Discharge	2.01	ft³/s

Results

Diameter		0.89	ft
Normal Depth		0.89	ft
Flow Area		0.62	ft²
Wetted Perimeter		2.80	ft
Hydraulic Radius		0.22	ft
Top Width		0.00	ft
Critical Depth		0.63	ft
Percent Full		100.0	%
Critical Slope		0.02835	ft/ft
Velocity		3.22	ft/s
Velocity Head		0.16	ft
Specific Energy		1.05	ft
Froude Number		0.00	
Maximum Discharge		2.16	ft³/s
Discharge Full		2.01	ft³/s
Slope Full		0.02000	ft/ft
Flow Type	SubCritical		

GVF Input Data

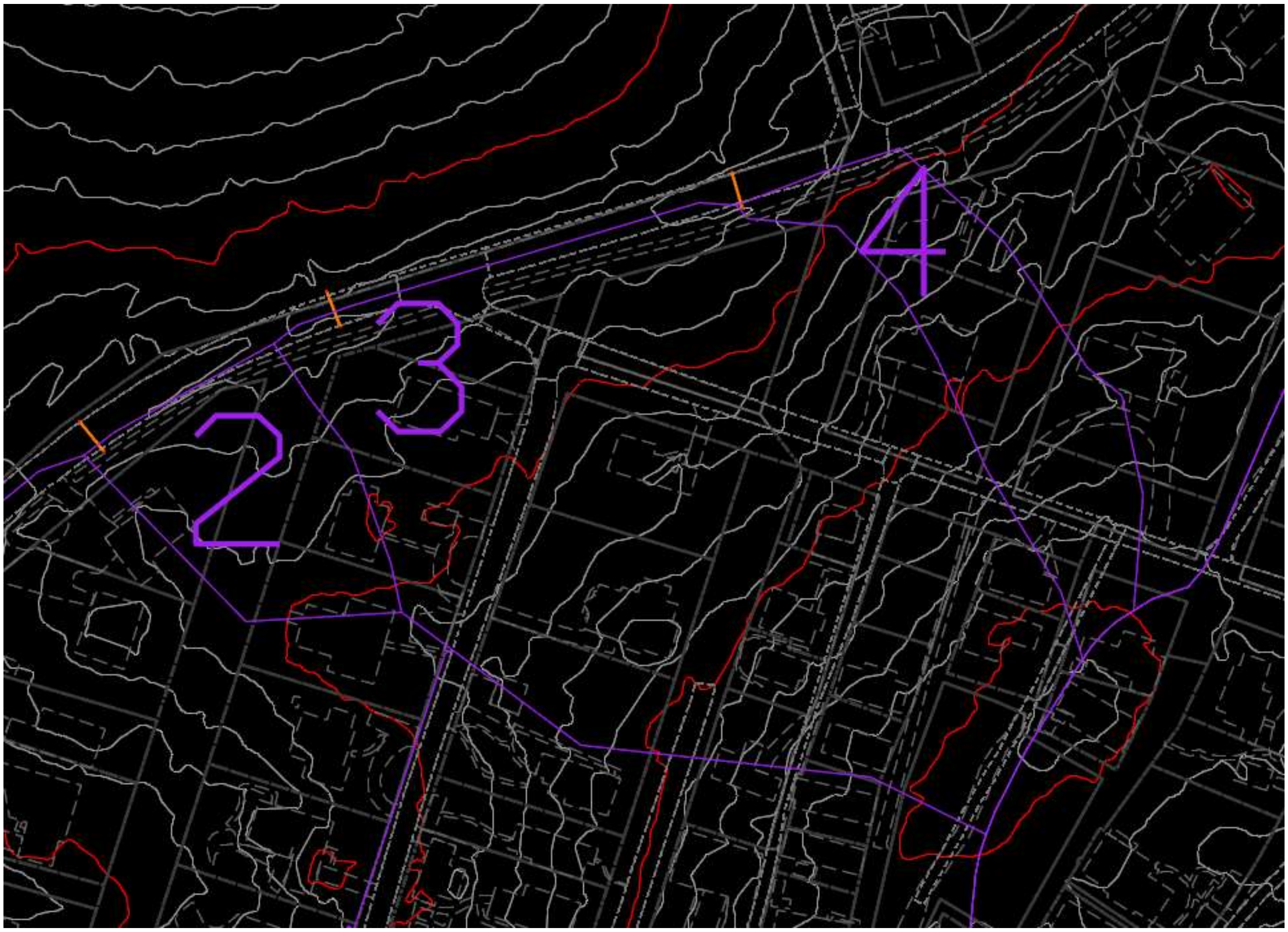
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

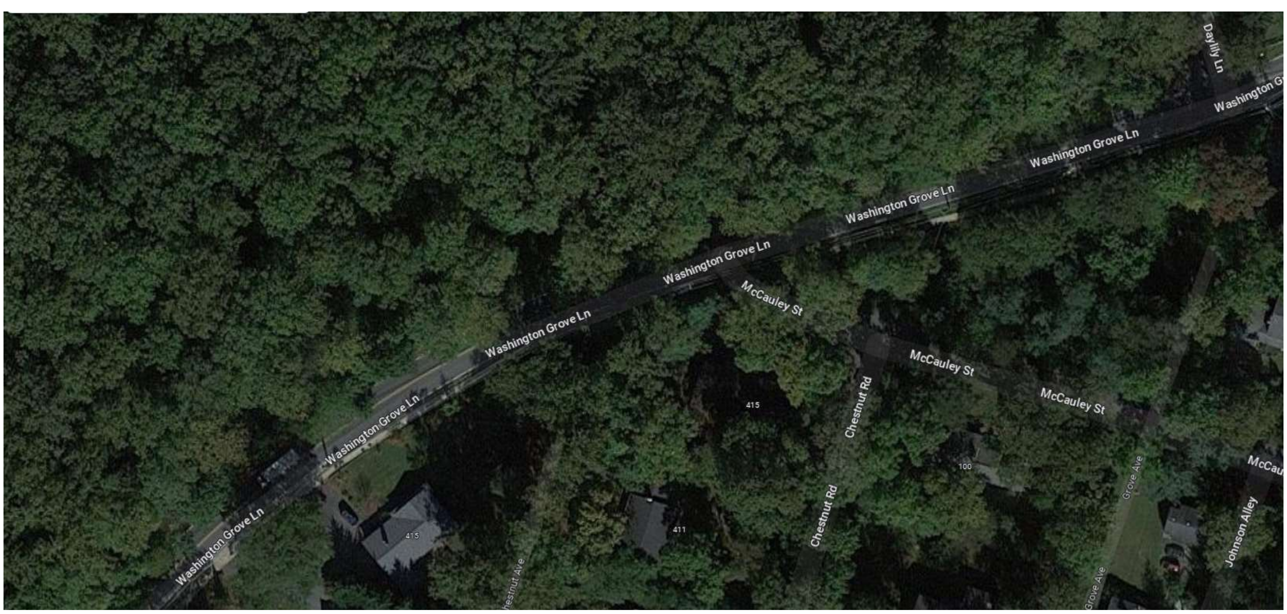
GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Study Point 3

Washington Grove Lane Crossing





3	**Washington Grove Lane Crossing**				
	Q = ciA				
	c	0.4			
	i	7.07	in/hr	0.000164	ft/sec
	Area	194130	sf		
	q=	12.70833	cfs		

Study Point 3

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.02000	ft/ft
Normal Depth	1.78	ft
Diameter	1.78	ft
Discharge	12.71	ft³/s

Results

Diameter	1.78	ft
Normal Depth	1.78	ft
Flow Area	2.49	ft²
Wetted Perimeter	5.59	ft
Hydraulic Radius	0.45	ft
Top Width	0.00	ft
Critical Depth	1.32	ft
Percent Full	100.0	%
Critical Slope	0.02458	ft/ft
Velocity	5.10	ft/s
Velocity Head	0.40	ft
Specific Energy	2.19	ft
Froude Number	0.00	
Maximum Discharge	13.67	ft³/s
Discharge Full	12.71	ft³/s
Slope Full	0.02001	ft/ft
Flow Type	SubCritical	

GVF Input Data

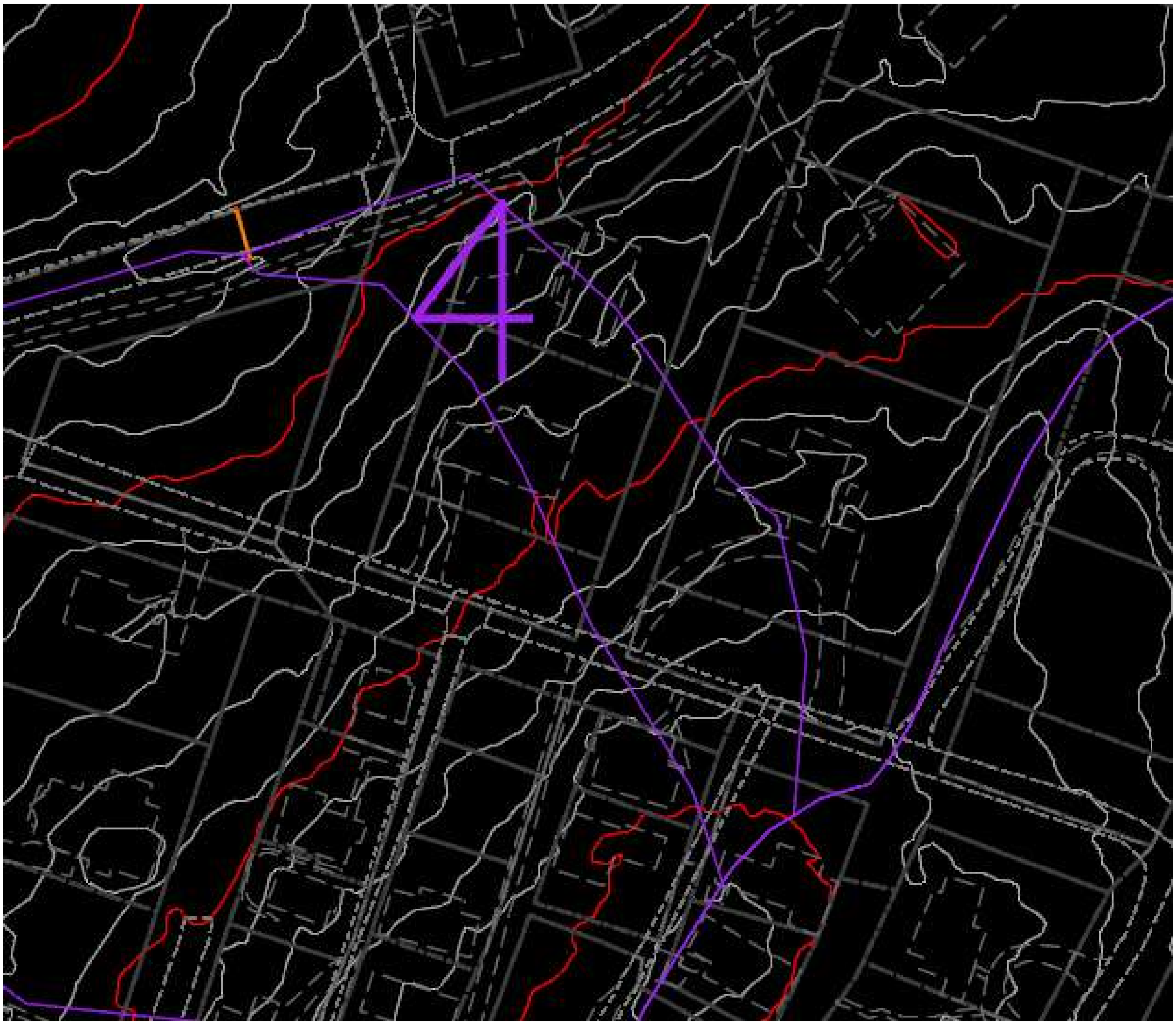
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

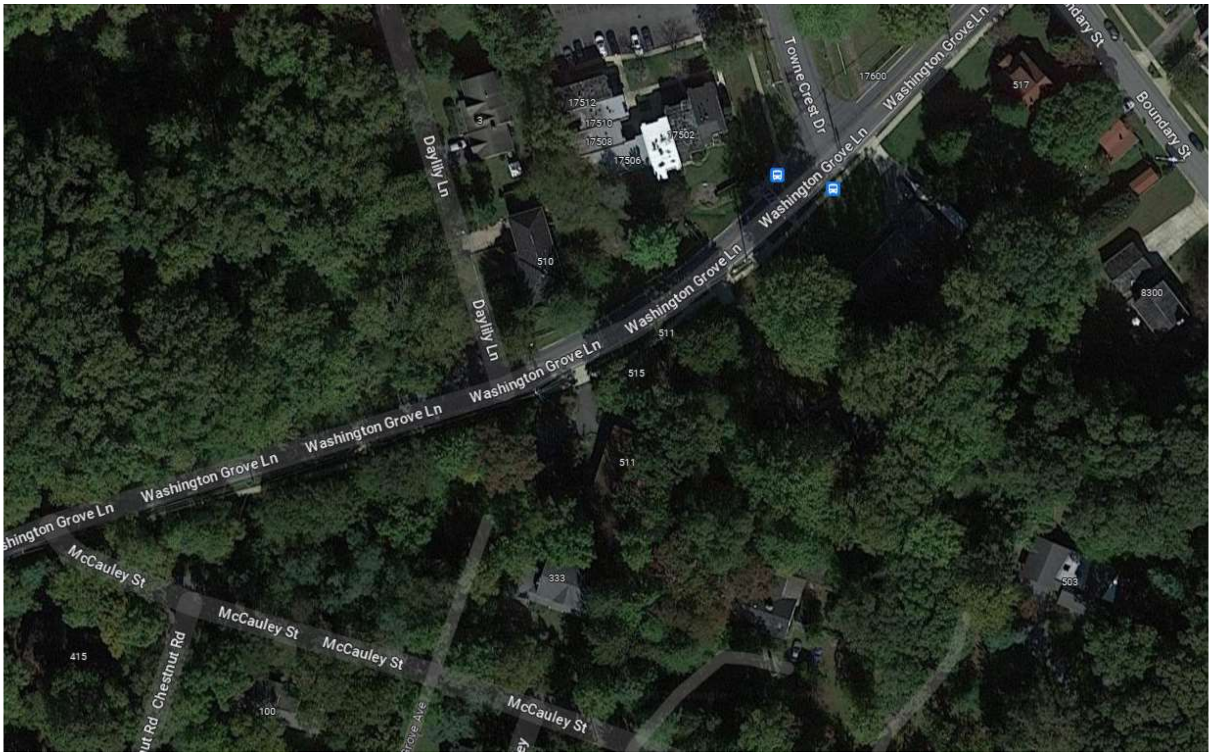
GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Study Point 4

Washington Grove Lane Crossing





4	**Washington Grove Lane Crossing**				
	Q = ciA				
	c	0.4			
	i	7.07	in/hr	0.000164	ft/sec
	Area	39383	sf		
	q=	2.578128	cfs		

Study Point 4

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.02000	ft/ft
Normal Depth	0.98	ft
Diameter	0.98	ft
Discharge	2.58	ft³/s

Results

Diameter		0.98	ft
Normal Depth		0.98	ft
Flow Area		0.75	ft²
Wetted Perimeter		3.08	ft
Hydraulic Radius		0.24	ft
Top Width		0.00	ft
Critical Depth		0.69	ft
Percent Full		100.0	%
Critical Slope		0.02779	ft/ft
Velocity		3.42	ft/s
Velocity Head		0.18	ft
Specific Energy		1.16	ft
Froude Number		0.00	
Maximum Discharge		2.77	ft³/s
Discharge Full		2.58	ft³/s
Slope Full		0.01999	ft/ft
Flow Type	SubCritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Study Point 5

Oak Street and Hickory Road Focus Point:


HICKORY ROAD
OAK
STOP

South East corner of the intersection – Good condition

Southwest corner of the intersection – Could be cleaned up a little

24”? SD in place good condition – further down Oak Street

5	**Oak Street**				
	Q = ciA				
	c	0.4			
	i	7.07	in/hr	0.000164	ft/sec
	Area	412263	sf		
	q=	26.98795	cfs		

Study Point 5

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.02000	ft/ft
Normal Depth	2.36	ft
Diameter	2.36	ft
Discharge	26.99	ft³/s

Results

Diameter	2.36	ft
Normal Depth	2.36	ft
Flow Area	4.38	ft²
Wetted Perimeter	7.42	ft
Hydraulic Radius	0.59	ft
Top Width	0.00	ft
Critical Depth	1.80	ft
Percent Full	100.0	%
Critical Slope	0.02330	ft/ft
Velocity	6.16	ft/s
Velocity Head	0.59	ft
Specific Energy	2.95	ft
Froude Number	0.00	
Maximum Discharge	29.03	ft³/s
Discharge Full	26.99	ft³/s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

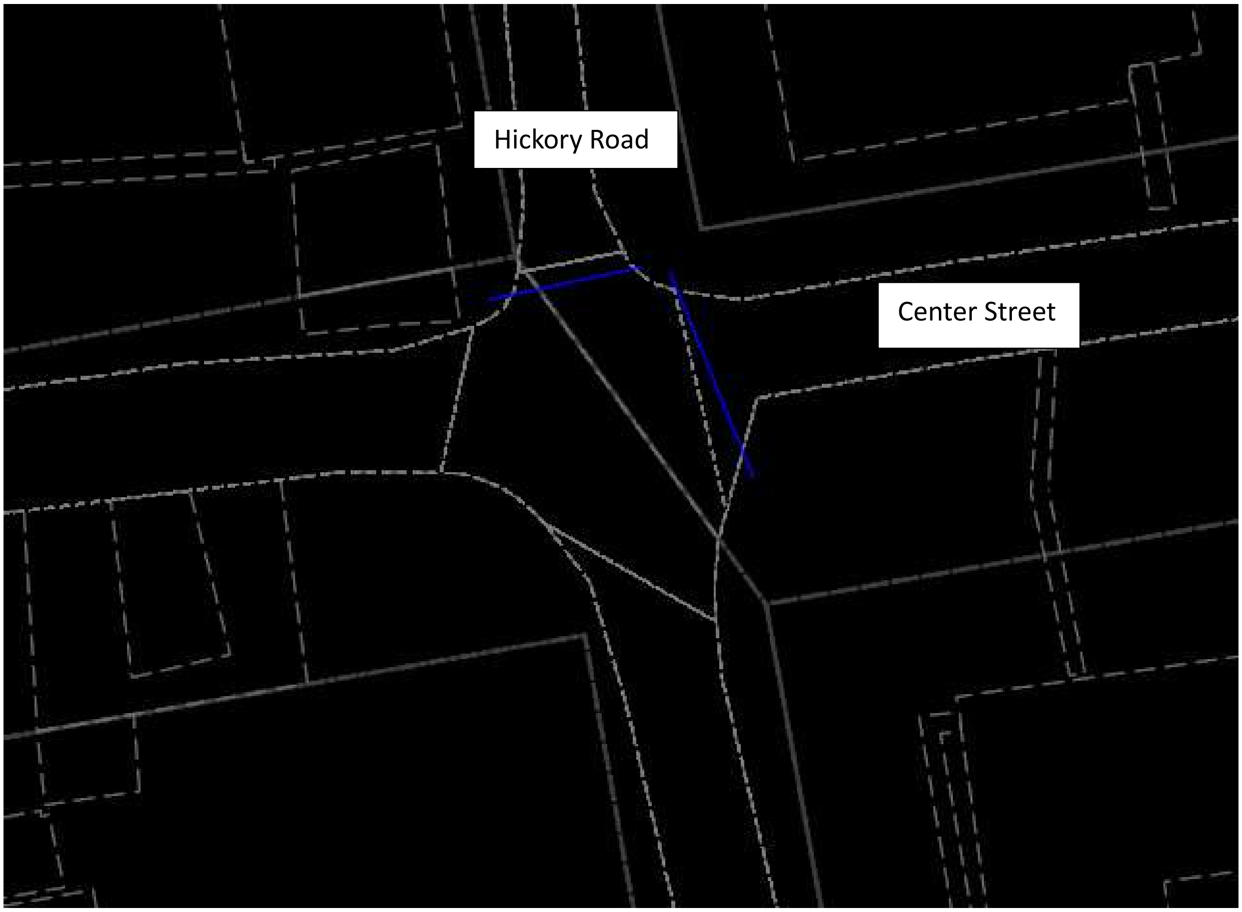
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Study Point 6:

Center Street and Hickory Road Focus Point




6
CENTER STREET
5
OAK STREET

Standing on Center Street Looking towards Washington Grove Lane at intersection of Center Street and Hickory Road

Invert In at Hickory and Center Street – Good condition

14” SD at invert in Southeast Corner of Hickory Road and Center Street Intersection

NorthEast Corner of Hickory Road and Center Street Intersection

Condition of SD – Poor clogged

Invert Out at Northeast Corner Location of Hickory and Center Street

Invert In – Northeast Corner of Hickory and Center Street

Invert Out Northwest Corner

Invert Out Northwest Corner

Center Street				
Q = ciA				
c	0.4			
i	7.07	in/hr	0.000164	ft/sec
Area	325578.2	sf		
q=	21.31331	cfs		

Study Point 6

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Diameter

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.02000	ft/ft
Normal Depth	2.16	ft
Diameter	2.16	ft
Discharge	21.31	ft³/s

Results

Diameter	2.16	ft
Normal Depth	2.16	ft
Flow Area	3.67	ft²
Wetted Perimeter	6.79	ft
Hydraulic Radius	0.54	ft
Top Width	0.00	ft
Critical Depth	1.63	ft
Percent Full	100.0	%
Critical Slope	0.02368	ft/ft
Velocity	5.81	ft/s
Velocity Head	0.52	ft
Specific Energy	2.69	ft
Froude Number	0.00	
Maximum Discharge	22.93	ft³/s
Discharge Full	21.31	ft³/s
Slope Full	0.02000	ft/ft
Flow Type	SubCritical	

GVF Input Data

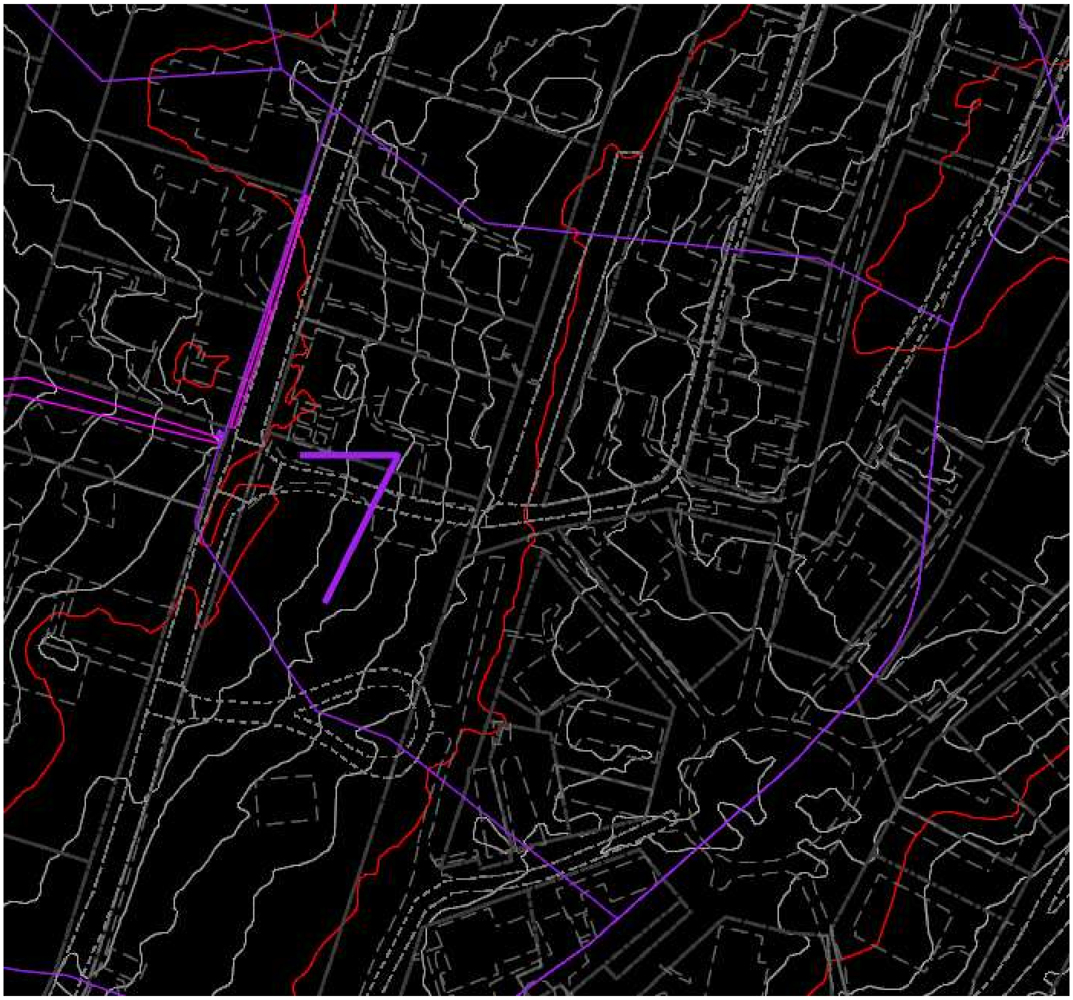
Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

Study Point 7:

Asphalt Channel near Church




Start of asphalt channel


Nearby inlet pipes to asphalt channel

7	**Church Trapezoidal Channel**				
	Q = ciA				
	c	0.4			
	i	7.07	in/hr	0.000164	ft/sec
	Area	173958	sf		
	q=	11.38781	cfs		

Assumptions:
1 ft width
1:1 slopes
Roughness coefficients – roughed asphalt
Slope taken from GIS

Study Point 7

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.03111	ft/ft
Left Side Slope	1.00	ft/ft (H:V)
Right Side Slope	1.00	ft/ft (H:V)
Bottom Width	1.00	ft
Discharge	11.39	ft³/s

Results

Normal Depth	0.73	ft
Flow Area	1.26	ft²
Wetted Perimeter	3.06	ft
Hydraulic Radius	0.41	ft
Top Width	2.46	ft
Critical Depth	1.11	ft
Critical Slope	0.00580	ft/ft
Velocity	9.06	ft/s
Velocity Head	1.27	ft
Specific Energy	2.00	ft
Froude Number	2.23	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.73	ft
Critical Depth	1.11	ft
Channel Slope	0.03111	ft/ft

Appendix B – Stream Assessment and Recommendations.

WASHINGTON GROVE EAST STREAM ASSESSMENT AND RECOMMENDATIONS

October 4, 2022

Prepared For:

Washington Grove, MD

Company Name: Soltesz LLC

Company Address: 4300 Forbes Boulevard, Suite 230

Lanham MD, 20706

Contents

Introduction 3
Observations 3
Recommendations 12
MS4 Crediting 15
Conclusion 15

Introduction

Washington Grove is a small light residential historic town that stands between the dense urban city of Gaithersburg. This town is bounded by a railroad to the southwest and two stands of Forest to the Northwest and the East. The stands of woods residing in Washington Grove contain the head waters for three major river systems in Maryland; the first to the Southeast the head waters to Muddy Creek, and second to the Northwest is Whetstone Run, which is fed by Whetstone Spring; this stream feeds Great Seneca Creek. Finally to the East is Mill Creek, which is a tributary of Rock Creek. All three of these systems feed the Potomac River that eventually leads to the Chesapeake Bay.

There are two naturally occurring springs on site. The first is Maple Spring which feeds Maple Lake, and the second is Whetstone Spring which feeds Whetstone Run and Whetstone Lake.

With the amount of first order spring fed streams that contribute to the Chesapeake Bay in this small town, it is imperative that an assessment be done and any corrective action taken to mitigate any potential loss of these rich natural resources.

September 20th 2022 Soltesz met with the Washington Grove City Council to address concern from the municipality regarding stream channel departure from stable conditions. Based on the visit these were Soltesz's observations.

Observations

On Washington Grove Lane there is a 200' catchment that receives runoff form the town of Washington Grove. On The downstream side of the system where the outfalls are there is evidence of accelerating erosion. Pictures 1 and 2 show the catchments and the downstream erosion.

Figure 1. Catchment for Washington Grove Westwoods

Figure 2. Catchment downstream of Washington Grove Lane

Figure 3. Erosion downstream of outfall. Although mild the residents have noticed a widening and deepening of the channel in this intermittent ditch.

Figure 4. Area that once was convered in vegetation now showing evidence of erorive velocities due to channeling that can not sustain vegeation on the banks.

Roughly, 100 feet downstream of the outfall from Washington Grove Lane there is evidence that the flow regime has changed and the incipience of down cutting and lateral widening is observed.

Figures 3 and 4 both show that where there was once vegetation downstream of the outfall from the community, and shallow concentration flow conditions has now evolved into a channel flow regime that is carving out a trapezoidal channel of dimensions witnessed in the photos above. The bare channel bottom and side slopes show where the highest velocity flow is during the lower frequency storms have removed finer sediment and have eroded to the more course gravel and cobbles sub-layers and confining elements such as surface protection from tree roots.

Moving downstream from the outfall this channel reaches a confluence with another channel that shows the beginning of more severe erosion. What appears to be holding the channel in place are logs and dense meadow vegetation as shown in Figures 5 and 6.

Further downstream the channel has widened severely due to channel instability and to the point that property has been lost and the security of community is at risk because the fence is compromised at this location. The steep bank angle, lack of vegetation, surface protection, fallen trees and fence posts in the channel, and presence of course material in the bed of the stream are indicative that this stream has been a victim of increased runoff. This is going to continue to down cut for contributing more and more sediment to Whetstone Run and thus the Chesapeake Bay. It can be reasoned from Figures 7 through 12 that this channel was at one time much shallower, with gentler bank angles. The only thing that appears to reduce the erosion hazard in this channel are the root protection on the banks and the cobbles and course gravel in the channel.

Figure 5. Channel further eroding due to increased runoff from community.

Figure 6. Channel erosion being mitigated by log that has been placed as a natural checkdam.

Figure 7. Channel further downstream has high indices for bank erosion hazard. Exposed bare soil with steep angles is a recipe for erosion and evidence that it has occurred.

Figure 8. Tree roots provide protection for the stream on the top of bank however it is only a matter of time before they are undercut and fall into the stream. Disconnection from the channel means lower water table which means the trees have less access to water.

Figure 9. Channel with minimal hinderance to erosion and severe entrenchment causing all flood flows to be contained in the channel and increase pressure on the banks.

Figure 10. Fence post shown about to fall in channel. Also new fence can be seen in background that was installed due to threat of theft of aeration equiptment for Maple Lake.

Figure 11. Apparently abandoned utility line that once had cover is now exposed and contributing to channel bank protection. Cast in place culvert after old undersized pipes were removed.

Figure 12. Looking upstream seeing where fence was replaced. Multile pipes and fence replacement show that besides impact to the environment this erosion is creating big expense for the towns infrastructure.

The accelerating vertical erosion appears to be creating an exorbitant cost for the community of Washington Grove. The failing culverts, fences and pipes are completely preventable and could be lessened. It is costing them both time, man power, and resources to keep up with this worsening problem.

Culvert on both the upstream and downstream ends have been heavily armored with rip-rap, and it is apparent from Figures 13 and 14 that this is mitigating the erosion. Once the rip-rap ends it can be seen that erosion commences with steep bank angles, bank undercutting, and trees that are on the edge of falling into the channel. This measure only appears to be working in a temporary condition because with the aforementioned erosion at the interface of the revetment that will cause the soil both under and to the sides of the rip-rap to fail which will lead to rip-rap scattering in the channel downstream.

Figure 13. Looking downstream of the Culvert. Trees are compromised right at the downstream limits of rip-rap armoring.

Figure 14. Channel downstream of culvert has been temporarily fixed with rip-rap however there is a risk of losing this rip-rap due to increased energy just below revetment.

The aforementioned reach along with the downstream portion of Whetstone Run converge at the location shown in Figures 15 through 18. Once the stream reaches here it appears that a stream restoration was constructed recently beyond the confluence where it flows into Kelly Park. At the crossing between the stream and the trail, the municipal leaders informed us that there was a culvert here; however, it had been removed and filled with stone. Now the ephemeral channel backs up to the invert of the upstream portion of the "ford" and creates a backwater condition that is washing out the upstream end for some ways. Also, there is a risk of potentially blowing out the stone ford. A pipe that can safely pass the 10-year flow ought to be placed here to provide safe passage for pedestrians and reduce erosion and deposition risk of the crossing and ephemeral stream.

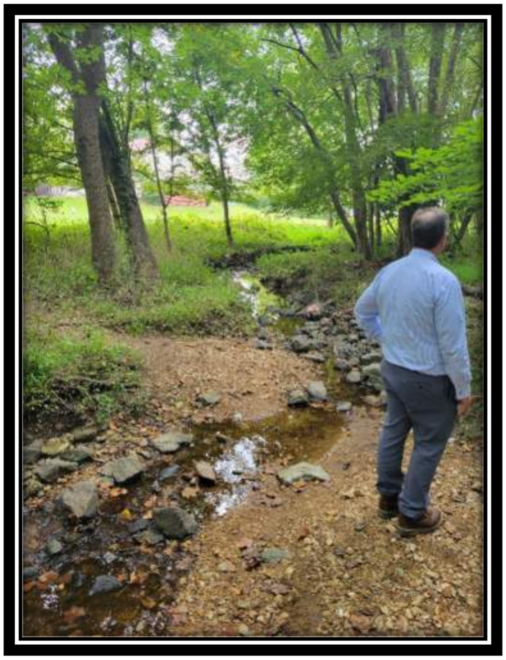


Figure 15. Confluence of two streams. Restored reach can be seen left of Jason.

Figure 16. Area where pipe was removed and "ford" was by default created. Backwater is causing washout of the upstream portion.

Figure 17. Stream crossing at trail and ephemeral ditch

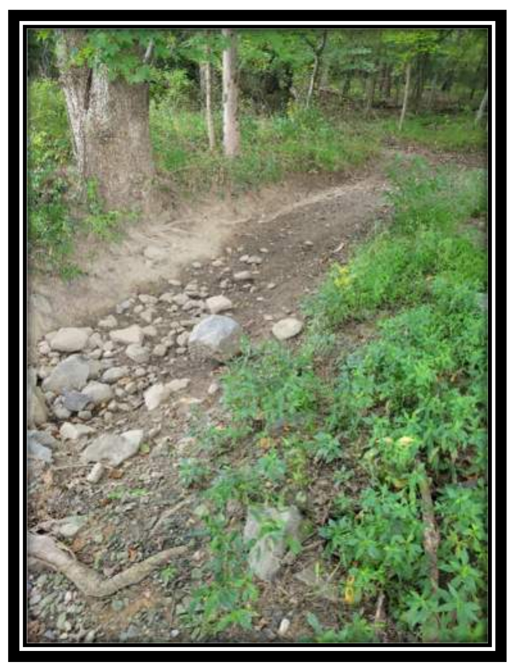


Figure 18. upstream of ford showing washout.

The path north of this leads to Whetstone Spring.

Figure 19.Whetsone Spring.

Figure 20. Whetstone Spring.

Moving upstream further north and to the west of the Town Crest Apartments, is a channel fed by the parking lot and surrounding property of the development. Figures 21 and 22 show that the pond is blowing out and there is incipient erosion of the channel. Similarly, to the south-end where the Catchment in the road had an outfall that was beginning to show signs of changing flow regime from shallow concentrated to channel flow, this intermittent ditch is as well showing signs of change.

Figure 21. Outfall pond downstream of Towncrest Apartments

Figure 22. Channel forming from what was shallow concentrated flow. Tree that once provided protection is now comprimised due to higher shear stresses.

Finally a bit south of this area there is a portion of the stream that has severe lateral erosion as well as minor vertical cut. This portion of the stream appears to be where the transition from ephemeral and intermittent switch to perennial with a nice base flow. This portion of the stream as illustrated in Figures 23 and 24, is contributing major amounts of sediment from the banks as well as minor amounts from channel bottom.

Figure 21. Perennial stream showing scour at the outer bends which are signs of lateral migration a departure from stable conditions.

Figure 22. Tree roots show where soil used to be when this was a sheet/ shallow concentrated flow condition and now it is a incised entrenched channel.

Recommendations

Soltesz's observations lead to a complex set of recommendations due to the complex nature of the problem in Washington Grove. What was observed has both long term and short term solutions as well as Instream and Watershed level fixes.

In the short-term the community needs to find a way to reduce the impacts of the runoff that are contributing to their sediment load and degradation of their infrastructure. To address this a distinction needs to be made between upstream of the reach and downstream in the reach. One observation that was a pattern throughout the watershed was that the upstream portions of each reach, where they meet the storm drain, or are within 200 feet of the storm drain, did not appear to be in severe states of departure from stable conditions. In these areas, plantings of low light riparian plants would help to establish surface protection from flow as well as increase the chances for shallow concentrated and sheet flow.

See Figure 23 and 24 for examples.

Figure 23. Ephemeral stream that could benefit from plantings

Figure 24. Area of sheet flow that is showing signs that it will start eroding.

The long term solution combines multiple strategies that would be helpful for meeting MS4 goals for the County as well as protecting the natural resources present on site. In the contributing drainage area of the streams on the west side of Washington Grove Environmental Site Design (ESD) could be utilized to encourage infiltration into the groundwater prior to reaching the stream channels. Figure 25 shows an example of micro-bio retention, which is an ESD practice.

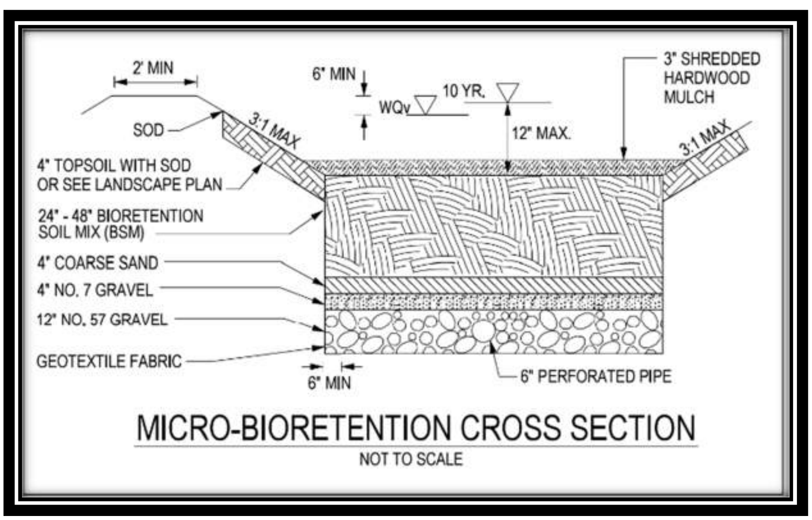


Figure 25. Microbioretention device.

For the streams that are fed by Maple Spring that had evidence of down cutting, an outfall protection could be used that would create step pools that would connect the water table to the floodplain, bringing back wildlife to the stream. Encourage increasing hydraulic residence time in the stream and slow the water down to release it at a rate that is non-erosion and brings back the stable condition. The subsoil would have the capability to increase filtration through the use of a sand-and-wood chip mixture that will clean the water as it passes through. Figure 26 shows a regenerative step pool that would be used for the outfall protection.

Figure 26. Regenerative Step Pool Storm Conveyance Example.

For the streams fed by the storm drain from Towncrest and the surrounding area, a natural channel design approach would be appropriate to encourage floodplain connectivity, wildlife habitat, and raise the water table. This would be accomplished by raising the stream channel to match the stable channel dimension patter and profile then add structures such as cross vanes, J hooks, and toe wood or soil lifts to stabilize the sections. Figure 27 shows an example of natural channel design.

Figure 27. Soltesz designed natural channel design in Lanham MD still stable after 2 years post construction.

MS4 Crediting

For the crediting per the 2020 guidelines the protocol 1 through 3 credits are ~41 impervious acres. For the protocol 4 and 5 credits the Equivalent impervious acres are ~45 acres. These credits would be a great benefit to delivering for the consent decree for Montgomery County's MS4 permit. Based on prior projects the estimated cost would be ~3.5 million dollars.

Conclusion

The community of Washington Grove has preserved these water resources and woods for a long time and now have seen them in a state of departure from stable, natural and healthy conditions. Soltesz recommends the strategies, which are above listed and based on that we have given recommendations for restoration. The potential for stream restoration is very high and would be able to deliver a substantial amount of credits for Montgomery County's' MS4 permit. The cost for this solution would be roughly 3.5 million dollars but would provide enjoyment for the community as well as safety and help mitigate the cost of lost infrastructure.