ROADWAY LOW IMPACT DEVELOPMENT PROJECT
FOREST ESTATES NEIGHBORHOOD

Montgomery County, Maryland
MT Project No. 5182-13

STORMWATER MANAGEMENT RETROFIT REPORT

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Prepared for:

Montgomery County
Department of Environmental Protection
255 Rockville Pike, Suite 120
Rockville, Maryland 20850

Prepared by:

McCormick Taylor
Engineers & Planners
Since 1946

509 South Exeter Street, 4th Floor
Baltimore, Maryland 21202
(410) 662-7400

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I. INTRODUCTION

The Montgomery County Department of Environmental Protection is proposing Low Impact Development (LID) stormwater best management practices (BMP) within the Forest Estates neighborhood in Silver Spring, Maryland. McCormick Taylor has identified and evaluated forty LID opportunities within the neighborhood in order to provide stormwater management of runoff from impervious surfaces to the maximum extend practicable (MEP). The proposed stormwater facilities will be installed coincident with roadway maintenance and/or rehabilitation to be completed by Montgomery County Department of Transportation (MCDOT). Construction is anticipated to begin in Fall 2011.

II. SOURCES OF INFORMATION

The sources of information provided for use in determining the appropriate LID feature for each site included:

- GIS Mapping
- Aerial Photos
- Field Investigation
- Topographic Survey and Utility Designations
- Geotechnical Subsurface Investigation

III. LOW IMPACT DEVELOPMENT (LID) OPPORTUNITIES

The Forest Estates neighborhood is located south of Dennis Avenue, west of Sligo Creek Park and north of Dublin Drive in Silver Spring, Maryland. The surrounding land use includes residential, commercial (Sligo Baptist Church), institutional (Sligo Middle School) and forested areas. Five storm drain outfalls were identified within the project limits as study point locations (Study Points A-E). Within the drainage areas to the study points, forty sites were initially identified as possible areas for LID implementation. Upon receiving and reviewing topographic survey and utility information, sixteen sites were eliminated due to major utility conflicts and/or critical tree root zone impacts. The remaining twenty six sites are described within this report, have been designed for maximum stormwater management treatment and are included within the construction plan set.

SITE SELECTION

A field assessment was completed on January 20, 2011 to identify possible LID opportunities within the project limits. Field mapping was generated with GIS information provided by Montgomery County which included property boundaries, utilities, contours and topographic features. Potential sites were chosen based on available space within the right of way, utility or vegetation conflicts, proximity to existing storm drain systems, existing drainage patterns and property ownership. A second field assessment was completed on February 7, 2011 with representatives of Montgomery County Department of Environmental Protection. Topographic survey, utility designations, soil borings and infiltration tests were completed subsequent to the field assessments and provided vital information for the design of the LID facilities.

Legend
Study Points
Study Point Drainage Areas
INWOOD AVE
DENNIS AVE
JULEP AVE
FOLK ST
WOODMAN AVE
WOODMAN AVE
IMPERIAL DR
DUBLIN DR
A
B
C
D
E
Forest Estates Study Points
0
400
800
Feet
1 inch = 400 feet
N
W
E
S
MONTGOMERY COUNTY
1776
MARYLAND
McCormick Taylor
Engineers & Planners
Since 1946

TYPES OF LID FACILITIES

LID features proposed throughout the project include bioretention, rain gardens, bioswales, modified biofilters, pavement removal and pervious sidewalks. Curb extensions were investigated, however the width of the existing roadway and the amount of vehicles parking on the street reduced the feasibility of this type of LID feature. Tree box filters were proposed but removed from the project based on the Contractor's concerns with installation under overhead utility lines.

Bioretention facilities were proposed in areas where an existing storm drain inlet or pipe was in close proximity. These facilities capture and filter runoff through layers of planting soil, sand and gravel prior to entering an underdrain system and ultimately the storm drain system. Vegetation within the facility increases nutrient uptake and improves aesthetics. A downstream storm drain inlet is required as an overflow or bypass structure to capture runoff from the larger storm events.

Rain garden facilities are similar to bioretention facilities, however they do not have an underdrain system and rely on the existing ground to infiltrate the filtered runoff. These facilities were proposed in areas where storm drain is not available or where the existing storm drain system is too shallow to tie an underdrain system into. Infiltration tests will be completed in areas where rain gardens are proposed to ensure adequate infiltration rates. If infiltration rates are insufficient, bioswales or grass swales with amended soils may be proposed to help filter pollutants from the stormwater runoff.

Other filtering facilities utilized within the project limits are bioswales and modified biofilters. Theses facilities have slightly different cross sections from the traditional bioretention or rain garden facility; however they also filter runoff through several layers of material. Modified biofilters were proposed along the east side of Inwood Avenue overtop an 30" RCP storm drain pipe as the filter layers aren't as thick and can accommodate shallow utility crossings. Bioswales were proposed in areas where the existing roadway slope is too steep to install a flat surfaced rain garden or bioretention facility. The bioswales provide treatment within a swale section as well as a smaller flat area near a downstream curb cut.

Several areas of pavement removal are also proposed. The majority of the pavement removal consists of concrete walkways that exist between the sidewalk and roadway in order to provide additional space for the appropriate LID retrofit. Removal of the existing roadway pavement within the Woodman Avenue N. cul-de-sac was investigated. However, based on the existing configuration of vehicle parking within the cul-de-sac and utility conflicts, pavement removal was not proposed.

Sidewalk replacement with pervious pavement is being analyzed throughout the entire project area. Pervious pavement acts in the same manner as rain gardens in that they rely on the existing ground to infiltrate filtered runoff. Infiltration tests will be completed to ensure adequate infiltration rates. Pervious pavement features will utilize a 2" overdrain (lying beneath the pervious surface, on top of the sub base) to prevent pooling above the sidewalk and ensure structural stability against freeze thaw scenarios. Design parameters/conflicts that may limit the extent of pervious pavement installation include >5% slopes, tree root impacts, utility conflicts, inadequate infiltration rates, and Type D hydrologic soils (primarily found along the stream floodplain). Pervious sidewalks were analyzed throughout the project

limits, however due to construction constraints; the use of pervious sidewalks will no longer be included within this project.

LID STORMWATER MANAGEMENT COMPUTATIONS

Stormwater management (SWM) volumes were calculated for each Study Area to determine an overall target stormwater management volume and for each LID feature to determine treatment provided. Summaries of each Study Area and LID site are located in the appropriate Appendix. SWM volumes calculated included the Water Quality Volume (WQv), Channel Protection Volume (Cpv), and Environmental Site Design Volume (ESDv). Variables such as drainage area, impervious area, hydrologic soil type, runoff curve number and time of concentration were used in computing the volumes. The volumes were based on the guidelines within the *2000 Maryland Stormwater Design Manual – Volumes I and II* and the 2010 Chapter 5 revisions.

Water Quality Volume (WQv):
The Water Quality volume is the storage needed to capture and treat the one inch of runoff based on the drainage area and percent of the area that is impervious. Drainage areas for each Study Point and LID feature were established by overlaying field reconnaissance information onto Montgomery County GIS mapping and verified with topographic survey. Due to the size of each drainage area, the land uses were simplified into impervious area, open space and forest. The impervious areas were further broken down into roadway and driveway aprons within the right of way, sidewalks within the right of way and impervious areas on private property, which includes driveways, walkways and rooftops per DEP's request.

Channel Protection Volume (Cpv):
The Channel Protection volume is the storage needed to manage the 1 year, 24 hour storm event. In addition to the drainage area and percentage impervious, the hydrologic soil type, runoff curve number and time of concentration need to be calculated.

Soil information was obtained from the Web Soil Survey developed by the US Department of Agriculture, National Resources Conservation Service (NRCS). (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx). Soils throughout the study area are primarily designated as hydrologic soil type "B" with medium amounts of types "D" and small amounts of type "C" found within the nearby stream's floodplain and between Julep Avenue and Inwood Ave.

Runoff Curve Numbers (RCN) were developed in accordance with SCS TR-55; using hydrologic parameters such as land use, hydrologic soil type, and land slope. The analysis assumed good hydrologic conditions for all land uses.

Time of concentration (Tc) is the time required for runoff to travel from the hydraulically most distant part of the drainage area to a point of investigation in the watershed. A maximum of 100 feet of overland flow was used for this study and the land slope was calculated based on Montgomery County GIS contours. Time of concentration values were used in determining Peak Discharge (q_u, cms/in) values using Figure D.11.1 in the *2000 Maryland Stormwater Design Manual.* Due to the size and imperviousness of the drainage areas, the majority of the Tc's were less than 0.1 hr (6 minutes). The Tc for the following LIDs were greater than 0.1 hr:

Table 1: Time of Concentration Summary

LID BMP #	Tc (min.)	Tc (hr.)
8	6.88	0.115
9	7.02	0.117
25	8.10	0.135

Environmental Site Design Volume (ESDv):
The Environmental Site Design volume is the storage needed to reduce the runoff from a drainage area to a level equivalent to a wooded site in good condition. Based on the drainage area, impervious cover, RCN and hydrologic soil types, rainfall targets, runoff depths and ESDv are calculated based on Table 5.3 in the *2010 Chapter 5* revisions to the *2000 Maryland Stormwater Design Manual – Volumes I and II*.

Stormwater Management Treatment Provided:
The treatment provided by each proposed LID facility was calculated based on the *2000 Maryland Stormwater Design Manual, Montgomery County Department of Permitting Services (DPS)* guidelines. The treatment volume provided by a bioretention facility or rain garden was calculated in two storage volumes; above surface storage and sub-surface storage. The sub-surface storage consists of the volume of runoff that can be stored within the void space of the filter media. A void space of 40% was used in the calculations.

The treatment volumes for the pervious pavement were calculated utilizing the *MDE ESD Process and Computations (July 2010)* guidelines. Equivalent ESD volumes per square foot were multiplied by the surface area of the proposed sidewalk to obtain a treatment volume. The equivalent ESD values are based on the soil type and depth of proposed subbase.

Calculations for the hydrologic and hydraulic variables and SWM volumes are located in the appropriate Appendix on the Unified Stormwater Management Sizing Spreadsheets.

STUDY POINT SUMMARIES

STUDY AREA A

Study Point A is located at a storm drain outfall across the street from 10300 Inwood Avenue, near the northwest corner of the Imperial Drive bridge. The drainage area to the outfall is approximately 7.76 acres and consists of residential, commercial (Sligo Baptist Church) and forested areas. Drainage areas for all study points were established by overlaying field reconnaissance information onto Montgomery County GIS mapping and verified with topographic survey.

Three bioswales are proposed within Study Area A. The three bioswales are proposed along the west side of Inwood Avenue.

Nineteen percent or 1.48 acres of the area draining to the study point is directed to proposed LID features. The three proposed facilities provide 632 ft^3 of stormwater management treatment. A summary of the existing hydrology and proposed stormwater management for Study Area A is included in Appendix A.

STUDY AREA B

Study Point B is located at a storm drain outfall across the street from 1600 Imperial Drive, near the southwest corner of the Imperial Drive bridge. The drainage area to the outfall is

approximately 13.03 acres and consists of residential and forested areas. However, only 6.90 acres of the drainage area is located within the project limits (north of Imperial Drive) and will be included in this assessment.

Seven LID retrofits are proposed within Study Area B: five bioretention facilities, two bioswales and one rain garden. Four of the bioretention facilities are located along Woodman Avenue. The fifth bioretention facility is located on Imperial Drive at the Forest Grove Drive intersection. The remaining bioswales and rain garden facilities are scattered throughout the study area to maximize stormwater management treatment.

Sixty five percent or 4.49 acres of the area draining to the study point, within the project limits, is directed to proposed LID features. The seven proposed facilities 1,504 ft^3 of stormwater management treatment. A summary of the existing hydrology and proposed stormwater management for Study Area B is included in Appendix B.

STUDY AREA C

Study Point C is located at a storm drain outfall across the street from 1515 Woodman Avenue N., near the northeast corner of the Imperial Drive bridge. The drainage area to the outfall is approximately 24.57 acres and consists of residential, institutional (Sligo Middle School) and forested areas. However, only 11.73 acres of the drainage area is located within the project limits (south of Dennis Avenue) and will be included in this assessment.

Fourteen LID retrofits are proposed within Study Area C: one bioretention facility, seven rain gardens, four bioswales and two modified biofilters. The bioretention facility is located on Julep Avenue at the Folk Street intersection. The modified biofilters are located along the east side of Inwood Ave overtop the existing 30" RCP storm drain pipe. The remaining facilities are located along the west side of Inwood Avenue, Folk Street and Julep Avenue. Additional facilities initially proposed within this study point were eliminated based on the depth and location of the existing storm drain pipes and critical tree root zone impacts.

Sixty-six percent or 7.75 acres of the area draining to the study point is directed to proposed LID features. The fourteen proposed facilities provide 2,593 ft^3 of stormwater management treatment. A summary of the existing hydrology and proposed stormwater management for Study Area C is included in Appendix C.

STUDY AREA D

Study Point D is located at a storm drain outfall across the street from 1505 Woodman Avenue N. The drainage area to the outfall is approximately 4.51 acres and consists of residential and forested areas.

Three LID retrofits are proposed within Study Area D: two bioretention facilities and one bioswale. All three facilities are located near the existing storm drain system outfall (Study Point D) along Woodman Avenue. Due to the shallow elevations of the storm drain system, proposed bioretention facilities are unable to tie into the existing inlets. Therefore, the underdrain from the facility on the north side of Woodman Avenue is proposed to combine with the underdrain from the facility on the south side prior to outfalling into the adjacent storm drain outfall channel. Additional facilities initially proposed within this study point were eliminated based on conflicts with underground fiber optic cables.

Sixty-three percent or 2.86 acres of the area draining to the study point is directed to proposed LID features. The three proposed facilities provide 1,267 ft^3 of stormwater

management treatment. A summary of the existing hydrology and proposed stormwater management for Study Area D is included in Appendix D.

STUDY AREA E

Study Point E is located at a storm drain outfall behind 1408 Woodman Avenue N. The drainage area to the outfall is approximately 2.46 acres and consists of residential and forested areas.

No LID retrofits are proposed within Study Area E. Facilities were initially proposed within this study point however the utility designation indicated a multitude of underground utilities, including cable television, telephone and fiber optic cables that would be impacted. Providing a single treatment facility at the outfall of the storm drain system (at the study point) to treat the entire drainage area was investigated but not pursued based on the property ownership (M-NCPPC), stream impacts and the tight project schedule.

A summary of the existing hydrology and proposed stormwater management for Study Area E is included in Appendix E.

RAINSCAPES PROGRAM COORDINATION

Based on the available space located within the Montgomery County right of way, full treatment of the contributing drainage area to several of the proposed LID features is difficult. Several proposed LID site have significantly large drainage areas in which the majority of the area is comprised of residential backyards or non-roadway areas. In these cases, additional upstream LID features are not feasible or practical due to utility and/or vegetation conflicts or the level of treatment that could be provided.

Montgomery County DEP RainScapes Program promotes and implements projects on residential, institutional, and commercial properties to reduce stormwater runoff. Eligible RainScapes techniques include; rain gardens, conservation landscaping, tree canopy, permeable pavers, green roofs and rain barrels. Incorporating the RainScapes features on private property within the project limits would greatly reduce the amount of treatment required within the right of way. For the calculations included in this report, it was assumed that RainScapes facilities will treat approximately twenty percent of the ESD volume for each Study Area.

Table 2: Study Area Treatment Summary

Study Area	No. of LID Sites	Treatment Volume Provided (ft^3)	Potential RainScapes Treatment (ft^3)	Total Treatment Volume (ft^3)	Target WQv (ft^3)
A	3	632	2,394	3,026	7,910
B	7	1,504	2,448	3,952	7,950
C	14	2,593	5,621	8,214	16,177
D	3	1,267	1,977	3,244	5,654
E	0	0	1,278	1,278	3,550
Project Totals	**27**	**5,996**	**13,718**	**19,714**	**41,241**

IV. CONCLUSION

The proposed Low Impact Development (LID) stormwater best management practices (BMP) within the Forest Estates neighborhood are intended to capture, treat and filter runoff from the existing impervious surfaces. The twenty six proposed LID features provide 5,996 cubic feet of stormwater management treatment volume. In order to maximize the treatment within each study area, RainScapes facilities may be implemented for an additional 13,718 cubic feet of treatment. The proposed facilities will provide environmental benefits by reducing impacts from uncontrolled and untreated runoff, improve the aesthetics of the neighborhood where reasonably possible and provide opportunities for community education.

Appendix A:

Study Point A – LID Summary and Computations

Montgomery County - Task 13 Roadway LID
Forest Estates LID Summary

Study Area	BMP #	Location	Existing Hydrology								Stormwater Management						Potential Retrofit Type	Proposed Cost
			Drainage Area (ac)	Total Impervious Area (ac)	Impervious Area (ac)			Forest Area (ac)	Open Space (ac)	Percent Impervious	Target Volumes (ft^3)			Volume Provided (ft^3)	Percent WQ_v Treatment	Percent ESD_v Treatment		
					ROW - Road & DW Aprons	ROW - Sidewalk	Private - Driveway, Walkway & Roof				WQ_v	ESD_v	1 Yr. Volume (Max.)					
A	29	10322 Inwood Ave	0.65	0.42	0.29	0.04	0.09	0.00	0.23	64.6%	1,498	2,997	3,896	241	16%	8%	Bioswale	$84,000
A	31	10312 Inwood Ave	0.51	0.25	0.11	0.02	0.12	0.00	0.26	49.0%	922	1,660	2,398	217	24%	13%	Bioswale	$50,000
A	39	10306 Inwood Ave	0.32	0.16	0.06	0.02	0.08	0.00	0.16	50.0%	575	1,034	1,494	174	30%	17%	Bioswale	$32,000
		Controlled Areas (ac)	1.48	0.83							**2,995**	**5,691**	**7,788**	**632**	**21%**	**11%**		
		Uncontrolled Areas (ac)	6.28	1.16														
		Study Area Total (ac)	**7.76**	**1.99**							**7,910**	**11,971**	**20,565**	**632**	**8%**	**5%**		
A		RainScapes												2,394			assume 20% of ESD_v	
A		Pervious Sidewalk															not utilized for this project	
Total Potential Treament Volume (Study Area A)														**3,026**	**38%**	**25%**		

Unified Stormwater Management Sizing

Outfall A

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	7.76	ac
Imp. to Facility =	1.99	ac
Percent Impervious =	26%	
R_V =	0.281	
Region =	Eastern	P= 1

Computed Water Quality Volume			
WQ_V =	0.1816 ac-ft	7,910	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0121	CN =	70.6
I_a/P =	0.32	I_a =	0.83
q_u (csm/in) =	727	P =	2.6
q_i (cfs) =	4.64	S =	4.16
q_o/q_i =	0.024		
q_o (cfs) =	0.112	Fig 6-1*: v_s/v_r =	0.648
Q_a - runoff (in) 1 yr =	0.526	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.53	c_o	0.682
v_s =	0.34	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume			
Cp_v =	0.2207 ac-ft	9,615	ft^3

Unified Stormwater Management Sizing

Outfall A

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	6.08	78%
C	70	0.00	0%
D	77	1.68	22%

* Actual RCN is less then 30, use RCN=38

Target RCN = 60

Proposed Imperviousness: 26%

A= 338,026 ft^2

P_E = rainfall target (from Table 5.3) = 1.5

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.42 R_V = 0.281

Computed ESD_V Volume

ESD_v = 0.2748 ac-ft 11,971 ft^3

ESD Targets:

P_E = 1.5134021 inches

Q_E = 0.42 inches

Forest Estates - Study Area A
Design Volumes

29 Bioswale

Surface Area (ft^2)	37	Above Surface Storage (ft^3)	*36*
Max WSEL Surface Area (ft^2)	84	Sub Surface Storage (ft^3)	*205*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	256		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*241*

31 Bioswale

Surface Area (ft^2)	41	Above Surface Storage (ft^3)	*45*
Max WSEL Surface Area (ft^2)	110	Sub Surface Storage (ft^3)	*172*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	215		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*217*

39 Bioswale

Surface Area (ft^2)	47	Above Surface Storage (ft^3)	*46*
Max WSEL Surface Area (ft^2)	106	Sub Surface Storage (ft^3)	*128*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	160		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*174*

LID Treatment Provided (ft^3)	*632*

Rainscapes

20% ESDv		Treatment Provided (ft^3)	*2,394*

Pervious Pavement

Subbase Depth (in)	12	(6, 9, 12)		
Hydrologic Soil Group	B	(A, B, C)		
RCN	*55*			
ESDV/ft2	*0.196*			
Equiv. PE (in)	*2.50*			
Sidewalk Surface Area (ft^2)	*4,060*		Potential Treatment (ft^3)	*796*

Addtional Treatment Provided (ft^3)	*3,190*

Total Treatment Provided (ft^3)	*3,822*

WQ_V (ft^3)	**7,910**
Target ESD_V (ft^3)	**11,971**

BMP # 29	Location:	10322 Inwood Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.42	65%
Forest	0.00	0%
Open Space	0.23	35%
Total Drainage Area =	**0.65**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.29	69%
ROW - Sidewalk	0.04	10%
On-Lot Impervious	0.09	21%
Total Impervious =	**0.42**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
1,498	2,997	241	8%

Study Area/Outfall	A

Possible Construction Conflicts

Utilities: water, utility pole
Vegetation: small tree
Other: roadway informational sign

Potential LID Retrofit Type

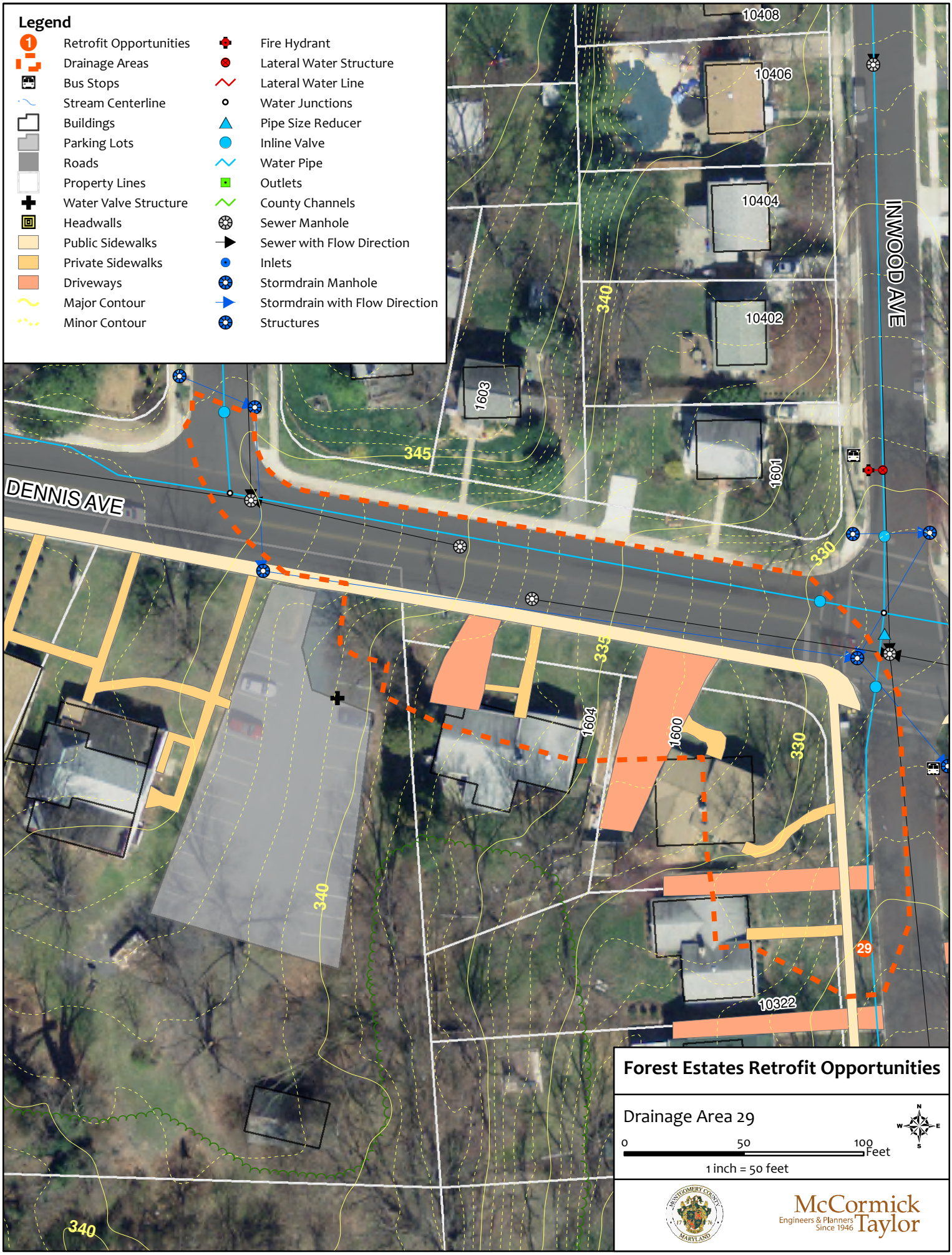
Bioswale

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs parallel to the curbline
- Tree roots from the stump (next to the small tree) may be present

Looking south from the driveway at 10322 Inwood Avenue

10322 Inwood Avenue - looking north towards Dennis Avenue



Forest Estates Retrofit Opportunities

Drainage Area 29

0 50 100 Feet

1 inch = 50 feet

McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10322 Inwood Ave - BMP 29

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.65	ac
Imp. to Facility =	0.42	ac
Percent Impervious =	65%	
R_V =	0.635	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0344	ac-ft	1,498	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0010	CN =	85.0
I_a/P =	0.14	I_a =	0.35
q_u (csm/in) =	983	P =	2.6
q_i (cfs) =	1.26	S =	1.76
q_o/q_i =	0.018		
q_o (cfs) =	0.023	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	1.261	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	1.26	c_o	0.682
v_s =	0.83	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0448	ac-ft	1,954	ft^3

Unified Stormwater Management Sizing

10322 Inwood Ave - BMP 29

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.65	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 65%

A= 28,336 ft^2

P_E = rainfall target (from Table 5.3) = 2.0

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 1.27 R_V = 0.635

Computed ESD_V Volume

ESD_v = 0.0688 ac-ft 2,997 ft^3

ESD Targets:

P_E = 2 inches

Q_E = 1.27 inches

BMP # 31	Location:	10312 Inwood Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.25	49%
Forest	0.00	0%
Open Space	0.26	51%
Total Drainage Area =	**0.51**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.11	44%
ROW - Sidewalk	0.02	8%
On-Lot Impervious	0.12	48%
Total Impervious =	**0.25**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
922	1,660	217	13%

Study Area/Outfall	A

Possible Construction Conflicts

Utilities: water, possible utility pole
Vegetation:
Other: speed hump sign

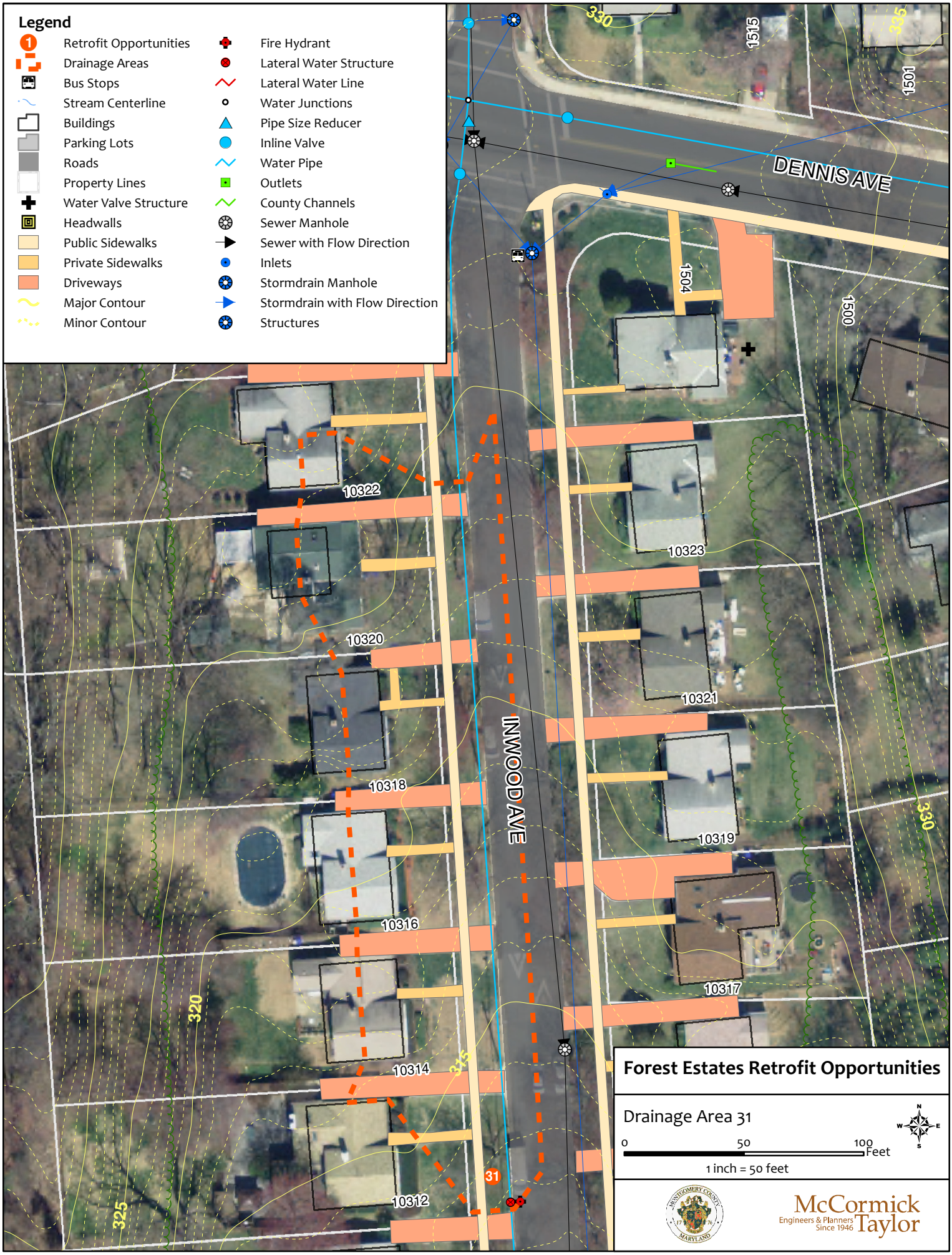
Potential LID Retrofit Type

Bioswale

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs parallel to the curbline, utility pole near the driveway of 10312 Inwood Avenue
- Adjacent to existing speed hump - would not impact drainage patterns along curbline

10314 Inwood Avenue - looking south towards Woodman Avenue


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
DENNIS AVE
INWOOD AVE
1515
1501
1504
1500
10322
10323
10320
10321
10318
10319
10316
10317
10314
10312
31
330
335
320
325
315
Forest Estates Retrofit Opportunities
Drainage Area 31
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10312 Inwood Ave - BMP 31

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.51	ac
Imp. to Facility =	0.25	ac
Percent Impervious =	50%	
R_V =	0.499	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0212	ac-ft	922	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0008	CN =	79.5
I_a/P =	0.20	I_a =	0.52
q_u (csm/in) =	970	P =	2.6
q_i (cfs) =	0.72	S =	2.58
q_o/q_i =	0.019		
q_o (cfs) =	0.013	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.930	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.93	c_o	0.682
v_s =	0.61	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0259	ac-ft	1,127	ft^3

Unified Stormwater Management Sizing

10312 Inwood Ave - BMP 31

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.51	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 50%

A= 22,172 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.90 R_V = 0.499

Computed ESD_V Volume

ESD_v = 0.0381 ac-ft 1,660 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.90 inches

BMP # 39	Location:	10306 Inwood Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.16	50%
Forest	0.00	0%
Open Space	0.16	50%
Total Drainage Area =	**0.32**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.06	38%
ROW - Sidewalk	0.02	13%
On-Lot Impervious	0.08	50%
Total Impervious =	**0.16**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
575	1,034	174	17%

Study Area/Outfall	A

Possible Construction Conflicts

Utilities:
Vegetation: tree
Other:

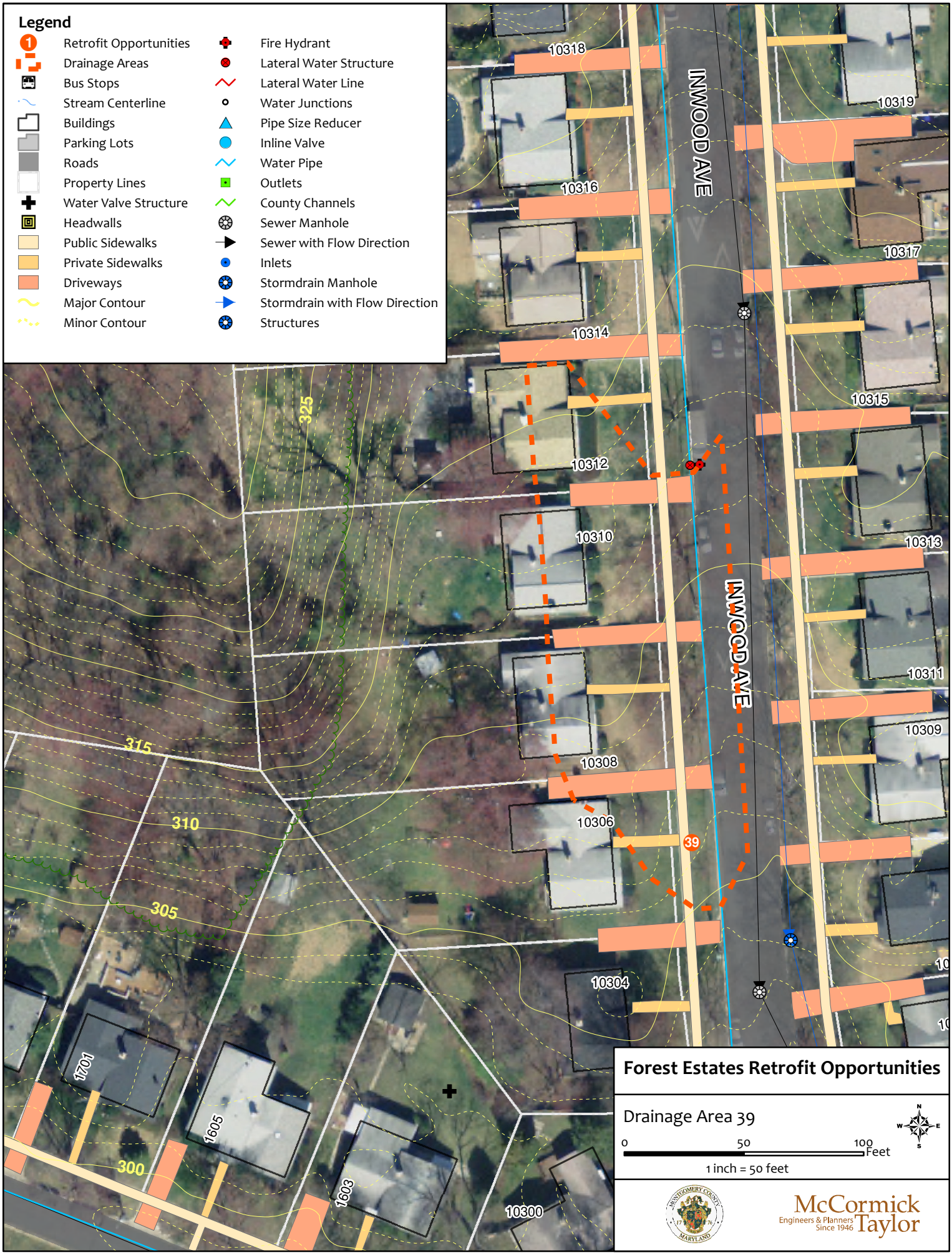
Potential LID Retrofit Type

Bioswale

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs parallel to the curbline

10306 Inwood Avenue - looking south towards Woodman Avenue


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
INWOOD AVE
INWOOD AVE
10318
10319
10316
10317
10314
10315
10312
10313
10310
10311
10309
10308
10306
10304
10300
39
325
315
310
305
300
1701
1605
1603
Forest Estates Retrofit Opportunities
Drainage Area 39
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners
Since 1946

Unified Stormwater Management Sizing

10306 Inwood Ave - BMP 39

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.32	ac
Imp. to Facility =	0.16	ac
Percent Impervious =	49%	
R_V =	0.488	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0132	ac-ft	575	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0005	CN =	79.0
I_a/P =	0.20	I_a =	0.53
q_u (csm/in) =	969	P =	2.6
q_i (cfs) =	0.44	S =	2.66
q_o/q_i =	0.019		
q_o (cfs) =	0.008	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.905	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.90	c_o	0.682
v_s =	0.59	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0161	ac-ft	699	ft^3

Unified Stormwater Management Sizing

10306 Inwood Ave - BMP 39

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.32	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 49%

A= 14,143 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.88 R_V = 0.488

Computed ESD_V Volume

ESD_v = 0.0237 ac-ft 1,034 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.88 inches

Appendix B:

Study Point B – LID Summary and Computations

Montgomery County - Task 13 Roadway LID
Forest Estates LID Summary

Study Area	BMP #	Location	Existing Hydrology								Stormwater Management						Potential Retrofit Type	Proposed Cost
			Drainage Area (ac)	Total Impervious Area (ac)	Impervious Area (ac)			Forest Area (ac)	Open Space (ac)	Percent Impervious	Target Volumes (ft^3)			Volume Provided (ft^3)	Percent WQ_V Treatment	Percent ESD_V Treatment		
					ROW - Road & DW Aprons	ROW - Sidewalk	Private - Driveway, Walkway & Roof				WQ_V	ESD_V	1 Yr. Volume (Max.)					
B	1	1700 Imperial Dr	1.05	0.23	0.07	0.02	0.14	0.05	0.77	21.9%	933	1,493	2,427	210	22%	14%	Bioretention	$46,000
B	3	1606 Imperial Dr	0.55	0.15	0.05	0.02	0.08	0.00	0.40	27.3%	579	926	1,505	84	15%	9%	Rain Garden	$30,000
B	6	1504 Woodman Ave S.	0.57	0.14	0.06	0.02	0.06	0.00	0.43	24.6%	576	891	1,497	399	69%	45%	Bioswale	$28,000
B	7	1708 Woodman Ave S.	0.21	0.12	0.06	0.01	0.05	0.00	0.09	57.1%	433	779	1,125	204	47%	26%	Bioretention	$24,000
B	8	1702-1704 Woodman Ave S.	0.95	0.20	0.06	0.01	0.13	0.00	0.75	21.1%	821	1,110	2,136	226	27%	20%	Bioretention	$40,000
B	9	1602 Woodman Ave S.	0.75	0.24	0.09	0.02	0.13	0.00	0.51	32.0%	920	1,587	2,391	169	18%	11%	Bioretention	$48,000
B	10	1600 Woodman Ave S. (along Woodman Ave S.)	0.41	0.14	0.05	0.02	0.07	0.00	0.27	34.1%	517	916	1,345	213	41%	23%	Bioretention	$28,000
		Controlled Areas (ac)	4.49	1.22							**4,779**	**7,702**	**12,425**	**1,504**	**31%**	**20%**		
		Uncontrolled Areas (ac)	2.41	0.83														
		Study Area Total (ac)	**6.90**	**2.05**							**7,950**	**12,238**	**20,671**	**1,504**	**19%**	**12%**		
B		RainScapes												2,448			assume 20% of ESD_V	
B		Pervious Sidewalk															not utilized for this project	
Total Potential Treament Volume (Study Area B)														**3,952**	**50%**	**32%**		

Unified Stormwater Management Sizing

Outfall B

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	6.90	ac		
Imp. to Facility =	2.05	ac		
Percent Impervious =	30%			
R_V =	0.317			
Region =	Eastern		P=	1

Computed Water Quality Volume				
WQ_V =	0.1825	ac-ft	7,950	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0108	CN =	73.6
I_a/P =	0.28	I_a =	0.72
q_u (csm/in) =	798	P =	2.6
q_i (cfs) =	5.58	S =	3.59
q_o/q_i =	0.022		
q_o (cfs) =	0.123	Fig 6-1*: v_s/v_r =	0.651
Q_a - runoff (in) 1 yr =	0.648	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.65	c_o	0.682
v_s =	0.42	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.2427	ac-ft	10,574	ft^3

Unified Stormwater Management Sizing

Outfall B

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	5.55	80%
C	70	0.31	4%
D	77	1.05	15%

* Actual RCN is less then 30, use RCN=38

Target RCN = 59

Proposed Imperviousness: 30%

A= 300,695 ft^2

P_E = rainfall target (from Table 5.3) = 1.5

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.49 R_V = 0.317

Computed ESD_V Volume

ESD_v = 0.2809 ac-ft 12,238 ft^3

ESD Targets:

P_E = 1.5392728 inches

Q_E = 0.49 inches

Forest Estates - Study Area B
Design Volumes

1 Bioretention

Surface Area (ft^2)	**116**	Above Surface Storage (ft^3)	***117***
Max WSEL Surface Area (ft^2)	**274**	Sub Surface Storage (ft^3)	***93***
Side Slopes (X:1)	**3**		
Ponding Depth (ft)	**0.6**		
Filter Media Depth (ft)	**2**		
Media Porosity	***0.4***	Treatment Provided (ft^3)	***210***

3 Rain Garden

Surface Area (ft^2)	**46**	Above Surface Storage (ft^3)	***47***
Max WSEL Surface Area (ft^2)	**112**	Sub Surface Storage (ft^3)	***37***
Side Slopes (X:1)	**2**		
Ponding Depth (ft)	**0.6**		
Filter Media Depth (ft)	**2**		
Media Porosity	***0.4***	Treatment Provided (ft^3)	***84***

Forest Estates - Study Area B
Design Volumes

6a Bioswale

Surface Area (ft^2)	31	Above Surface Storage (ft^3)	*37*
Max WSEL Surface Area (ft^2)	93	Sub Surface Storage (ft^3)	*135*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	169		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*172*

6b Bioswale

Surface Area (ft^2)	37	Above Surface Storage (ft^3)	*60*
Max WSEL Surface Area (ft^2)	162	Sub Surface Storage (ft^3)	*167*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	209		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*227*

7 Bioretention

Surface Area (ft^2)	110	Above Surface Storage (ft^3)	*116*
Max WSEL Surface Area (ft^2)	275	Sub Surface Storage (ft^3)	*88*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*204*

Forest Estates - Study Area B
Design Volumes

8	**Bioretention**			
	Surface Area (ft^2)	**128**	Above Surface Storage (ft^3)	***123***
	Max WSEL Surface Area (ft^2)	**283**	Sub Surface Storage (ft^3)	***102***
	Side Slopes (X:1)	**3**		
	Ponding Depth (ft)	**0.6**		
	Filter Media Depth (ft)	**2**		
	Media Porosity	***0.4***	Treatment Provided (ft^3)	***226***
9	**Bioretention**			
	Surface Area (ft^2)	**88**	Above Surface Storage (ft^3)	***98***
	Max WSEL Surface Area (ft^2)	**240**	Sub Surface Storage (ft^3)	***70***
	Side Slopes (X:1)	**3**		
	Ponding Depth (ft)	**0.6**		
	Filter Media Depth (ft)	**2**		
	Media Porosity	***0.4***	Treatment Provided (ft^3)	***169***
10	**Bioretention**			
	Surface Area (ft^2)	**120**	Above Surface Storage (ft^3)	***117***
	Max WSEL Surface Area (ft^2)	**269**	Sub Surface Storage (ft^3)	***96***
	Side Slopes (X:1)	**3**		
	Ponding Depth (ft)	**0.6**		
	Filter Media Depth (ft)	**2**		
	Media Porosity	***0.4***	Treatment Provided (ft^3)	***213***
			LID Treatment Provided (ft^3)	***1,504***

Forest Estates - Study Area B
Design Volumes

Rainscapes

20% ESDv

Treatment Provided (ft^3)	***2,448***

Pervious Pavement

Subbase Depth (in)	**12**	(6, 9, 12)
Hydrologic Soil Group	**B**	(A, B, C)
RCN	***55***	
ESDV/ft2	***0.196***	
Equiv. PE (in)	***2.50***	
Sidewalk Surface Area (ft^2)	***5,761***	

Potential Treatment (ft^3)	***1,129***

Addtional Treatment Provided (ft^3)	***3,577***

Total Treatment Provided (ft^3)	***5,081***

WQ_V (ft^3)	**7,950**
Target ESD_V (ft^3)	**12,238**

BMP # 1	Location:	1700 Imperial Dr Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.23	22%
Forest	0.05	5%
Open Space	0.77	73%
Total Drainage Area =	**1.05**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.07	30%
ROW - Sidewalk	0.02	9%
On-Lot Impervious	0.14	61%
Total Impervious =	**0.23**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
933	1,493	210	14%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities:
Vegetation:
Other:

Potential LID Retrofit Type

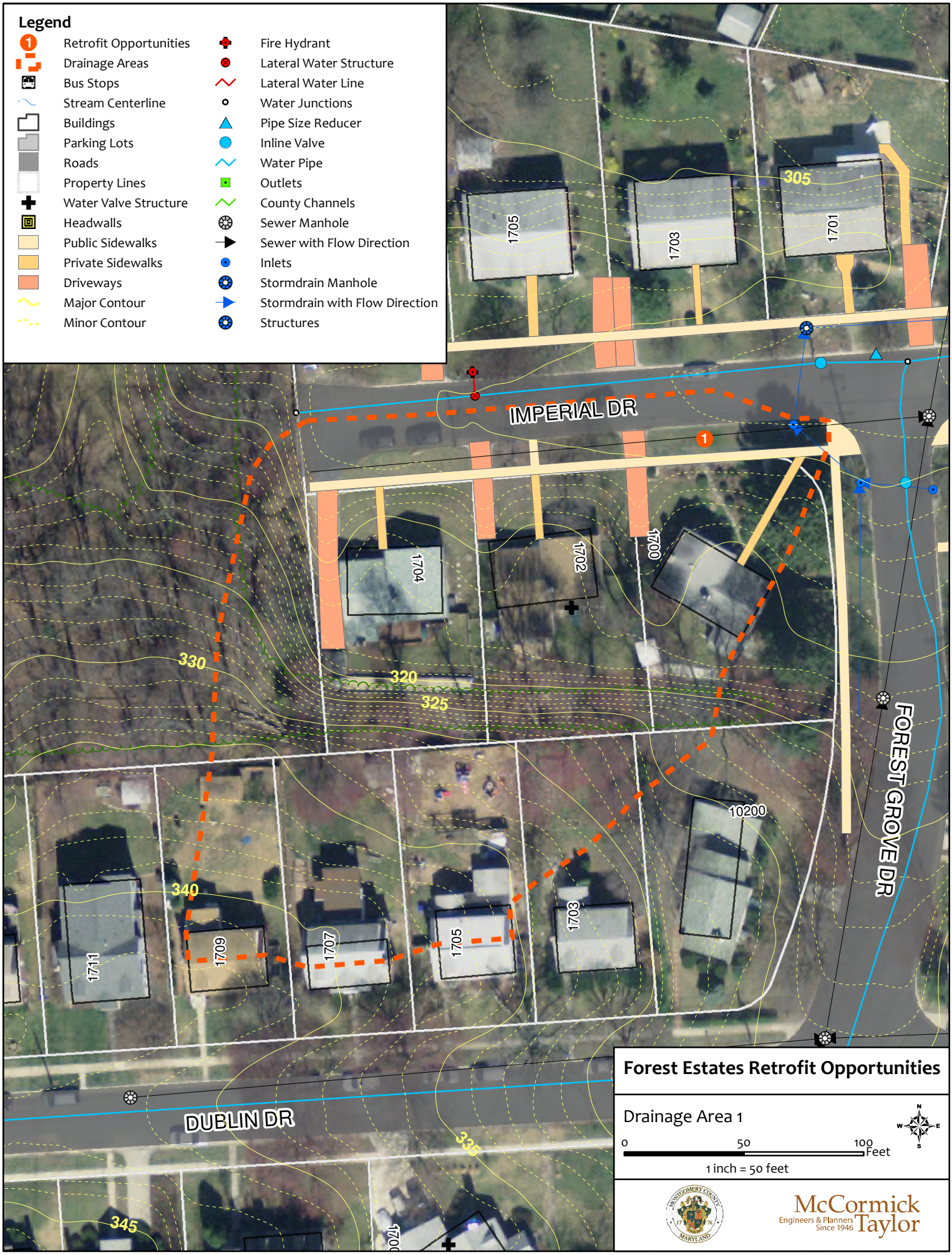
Bioretention

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into

Corner of Imperial and Forest Grove Drive

Looking towards Forest Grove Drive from the driveway at 1700 Imperial Drive


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
IMPERIAL DR
FOREST GROVE DR
DUBLIN DR
1705
1703
1701
305
1704
1702
1700
330
320
325
10200
340
1711
1709
1707
1705
1703
335
345
1700
Forest Estates Retrofit Opportunities
Drainage Area 1
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners
Since 1946

Unified Stormwater Management Sizing

1700 Imperial Drive - BMP 1

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	1.05	ac
Imp. to Facility =	0.23	ac
Percent Impervious =	22%	
R_V =	0.246	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0214	ac-ft	933	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0016	CN =	68.8
I_a/P =	0.35	I_a =	0.91
q_u (csm/in) =	896	P =	2.6
q_i (cfs) =	0.67	S =	4.54
q_o/q_i =	0.020		
q_o (cfs) =	0.014	Fig 6-1*: v_s/v_r =	0.654
Q_a - runoff (in) 1 yr =	0.459	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.46	c_o	0.682
v_s =	0.30	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0262	ac-ft	1,141	ft^3

Unified Stormwater Management Sizing

1700 Imperial Drive - BMP 1

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	1.05	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 22%

A= 45,593 ft^2

P_E = rainfall target (from Table 5.3) = 1.6

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.39 R_V = 0.246

Computed ESD_V Volume

ESD_v = 0.0343 ac-ft 1,493 ft^3

ESD Targets:

P_E = 1.6 inches

Q_E = 0.39 inches

BMP # 3	Location:	1606 Imperial Dr Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.15	27%
Forest	0.00	0%
Open Space	0.40	73%
Total Drainage Area =	**0.55**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.05	33%
ROW - Sidewalk	0.02	13%
On-Lot Impervious	0.08	53%
Total Impervious =	**0.15**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
579	926	84	9%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities: sanitary
Vegetation: 1 tree
Other: walkway between the sidewalk and roadway

Potential LID Retrofit Type

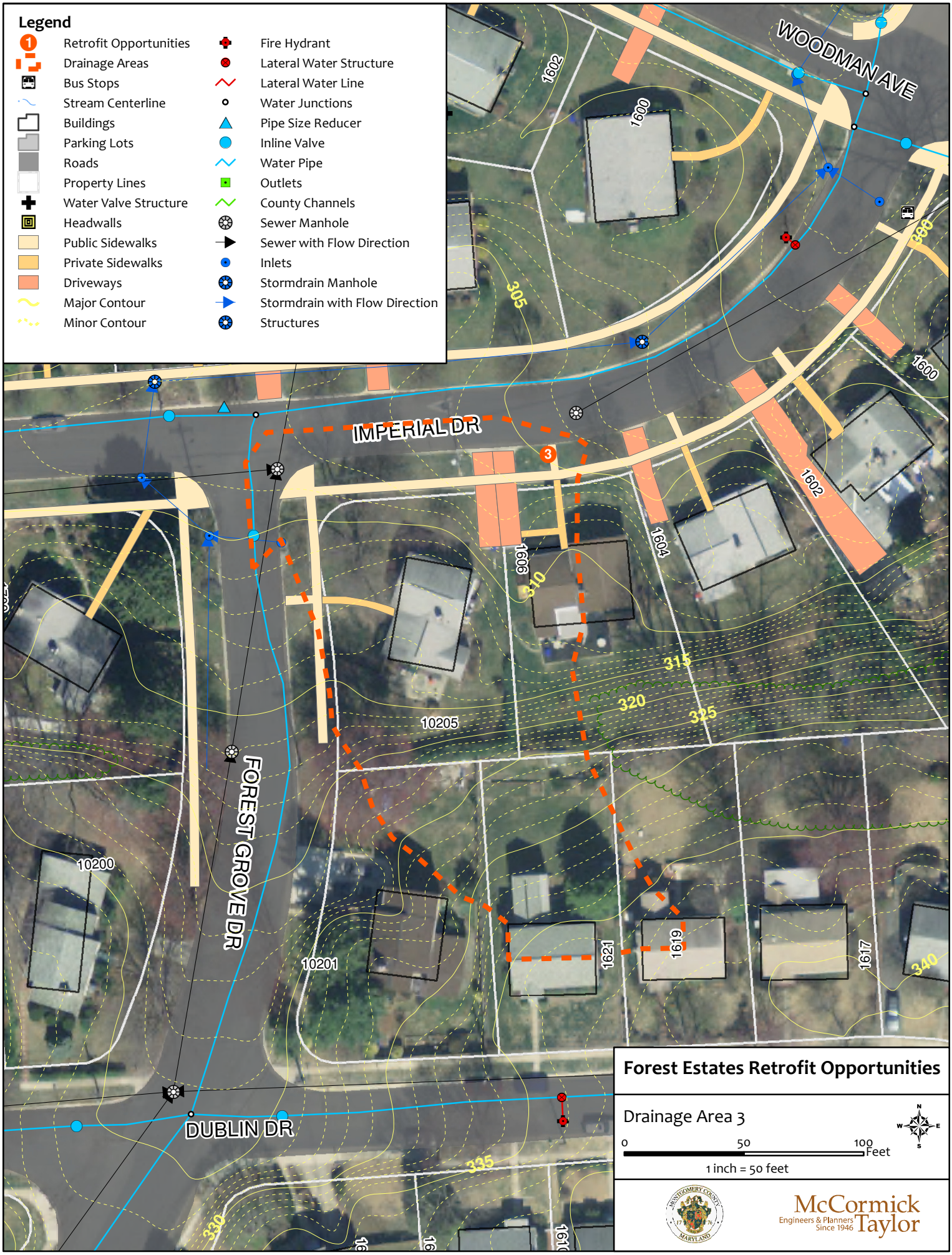
Rain Garden

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Remove walkway between sidewalk and roadway for pavement removal credit
- Sanitary manhole is located near the tree between the roadway and sidewalk

Looking eastbound from the driveway at 1606 Imperial Drive

Front of 1606 Imperial Drive



Forest Estates Retrofit Opportunities

Drainage Area 3

0 50 100 Feet

1 inch = 50 feet

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Unified Stormwater Management Sizing

1606 Imperial Drive - BMP 3

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.55	ac
Imp. to Facility =	0.15	ac
Percent Impervious =	27%	
R_V =	0.292	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0133	ac-ft	579	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0009	CN =	70.9
I_a/P =	0.32	I_a =	0.82
q_u (csm/in) =	933	P =	2.6
q_i (cfs) =	0.43	S =	4.10
q_o/q_i =	0.019		
q_o (cfs) =	0.008	Fig 6-1*: v_s/v_r =	0.655
Q_a - runoff (in) 1 yr =	0.539	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.54	c_o	0.682
v_s =	0.35	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0161	ac-ft	701	ft^3

Unified Stormwater Management Sizing

1606 Imperial Drive - BMP 3

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.55	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 27%

A= 23,809 ft^2

P_E = rainfall target (from Table 5.3) = 1.6

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.47 R_V = 0.292

Computed ESD_V Volume

ESD_v = 0.0213 ac-ft 926 ft^3

ESD Targets:

P_E = 1.6 inches

Q_E = 0.47 inches

BMP # 6	Location:	1504 Woodman Ave S. Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.14	25%
Forest	0.00	0%
Open Space	0.43	75%
Total Drainage Area =	**0.57**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.06	43%
ROW - Sidewalk	0.02	14%
On-Lot Impervious	0.06	43%
Total Impervious =	**0.14**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
576	891	399	45%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities: water, possible sanitary
Vegetation:
Other: steep slope of roadway

Potential LID Retrofit Type

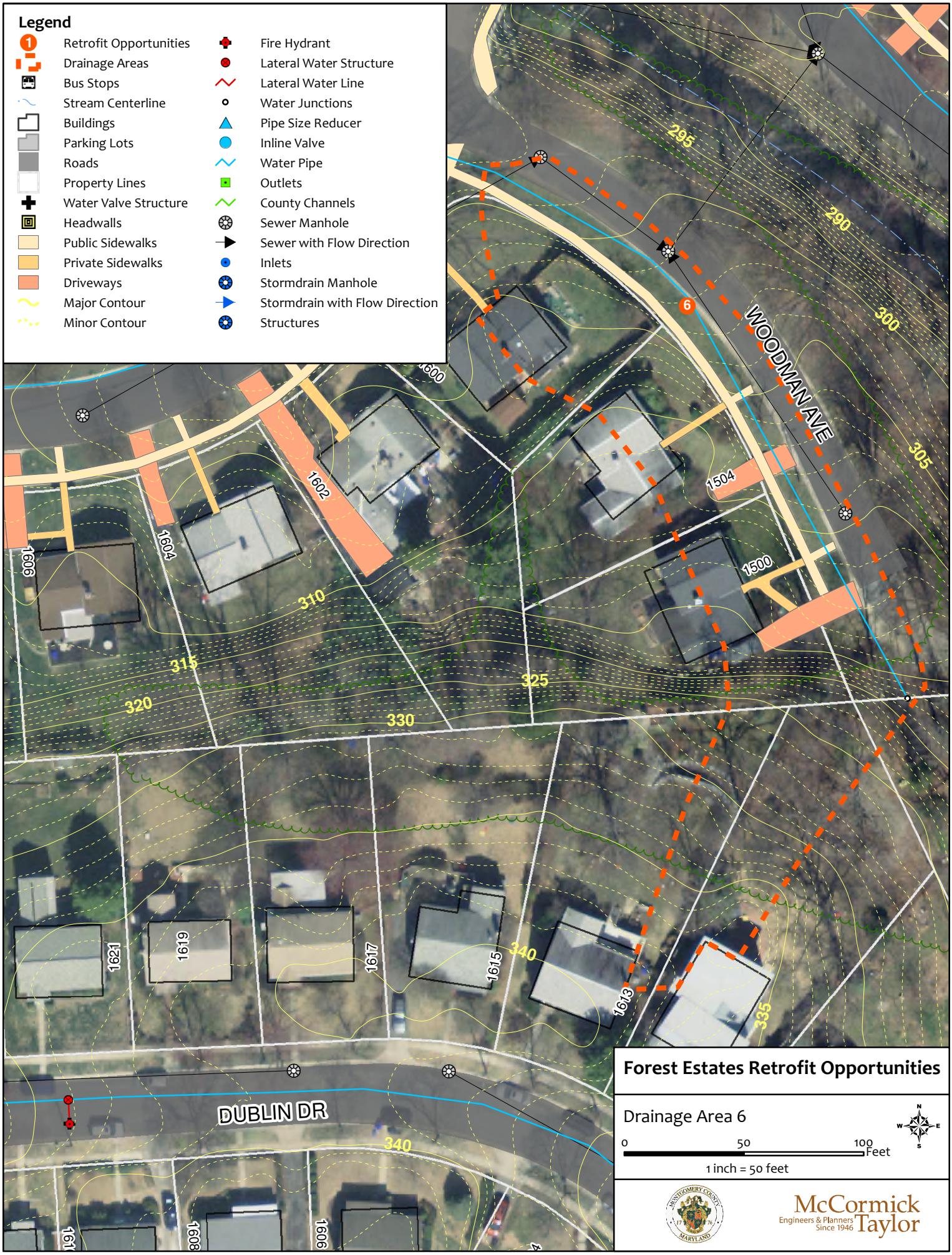
Bioswale

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into at intersection
- Water runs parallels to the road between the sidewalk and curbline
- Sanitary is located within the roadway - possible house connections
- Due to superelevation of roadway, no facilties are proposed on the stream side of the roadway
- Possibly bump out curb to provide additional treatment area within the right of way

Looking towards the intersection of Woodman Avenue (south) and Imperial Drive

Looking south towards the end of Woodman Avenue (south)


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
WOODMAN AVE
DUBLIN DR
295
290
300
305
310
315
320
325
330
335
340
1600
1602
1604
1606
1504
1500
1621
1619
1617
1615
1613
1608
6
Forest Estates Retrofit Opportunities
Drainage Area 6
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
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Unified Stormwater Management Sizing

1504 Woodman Ave S. - BMP 6

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.57	ac
Imp. to Facility =	0.14	ac
Percent Impervious =	25%	
R_V =	0.276	
Region =	Eastern	P= 1

Computed Water Quality Volume			
WQ_V =	0.0132 ac-ft	576	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0009	CN =	71.5
I_a/P =	0.31	I_a =	0.80
q_u (csm/in) =	942	P =	2.6
q_i (cfs) =	0.47	S =	3.99
q_o/q_i =	0.019		
q_o (cfs) =	0.009	Fig 6-1*: v_s/v_r =	0.655
Q_a - runoff (in) 1 yr =	0.560	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.56	c_o	0.682
v_s =	0.37	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume			
Cp_v =	0.0176 ac-ft	765	ft^3

Unified Stormwater Management Sizing

1504 Woodman Ave S. - BMP 6

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.50	87%
C	70	0.00	0%
D	77	0.07	13%

* Actual RCN is less then 30, use RCN=38

Target RCN = 58

Proposed Imperviousness: 25%

A= 25,022 ft^2

P_E = rainfall target (from Table 5.3) = 1.5

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.43 R_V = 0.276

Computed ESD_V Volume

ESD_v = 0.0205 ac-ft 891 ft^3

ESD Targets:

P_E = 1.5482535 inches

Q_E = 0.43 inches

BMP # 7	Location:	1708 Woodman Ave S. Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.12	57%
Forest	0.00	0%
Open Space	0.09	43%
Total Drainage Area =	**0.21**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.06	50%
ROW - Sidewalk	0.01	8%
On-Lot Impervious	0.05	42%
Total Impervious =	**0.12**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
433	779	204	26%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities: water, gas test valve, possible sanitary
Vegetation:
Other:

Potential LID Retrofit Type

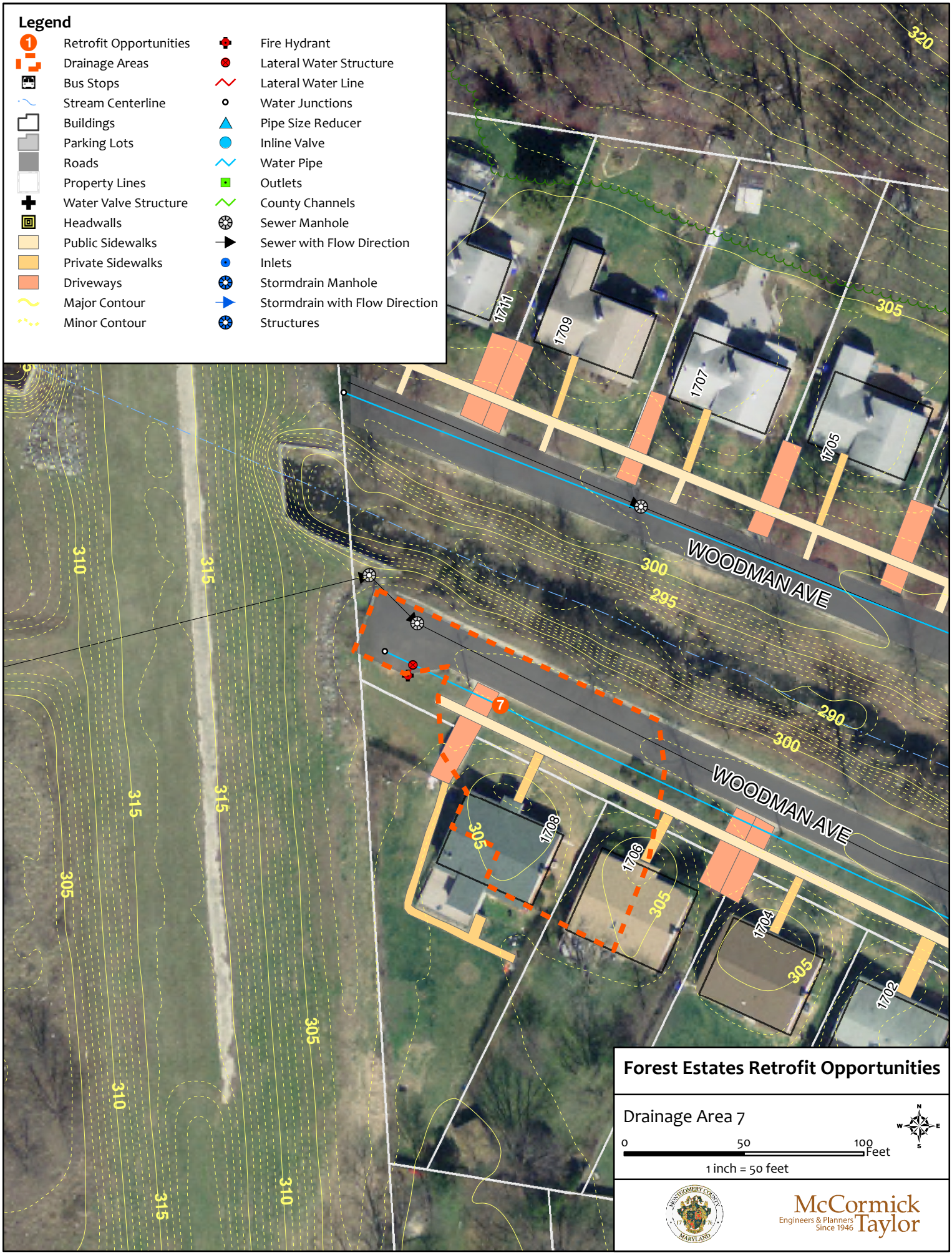
Bioretention

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs parallels to the road between the sidewalk and curbline
- Sanitary is located within the roadway - possible house connections

Looking across the driveway at 1708 Woodman Avenue (south)

Looking across the driveway at 1708 Woodman Avenue (south)


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
WOODMAN AVE
WOODMAN AVE
1711
1709
1707
1705
1708
1706
1704
1702
7
320
305
300
295
290
310
315
Forest Estates Retrofit Opportunities
Drainage Area 7
0
50
100
Feet
1 inch = 50 feet
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Unified Stormwater Management Sizing

1708 Woodman Ave S. - BMP 7

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.21	ac
Imp. to Facility =	0.12	ac
Percent Impervious =	57%	
R_V =	0.566	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0099	ac-ft	433	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0003	CN =	90.3
I_a/P =	0.08	I_a =	0.21
q_u (csm/in) =	1000	P =	2.6
q_i (cfs) =	0.54	S =	1.07
q_o/q_i =	0.018		
q_o (cfs) =	0.010	Fig 6-1*: v_s/v_r =	0.657
Q_a - runoff (in) 1 yr =	1.647	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	1.65	c_o	0.682
v_s =	1.08	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0190	ac-ft	826	ft^3

Unified Stormwater Management Sizing

1708 Woodman Ave S. - BMP 7

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.00	0%
C	70	0.00	0%
D	77	0.21	100%

* Actual RCN is less then 30, use RCN=38

Target RCN = 77

Proposed Imperviousness: 57%

A= 9,166 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 1.02 R_V = 0.566

Computed ESD_V Volume

ESD_v = 0.0179 ac-ft 779 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 1.02 inches

BMP # 8	Location:	1702-1704 Woodman Ave S. Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.20	21%
Forest	0.00	0%
Open Space	0.75	79%
Total Drainage Area =	**0.95**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.06	30%
ROW - Sidewalk	0.01	5%
On-Lot Impervious	0.13	65%
Total Impervious =	**0.20**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
821	1,110	226	20%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities: water, possible sanitary
Vegetation:
Other:

Potential LID Retrofit Type

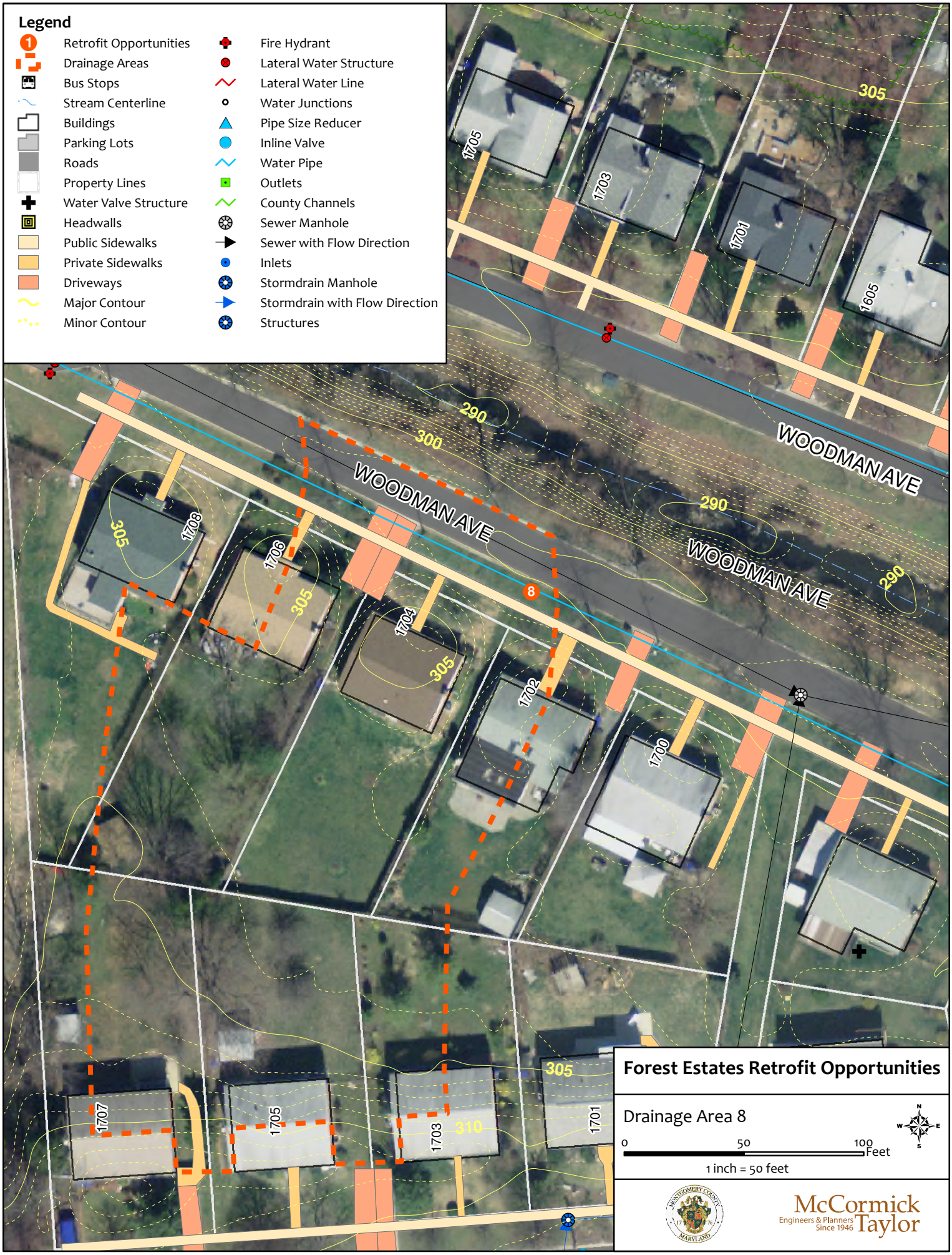
Bioretention

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs parallels to the road between the sidewalk and curbline
- Sanitary is located within the roadway - possible house connections

Looking west - area between 1702 and 1704 Woodman Avenue (south)

1702 Woodman Avenue (south)


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
WOODMAN AVE
WOODMAN AVE
WOODMAN AVE
1705
1703
1701
1605
305
290
300
290
290
1708
1706
1704
1702
1700
8
305
305
305
1707
1705
1703
1701
310
305
Forest Estates Retrofit Opportunities
Drainage Area 8
0
50
100
Feet
1 inch = 50 feet
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Unified Stormwater Management Sizing

1702-1704 Woodman Ave S - BMP 8

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.95	ac	
Imp. to Facility =	0.20	ac	
Percent Impervious =	21%		
R_V =	0.237		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0189	ac-ft	821	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0015	CN =	75.6
I_a/P =	0.25	I_a =	0.64
q_u (csm/in) =	910	P =	2.6
q_i (cfs) =	1.00	S =	3.22
q_o/q_i =	0.020		
q_o (cfs) =	0.020	Fig 6-1*: v_s/v_r =	0.654
Q_a - runoff (in) 1 yr =	0.739	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.74	c_o	0.682
v_s =	0.48	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0385	ac-ft	1,675	ft^3

Unified Stormwater Management Sizing

1702-1704 Woodman Ave S - BMP 8

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.36	38%
C	70	0.30	31%
D	77	0.30	31%

* Actual RCN is less then 30, use RCN=38

Target RCN = 67

Proposed Imperviousness: 21%

A= 41,584 ft^2

P_E = rainfall target (from Table 5.3) = 1.4

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.32 R_V = 0.237

Computed ESD_V Volume

ESD_v = 0.0255 ac-ft 1,110 ft^3

ESD Targets:

P_E = 1.350606 inches

Q_E = 0.32 inches

BMP # 9	Location:	1602 Woodman Ave S. Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.24	32%
Forest	0.00	0%
Open Space	0.51	68%
Total Drainage Area =	**0.75**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.09	38%
ROW - Sidewalk	0.02	8%
On-Lot Impervious	0.13	54%
Total Impervious =	**0.24**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
920	1,587	169	11%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities: water, possible sanitary and gas
Vegetation:
Other: sanitary easement between 1602 and 1700

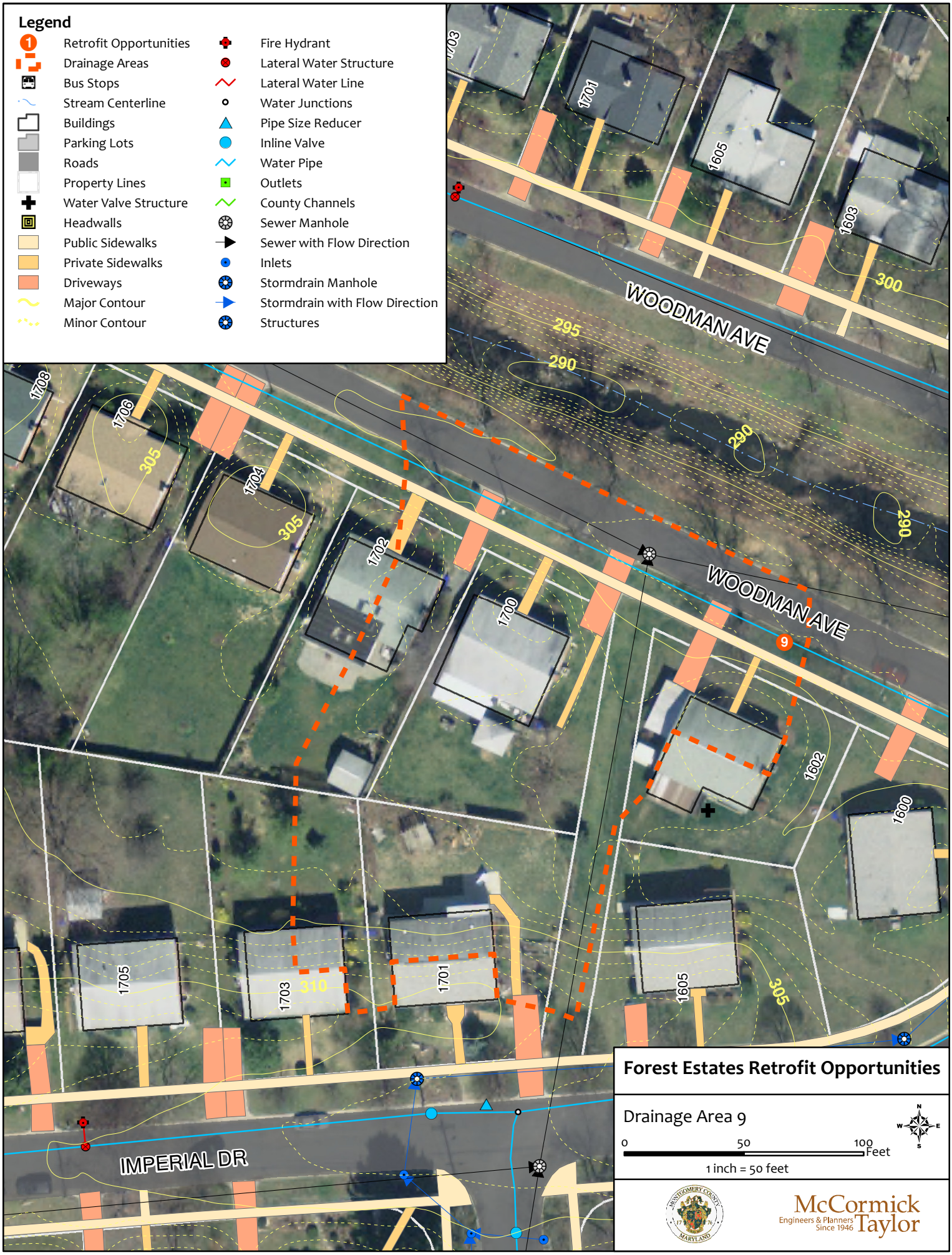
Potential LID Retrofit Type

Bioretention

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs parallels to the road between the sidewalk and curbline
- Sanitary and gas are located within the roadway - possible house connections
- Possible critical root zone impacts

Looking eastbound from the driveway at 1602 Woodman Avenue S.


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
WOODMAN AVE
WOODMAN AVE
IMPERIAL DR
1708
1706
1704
1702
1700
1705
1703
1701
1605
1603
1602
1600
305
310
300
295
290
9
Forest Estates Retrofit Opportunities
Drainage Area 9
0
50
100
Feet
1 inch = 50 feet
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Unified Stormwater Management Sizing

1602 Woodman Ave S. - BMP 9

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.75	ac	
Imp. to Facility =	0.24	ac	
Percent Impervious =	32%		
R_V =	0.338		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0211	ac-ft	920	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0012	CN =	75.8
I_a/P =	0.25	I_a =	0.64
q_u (csm/in) =	905	P =	2.6
q_i (cfs) =	0.79	S =	3.19
q_o/q_i =	0.020		
q_o (cfs) =	0.016	Fig 6-1*: v_s/v_r =	0.654
Q_a - runoff (in) 1 yr =	0.747	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.75	c_o	0.682
v_s =	0.49	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0305	ac-ft	1,328	ft^3

Unified Stormwater Management Sizing

1602 Woodman Ave S. - BMP 9

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.47	63%
C	70	0.01	1%
D	77	0.27	36%

* Actual RCN is less then 30, use RCN=38

Target RCN = 63

Proposed Imperviousness: 32%

A= 32,605 ft^2

P_E = rainfall target (from Table 5.3) = 1.7

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.58 R_V = 0.338

Computed ESD_V Volume

ESD_v = 0.0364 ac-ft 1,587 ft^3

ESD Targets:

P_E = 1.7263303 inches

Q_E = 0.58 inches

BMP # 10	Location:	1600 Woodman Ave S. (along Woodman Ave S.) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.14	34%
Forest	0.00	0%
Open Space	0.27	66%
Total Drainage Area =	**0.41**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.05	36%
ROW - Sidewalk	0.02	14%
On-Lot Impervious	0.07	50%
Total Impervious =	**0.14**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
517	916	213	23%

Study Area/Outfall	B

Possible Construction Conflicts

Utilities: water
Vegetation:
Other:

Potential LID Retrofit Type

Bioretention

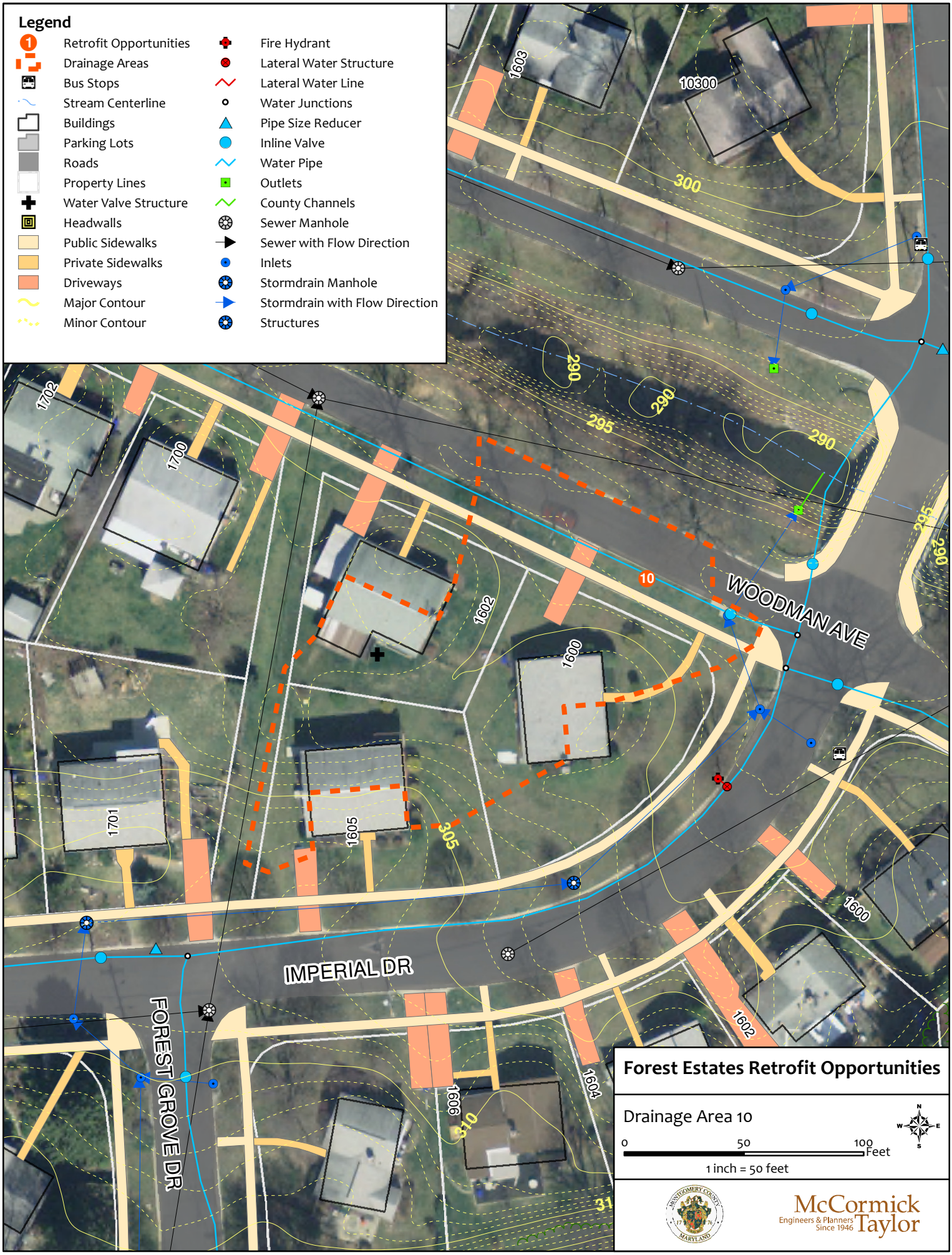
Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into
- Water runs parallels to the road between the sidewalk and curbline

(refer to BMP #5 for additional BMP at same address)

Southwest corner of the Woodman Avenue S. and Imperial Drive intersection

Inlet in front of 1600 Woodman Avenue (south)



Forest Estates Retrofit Opportunities

Drainage Area 10

0 50 100 Feet

1 inch = 50 feet

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Unified Stormwater Management Sizing

1602 Woodman Ave S.(along Woodman Ave) - BMP 10
Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.41	ac
Imp. to Facility =	0.14	ac
Percent Impervious =	33%	
R_V =	0.348	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0119	ac-ft	517	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0006	CN =	73.8
I_a/P =	0.27	I_a =	0.71
q_u (csm/in) =	955	P =	2.6
q_i (cfs) =	0.40	S =	3.56
q_o/q_i =	0.019		
q_o (cfs) =	0.008	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.655	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.65	c_o	0.682
v_s =	0.43	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0147	ac-ft	638	ft^3

Unified Stormwater Management Sizing

1602 Woodman Ave S.(along Woodman Ave) - BMP 10

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.35	85%
C	70	0.00	0%
D	77	0.06	15%

* Actual RCN is less then 30, use RCN=38

Target RCN = 58

Proposed Imperviousness: 33%

A= 17,843 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.62 R_V = 0.348

Computed ESD_V Volume

ESD_v = 0.0210 ac-ft 916 ft^3

ESD Targets:

P_E = 1.7702853 inches

Q_E = 0.62 inches

Appendix C:

Study Point C – LID Summary and Computations

Montgomery County - Task 13 Roadway LID
Forest Estates LID Summary

Study Area	BMP #	Location	Existing Hydrology								Stormwater Management						Potential Retrofit Type	Proposed Cost
			Drainage Area (ac)	Total Impervious Area (ac)	Impervious Area (ac)			Forest Area (ac)	Open Space (ac)	Percent Impervious	Target Volumes (ft^3)			Volume Provided (ft^3)	Percent WQ_v Treatment	Percent ESD_v Treatment		
					ROW - Road & DW Aprons	ROW - Sidewalk	Private - Driveway, Walkway & Roof				WQ_v	ESD_v	1 Yr. Volume (Max.)					
C	21	1515 Woodman Ave N. (along Folk Street)	0.36	0.16	0.07	0.02	0.07	0.00	0.20	44.4%	583	1,049	1,515	155	27%	15%	Bioretention	$32,000
C	22	10300 Julep Ave	0.56	0.28	0.12	0.04	0.12	0.00	0.28	50.0%	1,005	1,810	2,614	263	26%	15%	Bioswale	$56,000
C	23	10309 Folk Street	0.51	0.23	0.11	0.02	0.10	0.00	0.28	45.1%	861	1,549	2,238	103	12%	7%	Rain Garden	$46,000
C	25	10301 Julep Ave (along Folk Street)	2.33	0.48	0.13	0.03	0.32	0.00	1.85	20.6%	1,981	3,170	5,151	318	16%	10%	Bioswale	$96,000
C	26	10209 Julep Court	0.77	0.25	0.08	0.01	0.16	0.00	0.52	32.5%	957	1,722	2,488	661	69%	38%	Rain Garden	$50,000
C	27	10207 Folk Street	0.37	0.23	0.19	0.03	0.01	0.00	0.14	62.2%	806	1,613	2,096	212	26%	13%	Bioswale	$46,000
C	28	1504 Dennis Ave (along Inwood Ave)	0.15	0.07	0.04	0.01	0.02	0.00	0.08	46.7%	255	460	664	135	53%	29%	Modified Biofilter	$14,000
C	30	10321 Inwood Ave	0.20	0.11	0.04	0.01	0.06	0.00	0.09	55.0%	388	698	1,008	163	42%	23%	Rain Garden	$22,000
C	35	10312 Julep Ave	0.39	0.20	0.10	0.02	0.08	0.00	0.19	51.3%	723	1,301	1,880	85	12%	7%	Rain Garden	$40,000
C	36	10315 Julep Ave	0.63	0.32	0.16	0.04	0.12	0.00	0.31	50.8%	1,148	2,067	2,985	231	20%	11%	Rain Garden	$64,000
C	37	10312 Folk St	0.32	0.16	0.06	0.01	0.09	0.00	0.16	50.0%	580	1,044	1,507	0	0%	0%	Rain Garden	$32,000
C	41	10303 Folk St	0.44	0.19	0.06	0.02	0.11	0.00	0.25	43.2%	705	1,268	1,832	0	0%	0%	Bioswale	$38,000
C	42	10311 Inwood Ave	0.49	0.26	0.11	0.03	0.12	0.00	0.23	53.1%	938	1,689	2,440	158	17%	9%	Modified Biofilter	$52,000
C	43	10307 Julep Ave	0.28	0.15	0.07	0.02	0.06	0.00	0.13	53.6%	541	974	1,406	110	20%	11%	Rain Garden	$30,000
		Controlled Areas (ac)	7.80	3.09							**11,471**	**20,413**	**29,824**	**2,593**	**23%**	**13%**		
		Uncontrolled Areas (ac)	3.93	1.21														
		Study Area Total (ac)	**11.73**	**4.30**							**16,177**	**28,104**	**42,060**	**2,593**	**16%**	**9%**		
C		RainScapes												5,621			assume 20% of ESD_v	
C		Pervious Sidewalk															not utilized for this project	
Total Potential Treament Volume (Study Area C)														**8,214**	**51%**	**29%**		

Unified Stormwater Management Sizing

Outfall C

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	11.73	ac		
Imp. to Facility =	4.30	ac		
Percent Impervious =	37%			
R_V =	0.380			
Region =	Eastern		P=	1

Computed Water Quality Volume				
WQ_V =	0.3714	ac-ft	16,177	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0183	CN =	78.8
I_a/P =	0.21	I_a =	0.54
q_u (csm/in) =	779	P =	2.6
q_i (cfs) =	12.74	S =	2.70
q_o/q_i =	0.023		
q_o (cfs) =	0.288	Fig 6-1*: v_s/v_r =	0.650
Q_a - runoff (in) 1 yr =	0.893	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.89	c_o	0.682
v_s =	0.58	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.5675	ac-ft	24,720	ft^3

Unified Stormwater Management Sizing

Outfall C

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	8.05	69%
C	70	0.00	0%
D	77	3.68	31%

* Actual RCN is less then 30, use RCN=38

Target RCN = 62

Proposed Imperviousness: 37%

A= 510,959 ft^2

P_E = rainfall target (from Table 5.3) = 1.7

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.66 R_V = 0.380

Computed ESD_V Volume

ESD_v = 0.6452 ac-ft 28,104 ft^3

ESD Targets:

P_E = 1.7372549 inches

Q_E = 0.66 inches

Forest Estates - Study Area C
Design Volumes

21 Bioretention

Surface Area (ft^2)	90	Above Surface Storage (ft^3)	*83*
Max WSEL Surface Area (ft^2)	187	Sub Surface Storage (ft^3)	*72*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*155*

22 Bioswale

Surface Area (ft^2)	54	Above Surface Storage (ft^3)	*52*
Max WSEL Surface Area (ft^2)	120	Sub Surface Storage (ft^3)	*210*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	263		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*263*

23 Rain Garden

Surface Area (ft^2)	50	Above Surface Storage (ft^3)	*63*
Max WSEL Surface Area (ft^2)	160	Sub Surface Storage (ft^3)	*40*
Side Slopes (X:1)	2		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*	Treatment Provided (ft^3)	*103*

25 Bioswale

Surface Area (ft^2)	68	Above Surface Storage (ft^3)	*57*
Max WSEL Surface Area (ft^2)	122	Sub Surface Storage (ft^3)	*261*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	326		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*318*

Forest Estates - Study Area C
Design Volumes

26 Rain Garden

Surface Area (ft^2)	383	Above Surface Storage (ft^3)	*355*
Max WSEL Surface Area (ft^2)	799	Sub Surface Storage (ft^3)	*306*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*661*

27 Bioswale

Surface Area (ft^2)	51	Above Surface Storage (ft^3)	*49*
Max WSEL Surface Area (ft^2)	113	Sub Surface Storage (ft^3)	*162*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	203		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*212*

28 Modified Biofilter

Surface Area (ft^2)	64	Above Surface Storage (ft^3)	*69*
Max WSEL Surface Area (ft^2)	166	Sub Surface Storage (ft^3)	*66*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	166		
Filter Media Depth (ft)	1		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*135*

Forest Estates - Study Area C
Design Volumes

30 Modified Biofilter

Surface Area (ft^2)	69	Above Surface Storage (ft^3)	*82*
Max WSEL Surface Area (ft^2)	203	Sub Surface Storage (ft^3)	*81*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	203		
Filter Media Depth (ft)	1		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*163*

35 Rain Garden

Surface Area (ft^2)	49	Above Surface Storage (ft^3)	*50*
Max WSEL Surface Area (ft^2)	119	Sub Surface Storage (ft^3)	*39*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*	Treatment Provided (ft^3)	*90*

36 Rain Garden

Surface Area (ft^2)	47	Above Surface Storage (ft^3)	*47*
Max WSEL Surface Area (ft^2)	110	Sub Surface Storage (ft^3)	*38*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*	Treatment Provided (ft^3)	*85*

37 Rain Garden

Surface Area (ft^2)	110	Above Surface Storage (ft^3)	*99*
Max WSEL Surface Area (ft^2)	220	Sub Surface Storage (ft^3)	*132*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	3		
Media Porosity	*0.4*	Treatment Provided (ft^3)	*231*

Forest Estates - Study Area C
Design Volumes

41 Bioswale

Surface Area (ft^2)	72	Above Surface Storage (ft^3)	*68*
Max WSEL Surface Area (ft^2)	155	Sub Surface Storage (ft^3)	*127*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	159		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*195*

42 Modified Biofilter

Surface Area (ft^2)	83	Above Surface Storage (ft^3)	*82*
Max WSEL Surface Area (ft^2)	190	Sub Surface Storage (ft^3)	*76*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Surface Area (ft^2)	190		
Filter Media Depth (ft)	1		
Media Porosity	*0.4*		
		Treatment Provided (ft^3)	*158*

43 Rain Garden

Surface Area (ft^2)	63	Above Surface Storage (ft^3)	*60*
Max WSEL Surface Area (ft^2)	137	Sub Surface Storage (ft^3)	*50*
Side Slopes (X:1)	3		
Ponding Depth (ft)	0.6		
Filter Media Depth (ft)	2		
Media Porosity	*0.4*	Treatment Provided (ft^3)	*110*

LID Treatment Provided (ft^3) *2,878*

Rainscapes

20% ESDv		Treatment Provided (ft^3)	*5,621*

Pervious Pavement

Subbase Depth (in)	12	(6, 9, 12)
Hydrologic Soil Group	B	(A, B, C)
RCN	*55*	
ESDV/ft2	*0.196*	
Equiv. PE (in)	*2.50*	
Sidewalk Surface Area (ft^2)	*14,350*	
		Potential Treatment (ft^3) *2,813*

Addtional Treatment Provided (ft^3) *8,433*

Total Treatment Provided (ft^3) *11,312*

Forest Estates - Study Area C
Design Volumes

WQ_V (ft^3)	16,177
Target ESD_V (ft^3)	28,104

BMP # 21	Location:	1515 Woodman Ave N. (along Folk Street) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.16	44%
Forest	0.00	0%
Open Space	0.20	56%
Total Drainage Area =	**0.36**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.07	44%
ROW - Sidewalk	0.02	13%
On-Lot Impervious	0.07	44%
Total Impervious =	**0.16**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
583	1,049	155	15%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: water
Vegetation: trees
Other:

Potential LID Retrofit Type

Bioretention

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into
- Water present in the roadway running along the curbline - possible house connections
- Possible tree/critical root zone impacts

Looking east from the Folk Street and Woodman Avenue N. intersection

Existing inlet in front of 1515 Woodman Avenue N. (along Folk Street)

Forest Estates Retrofit Opportunities

Drainage Area 21

0 50 100 Feet

1 inch = 50 feet

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Unified Stormwater Management Sizing

1515 Woodman Ave N (along Folk St) - BMP 21
Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.36	ac
Imp. to Facility =	0.16	ac
Percent Impervious =	44%	
R_V =	0.446	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0134	ac-ft	583	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0006	CN =	83.8
I_a/P =	0.15	I_a =	0.39
q_u (csm/in) =	980	P =	2.6
q_i (cfs) =	0.65	S =	1.94
q_o/q_i =	0.018		
q_o (cfs) =	0.012	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	1.179	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	1.18	c_o	0.682
v_s =	0.77	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0232	ac-ft	1,011	ft^3

Unified Stormwater Management Sizing

1515 Woodman Ave N (along Folk St) - BMP 21
Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.14	38%
C	70	0.00	0%
D	77	0.22	62%

* Actual RCN is less then 30, use RCN=38

Target RCN = 69

Proposed Imperviousness: 44%
A= 15,689 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices
$Q_E = P_E x R_V$
ESD_v = runoff volume used in the design of specific ESD practices
$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.80 R_V = 0.446

Computed ESD_V Volume
ESD_v = 0.0241 ac-ft 1,049 ft^3

ESD Targets:
P_E = 1.8 inches
Q_E = 0.80 inches

BMP # 22	Location:	10300 Julep Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.28	50%
Forest	0.00	0%
Open Space	0.28	50%
Total Drainage Area =	**0.56**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.12	43%
ROW - Sidewalk	0.04	14%
On-Lot Impervious	0.12	43%
Total Impervious =	**0.28**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
1,005	1,810	263	15%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: water
Vegetation:
Other:

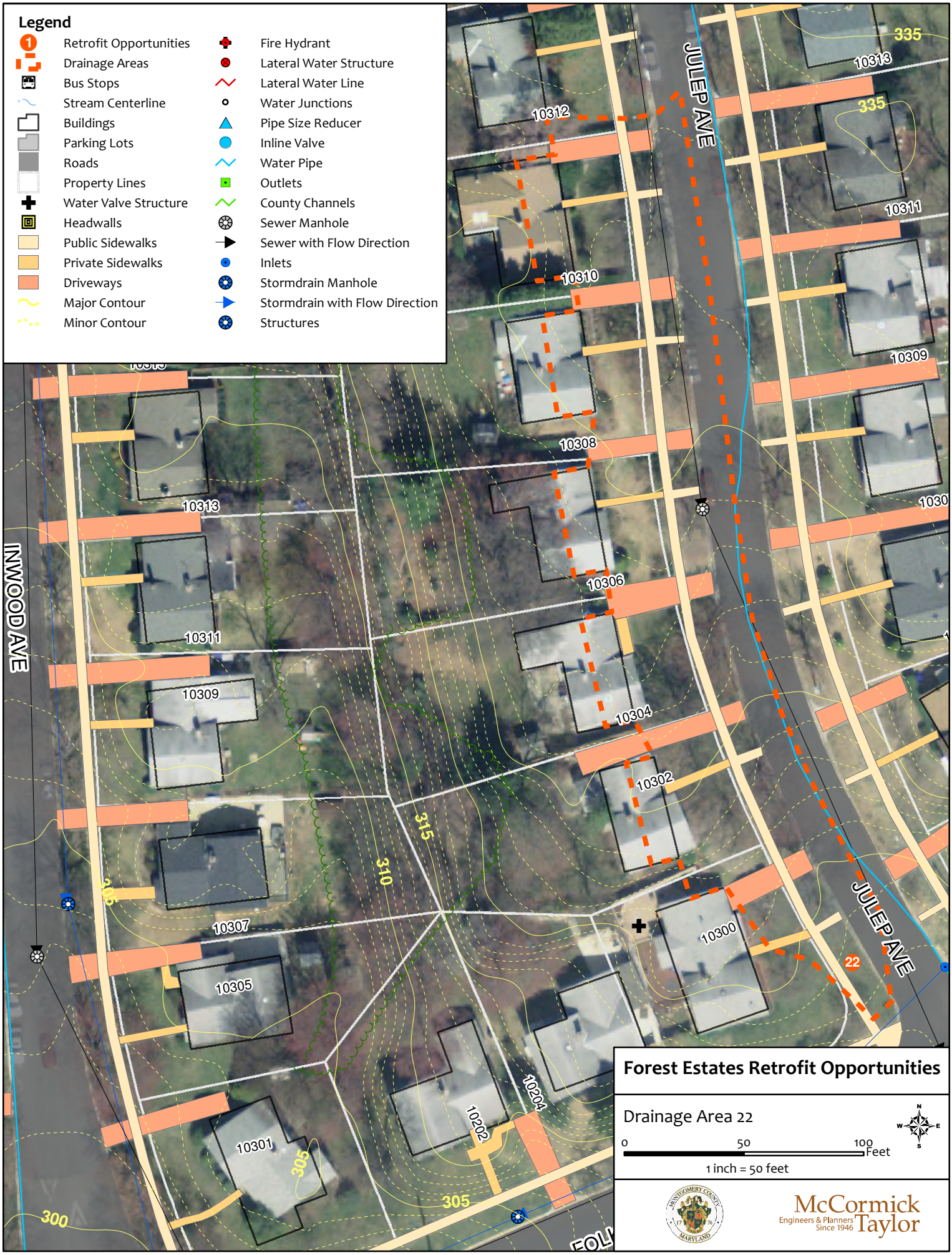
Potential LID Retrofit Type

Bioswale

Site Notes:

- Existing storm drain system pipe runs under this area - possible tie in
  may need to install a new inlet overtop the existing pipe for bypass/overflow
- Remove walkway between sidewalk and roadway for pavement removal credit
- Tree roots from the stump on other side of the walkway may be present

10300 Julep Avenue - looking north from the Julep Avenue and Folk Street intersection


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
JULEP AVE
INWOOD AVE
10313
10312
10311
10310
10309
10308
10306
10304
10302
10300
10307
10305
10301
10202
10204
335
315
310
305
300
22
Forest Estates Retrofit Opportunities
Drainage Area 22
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
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Unified Stormwater Management Sizing

10300 Julep Court - BMP 22

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.56	ac
Imp. to Facility =	0.28	ac
Percent Impervious =	49%	
R_V =	0.493	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0231	ac-ft	1,005	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0009	CN =	79.3
I_a/P =	0.20	I_a =	0.52
q_u (csm/in) =	970	P =	2.6
q_i (cfs) =	0.78	S =	2.61
q_o/q_i =	0.019		
q_o (cfs) =	0.015	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.921	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.92	c_o	0.682
v_s =	0.60	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0283	ac-ft	1,232	ft^3

Unified Stormwater Management Sizing

10300 Julep Court - BMP 22

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.55	98%
C	70	0.00	0%
D	77	0.01	2%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 49%

A= 24,472 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.89 R_V = 0.493

Computed ESD_V Volume

ESD_v = 0.0415 ac-ft 1,810 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.89 inches

BMP # 23	Location:	10309 Folk Street Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.23	45%
Forest	0.00	0%
Open Space	0.28	55%
Total Drainage Area =	**0.51**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.11	48%
ROW - Sidewalk	0.02	9%
On-Lot Impervious	0.10	43%
Total Impervious =	**0.23**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
861	1,549	103	7%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: water
Vegetation:
Other: basketball hoop

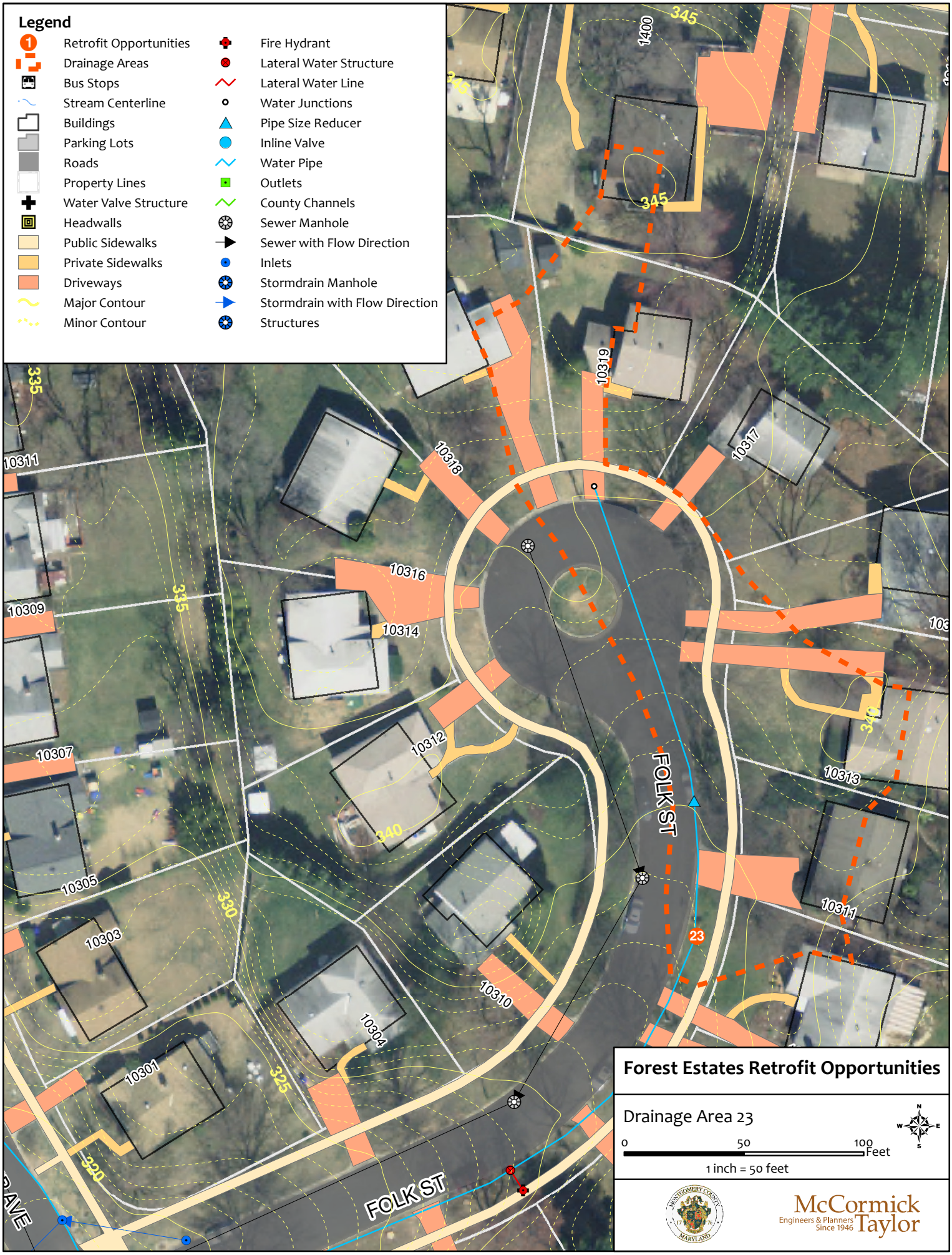
Potential LID Retrofit Type

Rain Garden

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs along curbline

10300 Julep Avenue - looking north from the Julep Avenue and Folk Street intersection


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
FOLK ST
FOLK ST
23
10311
10309
10307
10305
10303
10301
10304
10310
10312
10314
10316
10318
10319
10317
10313
10311
1400
345
340
335
330
325
320
Forest Estates Retrofit Opportunities
Drainage Area 23
0
50
100
Feet
1 inch = 50 feet
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Since 1946

Unified Stormwater Management Sizing

10309 Folk Street - BMP 23

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.51	ac	
Imp. to Facility =	0.23	ac	
Percent Impervious =	46%		
R_V =	0.461		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0198	ac-ft	861	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0008	CN =	77.9
I_a/P =	0.22	I_a =	0.57
q_u (csm/in) =	966	P =	2.6
q_i (cfs) =	0.66	S =	2.84
q_o/q_i =	0.019		
q_o (cfs) =	0.012	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.848	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.85	c_o	0.682
v_s =	0.56	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0238	ac-ft	1,039	ft^3

Unified Stormwater Management Sizing

10309 Folk Street - BMP 23

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.51	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 46%

A= 22,421 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.83 R_V = 0.461

Computed ESD_V Volume

ESD_v = 0.0356 ac-ft 1,549 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.83 inches

BMP # 25	Location:	10301 Julep Ave (along Folk Street) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.48	21%
Forest	0.00	0%
Open Space	1.85	79%
Total Drainage Area =	**2.33**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.13	27%
ROW - Sidewalk	0.03	6%
On-Lot Impervious	0.32	67%
Total Impervious =	**0.48**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
1,981	3,170	318	10%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: sanitary
Vegetation: small tree
Other: steep roadway slope

Potential LID Retrofit Type

Bioswale

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into
- Sanitary present along the curbline
- Due to fairly steep roadway grade, recommend tree box filter instead of bioretention facility

(refer to BMP #34 for additional BMP at same address)

10301 Julep Avenue from Folk Street

Forest Estates Retrofit Opportunities

Drainage Area 25

0 50 100 Feet

1 inch = 100 feet

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Unified Stormwater Management Sizing

10301 Julep Ave (along Folk St) - BMP 25

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	2.33	ac
Imp. to Facility =	0.48	ac
Percent Impervious =	20%	
R_V =	0.234	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0455	ac-ft	1,981	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0036	CN =	68.6
I_a/P =	0.35	I_a =	0.92
q_u (csm/in) =	790	P =	2.6
q_i (cfs) =	1.30	S =	4.59
q_o/q_i =	0.022		
q_o (cfs) =	0.029	Fig 6-1*: v_s/v_r =	0.651
Q_a - runoff (in) 1 yr =	0.452	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.45	c_o	0.682
v_s =	0.29	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0572	ac-ft	2,491	ft^3

Unified Stormwater Management Sizing

10301 Julep Ave (along Folk St) - BMP 25

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	2.33	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 20%

A= 101,625 ft^2

P_E = rainfall target (from Table 5.3) = 1.6

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.37 R_V = 0.234

Computed ESD_V Volume

ESD_v = 0.0728 ac-ft 3,170 ft^3

ESD Targets:

P_E = 1.6 inches

Q_E = 0.37 inches

BMP # 26	Location:	10209 Julep Court Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.25	32%
Forest	0.00	0%
Open Space	0.52	68%
Total Drainage Area =	**0.77**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.08	32%
ROW - Sidewalk	0.01	4%
On-Lot Impervious	0.16	64%
Total Impervious =	**0.25**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
957	1,722	661	38%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities:
Vegetation:
Other:

Potential LID Retrofit Type

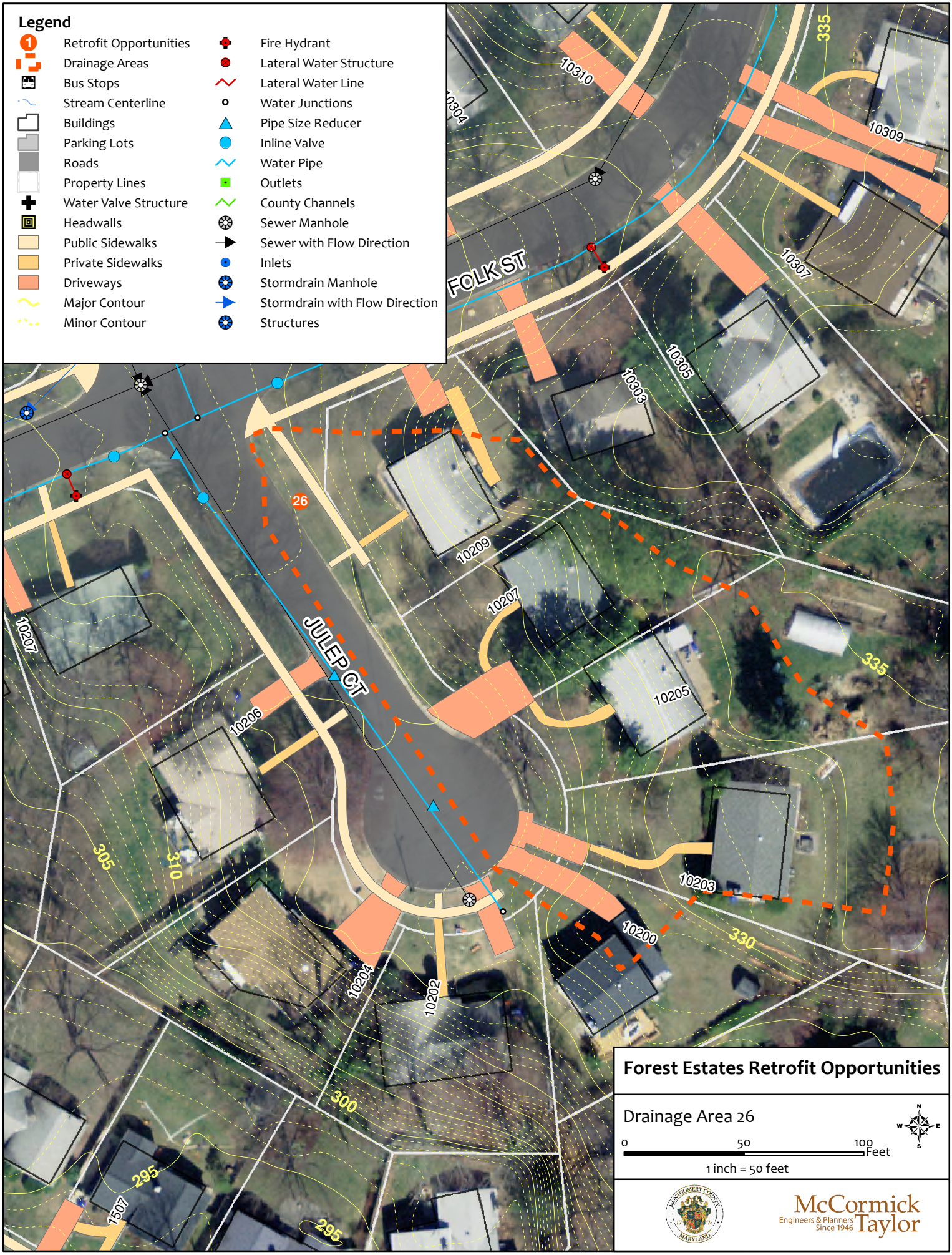
Rain Garden

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Remove walkway between sidewalk and roadway for pavement removal credit, if necessary for grading
- Possibly bump out curb to provide additional treatment area within the right of way

Looking southeast along Julep Court from the Folk Street intersection

Looking towards the Julep Court and Folk Street intersection



Forest Estates Retrofit Opportunities

Drainage Area 26

0 50 100 Feet

1 inch = 50 feet

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Unified Stormwater Management Sizing

10209 Julep Court - BMP 26

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.77	ac	
Imp. to Facility =	0.25	ac	
Percent Impervious =	33%		
R_V =	0.344		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0220	ac-ft	957	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0012	CN =	73.1
I_a/P =	0.28	I_a =	0.74
q_u (csm/in) =	953	P =	2.6
q_i (cfs) =	0.71	S =	3.68
q_o/q_i =	0.019		
q_o (cfs) =	0.014	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.627	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.63	c_o	0.682
v_s =	0.41	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0262	ac-ft	1,142	ft^3

Unified Stormwater Management Sizing

10209 Julep Court - BMP 26

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.77	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 33%

A= 33,340 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.62 R_V = 0.344

Computed ESD_V Volume

ESD_v = 0.0395 ac-ft 1,722 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.62 inches

BMP # 27	Location:	10207 Folk Street Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.23	62%
Forest	0.00	0%
Open Space	0.14	38%
Total Drainage Area =	**0.37**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.19	83%
ROW - Sidewalk	0.03	13%
On-Lot Impervious	0.01	4%
Total Impervious =	**0.23**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
806	1,613	212	13%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: water, fire hydrant
Vegetation: tree
Other: walkway between the sidewalk and roadway

Potential LID Retrofit Type

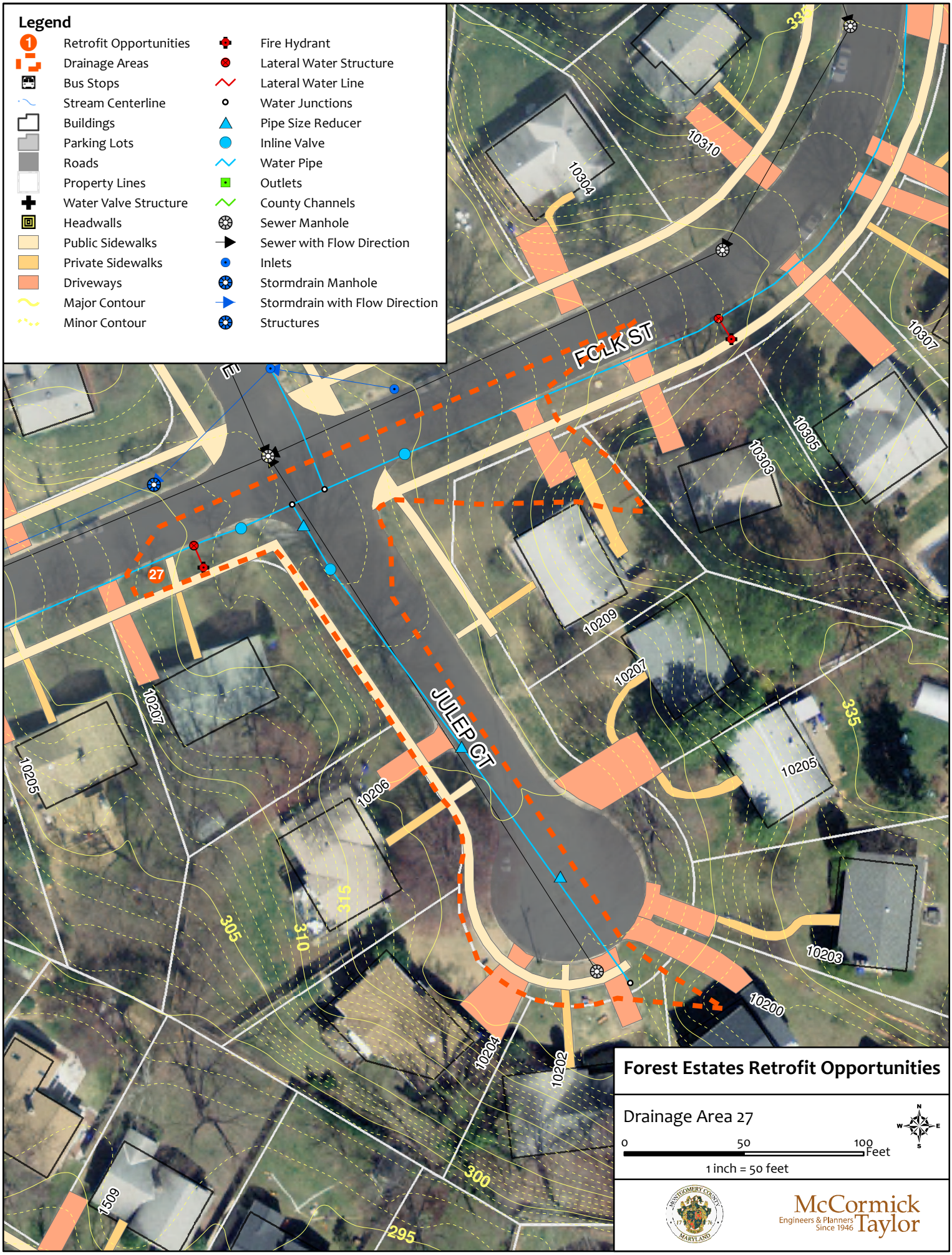
Bioswale

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- To utilized tree box filter - would need to install new storm drain pipe and tie into existing system
  will need to install a new inlet overtop the existing pipe for bypass/overflow
  tie into inlet at intersection of Folk Street and Woodman Avenue N.
- Remove walkway between sidewalk and roadway for pavement removal credit
- Water runs parallel to the curbline

Looking west down Folk Street from the Juelp Court intersection

Looking west down Folk Street from 10207 Folk Street



Forest Estates Retrofit Opportunities

Drainage Area 27

0 50 100 Feet

1 inch = 50 feet

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Unified Stormwater Management Sizing

10207 Folk Street - BMP 27

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.37	ac		
Imp. to Facility =	0.23	ac		
Percent Impervious =	61%			
R_V =	0.600			
Region =	Eastern		P=	1

Computed Water Quality Volume				
WQ_V =	0.0185	ac-ft	806	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0006	CN =	83.6
I_a/P =	0.15	I_a =	0.39
q_u (csm/in) =	980	P =	2.6
q_i (cfs) =	0.66	S =	1.96
q_o/q_i =	0.018		
q_o (cfs) =	0.012	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	1.169	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	1.17	c_o	0.682
v_s =	0.77	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0237	ac-ft	1,031	ft^3

Unified Stormwater Management Sizing

10207 Folk Street - BMP 27

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.37	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 61%

A= 16,135 ft^2

P_E = rainfall target (from Table 5.3) = 2.0

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 1.20 R_V = 0.600

Computed ESD_V Volume

ESD_v = 0.0370 ac-ft 1,613 ft^3

ESD Targets:

P_E = 2 inches

Q_E = 1.20 inches

BMP # 28	Location:	1504 Dennis Ave (along Inwood Ave) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.07	47%
Forest	0.00	0%
Open Space	0.08	53%
Total Drainage Area =	**0.15**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.04	57%
ROW - Sidewalk	0.01	14%
On-Lot Impervious	0.02	29%
Total Impervious =	**0.07**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
255	460	135	29%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: storm drain
Vegetation: tree
Other: bus stop

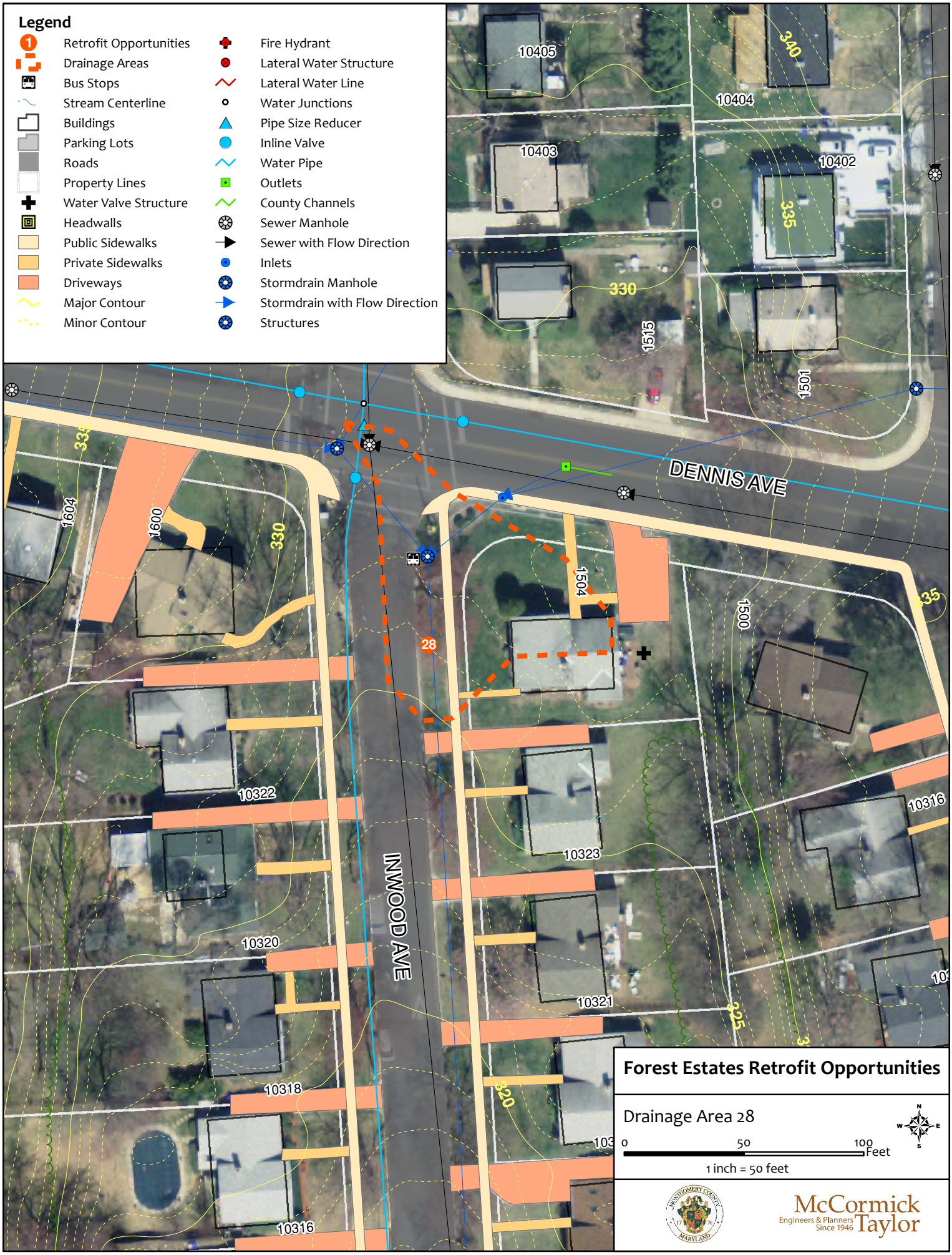
Potential LID Retrofit Type

Modified Biofilter

Site Notes:

- Existing storm drain system available to tie facility underdrain into
  could not locate the existing manhole shown in the GIS in the field
- Possible tree and/or critical root zone impacts
- Need to protect bus stop

Looking south on Inwood Avenue from the Dennis Avenue intersection



Forest Estates Retrofit Opportunities

Drainage Area 28

0 50 100 Feet

1 inch = 50 feet

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Unified Stormwater Management Sizing

1504 Dennis Ave (along Inwood Ave) - BMP 28
Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.15	ac	
Imp. to Facility =	0.07	ac	
Percent Impervious =	46%		
R_V =	0.461		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0059	ac-ft	255	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0002	CN =	78.1
I_a/P =	0.22	I_a =	0.56
q_u (csm/in) =	967	P =	2.6
q_i (cfs) =	0.20	S =	2.81
q_o/q_i =	0.019		
q_o (cfs) =	0.004	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.857	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.86	c_o	0.682
v_s =	0.56	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0071	ac-ft	311	ft^3

Unified Stormwater Management Sizing

1504 Dennis Ave (along Inwood Ave) - BMP 28
Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.15	96%
C	70	0.00	0%
D	77	0.01	4%

* Actual RCN is less then 30, use RCN=38

Target RCN = 56

Proposed Imperviousness: 46%
A= 6,645 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices
$Q_E = P_E x R_V$
ESD_v = runoff volume used in the design of specific ESD practices
$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.83 R_V = 0.461

Computed ESD_V Volume
ESD_v = 0.0106 ac-ft 460 ft^3

ESD Targets:
P_E = 1.8 inches
Q_E = 0.83 inches

BMP # 30	Location:	10321 Inwood Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.11	55%
Forest	0.00	0%
Open Space	0.09	45%
Total Drainage Area =	**0.20**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.04	36%
ROW - Sidewalk	0.01	9%
On-Lot Impervious	0.06	55%
Total Impervious =	**0.11**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
388	698	163	23%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities:
Vegetation:
Other: speed hump sign

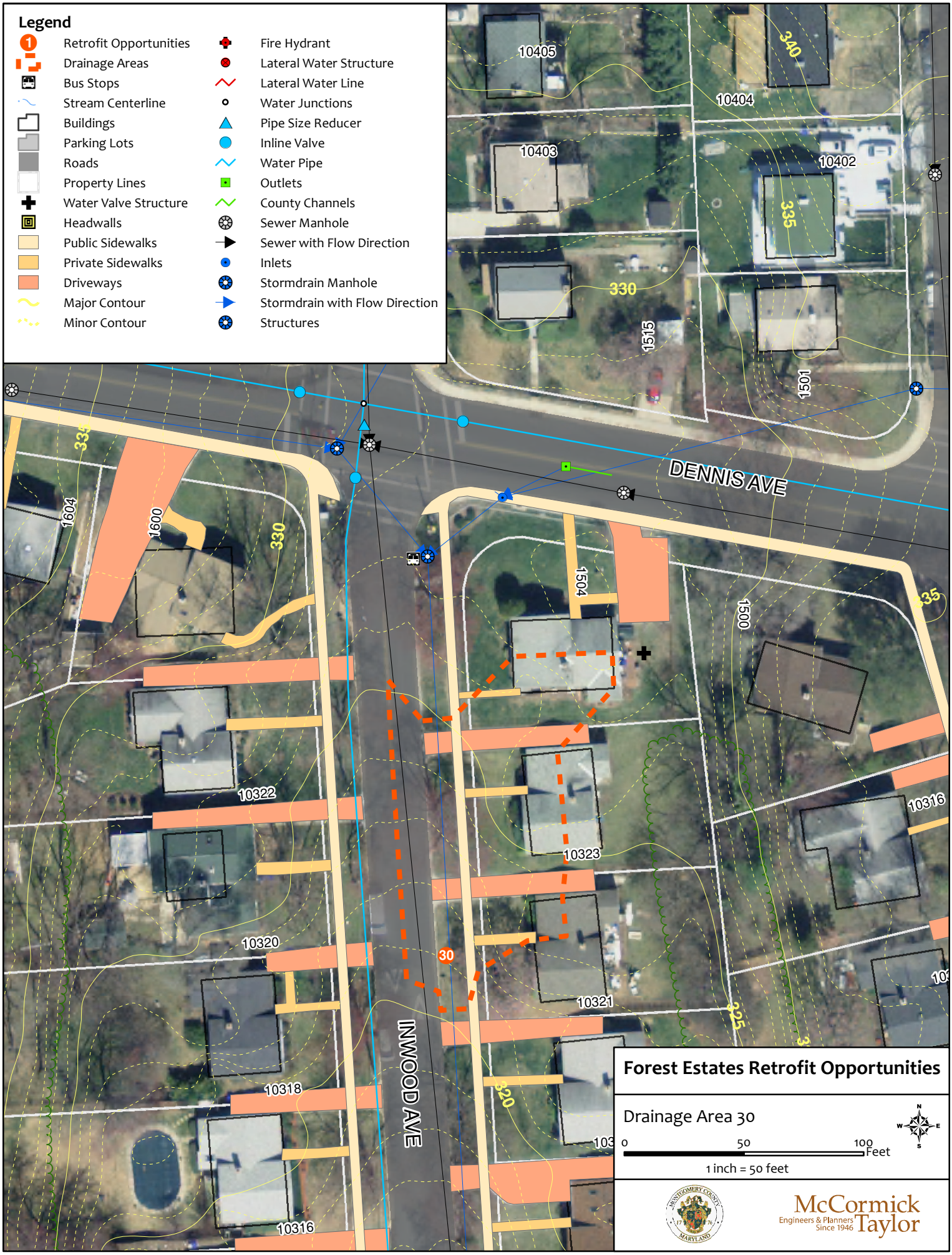
Potential LID Retrofit Type

Rain Garden

Site Notes:

- Existing storm drain system available to tie facility underdrain into
  will need to install a new inlet overtop the existing pipe for bypass/overflow
- Adjacent to existing speed hump - would not impact drainage patterns along curbline

10321 Inwood Avenue - looking north towards Dennis Avenue



Forest Estates Retrofit Opportunities

Drainage Area 30

0 50 100 Feet

1 inch = 50 feet

McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10321 Inwood Ave - BMP 30

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.20	ac	
Imp. to Facility =	0.11	ac	
Percent Impervious =	53%		
R_V =	0.530		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0089	ac-ft	388	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0003	CN =	80.9
I_a/P =	0.18	I_a =	0.47
q_u (csm/in) =	974	P =	2.6
q_i (cfs) =	0.31	S =	2.35
q_o/q_i =	0.019		
q_o (cfs) =	0.006	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	1.011	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	1.01	c_o	0.682
v_s =	0.66	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0111	ac-ft	486	ft^3

Unified Stormwater Management Sizing

10321 Inwood Ave - BMP 30

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.19	97%
C	70	0.00	0%
D	77	0.01	3%

* Actual RCN is less then 30, use RCN=38

Target RCN = 56

Proposed Imperviousness: 53%

A= 8,783 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.95 R_V = 0.530

Computed ESD_V Volume

ESD_v = 0.0160 ac-ft 698 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.95 inches

BMP # 35	Location:	10312 Julep Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.20	51%
Forest	0.00	0%
Open Space	0.19	49%
Total Drainage Area =	**0.39**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.10	50%
ROW - Sidewalk	0.02	10%
On-Lot Impervious	0.08	40%
Total Impervious =	**0.20**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
723	1,301	85	7%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: sanitary
Vegetation:
Other:

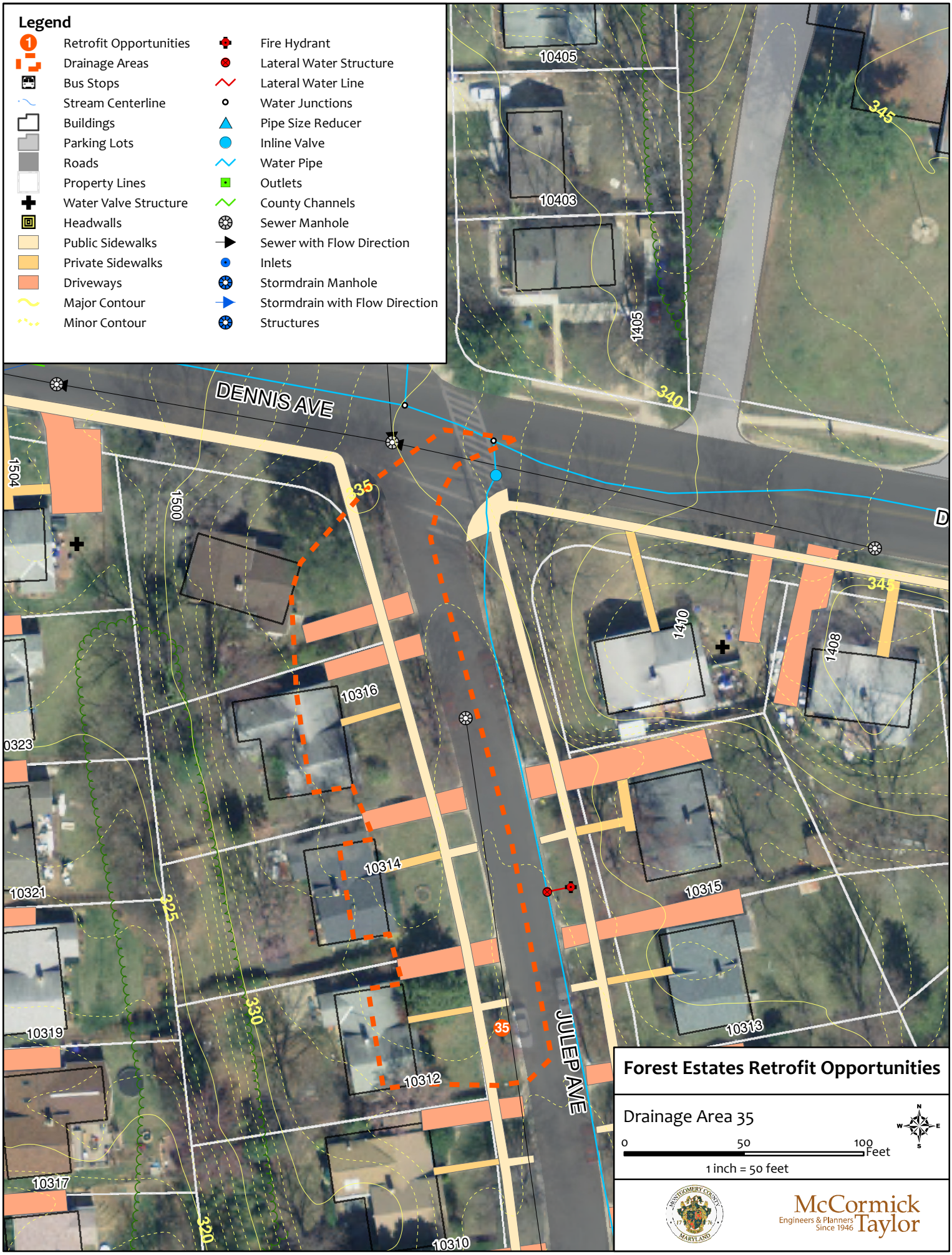
Potential LID Retrofit Type

Rain Garden

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Sanitary runs along curbline in front of 10312 Julep Avenue
- Remove walkway between sidewalk and roadway for pavement removal credit

10312 Julep Avenue - looking south towards Folk Street


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
DENNIS AVE
JULEP AVE
10405
10403
1405
1504
1500
10316
10323
10314
10321
10319
10317
10312
10310
1410
1408
10315
10313
35
345
340
335
330
325
320
Forest Estates Retrofit Opportunities
Drainage Area 35
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10312 Julep Ave - BMP 35

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.39	ac	
Imp. to Facility =	0.20	ac	
Percent Impervious =	52%		
R_V =	0.514		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0166	ac-ft	723	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0006	CN =	84.3
I_a/P =	0.14	I_a =	0.37
q_u (csm/in) =	981	P =	2.6
q_i (cfs) =	0.72	S =	1.86
q_o/q_i =	0.018		
q_o (cfs) =	0.013	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	1.212	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	1.21	c_o	0.682
v_s =	0.80	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0257	ac-ft	1,119	ft^3

Unified Stormwater Management Sizing

10312 Julep Ave - BMP 35

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.23	59%
C	70	0.00	0%
D	77	0.16	41%

* Actual RCN is less then 30, use RCN=38

Target RCN = 64

Proposed Imperviousness: 52%

A= 16,885 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.92 R_V = 0.514

Computed ESD_V Volume

ESD_v = 0.0299 ac-ft 1,301 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.92 inches

BMP # 36	Location:	10315 Julep Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.32	51%
Forest	0.00	0%
Open Space	0.31	49%
Total Drainage Area =	**0.63**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.16	50%
ROW - Sidewalk	0.04	13%
On-Lot Impervious	0.12	38%
Total Impervious =	**0.32**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
1,148	2,067	231	11%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: water, fire hydrant
Vegetation:
Other:

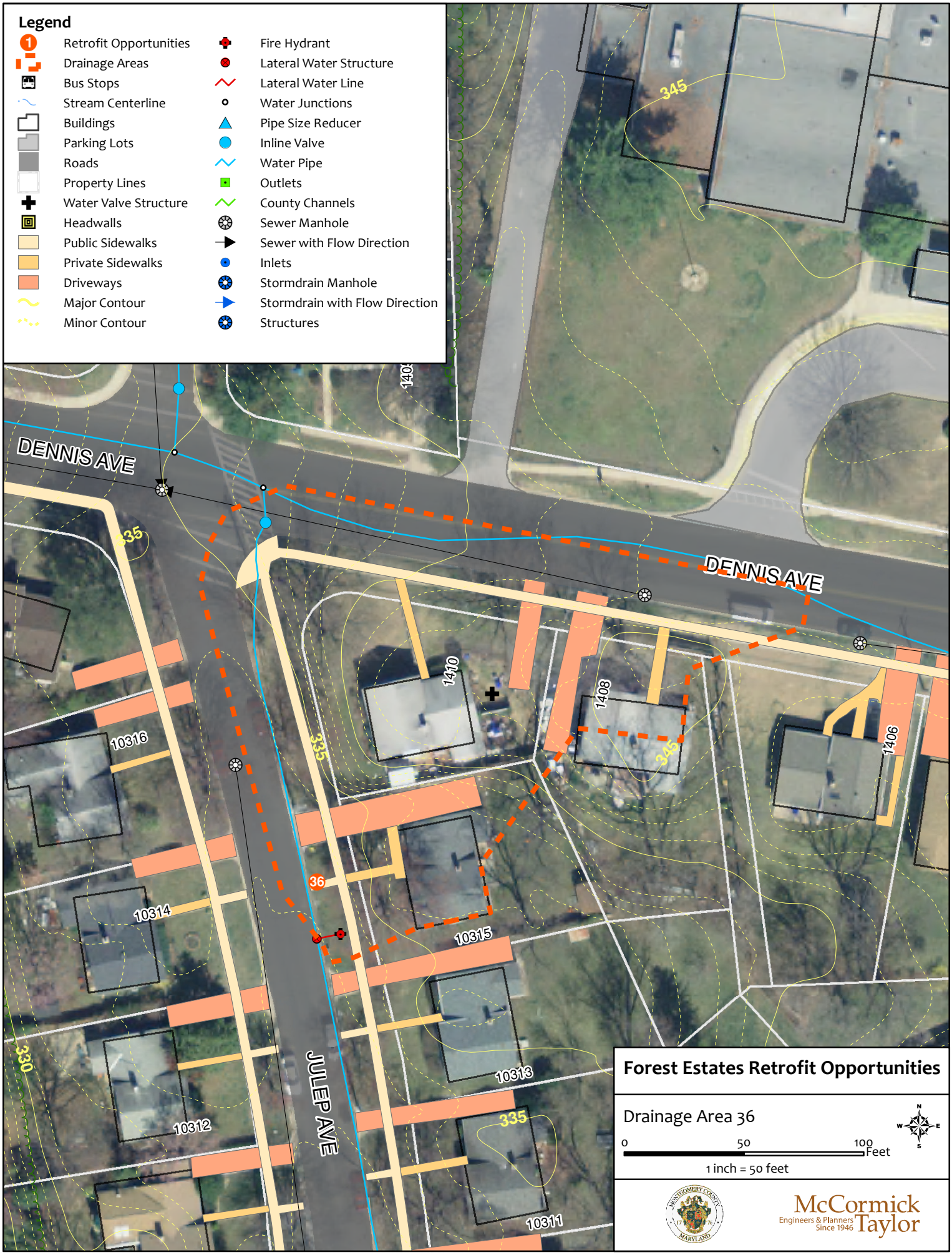
Potential LID Retrofit Type

Rain Garden

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Water runs along curbline, fire hydrant in front of house
- Remove walkway between sidewalk and roadway for pavement removal credit

10315 Julep Avenue - looking north towards Dennis Avenue


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
DENNIS AVE
DENNIS AVE
JULEP AVE
345
335
335
335
330
1410
1408
1406
10316
10314
10312
10315
10313
10311
36
Forest Estates Retrofit Opportunities
Drainage Area 36
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10315 Julep Ave - BMP 36

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.63	ac
Imp. to Facility =	0.32	ac
Percent Impervious =	50%	
R_V =	0.503	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.0264	ac-ft	1,148	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0010	CN =	79.6
I_a/P =	0.20	I_a =	0.51
q_u (csm/in) =	971	P =	2.6
q_i (cfs) =	0.89	S =	2.56
q_o/q_i =	0.019		
q_o (cfs) =	0.017	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.937	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.94	c_o	0.682
v_s =	0.61	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0322	ac-ft	1,405	ft^3

Unified Stormwater Management Sizing

10315 Julep Ave - BMP 36

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.63	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 50%

A= 27,413 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.90 R_V = 0.503

Computed ESD_V Volume

ESD_v = 0.0474 ac-ft 2,067 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.90 inches

BMP # 37	Location:	10312 Folk St Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.16	50%
Forest	0.00	0%
Open Space	0.16	50%
Total Drainage Area =	**0.32**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.06	38%
ROW - Sidewalk	0.01	6%
On-Lot Impervious	0.09	56%
Total Impervious =	**0.16**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
580	1,044	0	0%

Study Area/Outfall	C

Possible Construction Conflicts

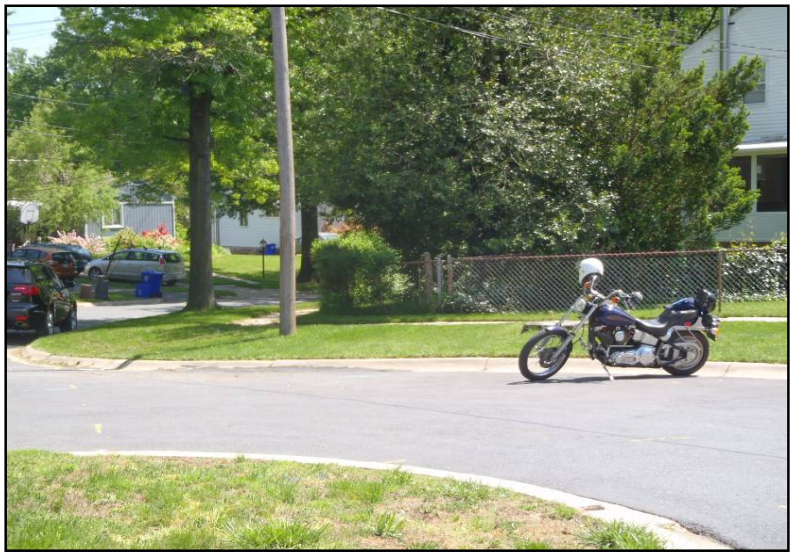
Utilities: sanitary, utility pole
Vegetation: trees
Other:

Potential LID Retrofit Type

Rain Garden

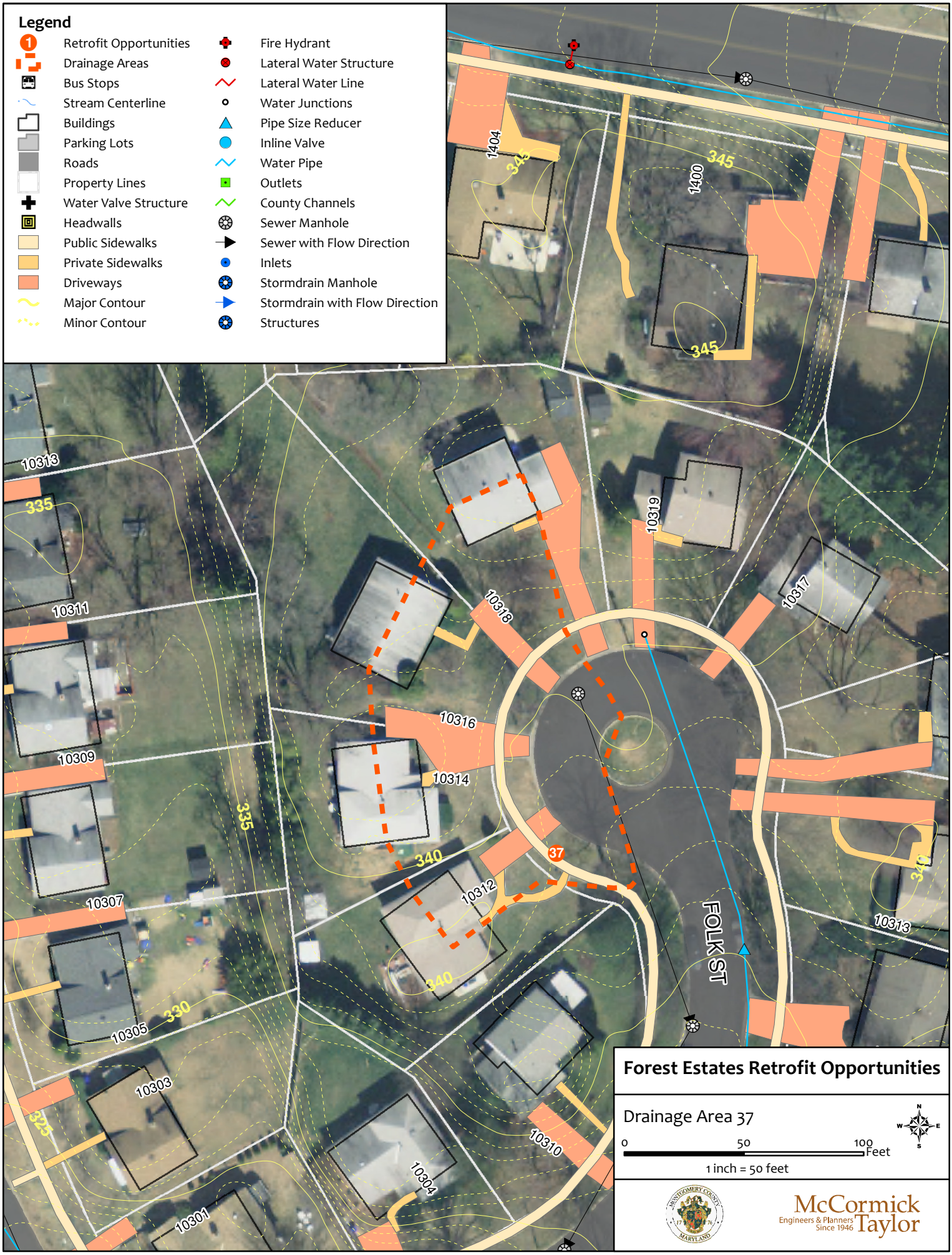
Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates
- Sanitary behind curb between utility pole and tree



10312 Folk Street - looking south

Looking towards the driveway at 10312 Folk Street


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
1404
1400
345
10313
335
10311
10309
10307
10305
330
10303
325
10301
10304
10310
10312
340
10314
10316
10318
10319
10317
37
FOLK ST
Forest Estates Retrofit Opportunities
Drainage Area 37
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10302 Folk St - BMP 37

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.32	ac	
Imp. to Facility =	0.16	ac	
Percent Impervious =	50%		
R_V =	0.499		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0133	ac-ft	580	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0005	CN =	79.4
I_a/P =	0.20	I_a =	0.52
q_u (csm/in) =	970	P =	2.6
q_i (cfs) =	0.45	S =	2.59
q_o/q_i =	0.019		
q_o (cfs) =	0.008	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.929	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.93	c_o	0.682
v_s =	0.61	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0163	ac-ft	708	ft^3

Unified Stormwater Management Sizing

10302 Folk St - BMP 37

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.32	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 50%

A= 13,953 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.90 R_V = 0.499

Computed ESD_V Volume

ESD_v = 0.0240 ac-ft 1,044 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.90 inches

BMP # 41	Location:	10303 Folk St Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.19	43%
Forest	0.00	0%
Open Space	0.25	57%
Total Drainage Area =	**0.44**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.06	32%
ROW - Sidewalk	0.02	11%
On-Lot Impervious	0.11	58%
Total Impervious =	**0.19**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
705	1,268	0	0%

Study Area/Outfall	C

Possible Construction Conflicts

Utilities: water
Vegetation:
Other:

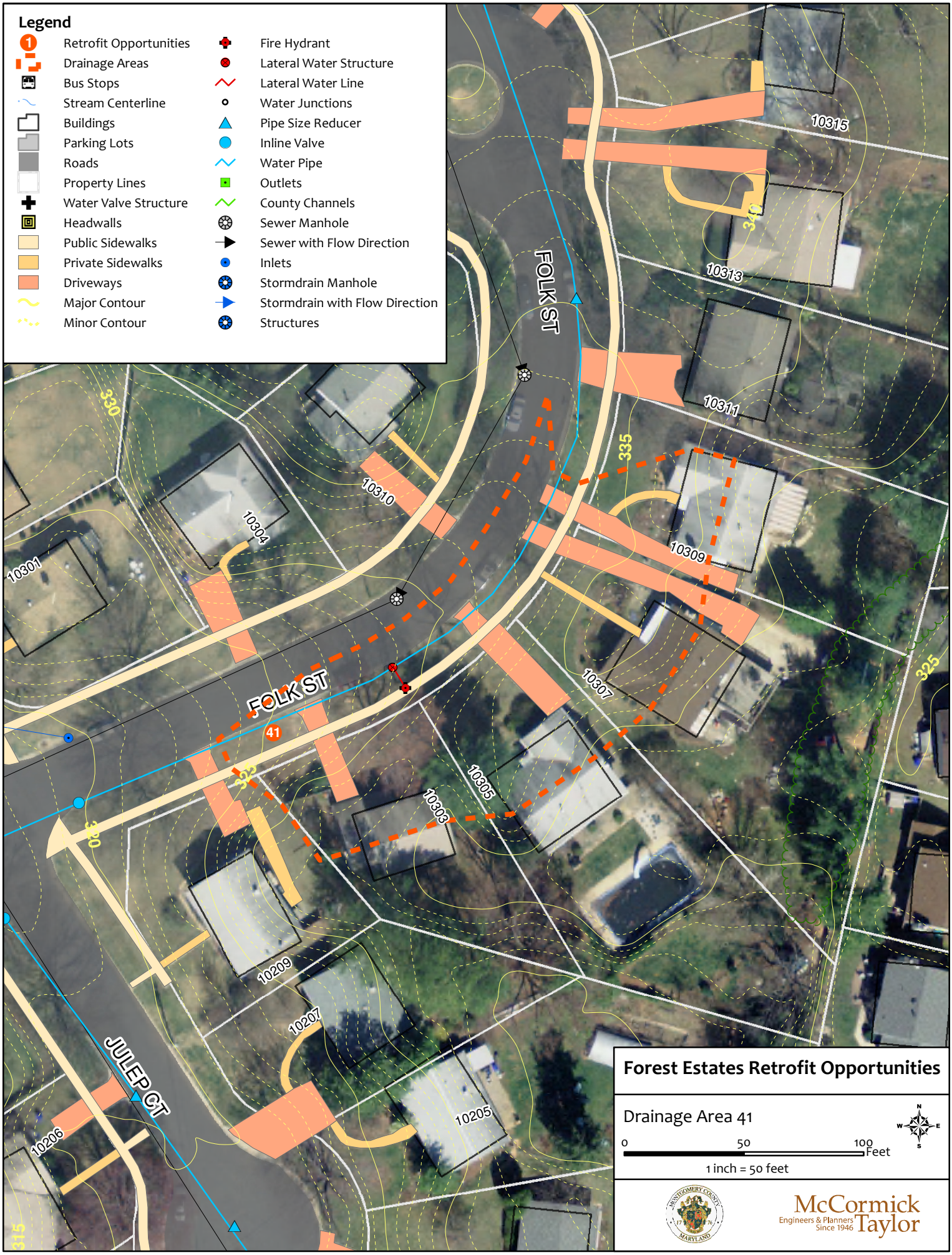
Potential LID Retrofit Type

Bioswale

Site Notes:

- No storm drain system available for underdrain tie in - need to verify infiltration rates

10303 Folk Street - looking east



Forest Estates Retrofit Opportunities

Drainage Area 41

0 50 100 Feet

1 inch = 50 feet

McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10303 Folk St - BMP 41

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.44	ac	
Imp. to Facility =	0.19	ac	
Percent Impervious =	44%		
R_V =	0.442		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0162	ac-ft	705	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0007	CN =	77.1
I_a/P =	0.23	I_a =	0.59
q_u (csm/in) =	964	P =	2.6
q_i (cfs) =	0.54	S =	2.97
q_o/q_i =	0.019		
q_o (cfs) =	0.010	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.810	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.81	c_o	0.682
v_s =	0.53	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0194	ac-ft	846	ft^3

Unified Stormwater Management Sizing

10303 Folk St - BMP 41

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.44	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 44%

A= 19,118 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.80 R_V = 0.442

Computed ESD_V Volume

ESD_v = 0.0291 ac-ft 1,268 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.80 inches

BMP # 42	Location:	10311 Inwood Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.26	53%
Forest	0.00	0%
Open Space	0.23	47%
Total Drainage Area =	**0.49**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.11	42%
ROW - Sidewalk	0.03	12%
On-Lot Impervious	0.12	46%
Total Impervious =	**0.26**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
938	1,689	158	9%

Study Area/Outfall	C

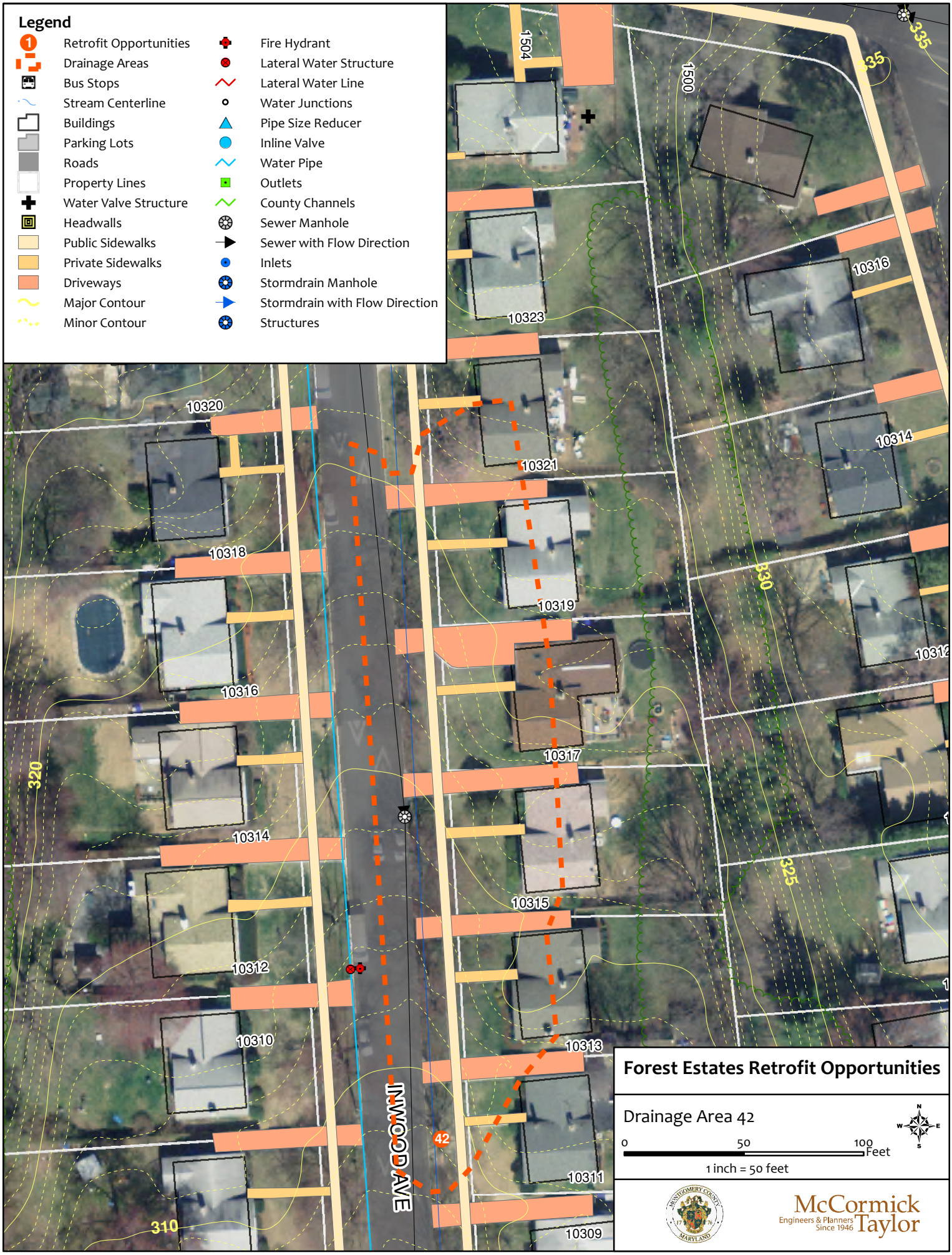
Possible Construction Conflicts

Utilities:
Vegetation:
Other:

Potential LID Retrofit Type

Modified Biofilter

Site Notes:


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
1504
1500
335
10316
10323
10320
10321
10314
10318
10319
330
10312
10316
10317
320
10314
325
10315
10312
10310
10313
INWOOD AVE
42
10311
310
10309
Forest Estates Retrofit Opportunities
Drainage Area 42
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10311 Inwood Ave - BMP 42

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.49	ac		
Imp. to Facility =	0.26	ac		
Percent Impervious =	53%			
R_V =	0.528			
Region =	Eastern		P=	1

Computed Water Quality Volume				
WQ_V =	0.0215	ac-ft	938	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0008	CN =	77.1
I_a/P =	0.23	I_a =	0.59
q_u (csm/in) =	964	P =	2.6
q_i (cfs) =	0.60	S =	2.97
q_o/q_i =	0.019		
q_o (cfs) =	0.011	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.810	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.81	c_o	0.682
v_s =	0.53	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0217	ac-ft	945	ft^3

Unified Stormwater Management Sizing

10311 Inwood Ave - BMP 42

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.49	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 53%

A= 21,344 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.95 R_V = 0.528

Computed ESD_V Volume

ESD_v = 0.0388 ac-ft 1,689 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.95 inches

BMP # 43	Location:	10307 Julep Ave Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.15	54%
Forest	0.00	0%
Open Space	0.13	46%
Total Drainage Area =	**0.28**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.07	47%
ROW - Sidewalk	0.02	13%
On-Lot Impervious	0.06	40%
Total Impervious =	**0.15**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
541	974	110	11%

Study Area/Outfall	C

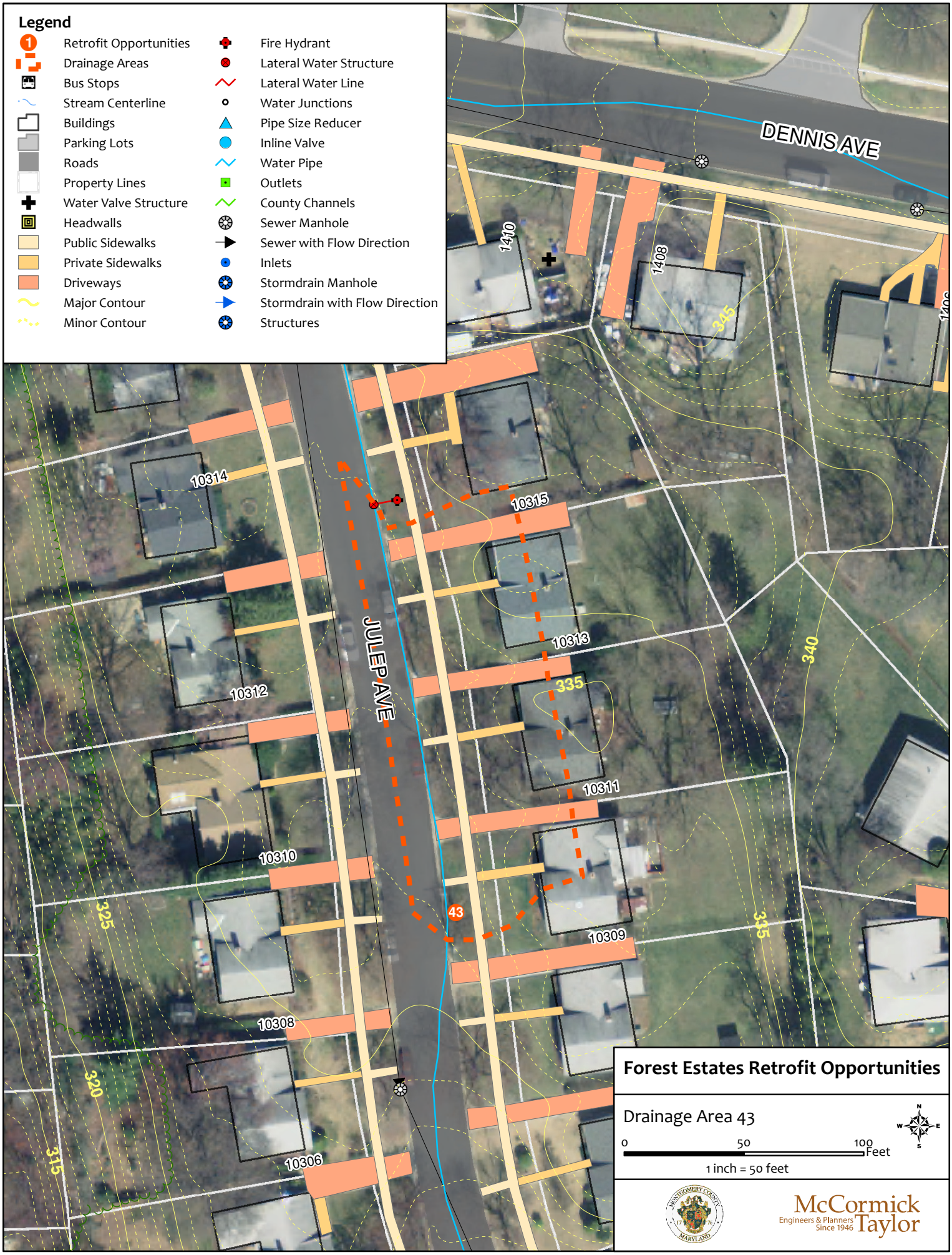
Possible Construction Conflicts

Utilities:
Vegetation:
Other:

Potential LID Retrofit Type

Rain Garden

Site Notes:


Legend
Retrofit Opportunities
Drainage Areas
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
DENNIS AVE
JULEP AVE
1410
1408
345
10314
10315
10313
335
340
10312
10311
10310
325
43
10309
335
10308
320
315
10306
Forest Estates Retrofit Opportunities
Drainage Area 43
0
50
100
Feet
1 inch = 50 feet
McCormick Taylor
Engineers & Planners Since 1946

Unified Stormwater Management Sizing

10307 Julep Ave - BMP 43

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	0.28	ac	
Imp. to Facility =	0.15	ac	
Percent Impervious =	54%		
R_V =	0.532		
Region =	Eastern		P= 1

Computed Water Quality Volume				
WQ_V =	0.0124	ac-ft	541	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0004	CN =	77.1
I_a/P =	0.23	I_a =	0.59
q_u (csm/in) =	964	P =	2.6
q_i (cfs) =	0.34	S =	2.97
q_o/q_i =	0.019		
q_o (cfs) =	0.006	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.810	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.81	c_o	0.682
v_s =	0.53	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.0124	ac-ft	540	ft^3

Unified Stormwater Management Sizing

10307 Julep Ave - BMP 43

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	0.28	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 54%

A= 12,197 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.96 R_V = 0.532

Computed ESD_V Volume

ESD_v = 0.0224 ac-ft 974 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.96 inches

Appendix D:

Study Point D – LID Summary and Computations

Montgomery County - Task 13 Roadway LID
Forest Estates LID Summary

Study Area	BMP #	Location	Existing Hydrology								Stormwater Management						Potential Retrofit Type	Proposed Cost
			Drainage Area (ac)	Total Impervious Area (ac)	Impervious Area (ac)			Forest Area (ac)	Open Space (ac)	Percent Impervious	Target Volumes (ft^3)			Volume Provided (ft^3)	Percent WQ_v Treatment	Percent ESD_v Treatment		
					ROW - Road & DW Aprons	ROW - Sidewalk	Private - Driveway, Walkway & Roof				WQ_v	ESD_v	1 Yr. Volume (Max.)					
D	12	1507 Woodman Ave N. (stream side of the road)	0.16	0.13	0.13	0.00	0.00	0.00	0.03	81.3%	453	816	1,179	781	172%	96%	Bioretention	$26,000
D	13	1505 Woodman Ave N. (stream side of the road)	0.81	0.30	0.16	0.02	0.12	0.02	0.49	37.0%	1,112	2,002	2,892	375	34%	19%	Bioswale	$60,000
D	18	1505/1507 Woodman Ave N. (resident side of road)	1.89	0.55	0.16	0.05	0.34	0.00	1.34	29.1%	2,140	2,996	5,563	111	5%	4%	Bioretention	$110,000
		Controlled Areas (ac)	2.86	0.98							**3,705**	**5,814**	**9,634**	**1,267**	**34%**	**22%**		
		Uncontrolled Areas (ac)	1.65	0.50														
		Study Area Total (ac)	**4.51**	**1.48**							**5,654**	**9,886**	**14,700**	**1,267**	**22%**	**13%**		
D		RainScapes												1,977			assume 20% of ESD_V	
D		Pervious Sidewalk															not utilized for this project	
Total Potential Treament Volume (Study Area D)														**3,244**	**57%**	**33%**		

Unified Stormwater Management Sizing

Outfall D

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	4.51	ac
Imp. to Facility =	1.48	ac
Percent Impervious =	33%	
R_V =	0.345	
Region =	Eastern	P= 1

Computed Water Quality Volume				
WQ_V =	0.1298	ac-ft	5,654	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0070	CN =	75.8
I_a/P =	0.25	I_a =	0.64
q_u (csm/in) =	774	P =	2.6
q_i (cfs) =	4.07	S =	3.19
q_o/q_i =	0.023		
q_o (cfs) =	0.093	Fig 6-1*: v_s/v_r =	0.650
Q_a - runoff (in) 1 yr =	0.746	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.75	c_o	0.682
v_s =	0.49	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.1823	ac-ft	7,942	ft^3

Unified Stormwater Management Sizing

Outfall D

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	3.35	74%
C	70	0.00	0%
D	77	1.16	26%

* Actual RCN is less then 30, use RCN=38

Target RCN = 61

Proposed Imperviousness: 33%

A= 196,456 ft^2

P_E = rainfall target (from Table 5.3) = 1.7

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.60 R_V = 0.345

Computed ESD_V Volume

ESD_v = 0.2269 ac-ft 9,886 ft^3

ESD Targets:

P_E = 1.7485588 inches

Q_E = 0.60 inches

Forest Estates - Study Area D
Design Volumes

12	**Bioretention**			
	Surface Area (ft^2)	**520**	Above Surface Storage (ft^3)	***365***
	Max WSEL Surface Area (ft^2)	**696**	Sub Surface Storage (ft^3)	***416***
	Side Slopes (X:1)	**3**		
	Ponding Depth (ft)	**0.6**		
	Filter Media Depth (ft)	**2**		
	Media Porosity	***0.4***	Treatment Provided (ft^3)	***781***
13	**Bioswale**			
	Surface Area (ft^2)	**43**	Above Surface Storage (ft^3)	***54***
	Max WSEL Surface Area (ft^2)	**136**	Sub Surface Storage (ft^3)	***322***
	Side Slopes (X:1)	**3**		
	Ponding Depth (ft)	**0.6**		
	Filter Media Surface Area (ft^2)	**402**		
	Filter Media Depth (ft)	**2**		
	Media Porosity	***0.4***		
			Treatment Provided (ft^3)	***375***
18	**Bioretention**			
	Surface Area (ft^2)	**59**	Above Surface Storage (ft^3)	***63***
	Max WSEL Surface Area (ft^2)	**152**	Sub Surface Storage (ft^3)	***47***
	Side Slopes (X:1)	**2**		
	Ponding Depth (ft)	**0.6**		
	Filter Media Depth (ft)	**2**		
	Media Porosity	***0.4***	Treatment Provided (ft^3)	***111***
			LID Treatment Provided (ft^3)	***1,267***

Forest Estates - Study Area D
Design Volumes

Rainscapes

20% ESDv

Treatment Provided (ft^3)	***1,977***

Pervious Pavement

Subbase Depth (in)	**12**	(6, 9, 12)
Hydrologic Soil Group	**B**	(A, B, C)
RCN	***55***	
ESDV/ft2	***0.196***	
Equiv. PE (in)	***2.50***	
Sidewalk Surface Area (ft^2)	***3,212***	

Potential Treatment (ft^3)	***630***

Addtional Treatment Provided (ft^3)	***2,607***

Total Treatment Provided (ft^3)	***3,873***

WQ_V (ft^3)	**5,654**
Target ESD_V (ft^3)	**9,886**

BMP # 12	Location:	1507 Woodman Ave N. (stream side of the road) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.13	81%
Forest	0.00	0%
Open Space	0.03	19%
Total Drainage Area =	**0.16**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.13	100%
ROW - Sidewalk	0.00	0%
On-Lot Impervious	0.00	0%
Total Impervious =	**0.13**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
453	816	781	96%

Study Area/Outfall	D

Possible Construction Conflicts

Utilities: sanitary
Vegetation: trees
Other: floodplain, proximity to stream banks

Potential LID Retrofit Type

Bioretention

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into
- Adjacent to storm drain outfall
- Sanitary is present in the road and crosses the stream near the storm drain outfall
- Possible combination of bioretention and tree box filter due to proximity of stream banks and possible stability issues

(refer to BMP #18 for additional BMP at same address)

Woodman Avenue N. looking eastbound across the road from 1507 Woodman Avenue N.

Woodman Avenue N. looking westbound from the existing inlet

Forest Estates Retrofit Opportunities

Drainage Area 12

0 50 100 Feet

1 inch = 100 feet

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BMP # 13	Location:	1505 Woodman Ave N. (stream side of the road) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.30	37%
Forest	0.02	2%
Open Space	0.49	60%
Total Drainage Area =	**0.81**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.16	53%
ROW - Sidewalk	0.02	7%
On-Lot Impervious	0.12	40%
Total Impervious =	**0.30**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
1,112	2,002	375	19%

Study Area/Outfall	D

Possible Construction Conflicts

Utilities: sanitary
Vegetation: trees
Other: floodplain, proximity to stream banks

Potential LID Retrofit Type

Bioswale

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into
- Adjacent to storm drain outfall
- Sanitary is present in the road and connects to a manhole adjacent to the shoulder
- Possible combination of bioretention and tree box filter due to proximity of stream banks and possible stability issues
- Avoid existing hiking trail

(refer to BMP #19 for additional BMP at same address)

Woodman Avenue N. looking westbound across the road from 1505 Woodman Avenue N. (note existing inlet on the left side of the photo)

Woodman Avenue N. looking eastbound across the road from 1505 Woodman Avenue N.

Legend
Retrofit Opportunities
Bus Stops
Stream Centerline
Buildings
Parking Lots
Roads
Property Lines
Water Valve Structure
Headwalls
Public Sidewalks
Private Sidewalks
Driveways
Major Contour
Minor Contour
Fire Hydrant
Lateral Water Structure
Lateral Water Line
Water Junctions
Pipe Size Reducer
Inline Valve
Water Pipe
Outlets
County Channels
Sewer Manhole
Sewer with Flow Direction
Inlets
Stormdrain Manhole
Stormdrain with Flow Direction
Structures
WOODMAN AVE
LEP CT
13
Forest Estates Retrofit Opportunities
Drainage Area 13
0
50
100
Feet
1 inch = 100 feet
McCormick Taylor
Engineers & Planners
Since 1946

BMP # 18	Location:	1505/1507 Woodman Ave N. (resident side of road) Forest Estates Neighborhood	Inspection Date:	1/10/2011

Hydrology Summary

Land Use	Area (ac)	Percentage
Impervious Area	0.55	29%
Forest	0.00	0%
Open Space	1.34	71%
Total Drainage Area =	**1.89**	**100%**

Impervious Area Breakdown

Area Type	Area (ac)	Percentage
ROW - Road & Driveways	0.16	29%
ROW - Sidewalk	0.05	9%
On-Lot Impervious	0.34	62%
Total Impervious =	**0.55**	**100%**

SWM Volume Summary (ft^3)

Target Treatment		Treatment Provided	% ESD_V Treated
WQ_V	ESD_V		
2,140	2,996	111	4%

Study Area/Outfall	D

Possible Construction Conflicts

Utilities: sanitary
Vegetation: 1 small tree
Other: walkway between the sidewalk and roadway

Potential LID Retrofit Type

Bioretention

Site Notes:

- Existing storm drain system and inlet available to tie facility underdrain into
- Sanitary manhole is present in front of 1507, sanitary line runs in front of 1505
- Water present in the roadway - possible house connections
- Remove walkway between sidewalk and roadway for pavement removal credit

(refer to BMP #12 for additional BMP at same address)

1507 Woodman Avenue N. looking east - note existing inlet in the background

1507 Woodman Avenue N. looking west from the existing inlet

Forest Estates Retrofit Opportunities

Drainage Area 18

0 50 100 Feet

1 inch = 100 feet

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Engineers & Planners Since 1946

Appendix E:

Study Point E – LID Summary and Computations

Montgomery County - Task 13 Roadway LID
Forest Estates LID Summary

Study Area	BMP #	Location	Existing Hydrology								Stormwater Management						Potential Retrofit Type	Proposed Cost
			Drainage Area (ac)	Total Impervious Area (ac)	Impervious Area (ac)			Forest Area (ac)	Open Space (ac)	Percent Impervious	Target Volumes (ft^3)			Volume Provided (ft^3)	Percent WQ_v Treatment	Percent ESD_v Treatment		
					ROW - Road & DW Aprons	ROW - Sidewalk	Private - Driveway, Walkway & Roof				WQ_v	ESD_v	1 Yr. Volume (Max.)					
E																		$0
		Controlled Areas (ac)	0.00	0.00							0	0	0	0	0%	0%		
		Uncontrolled Areas (ac)	2.46	0.95														
		Study Area Total (ac)	**2.46**	**0.95**							**3,550**	**6,390**	**9,230**	**0**	**0%**	**0%**		
E		RainScapes												1,278			assume 20% of ESD_v	
E		Pervious Sidewalk															not utilized for this project	
Total Potential Treament Volume (Study Area E)														**1,278**	**36%**	**20%**		

Unified Stormwater Management Sizing

Outfall E

Montgomery County Task 13 - Forest Estates

Water Quality Volume - WQ_V

Water Quality Volume:	Rainfall Depth	
$WQ_V = [(P)*(R_V)*(A)]/12$	Region	P
$R_V = 0.05+0.009(I)$	Eastern Zone	1 inch
A = Site Area (acres)	Western Zone	0.9 inch

Site Information

DA to Facility =	2.46	ac		
Imp. to Facility =	0.95	ac		
Percent Impervious =	39%			
R_V =	0.398			
Region =	Eastern		P=	1

Computed Water Quality Volume				
WQ_V =	0.0815	ac-ft	3,550	ft^3

Channel Protection Volume - Cp_V (1yr, 24hr management)

Drainage area (mi^2) =	0.0038	CN =	78.6
I_a/P =	0.21	I_a =	0.54
q_u (csm/in) =	955	P =	2.6
q_i (cfs) =	3.25	S =	2.72
q_o/q_i =	0.019		
q_o (cfs) =	0.061	Fig 6-1*: v_s/v_r =	0.656
Q_a - runoff (in) 1 yr =	0.886	(eq. 2-3, TR-55 Manual)	

* equation on p. F-1 used instead of figure (TR-55 Manual)

v_r =	0.89	c_o	0.682
v_s =	0.58	c_1	-1.43
		c_2	1.64
		c_3	-0.804

Computed Cp_v - Quantity Volume				
Cp_v =	0.1191	ac-ft	5,188	ft^3

Unified Stormwater Management Sizing

Outfall E

Montgomery County Task 13 - Forest Estates

ESD Sizing Requirements

Pre-Developed Conditions: (calculate the RCN for "woods in good condition")

HSG	RCN	Area	Percent
A*	38	0.00	0%
B	55	2.46	100%
C	70	0.00	0%
D	77	0.00	0%

* Actual RCN is less then 30, use RCN=38

Target RCN = 55

Proposed Imperviousness: 39%

A= 107,158 ft^2

P_E = rainfall target (from Table 5.3) = 1.8

Q_E = runoff depth in inches that must be treated using ESD practices

$Q_E = P_E x R_V$

ESD_v = runoff volume used in the design of specific ESD practices

$ESD_v = ((P_E)(R_V)(A))/12$

Q_E= 0.72 R_V = 0.398

Computed ESD_V Volume

ESD_v = 0.1467 ac-ft 6,390 ft^3

ESD Targets:

P_E = 1.8 inches

Q_E = 0.72 inches

Forest Estates - Study Area E
Design Volumes

LID Treatment Provided (ft^3)	***0***

Rainscapes

20% ESDv

Treatment Provided (ft^3)	***1,278***

Pervious Pavement

Subbase Depth (in)	**12**	(6, 9, 12)
Hydrologic Soil Group	**B**	(A, B, C)
RCN	***55***	
ESDV/ft2	***0.196***	
Equiv. PE (in)	***2.50***	
Sidewalk Surface Area (ft^2)	***3,164***	

Potential Treatment (ft^3)	***620***

Addtional Treatment Provided (ft^3)	***1,898***

Total Treatment Provided (ft^3)	***1,898***

WQ_V (ft^3)	**3,550**
Target ESD_V (ft^3)	**6,390**

Appendix G:

Geotechnical Subsurface Investigation Report

Appendix F:

Forest Estates Retrofit Opportunities Map