

University Park Flood Attenuation

Potential SWM Facilities Assessment Report

Introduction

The Town of University Park is proposing to implement several stormwater management and storm drain improvements to provide flood mitigation within frequently flooded areas of the town. The Town contracted Rummel, Klepper and Kahl, LLC (RK&K) to assess potential opportunities for these stormwater management facilities. The objective of the assigned task was to recommend and conceptually present feasible stormwater management facilities and drainage improvement locations to manage runoff from the streets, driveways, and sidewalks during large storm events. On May 4, 2022, RK&K met with Town officials to review a draft list of potential locations and conduct an initial site visit. During May 2022, RK&K completed more detailed site assessments while searching for other potential opportunities.

This report summarizes the findings of the assessment and provides recommendations for the types and sizes of stormwater management facilities. Included with the report are supplemental exhibits showing the project location, proposed stormwater facilities and/or drainage improvements, suggested stormwater facility priority ranking and supporting concept design computations. The Appendices section includes:

- *Appendix 1: Location Map and Potential SWM Sites (provided by Town)*
- *Appendix 2: Priority Ranking Tables*
- *Appendix 3: SWM and Storm Drain Computations*
- *Appendix 4: Example Typical Sections of Proposed Stormwater Management Practices*
- *Appendix 5: Potential SWM Opportunities Concept Plans*
- *Appendix 6: Cost Estimate Tables*

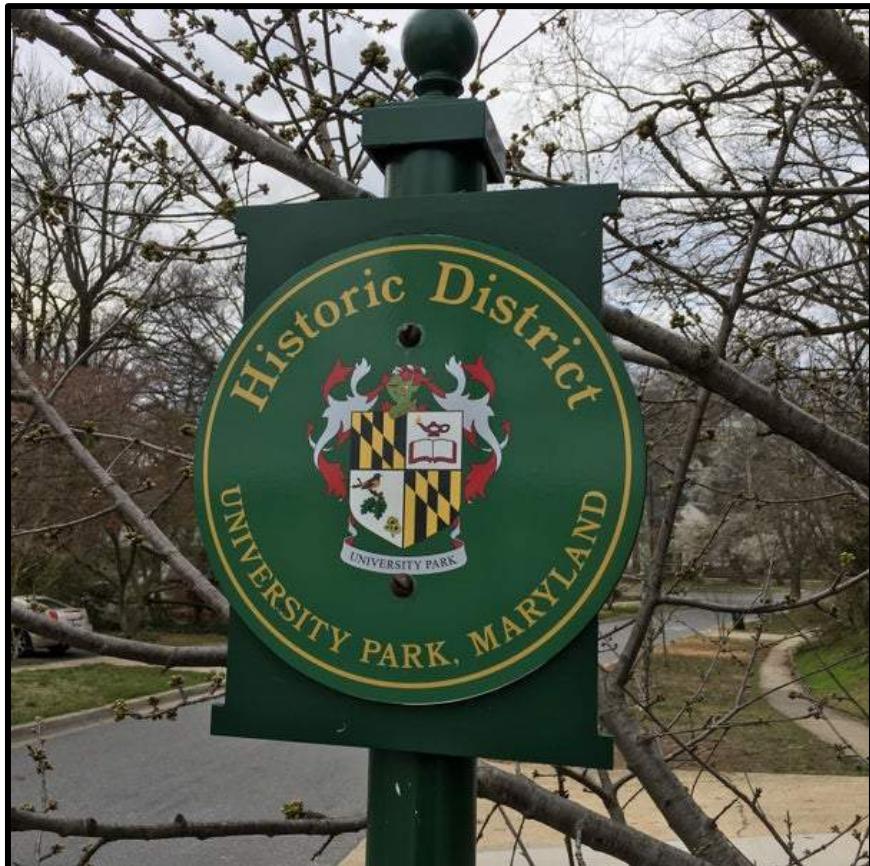
Project Area Description

The project area is limited to the Town of University Park located in Prince George's County, northeast of Washington, DC. It extends as far west as Adelphi Road, as far north as Wells Parkway and Clagett Road, as far east as Baltimore Ave, and as far south as East-West Highway. The Town's limits fall within the watershed of two tributaries to the Northeast Branch of the Anacostia River; Guilford Run lies just north of the Town's limits, while Wells Run approximately bisects the community. Both watersheds have been identified as susceptible to frequent and significant flooding. Based on the Web Soil Survey (NRCS), the soils within the Town fall predominantly within the 'D' Hydrological Soil Group (HSG) with an area of HSG C located in the northeast corner. HSG D soils are classified as having a very slow infiltration rate resulting in a high runoff potential when thoroughly wet. They generally consist of soils with a high water table and high clay content.

Site Assessments and Results

During the project initiation phase, the Town provided RK&K an Excel spreadsheet of potential sites for improvements within the town. The locations were discussed and expanded upon during the May 4, 2022 visit conducted with the Town (See Appendix 1 for compiled spreadsheet for reference). Table 1 presents the

UNIVERSITY PARK FLOOD ATTENUATION POTENTIAL SWM FACILITIES ASSESSMENT



Prepared for:

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location names as identified by the Town with RK&K site reference numbers corresponding to each location. Additional sites identified by RK&K are listed and discussed in later sections of this report.

Table 1. RK&K Sites Corresponding to Locations

Location Name	Corresponding RK&K Site(s)
1. 43rd Avenue Dead End	17
2. Clagett-Pineway/Pineway SW System	1, 2, 3, 4, 5, 6, 7, 7a, 7b
3. 4401 College Heights Drive	--
4. 4000 Block Beechwood	25, 26
5. Tuckerman/Sheridan	30
6. & 7. 44th Avenue at Van Buren, 4400 Block Van Buren	12, 13, 14
8. 6500 44th Avenue	--
9. 40th Avenue Cul-de-sac, Unnamed Alley between 40th Avenue and 41st Avenue Cul-de-sac, 41st Avenue Cul-de-sac, Alley Behind 6507 Adelphi Road	19, 20, 21, 22, 23
10. 6724 Baltimore Road	31
11. 6513 Queens Chapel Road	18
12. 4413 Tuckerman Street	15a, 15b
13. & 14. Clean Water Partnership	--
15. 7000-7100 Block of Wells Parkway	28, 29, 34
16. 6705 44th Avenue	11
17. 6922 Pineway	8

An initial desktop analysis was performed to identify potential site constraints and prepare site assessment mapping using publicly available GIS data. Since underground utilities present a significant feasibility constraint, potential utility conflicts were identified using record documents, coordination with utility companies, and GIS data. Field assessments were conducted to further evaluate site feasibility, topographical features and contributing flooding factors such as insufficient drainage interception or conveyance.

The types of stormwater management practices considered in the assessment included bioretention facilities, micro-bioretention facilities, bioswales, pervious pavement and various storm drain improvements. To evaluate the priority for project implementation, a ranking system was developed based on such factors as stormwater retention benefit, treatment area, degree of utility and tree impacts, context, property impact and conceptual cost. The proposed facilities were ranked using the scoring system presented below in Figure 1. Drainage area delineations and preliminary hydrologic and hydraulic (H&H) computations were completed to size facilities and quantify parameters for the ranking system. The H&H computations can be found in Appendix 3.

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Facility Drainage Area		
		RANKING
		High A 17-25
	Large drainage area	6
	Medium drainage area	3
	Small drainage area	1
Facility Performance within Available Footprint¹		
		Medium B 9-16
	Runoff/Retention Volume High	6
	Runoff/Retention Volume Medium	3
	Runoff/Retention Volume Low	1
Stormdrain connection²		
		Low C 3-8
	High (adjacent stormwater inlet/manhole)	3
	Medium (connection to pipe/roadway impact)	2
	Low (connection to pipe/roadway impact/ potential utility impact)	1
Tree Impacts³		
		No existing tree or dead tree
		3
		Recently planted or young trees
		2
		Established but damaged trees
		1
Utility conflict⁴		
		No conflict
		3
		Minor (perpendicular or adjacent)
		2
		Within offset or cable
		1
Community Aesthetics and Engagement⁵		
		Yes
		2
		No
		0
Property Conflicts⁶		
		Yes
		-2
		No
		0
Grouped⁷		
		Yes
		2
		No
		0

1. Volume of stormwater treated per available footprint of proposed facility
2. Only facilities within a reasonable distance to the SW system were considered
3. All areas near mature trees or within mature tree root zones were discarded
4. Areas with major utility conflicts were not considered. Utility clearances vary.
5. Community enhancement, and educational opportunities
6. Not within the town's right-of-way
7. Proposed facilities in a cluster. Easier maintenance

Figure 1. University Park Scoring and Ranking Chart

This assessment included thirteen (13) facilities and six (6) storm drain improvements (see Appendix 2). Tables 2 and 3 present the assessed facilities and storm drains from the highest ranked to the lowest. The assessment resulted in the recommendation of one (1) improved storm drain system, two (2) detention/pond systems, and eleven (11) microbioretention facilities with "A" ranking (Table 2). Further ranking details are presented in Appendix 2. Cost estimates for each improvement are listed in Appendix 6. For reference, example facility typical sections of the recommended improvements can be found in Appendix 4. Plans showing the concept layouts of the stormwater management and storm drainage facilities are included in Appendix 5.

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Table 2. University Park SWM Facilities Rankings and Costs

Facility ID	Green Infrastructure Type	Score	Ranking	Cost
32	<i>Micro-Bioretention</i>	21	A	\$115,841.70
33	<i>Wet Pond</i>	21	A	\$156,338.30
31	<i>Micro-Bioretention</i>	20	A	\$56,745.45
8	<i>Detention Facility*</i>	19	A	\$149,330.25
18	<i>Micro-Bioretention</i>	19	A	\$75,862.80
22	<i>Micro-Bioretention</i>	18	A	\$53,809.43
23	<i>Micro-Bioretention</i>	18	A	\$80,424.00
28	<i>Micro-Bioretention</i>	18	A	\$124,781.40
27	<i>Micro-Bioretention</i>	17	A	\$102,505.05
20	<i>Micro-Bioretention</i>	17	A	\$89,420.18
34	<i>Micro-Bioretention</i>	17	A	\$85,628.93
15A	<i>Micro-Bioretention</i>	17	A	\$26,007.53
15B	<i>Micro-Bioretention</i>	17	A	\$20,749.73
9	<i>Micro-Bioretention</i>	16	B	\$79,029.45
29	<i>Micro-Bioretention</i>	15	B	\$72,225.45
30	<i>Micro-Bioretention</i>	15	B	\$104,354.10
	<i>Curb Cut to Existing</i>			
24	<i>Micro-Bioretention</i>	14	B	\$475.00
21	<i>Infiltration Trenches</i>	12	B	\$27,735.75

* Does not include property acquisition cost

Table 3. University Park Storm Drain Rankings and Costs

Facility ID	Green Infrastructure Type	Score	Ranking	Cost
16	<i>Storm Drain</i>	17	A	\$91,496.25
12	<i>Storm Drain</i>	15	B	\$51,583.50
11	<i>Storm Drain</i>	13	B	\$13,277.25
13	<i>Storm Drain</i>	13	B	\$28,903.50
14	<i>Storm Drain</i>	12	B	\$29,146.50
32A	<i>Storm Drain</i>	9	B	\$36,288.00

The following is a brief description of the assessment locations and recommended action corresponding to the Town's and RK&K naming conventions.

Location 1: 43rd Avenue Dead End (RK&K SWM Site 17)

The dead end of 43rd avenue was identified by the Town as an area for a potential drainage swale reconstruction and asphalt replacement. No action is recommended in this location. The Town notified RK&K that this area is being upgraded in coordination with an on-going Prince George's County program.

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Location 2: Clagett-Pineway/Pineway SW System (RK&K Storm Drain Sites 1,2,3,4,5,6,7,7a,7b)

The Town identified Clagett-Pineway as a candidate for drainage improvements including extending the existing storm drain system upstream to Woodberry Street. No action is recommended in this location. The Town notified RK&K that this area is being upgraded in coordination with an on-going Prince George's County program.

Location 3: 4401 College Heights Drive

The Town identified 4401 College Heights Drive as eligible for a rain garden at the road realignment. Discussions during the site visit indicated there was some uncertainty and/or decision at this location; therefore, no recommended action is provided as this time.

Location 4: 4000 Block Beechwood (RK&K SWM Sites 25, 26)

The Town identified the potential for a rain garden within the triangle formed by 40th Avenue, College Heights Drive, and Beechwood Road as well as the circle formed by Beechwood Road. No action is recommended in this location. A micro-bioretention facility was considered in the triangle (RK&K SWM Site 25), but placement faced conflict from tree roots and sanitary sewer and water utilities. The circle formed by Beechwood Rd (RK&K SWM Site 26) was also considered for a micro-bioretention facility, but it would provide little stormwater management storage, had difficulty connecting to an existing storm drain network, and faced the same utility conflicts with sanitary sewer and water lines. Thus, both sites are not recommended for any stormwater improvements.

Location 5: Tuckerman/Sheridan (RK&K SWM Site 30)

Recommended Action: This location includes the construction of bioretention off 44th Avenue in the park. While initial assessments considered a larger SWM facility within the park limits, we are not in favor of such a facility since it appears the area already experiences flooding issues and sending more water and/or storing water may further worsen the problem. Further hesitation would be the impact to mature trees. Accordingly, we propose an alternative of constructing a smaller micro-bioretention off 44th Avenue to treat the impervious area from the vicinity. This bioretention facility discharges through an underdrain to Wells Run.

Locations 6 & 7: 44th Avenue at Van Buren Street, 4400 Block Van Buren Street (RK&K Storm Drain Sites 12,13,14)

Recommended Action: Construct three inlets on the southern side of Van Buren Street. These inlets will reduce the water spread into the road and capture excess runoff before it can overtop the curb and contribute flooding to nearby properties. The inlets will tie into the existing storm drain system on the northern side of Van Buren Street. This action focuses on capturing stormwater and directing it to a closed system and does not require regrading. Future improvement efforts could involve collecting survey data to determine if regrading is feasible and determine potential impacts to adjacent infrastructure based on the roadway geometry. Adding a combination inlet on Baltimore Avenue upstream of Van Buren Street was also considered. However, this

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configuration resulted in the connecting pipe conflicting with an ADA ramp and water utility line. Accordingly, inlets were proposed only along Van Buren Street.

Location 8: 6500 44th Avenue

Recommended Action: Construct a berm with a top elevation of 56' to provide protection at 6500 44th Avenue north of Wells Run. The berm elevation corresponds to providing protection from Wells Run during up to the 10-year storm. To predict the 10-yr storm elevation, discharge estimates to the culverts under 44th Avenue and further downstream at Baltimore Avenue were developed based on the Fixed Region Regression Equations as recommended by the Maryland Hydrology Panel. Discharges were input into the Federal Highway Administration's HY-8 Culvert Hydraulic Analysis Program to determine headwater elevations. Headwater elevations upstream of 44th Avenue considered the effects of tailwater generated by the Baltimore Avenue culvert crossing and were used in conjunction with the most recent LIDAR data to determine the approximate location of the berm.

Location 9: 40th Avenue Cul-de-sac, Unnamed Alley between 40th Avenue and 41st Avenue Cul-de-sac, 41st Avenue Cul-de-sac, Tennyson Road, and Alley Behind 6507 Adelphi Road (RK&K SWM Sites 19, 20, 21, 22, 23, and 24)

The Town identified the cul-de-sac end of 40th Avenue, the Unnamed Alley between 40th Avenue and 41st Avenue, the cul-de-sac end of 41st Avenue as potential pave drain locations for stormwater management.

Existing ditches along a gravel driveway between 4010 and 4012 Tennyson Road and the alley behind 6507 Adelphi Road were identified as having existing drainage issues. Additionally, an existing SWM facility at the downstream limits of Tennyson Road adjacent to Town Park was identified as an existing facility that didn't receive drainage.

Recommended Action: No action is recommended for the alley behind 6507 Adelphi Road (RK&K SWM Site 19). Improvements in this area are not impossible but were deemed expensive and difficult to construct within the confines of the alley.

Provide micro-bioretentions (RK&K SWM Sites 20, 22, 23) near the cul-de-sacs and Wells Run to treat stormwater. Permeable pavement/pave-drain was considered as a potential stormwater management approach in these locations; however, the underlying D-soils cause the site to be unsuitable for these types of improvements per MDE guidelines. While not recommended, permeable pavement could be installed with an underdrain to ensure proper drainage. This would provide some water quantity storage but would not treat water quality effectively.

Infiltration trenches are proposed on either side of the existing gravel driveway off Tennyson Road (RK&K SWM Site 21). These are intended to reduce ponding along the edges of the driveway and to convey the stormwater downstream to the gutter of Tennyson Road.

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Provide a cut in the curb in front of the existing bioretention facility (RK&K SWM Site 24) at the end of Tennyson Road. This will allow the facility to capture and treat the runoff from Tennyson Road that is currently being blocked by the curb.

Location 10: 6724 Baltimore Road (RK&K SWM Site 31)

Recommended Action: Installation of permeable/pave-drain pavement in the parking lot at 6724 Baltimore Road (Town Hall) was considered. However, the underlying soils D-soils cause the site to be unsuitable for this type of improvement per MDE guidelines. While not recommended, permeable pavement could be installed with an underdrain to ensure proper drainage. This would provide some water quantity storage but would not treat water quality effectively. As an alternative to pave-drain pavement, a micro-bioretention is proposed in open space near the southern entrance to the parking lot. This facility would discharge to the west of the parking lot, drain to RK&K Storm Drain Site 11 and ultimately tie-into an existing curb-on-grade (COG) inlet.

Location 11: 6513 Queens Chapel Road (RK&K SWM Site 18)

Recommended Action: Installation of permeable pavement in the parking lot at 6513 Queens Chapel Road (Langley Park Spanish Seventh-day Adventist Church parking lot) was considered. However, the underlying soils D-soils cause the site to be unsuitable for this type of improvement. See Recommended Action discussion for Location 10. As an alternative to permeable pavement, a micro-bioretention is proposed in open space adjacent to the Church. This facility would discharge to RK&K Site 16 and ultimately tie-into an existing combination inlet.

Location 12: 4413 Tuckerman Street (RK&K SWM Sites 15a and 15b)

Recommended Action: Installation of permeable pavement in the parking lot at 4413 Tuckerman Lane (Iglesia Fuente De Vida Church parking lot) was considered. The underlying soils D-soils cause the site to be unsuitable for this type of improvement. See Recommended Action discussion for Location 10. As an alternative to permeable pavement, micro-bioretentions are proposed within grass strips between Tuckerman Street and the Church's parking lot. The facilities can discharge to an existing COG inlet at the intersection of Tuckerman Street and Baltimore Avenue.

Locations 13 and 14: Queens Chapel Road (RK&K SWMM Site 16)

Recommended Action: Discussions during the field visit with the Town included the Clean Water Partnership and how they may be involved future projects including potentially providing dry wells along Queens Chapel Road. The underlying soils D-soils cause the site to be unsuitable for this type of improvement. Per Chapter 5 of Maryland's Stormwater Design Manual, dry wells should only be installed in soils groups A or B; therefore, these sites were not progressed. While not recommended, dry wells could be installed if a suitable outfall is determined for the underdrain to ensure proper drainage. During the field visit, the town also indicated that a large amount of unsuitable material, within unknown horizontal limits, may be beneath Queens Chapel Road that could present challenges during construction.

The flow line adjacent to parking spaces, in front of Langley Park Spanish Seventh-day Adventist Church and along Queens Chapel Road was identified as an area of potential drainage improvement. Queens Chapel Road

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and the parking spaces are graded such that flow leaves the curb line and continues down Queens Chapel Road adjacent to the travel lane instead of following the curb line. This occurs because the existing grades effectively form a v-ditch along the travel lane where the parking spaces begin.

Provide a concrete gutter to channel the flow behind the parking spaces to a proposed combination inlet downstream of the parking spaces, at the entrance to the Church's parking lot. Initially a combination inlet was proposed prior to the parking spaces along Queens Chapel Road, however this resulted in an excessively long pipe to connect to the downstream existing inlet.

Location 15: 7000-7100 Block of Wells Parkway (RK&K SWM Sites 28, 29, 34)

Recommended Action: Wells Parkway, west of Eversfield Drive, was identified as a location with wide right-of-way width between Wells Parkway and residential houses to the south-southwest. Provide micro-bioretentions (RK&K SWM Sites 28 and 29) at the intersections of Wells Parkway and Calverton Road in the southwest quadrant and discharge the facilities to existing infrastructure. Provide a micro-bioretention (RK&K SWM Site 34) at the intersection of Wells Parkway and Eversfield Drive in the southwest quadrant and discharge the facility to Wells Run. These three locations were chosen as they are in open space with accessible discharge points. Other locations along Wells Parkway were considered but not furthered because limited drainage contributions, tree impacts, or the presence of Wells Run which begins at the intersection of Wells Parkway and Calverton Road in the southeast quadrant.

Location 16: 6705 44th Avenue (RK&K Storm Drain Site 11)

Recommended Action: An existing drainage ditch runs between 6705 and 6707 44th Avenue that discharges through the sidewalk to 44th Avenue's curb line via a metal topped trench drain. A significant grade difference exists between the sidewalk and ditch's flowline that presents a potential hazard to pedestrians walking along the sidewalk.

Regrade the ditch as necessary to provide positive flow into a single Type K inlet (open-end grate for non-traffic areas) to collect drainage and have a 15" RCP from the Type K inlet discharge to an adjacent curb-on-grade inlet. The Type K inlet should be constructed such that it is similar in elevation to that of the sidewalk to reduce hazard potential in case a pedestrian steps off the sidewalk.

Location 17: 6922 Pineway (RK&K SWM Site 8)

Recommended Action: Purchase the vacant residential property at 6922 Pineway, provide a SWM detention facility, and have the upstream drainage infrastructure discharge into the facility. Using a SWM control structure, have the detention facility discharge into existing downstream infrastructure.

RK&K Additional Site Assessments and Results

In addition to the locations noted by the Town above, RK&K identified further locations that are recommended for stormwater management improvements below.

RK&K SWM Site 9: Queens Chapel Road and Pineway

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RK&K investigated drainage improvement opportunities along Queens Chapel Road including the northern portion up to Pineway. No action is recommended in this location. The Town notified RK&K that this area is being upgraded in coordination with an on-going Clean Water Partnership project.

RK&K SWM Site 27: Across from 6603 Wells Parkway

Recommended Action: Due to the available space, RK&K identified this location as a candidate for a micro-bioretention facility to treat stormwater. A micro-bioretention facility is recommended between Wells Parkway and Wells Run. A curb cut will allow stormwater to reach the facility so that it can partially treat the impervious area of Wells Parkway while avoiding impacts to existing utilites. The facility would discharge to Wells Run through an underdrain.

RK&K SWM Sites 32, 32A: Northeast Corner of University Park Elementary School (UPES) Cricket Pitch

Recommended Action: Due to the available space and proximity to Underwood Street, RK&K identified the northeast corner of the UPES recreational field as a potential micro-bioretention facility location. A micro-bioretention facility is recommended at the toe of the slope connecting the cricket pitch to Underwood Street. A combination inlet and drop manhole is proposed along Underwood Street to capture the stormwater from the street and safely convey it down the recreational field's grade. This enables the facility to treat the impervious area from Underwood Street, and the facility then discharges to Wells Run through an underdrain.

RK&K SWM Site 33: 4001 Beechwood Road

Recommended Action: Due to a large contributing drainage area upstream that consist of residential housing and the elimination of smaller facilities along Beechwood and 40th Avenue, a wet pond is proposed. The pond is designed to collect and store runoff, ultimately discharging to Wells Run. While this location is currently wooded, upstream flow is already being directed to this location via the existing infrastructure. Implementing a SWM wet pond may provide relatively considerable flood attenuation volume.

Additional Benefits Discussion and Cost Considerations

Tables 2 and 3 above show that all proposed SWM and storm drain sites resulted in an individual ranking of A or B; however, the cost-benefit of these potential projects varies depending on the size and extent of the project. For example, micro-bioretention facilities such as SWM Sites 9, 15A, 15B, 18, 27, 28, 29, 30, 31, 32, 34 all provide opportunities for the Town to improve drainage conditions and obtain stormwater credits. Additionally, these facilities provide water quality treatment and, depending on their size, a minor benefit of flood attenuation and storage. These benefits are provided at different costs for each facility, which are listed in Table 2. A further breakdown of cost estimates for each facility is available in Appendix 6. The wet pond at Site 33 and detention facility at Site 8 offer the same benefits as micro-bioretention facilities but at a larger scale and corresponding larger cost. As discussed above, many of the identified sites provide similar benefits due to the similar nature of proposed improvements.

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Expanding upon discussions above, some more unique benefits at specific locations above include:

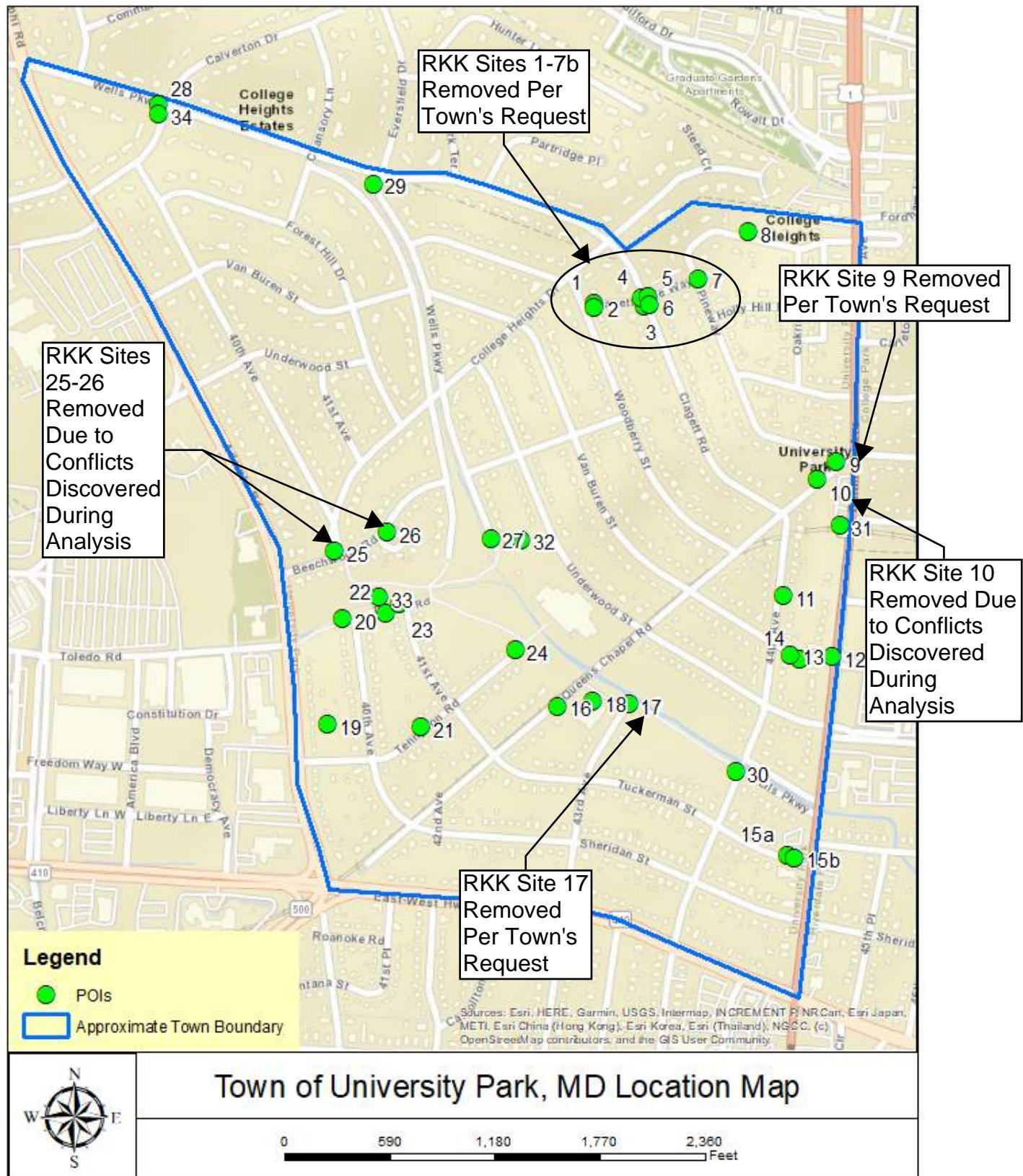
- Site 11 includes the proposed type K inlet and additional drainage pipe along 44th Avenue addresses the hazardous drop-off from the sidewalk into the ditch while adequately conveying storm flows to a closed system. As a result, this inlet offers the unique benefit of enhanced safety alongside improved drainage.
- Sites 12, 13, and 14 includes storm drain improvements along Van Buren Street which provides the benefit of increased efficiency of the storm drain system to capture runoff, reduced roadway spread, and reduced nuisance flooding to residents especially those along the southside of Van Buren Street. These targeted improvements help address runoff from Baltimore Avenue which is managed by the Maryland Department of Transportation State Highway Administration.
- Site 16 includes the proposed concrete channel connection to a closed storm drain along Queen's Chapel Road which channelizes flow to the inlet and reduces both the width and length of unmanaged spread as the flow does not need to travel as far to reach an inlet in the proposed condition. This also reduces the potential for the unmanaged spread to freeze in the wintertime, minimizing hazardous icy conditions in the roadway.
- Location 8 includes the proposed berm adjacent to the house at 6500 44th Avenue. Based on preliminary H&H modeling described above, the proposed berm provides flood relief up to the 10-year storm, while reducing the frequency of flooding and damages to that house.

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Appendix 1

Location Map and Potential SWM Sites (provided by Town)

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Potential SWM Sites (Provided by Town)		
Location	Address	Potential Action
1	43 rd Avenue dead end	Reconstruct drainage swale and replace asphalt at dead end with stone
2	Clagett-Pineway/Pineway SW system	Extend to Woodberry "as originally designed in the 50s"
3	4401 College Heights Drive	Rain garden at road realignment
4	4000 block Beechwood	Rain gardens in triangle and circle
5	Tuckerman/Sheridan	Construct bioretention off of 44th Ave in park
6	44 th Avenue at Van Buren	Relocate inlet, new inlet at 6607 VB and/or new inlet on Baltimore Ave above VB
7	4400 block Van Buren	Regrade between Balt Ave and 44th Ave
8	6500 44th	Construct berm in park
9	40th, 41st, Tennyson and alleys	Install pave drain in cul de sacs
10	6724 Baltimore Ave	Install pave drain in parking lot
11	6513 Queens Chapel Rd	Subsidize permeable pavers for Church parking lot
12	4413 Tuckerman	subsidize permeable pavers for Church parking lot
13	QCR	Clean Water Partnership project (incl possible dry wells)
14	Clean Water Partnership	Other opportunities?
15	7000-7100 block Wells Pkwy	very wide ROW--install bioretention
16	6705 44th avenue	install grate inlet and connect to existing SD system
17	6922 Pineway	Open lot with drainage infrastructure. Town could potentially purchase

Field visit discussion also included:

1. Alley behind 6507 Adelphi Road
2. Drainage between 4010 and 4012 Tennyson Lane
3. Unnamed alley between 40th and 41st Avenue

Notes:

Added/discussed during site visit

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Appendix 2

Ranking Tables

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University Park SWM Facilities Ranking Table Scoring

Facility ID	Green Infrastructure Type	Approximate Address	Facility Drainage Area						Facility Performance		Storm Drain Connection		Tree Impacts		Utility Conflict		Community Aesthetics and Engagement		Property Conflicts Grouped	Score	RANKING
			6	6	3	1	3	2	-2	0	19	A									
8	Detention Facility	Between 6914 Pineway and 6924 Pineway	6	6	3	1	3	2	-2	0	19	A									
15a	Micro-Bioretention	Between 4410 Tuckerman St and Baltimore Ave	6	1	3	1	2	2	0	2	17	B									
15b	Micro-Bioretention	Between 4410 Tuckerman St and Baltimore Ave	6	1	3	1	2	2	0	2	17	B									
18	Micro-Bioretention	6513 Queens Chapel Rd	3	6	1	2	3	2	0	2	19	A									
20	Micro-Bioretention	40th Ave Cul-De-Sac	6	3	1	1	2	2	0	2	17	A									
21	Infiltration Trenches	Between 4010 Tennyson Rd and 4012 Tennyson Rd	6	1	1	3	1	0	0	0	12	B									
22	Micro-Bioretention	Cul-De-Sac between 40th Ave and 41st Ave	6	3	1	1	3	2	0	2	18	A									
22	Micro-Bioretention	Cul-De-Sac between 40th Ave and 41st Ave	6	3	1	1	3	2	0	2	18	A									
23	Micro-Bioretention	41st Ave Cul-De-Sac	6	3	1	1	3	2	0	2	18	A									
27	Micro-Bioretention	Across from 6603 Wells Pkwy	6	3	1	1	2	2	0	2	17	A									
28	Micro-Bioretention	SW Corner of Wells Pkwy and Calverton Dr Intersection	6	3	3	1	1	2	0	2	18	A									
29	Micro-Bioretention	SW Corner of Wells Pkwy and Eversfield Dr Intersection	3	6	1	2	1	2	0	0	15	B									
30	Micro-Bioretention	Across from 4433 Wells Pkwy (44th Ave Side)	6	1	1	2	3	2	0	0	15	B									
31	Micro-Bioretention	6724 Baltimore Ave	3	6	1	3	3	2	0	2	20	A									
32	Micro-Bioretention	4311 Underwood St	6	6	1	3	3	2	-2	2	21	A									
33	Wet Pond	4001 Beechwood Rd	6	6	1	1	3	2	0	2	21	A									
34	Micro-Bioretention	3806 Calverton Dr	6	1	3	2	1	2	0	2	17	A									

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Potential SWM Facilities Assessment Report

University Park Storm Drains Ranking Table Scoring

<i>Facility ID</i>	<i>Green Infrastructure Type</i>	<i>Approximate Address</i>	<i>Facility Drainage Area</i>	<i>Facility Performance</i>	<i>Storm Drain Connection</i>	<i>Tree Impacts</i>	<i>Utility Conflict</i>	<i>Community Aesthetics and Engagement</i>	<i>Property Conflicts</i>	<i>Grouped</i>	<i>Score</i>	<i>RANKING</i>
11	Storm Drain	Between 6707 44th Ave and 6705 44th Ave	6	1	3	2	1	0	0	0	13	B
12	Storm Drain	4417 Van Buren St	6	1	1	2	3	0	0	2	15	B
13	Storm Drain	6607 44th Ave (Van Buren St Side) Between 6607 44th Ave and 4417 Van Buren	6	1	1	2	1	0	0	2	13	B
14	Storm Drain	St	6	1	1	1	1	0	0	2	12	B
16	Storm Drain	6513 Queens Chapel Rd	6	1	3	3	2	0	0	2	17	B
32A	Storm Drain	Across from 4312 Underwood St	1	1	1	1	3	0	0	2	9	B

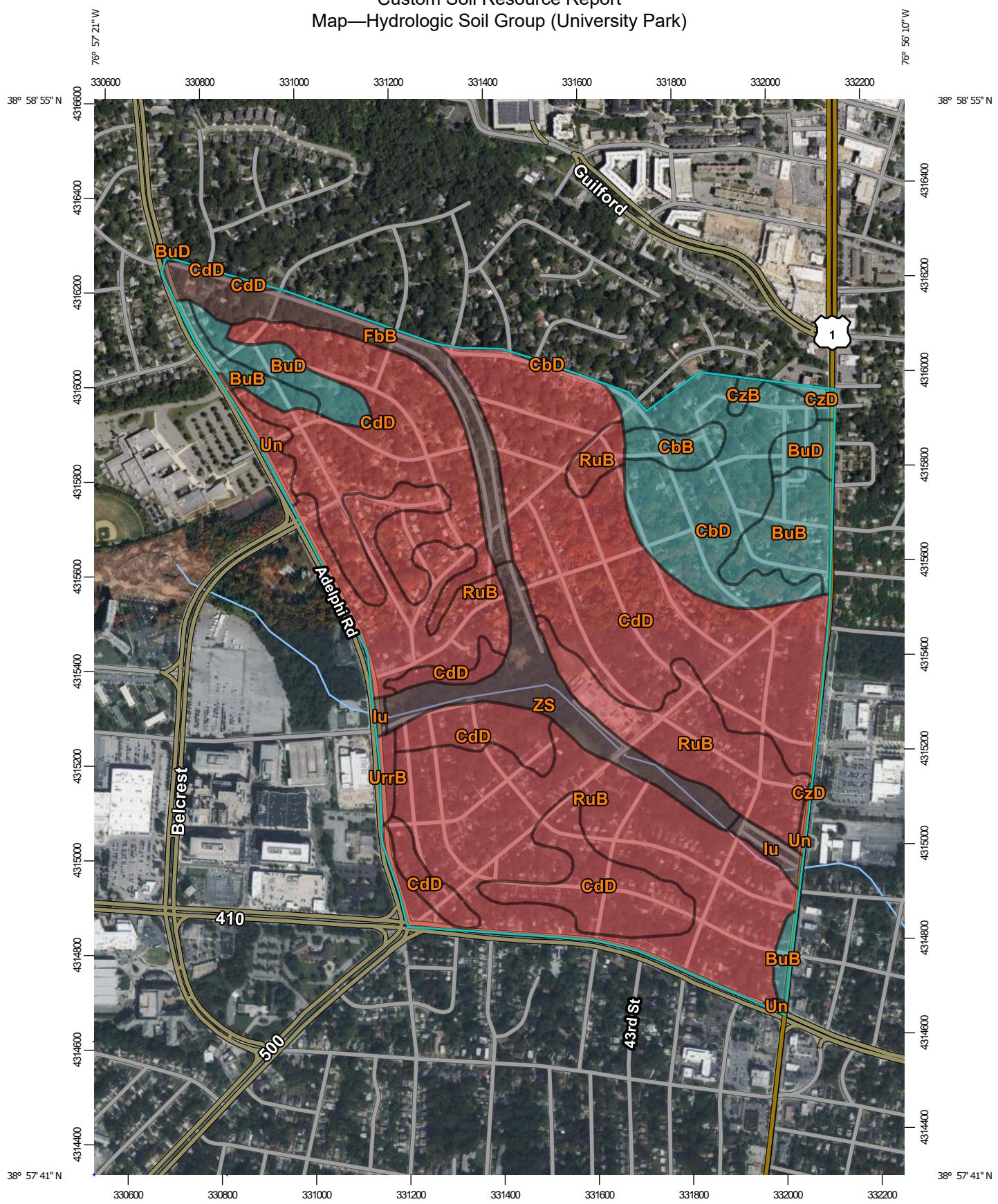
**University Park Flood Attenuation
Potential SWM Facilities Assessment Report**

Appendix 3

SWM and Storm Drain Computations

Soils, Drainage Area/Impervious Area, Runoff, and ESD
Computations

Custom Soil Resource Report
Map—Hydrologic Soil Group (University Park)



Map Scale: 1:11,100 if printed on A portrait (8.5" x 11") sheet.



Meters

Map projection: Web Mercator. Corner coordinates: WGS84. Edge ticks: UTM_Zone_18N_WGS84

Custom Soil Resource Report

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

- C
- C/D
- D
- Not rated or not available

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D

Water Features

- ~ Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Prince George's County, Maryland

Survey Area Data: Version 19, Aug 27, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 3, 2015—Jun 18, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group (University Park)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BuB	Beltsville-Urban land complex, 0 to 5 percent slopes	C	14.7	4.4%
BuD	Beltsville-Urban land complex, 5 to 15 percent slopes	C	9.1	2.8%
CbB	Chillum-Urban land complex, 0 to 5 percent slopes	C	3.7	1.1%
CbD	Chillum-Urban land complex, 5 to 15 percent slopes	C	29.1	8.8%
CdD	Christiana-Downer-Urban land complex, 5 to 15 percent slopes	D	131.6	39.9%
CzB	Croom-Urban land complex, 0 to 5 percent slopes	C	0.8	0.2%
CzD	Croom-Urban land complex, 5 to 15 percent slopes	C	1.2	0.4%
FbB	Fallsington-Urban land complex, 0 to 5 percent slopes	B/D	15.0	4.5%
Iu	Issue-Urban land complex, occasionally flooded	B/D	2.5	0.8%
RuB	Russett-Christiana-Urban land complex, 0 to 5 percent slopes	D	101.5	30.8%
Un	Urban land	D	3.1	1.0%
UrrB	Urban land-Russett-Christiana complex, 0 to 5 percent slopes	D	1.5	0.4%
ZS	Zekiah and Issue soils, frequently flooded	B/D	15.9	4.8%
Totals for Area of Interest			329.7	100.0%

Rating Options—Hydrologic Soil Group (University Park)*Aggregation Method:* Dominant Condition*Component Percent Cutoff:* None Specified*Tie-break Rule:* Higher

Drainage Area and Impervious Area Calculation (As Determined in GIS)			
POI/Site	AREA_IMPERVIOUS (AC)	AREA_TOTAL (AC)	PERCENT_IMPERVIOUS
1	0.427	1.16	36.81
2	1.047	2.63	39.81
3	1.858	5.689	32.66
4	1.186	4.086	29.03
5	1.163	3.588	32.41
6	1.014	2.406	42.14
7	4.579	12.327	37.15
8	1.627	6.124	26.57
9	0.810	1.822	44.46
10	0.248	0.675	36.74
11	1.139	4.287	26.57
12	0.629	0.629	100.00
13	0.485	1.562	31.05
14	0.259	0.486	53.29
15a	1.883	4.709	39.99
15b	0.281	0.634	44.32
16	2.667	8.026	33.23
17	1.348	3.863	34.90
18	0.075	0.284	26.41
19	0.241	0.735	32.79
20	0.482	1.294	37.25
21	0.577	1.932	29.87
22	0.214	0.952	22.48
23	0.401	1.064	37.69
24	0.389	0.957	40.65
25	0.092	0.143	64.34
26	0.119	0.317	37.54
27	0.582	2.287	25.45
28	0.514	1.413	36.38
29	0.094	0.194	48.45
30	2.131	5.691	37.45
31	0.124	0.236	52.54
32	0.114	0.42	27.14
33	5.368	13.917	38.57
34	1.474	4.74	31.10

E. Brody

Prince George's NOAA_C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area and Peak Flow and Peak Time (hr) by Rainfall Return Period	
	10-Yr (cfs) (hr)
SUBAREAS	
Three	13.94 12.26
Two	10.45 12.13
One	4.24 12.16
Four	12.55 12.16
Five	12.22 12.14
Six	7.75 12.16
Seven	17.34 12.20
Eight	21.24 12.14
Nine	5.95 12.16
REACHES	
OUTLET	100.28

E. Brody

Prince George's NOAA_C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	10-Yr (cfs) (hr)

SUBAREAS	
Seven A	6.26
	12.12

Seven B	9.91
	12.30

ThirtyTwoA	0.31
	12.12

REACHES

OUTLET	12.93
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E. Brody

Prince George's NOAA_C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	10-Yr (cfs) (hr)

SUBAREAS

Eleven	16.83 12.14
Twelve	2.36 12.16
Thirteen	5.87 12.16
Fourteen	1.06 12.16
FifteenA	12.98 12.26
Sixteen	25.45 12.21
Seventeen	13.40 12.17
Eighteen	1.06 12.16
Nineteen	2.79 12.16
FifteenB	2.36 12.16

REACHES

OUTLET	79.91
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J. Walsh

Prince George's NOAA_C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	10-Yr (cfs) (hr)

SUBAREAS	
TwentyOne	7.27
	12.16

TwentyTwo	3.56
	12.16

TwentyThre	4.00
	12.16

TwentyFour	1.76
	12.16

TwentyFive	0.66
	12.15

TwentySix	1.20
	12.16

TwentySeve	7.48
	12.19

TwentyEigh	5.30
	12.16

TwentyNine	0.70
	12.16

Twenty	4.86
	12.16

REACHES

OUTLET	36.43
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J. Walsh

Prince George's NOAA_C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period
	10-Yr (cfs) (hr)
SUBAREAS	
Thirty	17.82 12.30
ThirtyOne	0.91 12.16
ThirtyTwo	1.59 12.16
ThirtyFour	14.68 12.19

REACHES

OUTLET	32.24
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PROVIDED TREATMENT: ACHIEVED PE , TREATED ESDv, AND TREATED ReV FOR BMPs WITH STORAGE												
A	B	C	D	E	F	G	H	I	J	K	L	M
BMP	DA to BMP	Proposed Ai to BMP	I%	Rv	Provided Surface Storage	ESDv provided based on size of BMP	ESDv based on $P_E = 2.6$ and DA to BMP	PROVIDED ESDv	P_E Achieved	Effective Impervious Area Treated [$P_E=1$ inch is 100%]	Weighted Soil Specific Recharge Factor S	PROVIDED RECHARGE VOLUME Re_v
	(acres)	(acres)			(cf)	(cf)	(cf)	(cf)	(in)	(acres)		(cf)
D-8	6.12	1.63	0.27	0.29	11937	15916	16734	15916	2.47	1.63	0.00	0.00
MB-9	1.82	0.81	0.45	0.45	836	1115	7739	1115	0.37	0.30	0.00	0.00
BS-10	0.67	0.25	0.37	0.38	1616	2155	2423	2155	2.31	0.25	0.00	0.00
MB-15a	4.71	1.88	0.40	0.41	85	113	18192	113	0.02	0.03	0.00	0.00
MB-15b	0.63	0.28	0.44	0.45	68	91	2676	91	0.09	0.02	0.00	0.00
MB-17	3.86	1.35	0.35	0.36	611	815	13272	815	0.16	0.22	0.00	0.00
MB-18	0.28	0.07	0.25	0.28	464	619	727	619	2.21	0.07	0.00	0.00
MB-20	1.29	0.48	0.37	0.38	851	1135	4686	1135	0.63	0.30	0.00	0.00
Infiltration Trench-21	1.93	0.58	0.30	0.32		0	5837	0	0.00	0.00	0.00	0.00
MB-22	0.95	0.21	0.22	0.25	456	608	2232	608	0.71	0.15	0.00	0.00
MB-23	1.06	0.40	0.38	0.39	758	1011	3898	1011	0.67	0.27	0.00	0.00
B-24	0.96	0.39	0.41	0.42	231	308	3766	308	0.21	0.08	0.00	0.00
MB-25	0.14	0.09	0.64	0.63		0	831	0	0.00	0.00	0.00	0.00
MB-27	2.29	0.58	0.25	0.28	1129	1505	6007	1505	0.65	0.38	0.00	0.00
MB-28	1.41	0.51	0.36	0.38	1371	1828	4997	1828	0.95	0.49	0.00	0.00
MB-29	0.19	0.09	0.47	0.48	778	1037	854	854	2.60	0.09	0.00	0.00
MB-30	5.69	2.13	0.37	0.39	1089	1452	20778	1452	0.18	0.39	0.00	0.00
MB-31	0.24	0.12	0.50	0.50	460	613	1133	613	1.41	0.12	0.00	0.00
MB-32	0.42	0.11	0.26	0.29	372	496	1133	496	1.14	0.11	0.00	0.00
WP-33	13.92	5.37	0.39	0.40	43806	58408	52183	52183	2.60	5.37	0.00	0.00
MB-34	4.74	1.47	0.31	0.33	913	1217	14723	1217	0.21	0.32	0.00	0.00
							TOTAL:	84,033		10.58		0
								cf		ac		cf

Column D: $I\% = Ai/DA \rightarrow D = C/B$

Column E: $Rv = 0.9(I\%) + 0.05 \rightarrow E = 0.9D + 0.05$

Column F: Provided Surface Storage = the actual storage volume from the top of media to the invert of the outlet.

Column G: ESDv provided based on size of BMP is a function of the design criteria for the BMP. For BMPs requiring min. 75% surface storage, $G = F/0.75$.

Column H: ESDv based on $P_E = 2.6$ inches is the maximum ESDv the BMP can provide.

Column I: The smaller of G vs. H determines the treated ESDv.

Column J: P_E achieved = $ESDv/(Rv)(A) \rightarrow J = (12 \text{ in}/\text{ft})/(E)(B)/(43,560 \text{ ac}/\text{sf})$.

Column K: Effective Impervious Area Treated is the equivalent amount of impervious area receiving full treatment by pro-rating partial treatment (i.e. $P_E < 1$ inch).

$P_E \geq 1.0$ inch is considered 100% water quality treatment. $P_E = 1.0$ inch and $P_E = 2.6$ inch have the same Effective Impervious Area Treated.

If $P_E \geq 1.0$ then $K = C$. If $P_E < 1.0$ then $K = C \times J$.

Column L: Weighted Soil Specific Recharge Factor is dependent on Hydrologic Soil Group. Use value from Step 9 of SWM Calculator.

Column M: For BMPs without underdrain and submerged gravel wetlands, provided $Re_v = S \times$ provided WQv.

For BMPs with underdrain (except SGWs), provided Re_v is equal to the storage provided below the underdrain in the media voids.

Storm Drain Computations (Hydraulic Toolbox)

Hydraulic Analysis Report

Project Data

Project Title: University Park Proposed Inlets and Pipes
Designer: JTW
Project Date: Tuesday, October 25, 2022
Project Units: U.S. Customary Units
Notes:

Curb and Gutter Analysis: POI 1

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0092 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 12.2852 ft

Gutter Result Parameters

Design Flow: 4.2400 cfs
Gutter Depression: 0.0000 in
Area of Flow: 1.5093 ft²
Eo (Gutter Flow to Total Flow): 0.2028
Gutter Depth at Curb: 2.9484 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2710 ft
Grate Length: 5.2083 ft
Length of Inlet: 5.2083 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 2.9969 cfs
Bypass Flow: 1.2431 cfs
Approach Velocity: 2.8093 ft/s
Splash-over Velocity: 10.5388 ft/s
Efficiency: 0.7068

Channel Analysis: POI 1 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.2500 ft
Longitudinal Slope: 0.0090 ft/ft
Manning's n: 0.0130
Flow: 4.2400 cfs

Result Parameters

Depth: 0.7647 ft
Area of Flow: 0.7867 ft²
Wetted Perimeter: 2.2452 ft
Hydraulic Radius: 0.3504 ft
Average Velocity: 5.3896 ft/s
Top Width: 1.2184 ft
Froude Number: 1.1820
Critical Depth: 0.8337 ft
Critical Velocity: 4.8759 ft/s
Critical Slope: 0.0070 ft/ft
Critical Top Width: 1.18 ft
Calculated Max Shear Stress: 0.4294 lb/ft²
Calculated Avg Shear Stress: 0.1968 lb/ft²

Curb and Gutter Analysis: POI 2

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0157 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 15.5958 ft

Gutter Result Parameters

Design Flow: 10.4500 cfs
Gutter Depression: 0.0000 in
Area of Flow: 2.4323 ft²
Eo (Gutter Flow to Total Flow): 0.1622
Gutter Depth at Curb: 3.7430 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2708 ft
Grate Length: 5.2083 ft
Length of Inlet: 5.2083 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 5.7210 cfs
Bypass Flow: 4.7290 cfs
Approach Velocity: 4.2964 ft/s
Splash-over Velocity: 10.5388 ft/s
Efficiency: 0.5475

Channel Analysis: POI 2 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 2.0000 ft
Longitudinal Slope: 0.0090 ft/ft
Manning's n: 0.0130
Flow: 14.6900 cfs

Result Parameters

Depth: 1.2147 ft
Area of Flow: 1.9970 ft²
Wetted Perimeter: 3.5745 ft
Hydraulic Radius: 0.5587 ft
Average Velocity: 7.3561 ft/s
Top Width: 1.9533 ft
Froude Number: 1.2821
Critical Depth: 1.3809 ft
Critical Velocity: 6.3492 ft/s
Critical Slope: 0.0062 ft/ft
Critical Top Width: 1.85 ft
Calculated Max Shear Stress: 0.6822 lb/ft²
Calculated Avg Shear Stress: 0.3138 lb/ft²

Curb and Gutter Analysis: POI 3

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0096 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0130
Gutter Width: 1.0000 ft
Width of Spread: 20.1373 ft

Gutter Result Parameters

Design Flow: 18.6690 cfs
Gutter Depression: 0.0000 in
Area of Flow: 4.0551 ft²
Eo (Gutter Flow to Total Flow): 0.1272
Gutter Depth at Curb: 4.8329 in

Inlet Input Parameters

Inlet Location: Inlet in Sag
Percent Clogging: 0.0000 %
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Curb opening height: 6.0000 in
Local Depression: 0.0000 in

Inlet Result Parameters

Perimeter: 9.7500 ft
Effective Perimeter: 9.7500 ft
Area: 6.7443 ft²
Effective Area: 6.7443 ft²
Depth at center of grate: 0.7413 ft
Computed Width of Spread at Sag: 38.2002 ft
Flow type: Weir Flow
Efficiency: 1.0000

Channel Analysis: POI 3 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 2.5000 ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0130

Flow: 41.1800 cfs

Result Parameters

Depth: 2.0582 ft

Area of Flow: 4.3237 ft²

Wetted Perimeter: 5.6848 ft

Hydraulic Radius: 0.7606 ft

Average Velocity: 9.5243 ft/s

Top Width: 1.9071 ft

Froude Number: 1.1147

Critical Depth: 2.1533 ft

Critical Velocity: 9.1577 ft/s

Critical Slope: 0.0093 ft/ft

Critical Top Width: 1.73 ft

Calculated Max Shear Stress: 1.2843 lb/ft²

Calculated Avg Shear Stress: 0.4746 lb/ft²

Curb and Gutter Analysis: POI 4

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0087 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0130
Gutter Width: 1.0000 ft
Width of Spread: 18.3100 ft

Gutter Result Parameters

Design Flow: 13.7930 cfs
Gutter Depression: 0.0000 in
Area of Flow: 3.3526 ft²
Eo (Gutter Flow to Total Flow): 0.1393
Gutter Depth at Curb: 4.3944 in

Inlet Input Parameters

Inlet Location: Inlet in Sag
Percent Clogging: 0.0000 %
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Curb opening height: 6.0000 in
Local Depression: 0.0000 in

Inlet Result Parameters

Perimeter: 9.7500 ft
Effective Perimeter: 9.7500 ft
Area: 6.7443 ft²
Effective Area: 6.7443 ft²
Depth at center of grate: 0.6058 ft
Computed Width of Spread at Sag: 31.4268 ft
Flow type: Weir Flow
Efficiency: 1.0000

Channel Analysis: POI 4 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular

Pipe Diameter: 1.5000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0130

Flow: 12.5500 cfs

Result Parameters

Depth: 1.0573 ft

Area of Flow: 1.3313 ft²

Wetted Perimeter: 2.9895 ft

Hydraulic Radius: 0.4453 ft

Average Velocity: 9.4269 ft/s

Top Width: 1.3683 ft

Froude Number: 1.6842

Critical Depth: 1.3352 ft

Critical Velocity: 7.5531 ft/s

Critical Slope: 0.0127 ft/ft

Critical Top Width: 0.94 ft

Calculated Max Shear Stress: 1.3195 lb/ft²

Calculated Avg Shear Stress: 0.5558 lb/ft²

Curb and Gutter Analysis: POI 5

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0170 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0130
Gutter Width: 1.0000 ft
Width of Spread: 15.4331 ft

Gutter Result Parameters

Design Flow: 12.2200 cfs
Gutter Depression: 0.0000 in
Area of Flow: 2.3818 ft²
Eo (Gutter Flow to Total Flow): 0.1638
Gutter Depth at Curb: 3.7039 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 6.2255 cfs
Bypass Flow: 5.9945 cfs
Approach Velocity: 5.1306 ft/s
Splash-over Velocity: 10.5411 ft/s
Efficiency: 0.5095

Curb and Gutter Analysis: POI 6

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0182 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0130
Gutter Width: 1.0000 ft
Width of Spread: 12.8459 ft

Gutter Result Parameters

Design Flow: 7.7500 cfs
Gutter Depression: 0.0000 in
Area of Flow: 1.6502 ft²
Eo (Gutter Flow to Total Flow): 0.1946
Gutter Depth at Curb: 3.0830 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: P - 1-7/8
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 4.4555 cfs
Bypass Flow: 3.2945 cfs
Approach Velocity: 4.6964 ft/s
Splash-over Velocity: 13.4605 ft/s
Efficiency: 0.5749

Channel Analysis: POI 6 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 3.0000 ft
Longitudinal Slope: 0.0070 ft/ft
Manning's n: 0.0130
Flow: 48.9300 cfs

Result Parameters

Depth: 2.1776 ft
Area of Flow: 5.4957 ft²
Wetted Perimeter: 6.1186 ft
Hydraulic Radius: 0.8982 ft
Average Velocity: 8.9032 ft/s
Top Width: 2.6764 ft
Froude Number: 1.0949
Critical Depth: 2.2764 ft
Critical Velocity: 8.5025 ft/s
Critical Slope: 0.0063 ft/ft
Critical Top Width: 2.57 ft
Calculated Max Shear Stress: 0.9512 lb/ft²
Calculated Avg Shear Stress: 0.3923 lb/ft²

Curb and Gutter Analysis: POI 7

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0196 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 21.8328 ft

Gutter Result Parameters

Design Flow: 28.6740 cfs
Gutter Depression: 0.0000 in
Area of Flow: 4.7667 ft²
Eo (Gutter Flow to Total Flow): 0.1177
Gutter Depth at Curb: 5.2399 in

Inlet Input Parameters

Inlet Location: Inlet in Sag
Percent Clogging: 0.0000 %
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Curb opening height: 6.0000 in
Local Depression: 0.0000 in

Inlet Result Parameters

Perimeter: 9.7500 ft
Effective Perimeter: 9.7500 ft
Area: 6.7443 ft²
Effective Area: 6.7443 ft²
Depth at center of grate: 0.9868 ft
Computed Width of Spread at Sag: 50.4764 ft
Flow type: Weir Flow
Efficiency: 1.0000

Curb and Gutter Analysis: POI 7A

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0090 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 18.3655 ft

Gutter Result Parameters

Design Flow: 12.2540 cfs
Gutter Depression: 0.0000 in
Area of Flow: 3.3729 ft²
Eo (Gutter Flow to Total Flow): 0.1389
Gutter Depth at Curb: 4.4077 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 6.8640 cfs
Bypass Flow: 5.3900 cfs
Approach Velocity: 3.6330 ft/s
Splash-over Velocity: 10.5411 ft/s
Efficiency: 0.5601

Curb and Gutter Analysis: POI 7B

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0090 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 18.8870 ft

Gutter Result Parameters

Design Flow: 13.2040 cfs
Gutter Depression: 0.0000 in
Area of Flow: 3.5672 ft²
Eo (Gutter Flow to Total Flow): 0.1352
Gutter Depth at Curb: 4.5329 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 7.2595 cfs
Bypass Flow: 5.9445 cfs
Approach Velocity: 3.7015 ft/s
Splash-over Velocity: 10.5411 ft/s
Efficiency: 0.5498

Channel Analysis: POI 7B D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 3.0000 ft
Longitudinal Slope: 0.0080 ft/ft
Manning's n: 0.0130
Flow: 58.8400 cfs

Result Parameters

Depth: 2.4225 ft
Area of Flow: 6.1157 ft²
Wetted Perimeter: 6.6995 ft
Hydraulic Radius: 0.9129 ft
Average Velocity: 9.6211 ft/s
Top Width: 2.3656 ft
Froude Number: 1.0545
Critical Depth: 2.4800 ft
Critical Velocity: 9.4158 ft/s
Critical Slope: 0.0077 ft/ft
Critical Top Width: 2.27 ft
Calculated Max Shear Stress: 1.2093 lb/ft²
Calculated Avg Shear Stress: 0.4557 lb/ft²

Curb and Gutter Analysis: POI 11 - Grate

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0010 ft/ft
Cross-Slope of Pavement: 0.0010 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0350
Gutter Width: 1.0000 ft
Width of Spread: 189.5666 ft

Gutter Result Parameters

Design Flow: 6.0000 cfs
Gutter Depression: 0.0000 in
Area of Flow: 17.9677 ft²
Eo (Gutter Flow to Total Flow): 0.0140
Gutter Depth at Curb: 2.2748 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Grate
Grate Type: Reticuline
Grate Width: 3.4600 ft
Grate Length: 3.5000 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 2.9237 cfs
Bypass Flow: 3.0763 cfs
Approach Velocity: 0.3339 ft/s
Splash-over Velocity: 6.4902 ft/s
Efficiency: 0.4873

Weir Analysis: POI 11 - Weir Analysis

Notes:

Input Parameters

Notes:

Coefficient: 3.1000

Flow: 10.0762 cfs

Result Parameters

Head: 1.2500 ft

Channel Analysis: POI 11 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.2500 ft
Longitudinal Slope: 0.0600 ft/ft
Manning's n: 0.0130
Flow: 16.8300 cfs

Result Parameters

Depth: 1.1196 ft
Area of Flow: 1.1593 ft²
Wetted Perimeter: 3.1049 ft
Hydraulic Radius: 0.3734 ft
Average Velocity: 14.5180 ft/s
Top Width: 0.7641 ft
Froude Number: 2.0771
Critical Depth: 1.2411 ft
Critical Velocity: 13.7282 ft/s
Critical Slope: 0.0633 ft/ft
Critical Top Width: 0.21 ft
Calculated Max Shear Stress: 4.1919 lb/ft²
Calculated Avg Shear Stress: 1.3979 lb/ft²

Curb and Gutter Analysis: POI 12

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0637 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 7.0640 ft

Gutter Result Parameters

Design Flow: 2.5500 cfs
Gutter Depression: 0.0000 in
Area of Flow: 0.4990 ft²
Eo (Gutter Flow to Total Flow): 0.3347
Gutter Depth at Curb: 1.6954 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2708 ft
Grate Length: 5.2083 ft
Length of Inlet: 5.2083 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 1.9421 cfs
Bypass Flow: 0.6079 cfs
Approach Velocity: 5.1103 ft/s
Splash-over Velocity: 10.5388 ft/s
Efficiency: 0.7616

Channel Analysis: POI 12 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.2500 ft
Longitudinal Slope: 0.0650 ft/ft
Manning's n: 0.0130
Flow: 2.3600 cfs

Result Parameters

Depth: 0.3197 ft
Area of Flow: 0.2478 ft²
Wetted Perimeter: 1.3256 ft
Hydraulic Radius: 0.1869 ft
Average Velocity: 9.5254 ft/s
Top Width: 1.0907 ft
Froude Number: 3.5221
Critical Depth: 0.6140 ft
Critical Velocity: 3.9343 ft/s
Critical Slope: 0.0057 ft/ft
Critical Top Width: 1.25 ft
Calculated Max Shear Stress: 1.2968 lb/ft²
Calculated Avg Shear Stress: 0.7581 lb/ft²

Curb and Gutter Analysis: POI 13

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0309 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0130
Gutter Width: 1.0000 ft
Width of Spread: 10.7744 ft

Gutter Result Parameters

Design Flow: 6.3180 cfs
Gutter Depression: 0.0000 in
Area of Flow: 1.1609 ft²
Eo (Gutter Flow to Total Flow): 0.2290
Gutter Depth at Curb: 2.5859 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 3.7920 cfs
Bypass Flow: 2.5260 cfs
Approach Velocity: 5.4424 ft/s
Splash-over Velocity: 10.5411 ft/s
Efficiency: 0.6002

Channel Analysis: POI 13 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.2500 ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0130
Flow: 5.8700 cfs

Result Parameters

Depth: 0.7287 ft
Area of Flow: 0.7426 ft²
Wetted Perimeter: 2.1718 ft
Hydraulic Radius: 0.3419 ft
Average Velocity: 7.9049 ft/s
Top Width: 1.2327 ft
Froude Number: 1.7948
Critical Depth: 0.9802 ft
Critical Velocity: 5.6858 ft/s
Critical Slope: 0.0090 ft/ft
Critical Top Width: 1.03 ft
Calculated Max Shear Stress: 0.9094 lb/ft²
Calculated Avg Shear Stress: 0.4267 lb/ft²

Curb and Gutter Analysis: POI 14

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0581 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 6.7148 ft

Gutter Result Parameters

Design Flow: 2.1280 cfs
Gutter Depression: 0.0000 in
Area of Flow: 0.4509 ft²
Eo (Gutter Flow to Total Flow): 0.3498
Gutter Depth at Curb: 1.6116 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2710 ft
Grate Length: 5.2080 ft
Length of Inlet: 5.2080 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 1.6804 cfs
Bypass Flow: 0.4476 cfs
Approach Velocity: 4.7196 ft/s
Splash-over Velocity: 10.5384 ft/s
Efficiency: 0.7897

Channel Analysis: POI 14 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.2500 ft
Longitudinal Slope: 0.0200 ft/ft
Manning's n: 0.0130
Flow: 1.8500 cfs

Result Parameters

Depth: 0.3816 ft
Area of Flow: 0.3172 ft²
Wetted Perimeter: 1.4634 ft
Hydraulic Radius: 0.2167 ft
Average Velocity: 5.8329 ft/s
Top Width: 1.1513 ft
Froude Number: 1.9584
Critical Depth: 0.5408 ft
Critical Velocity: 3.6372 ft/s
Critical Slope: 0.0054 ft/ft
Critical Top Width: 1.24 ft
Calculated Max Shear Stress: 0.4762 lb/ft²
Calculated Avg Shear Stress: 0.2705 lb/ft²

Curb and Gutter Analysis: POI 16

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0255 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0130
Gutter Width: 1.0000 ft
Width of Spread: 17.1268 ft

Gutter Result Parameters

Design Flow: 19.7700 cfs
Gutter Depression: 0.0000 in
Area of Flow: 2.9333 ft²
Eo (Gutter Flow to Total Flow): 0.1484
Gutter Depth at Curb: 4.1104 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2700 ft
Grate Length: 5.2100 ft
Length of Inlet: 5.2100 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 8.5530 cfs
Bypass Flow: 11.2170 cfs
Approach Velocity: 6.7399 ft/s
Splash-over Velocity: 10.5411 ft/s
Efficiency: 0.4326

Channel Analysis: POI 16 D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 2.0000 ft
Longitudinal Slope: 0.0260 ft/ft
Manning's n: 0.0130
Flow: 19.7700 cfs

Result Parameters

Depth: 1.0492 ft
Area of Flow: 1.6691 ft²
Wetted Perimeter: 3.2400 ft
Hydraulic Radius: 0.5152 ft
Average Velocity: 11.8445 ft/s
Top Width: 1.9976 ft
Froude Number: 2.2835
Critical Depth: 1.5977 ft
Critical Velocity: 7.3480 ft/s
Critical Slope: 0.0080 ft/ft
Critical Top Width: 1.60 ft
Calculated Max Shear Stress: 1.7022 lb/ft²
Calculated Avg Shear Stress: 0.8358 lb/ft²

Curb and Gutter Analysis: POI 32A

Notes:

Gutter Input Parameters

Longitudinal Slope of Road: 0.0330 ft/ft
Cross-Slope of Pavement: 0.0200 ft/ft
Uniform Gutter Geometry
Manning's n: 0.0150
Gutter Width: 1.0000 ft
Width of Spread: 3.6254 ft

Gutter Result Parameters

Design Flow: 0.3100 cfs
Gutter Depression: 0.0000 in
Area of Flow: 0.1314 ft²
Eo (Gutter Flow to Total Flow): 0.5776
Gutter Depth at Curb: 0.8701 in

Inlet Input Parameters

Inlet Location: Inlet on Grade
Inlet Type: Equal-length Combo
Grate Type: Curved vane
Grate Width: 2.2710 ft
Grate Length: 5.2083 ft
Length of Inlet: 5.2083 ft
Local Depression: 0.0000 in

Inlet Result Parameters

Intercepted Flow: 0.3100 cfs
Bypass Flow: 0.0000 cfs
Approach Velocity: 2.3585 ft/s
Splash-over Velocity: 10.5388 ft/s
Efficiency: 1.0198

Channel Analysis: POI 32A D/S Pipe

Notes:

Input Parameters

Channel Type: Circular
Pipe Diameter: 1.0000 ft
Longitudinal Slope: 0.0500 ft/ft
Manning's n: 0.0130
Flow: 0.3100 cfs

Result Parameters

Depth: 0.1347 ft
Area of Flow: 0.0632 ft²
Wetted Perimeter: 0.7516 ft
Hydraulic Radius: 0.0841 ft
Average Velocity: 4.9055 ft/s
Top Width: 0.6828 ft
Froude Number: 2.8417
Critical Depth: 0.2292 ft
Critical Velocity: 2.2822 ft/s
Critical Slope: 0.0057 ft/ft
Critical Top Width: 0.84 ft
Calculated Max Shear Stress: 0.4203 lb/ft²
Calculated Avg Shear Stress: 0.2623 lb/ft²

Fixed Region Regression Equations and HY-8 Computations
(POI/Site 30)

FRRE Discharge
 GISHydro Release Version Date: v0.6 (Beta)
 Project Name: University Park_Wells Run Rt1 Culvert
 Analysis Date: October 13 2022
 Hydrologic Region: Western Coastal Plain
 Weight of Total Area: 100.00%

Discharges used in HY-8 = average of 2022 fixed region equations and upper 67% confidence limit (target calibration range)

2022 Maryland Fixed Region Equations

Peak Flow (Total Area Weighted)

Q(1.25):	144 cfs
Q(1.50):	192 cfs
Q(2):	265 cfs
Q(5):	551 cfs
Q(10):	852 cfs
Q(25):	1410 cfs
Q(50):	1975 cfs
Q(100):	2703 cfs
Q(200):	3677 cfs
Q(500):	5408 cfs

Q For HY8	
Q(2):	361.5
Q(10):	1062
Q(25):	1695
Q(50):	2341
Q(100):	3224.5

Prediction Intervals (Total Area Weighted)

Return Period	50 %		67 %		90 %		95 %	
	lower	upper	lower	upper	lower	upper	lower	upper
1.25	98	210	81	254	57	365	47	438
1.5	133	278	110	334	78	475	65	567
2	184	382	154	458	109	649	91	772
5	403	753	346	878	257	1182	221	1372
10	651	1114	571	1272	442	1644	389	1868
25	1123	1770	1004	1980	808	2460	724	2743
50	1599	2440	1441	2707	1178	3313	1065	3664
100	2172	3364	1950	3746	1582	4617	1425	5125
200	2855	4736	2521	5364	1979	6830	1754	7708
500	3906	7488	3328	8789	2439	11992	2088	14008

Hydrologic Region Parameters

Region: Western Coastal Plain
 Area (sq mi): 0.925
 Impervious Area (%): 49.65
 A Soil (%): 0
 Skew: 0.541
 Gage ID: No Adjustment

Hydrologic Region Flood Frequency Estimates

Return Period	Peak Flow Standard E Equivalent Standard Error of Prediction				
	[cfs]	[percent]	[logs]		
1.25	144	61.8	0.89	0.2468	
1.5	192	59.8	0.85	0.2401	
2	265	58.8	0.95	0.2366	
5	551	49.2	2.48	0.2021	
10	852	41.7	5.09	0.174	
25	1410	35	10.92	0.1475	
50	1975	32.3	16.47	0.1369	
100	2703	33.5	19.21	0.1418	
200	3677	39.1	17.44	0.164	
500	5408	51.6	13.19	0.2109	

FRRE Discharge
 GISHydro Release Version Date: v0.6 (Beta)
 Project Name: University Park_Wells Run 44th Avenue Culvert
 Analysis Date: October 13 2022
 Hydrologic Region: Western Coastal Plain
 Weight of Total Area: 100.00%

Discharges used in HY-8 headwaters elevations analysis = average of 2022 fixed region equations and upper 67% confidence limit (target calibration range)

2022 Maryland Fixed Region Equations

Peak Flow (Total Area Weighted)

Q(1.25):	140 cfs
Q(1.50):	187 cfs
Q(2):	259 cfs
Q(5):	539 cfs
Q(10):	834 cfs
Q(25):	1381 cfs
Q(50):	1937 cfs
Q(100):	2652 cfs
Q(200):	3611 cfs
Q(500):	5318 cfs

Q For HY8	
Q(2):	353.5
Q(10):	1040
Q(25):	1661.5
Q(50):	2297
Q(100):	3165.5

Prediction Intervals (Total Area Weighted)

Return Period	50 %		67 %		90 %		95 %	
	lower	upper	lower	upper	lower	upper	lower	upper
1.25	96	205	79	248	55	357	46	429
1.5	129	272	108	326	76	465	63	555
2	180	374	150	448	106	635	89	756
5	394	737	338	859	251	1158	216	1345
10	637	1091	558	1246	432	1611	380	1832
25	1100	1735	983	1942	790	2414	709	2692
50	1567	2394	1412	2657	1154	3253	1043	3599
100	2130	3303	1912	3679	1551	4536	1397	5037
200	2802	4654	2473	5273	1941	6719	1720	7584
500	3838	7368	3268	8652	2394	11813	2048	13804

Hydrologic Region Parameters

Region: Western Coastal Plain
 Area (sq mi): 0.89
 Impervious Area (%): 50.11
 A Soil (%): 0
 Skew: 0.541
 Gage ID: No Adjustment

Hydrologic Region Flood Frequency Estimates

Return Period	Peak Flow Standard E Equivalent Standard Error of Prediction				
	[cfs]	[percent]	[logs]		
1.25	140	61.9	0.89	0.2474	
1.5	187	60	0.84	0.2407	
2	259	59	0.94	0.2372	
5	539	49.3	2.47	0.2026	
10	834	41.8	5.07	0.1744	
25	1381	35.1	10.87	0.1479	
50	1937	32.4	16.39	0.1373	
100	2652	33.6	19.12	0.1421	
200	3611	39.3	17.35	0.1644	
500	5318	51.7	13.13	0.2114	

HY-8 Culvert Analysis Report

Crossing Discharge Data

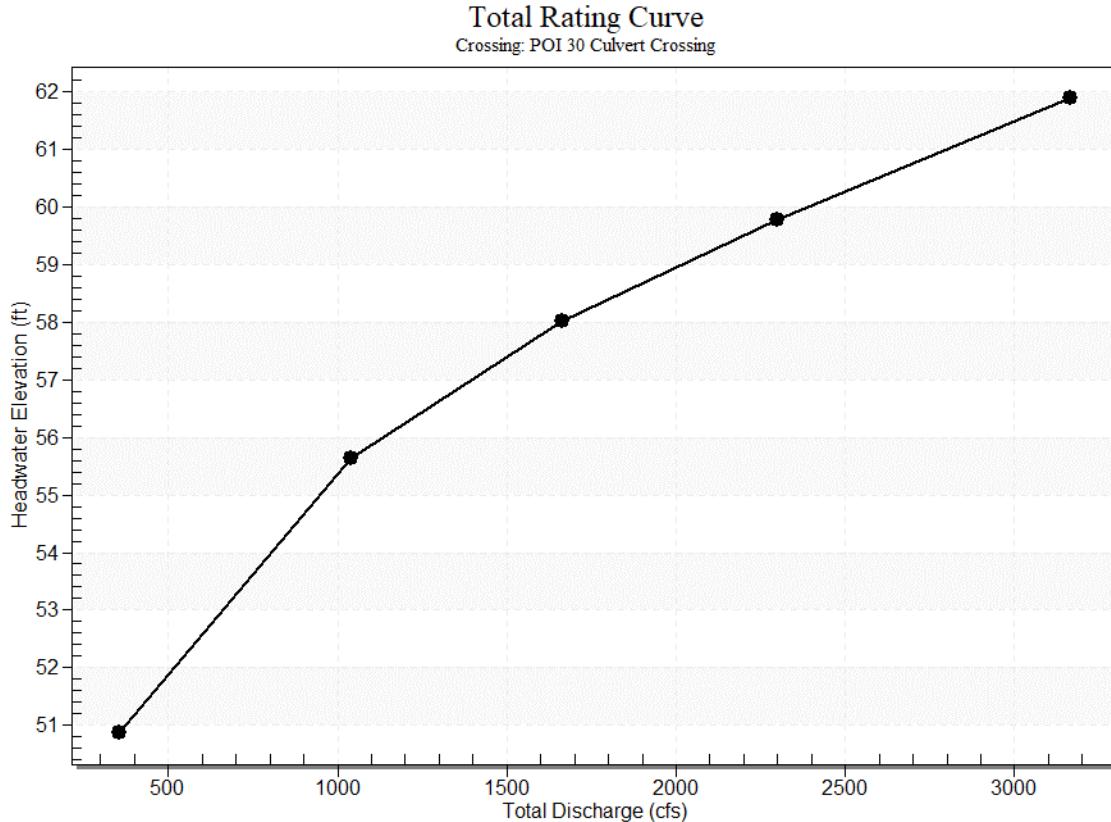
Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: POI 30 Culvert Crossing

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Main Culvert Barrels Discharge (cfs)	Relief Culvert Barrels Discharge (cfs)	Roadway Discharge (cfs)	Iterations
50.88	2-Year	354.00	268.75	85.70	0.00	10
55.62	10-Year	1040.00	562.58	163.20	314.26	6
58.02	25-Year	1662.00	415.55	120.62	1127.52	4
59.78	50-Year	2297.00	405.85	117.64	1776.82	3
61.88	100-Year	3166.00	417.96	121.18	2624.78	3
54.00	Overtopping	885.69	192.98	56.23	0.00	Overtopping

10-yr headwater elevation. Set proposed berm adjacent to 6500 44th Avenue to elevation 56

Rating Curve Plot for Crossing: POI 30 Culvert Crossing



Culvert Data: Main Culvert Barrels

Table 2 - Culvert Summary Table: Main Culvert Barrels

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2-Year	354.00 cfs	268.75 cfs	50.88	2.89	3.546	3-M1t	1.91	1.88	3.14	2.06	4.66	0.00
10-Year	1040.00 cfs	562.58 cfs	55.62	4.76	8.292	4-FFF	3.20	3.08	5.67	6.64	5.41	0.00
25-Year	1662.00 cfs	415.55 cfs	58.02	3.88	10.686	4-FFF	2.58	2.52	5.67	9.34	4.00	0.00

50-Year	2297.00 cfs	405.85 cfs	59.78	3.82	12.449	4-FFF	2.54	2.48	5.67	11.12	3.91	0.00
100-Year	3166.00 cfs	417.96 cfs	61.88	3.90	14.550	4-FFF	2.59	2.53	5.67	13.20	4.02	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

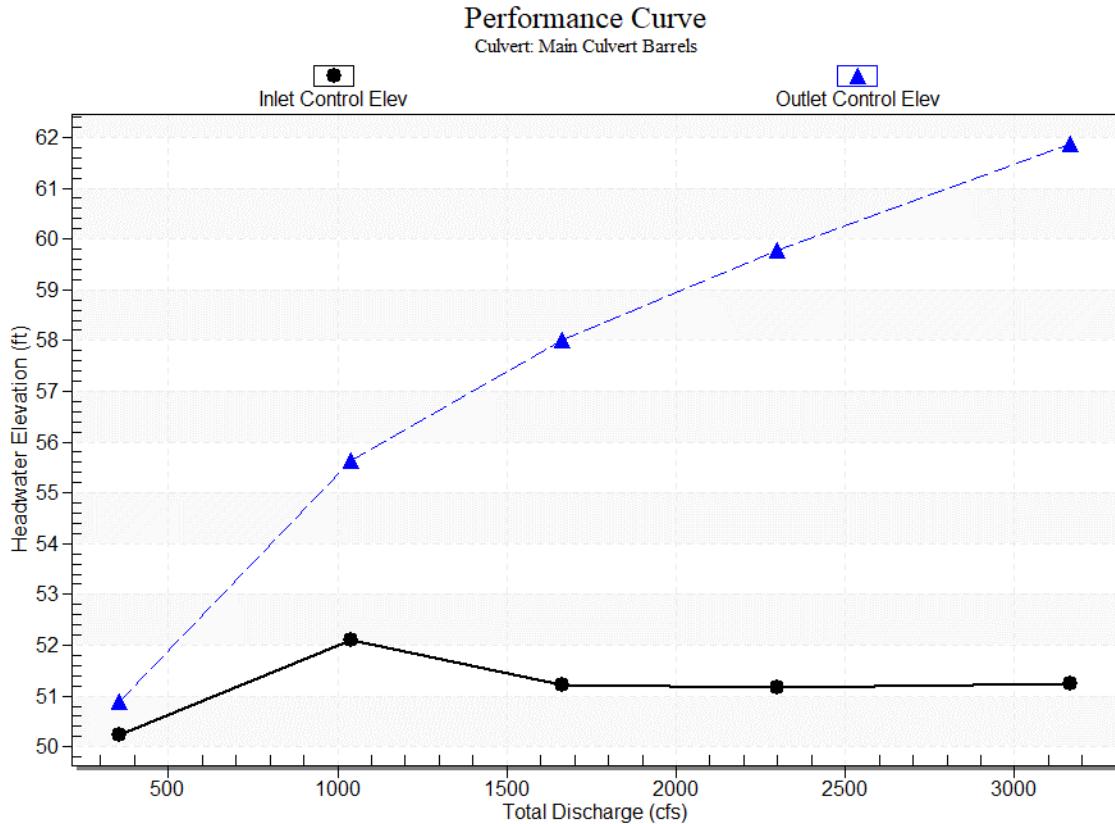
Inlet Elevation (invert): 47.33 ft,

Outlet Elevation (invert): 47.23 ft

Culvert Length: 36.00 ft,

Culvert Slope: 0.0030

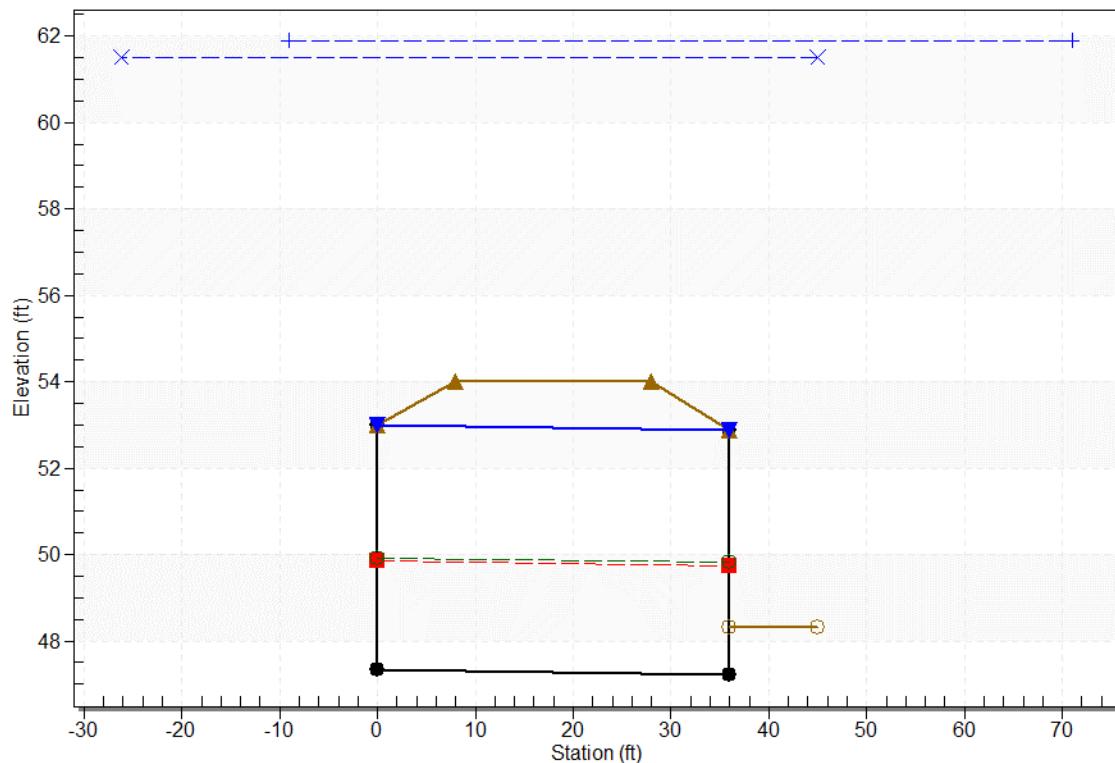
Culvert Performance Curve Plot: Main Culvert Barrels



Water Surface Profile Plot for Culvert: Main Culvert Barrels

Crossing - POI 30 Culvert Crossing, Design Discharge - 3166.0 cfs

Culvert - Main Culvert Barrels, Culvert Discharge - 418.0 cfs



Site Data - Main Culvert Barrels

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 47.33 ft

Outlet Station: 36.00 ft

Outlet Elevation: 47.23 ft

Number of Barrels: 2

Culvert Data Summary - Main Culvert Barrels

Barrel Shape: Concrete Box

Barrel Span: 9.17 ft

Barrel Rise: 5.67 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge (30-75° flare) Wingwall

Inlet Depression: None

Culvert Data: Relief Culvert Barrels

Table 3 - Culvert Summary Table: Relief Culvert Barrels

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2-Year	354.00 cfs	85.70 cfs	50.88	2.69	3.046	3-M1t	1.97	1.89	2.64	2.06	4.41	0.00
10-Year	1040.00 cfs	163.20 cfs	55.62	4.01	7.792	4-FFF	2.92	2.64	4.50	6.64	5.13	0.00
25-Year	1662.00 cfs	120.62 cfs	58.02	3.33	10.186	4-FFF	2.40	2.26	4.50	9.34	3.79	0.00
50-Year	2297.00 cfs	117.64 cfs	59.78	3.27	11.948	4-FFF	2.37	2.23	4.50	11.12	3.70	0.00
100-Year	3166.00 cfs	121.18 cfs	61.88	3.33	14.049	4-FFF	2.41	2.26	4.50	13.20	3.81	0.00

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

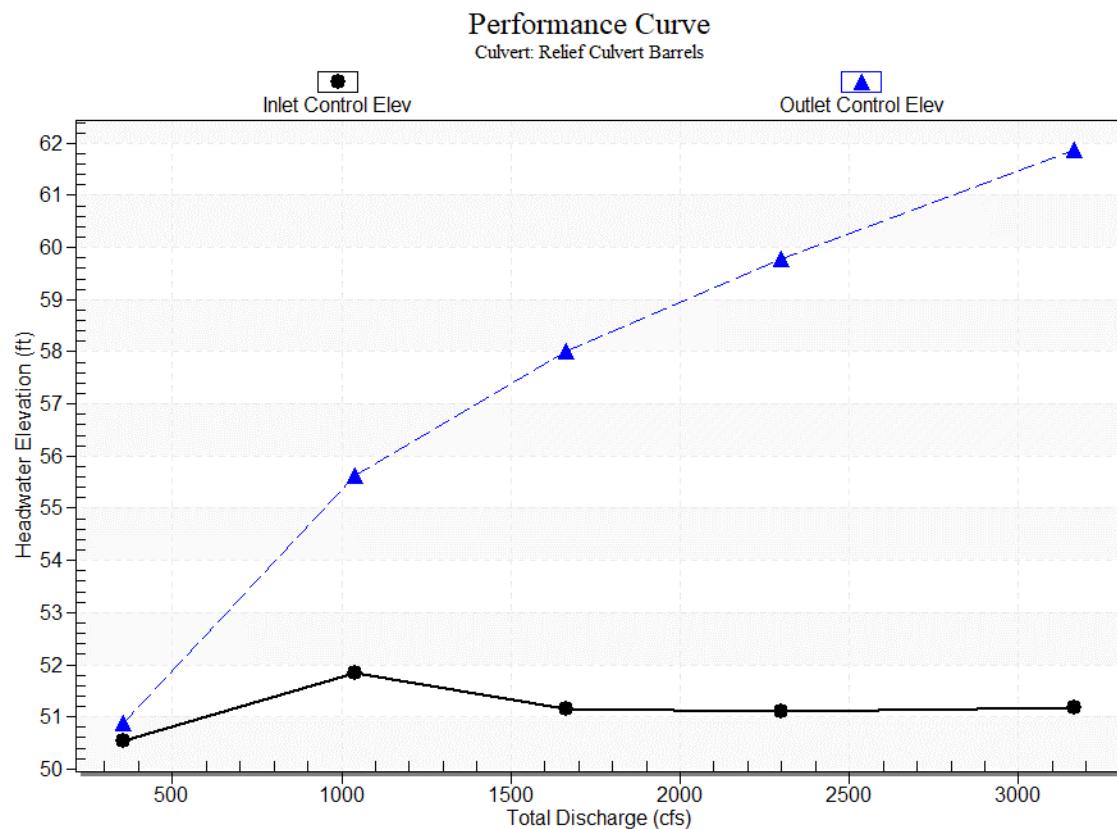
Inlet Elevation (invert): 47.83 ft,

Outlet Elevation (invert): 47.73 ft

Culvert Length: 36.00 ft,

Culvert Slope: 0.0030

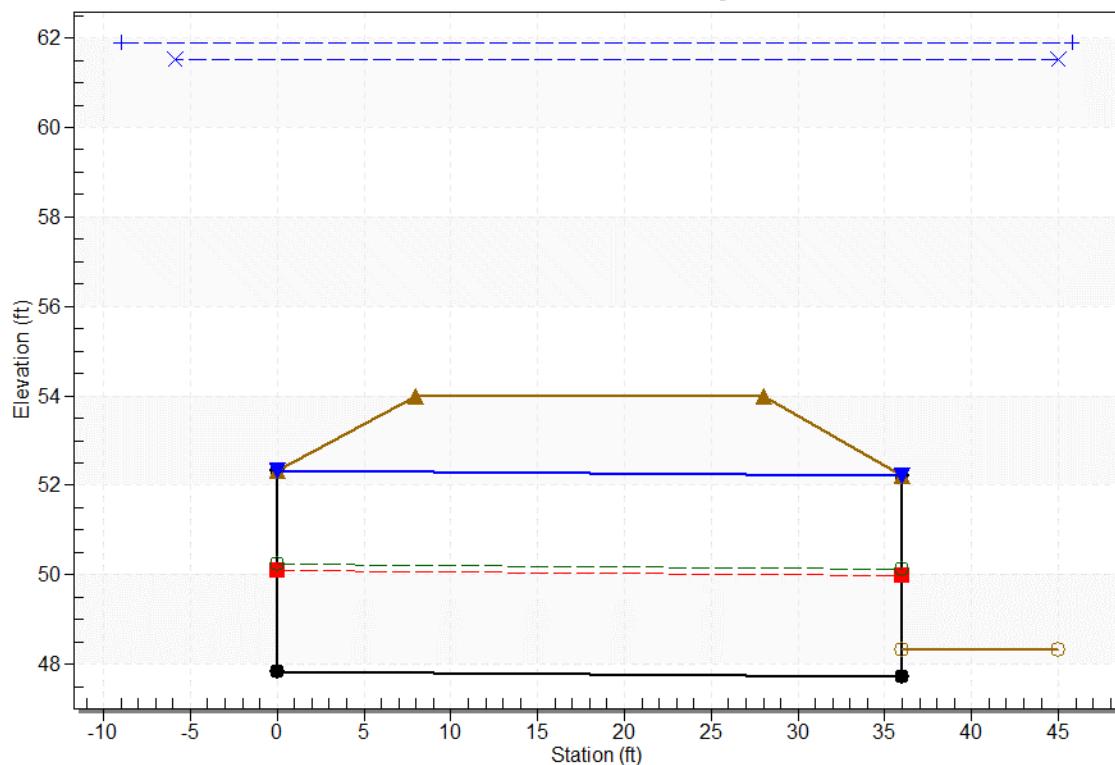
Culvert Performance Curve Plot: Relief Culvert Barrels



Water Surface Profile Plot for Culvert: Relief Culvert Barrels

Crossing - POI 30 Culvert Crossing, Design Discharge - 3166.0 cfs

Culvert - Relief Culvert Barrels, Culvert Discharge - 121.2 cfs



Site Data - Relief Culvert Barrels

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 47.83 ft

Outlet Station: 36.00 ft

Outlet Elevation: 47.73 ft

Number of Barrels: 2

Culvert Data Summary - Relief Culvert Barrels

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Tailwater Data for Crossing: POI 30 Culvert Crossing

Table 4 - Downstream Channel Rating Curve (Crossing: POI 30 Culvert Crossing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)
354.00	50.37	50.37	0.00
1040.00	54.95	54.95	0.00
1662.00	57.65	57.65	0.00
2297.00	59.43	59.43	0.00
3166.00	61.51	61.51	0.00

Tailwater Channel Data - POI 30 Culvert Crossing

Tailwater Channel Option: Enter Rating Curve

Channel Invert Elevation: Enter Rating Curve

Roadway Data for Crossing: POI 30 Culvert Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 54.00 ft

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

Rt. 1 culvert crossing headwater elevations used as tailwater rating curve for culverts underneath 44th avenue

HY-8 Culvert Analysis Report

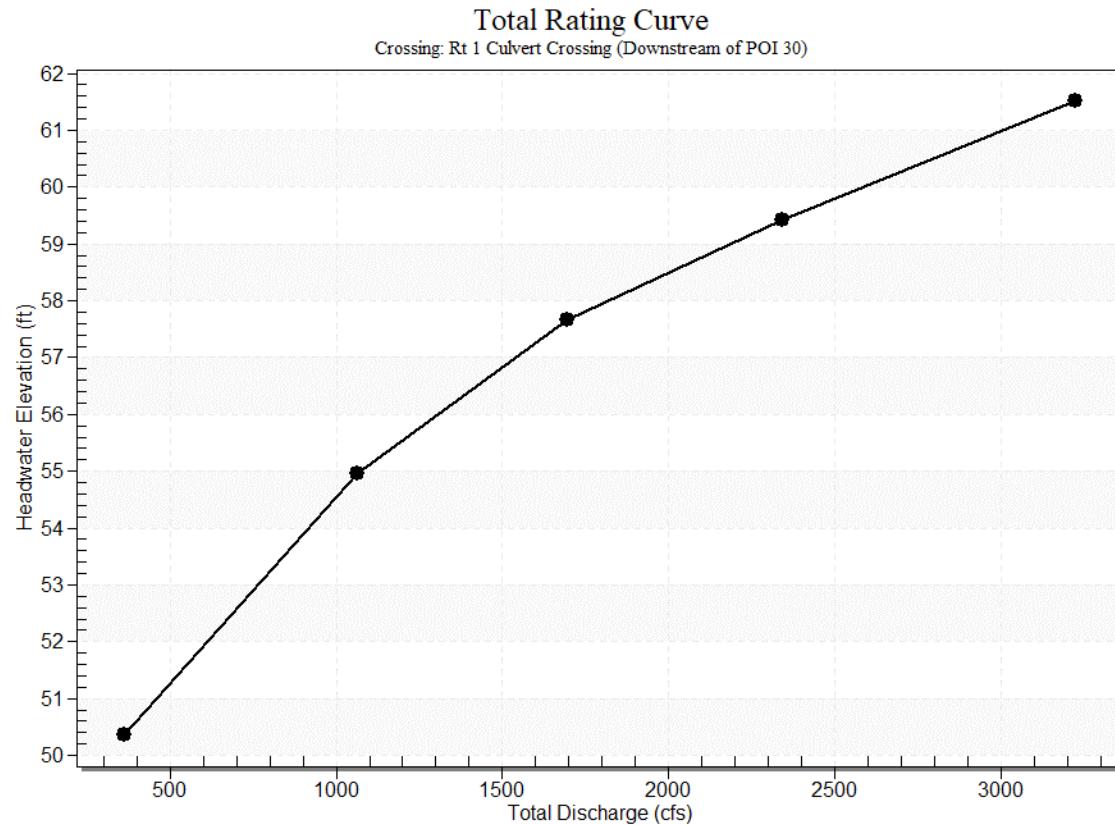
Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Rt 1 Culvert Crossing (Downstream of POI 30)

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
50.37	2-Year	361.50	361.50	0.00	1
54.95	10-Year	1062.00	1062.00	0.00	1
57.65	25-Year	1695.00	1275.75	419.26	4
59.43	50-Year	2341.00	1087.28	1254.23	5
61.51	100-Year	3224.50	819.40	2405.10	4
56.00	Overtopping	1259.61	1259.61	0.00	Overtopping

Rating Curve Plot for Crossing: Rt 1 Culvert Crossing (Downstream of POI 30)



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2-Year	361.50 cfs	361.50 cfs	50.37	3.97	4.416	1-S1t	1.80	2.32	4.10	4.10	4.90	5.17
10-Year	1062.00 cfs	1062.00 cfs	54.95	8.04	8.999	1-S1t	3.66	4.76	7.95	7.95	7.43	7.04
25-Year	1695.00 cfs	1275.75 cfs	57.65	9.12	11.705	4-FFf	4.15	5.38	9.00	10.51	7.87	7.96
50-Year	2341.00 cfs	1087.28 cfs	59.43	8.17	13.479	4-FFf	3.72	4.84	9.00	12.69	6.71	8.64
100-Year	3224.50 cfs	819.40 cfs	61.51	6.77	15.563	4-FFf	3.08	4.01	9.00	15.25	5.06	9.34

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

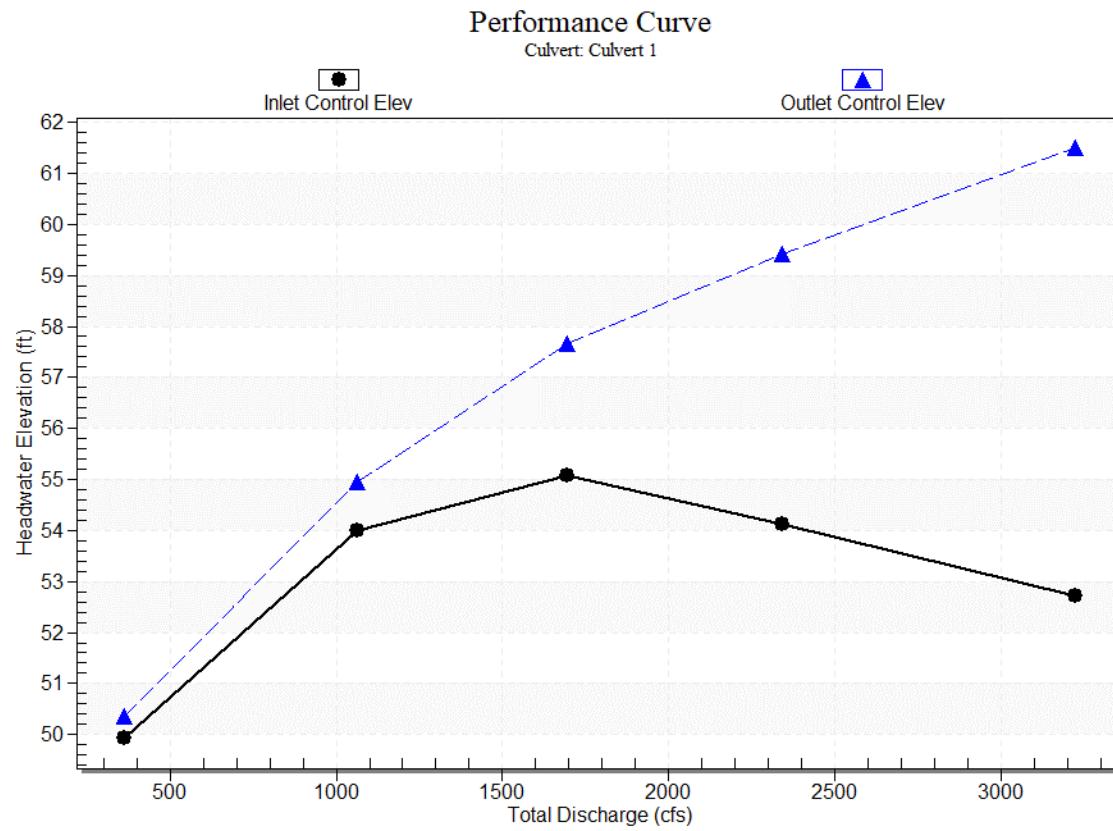
Inlet Elevation (invert): 45.95 ft,

Outlet Elevation (invert): 45.64 ft

Culvert Length: 66.00 ft,

Culvert Slope: 0.0047

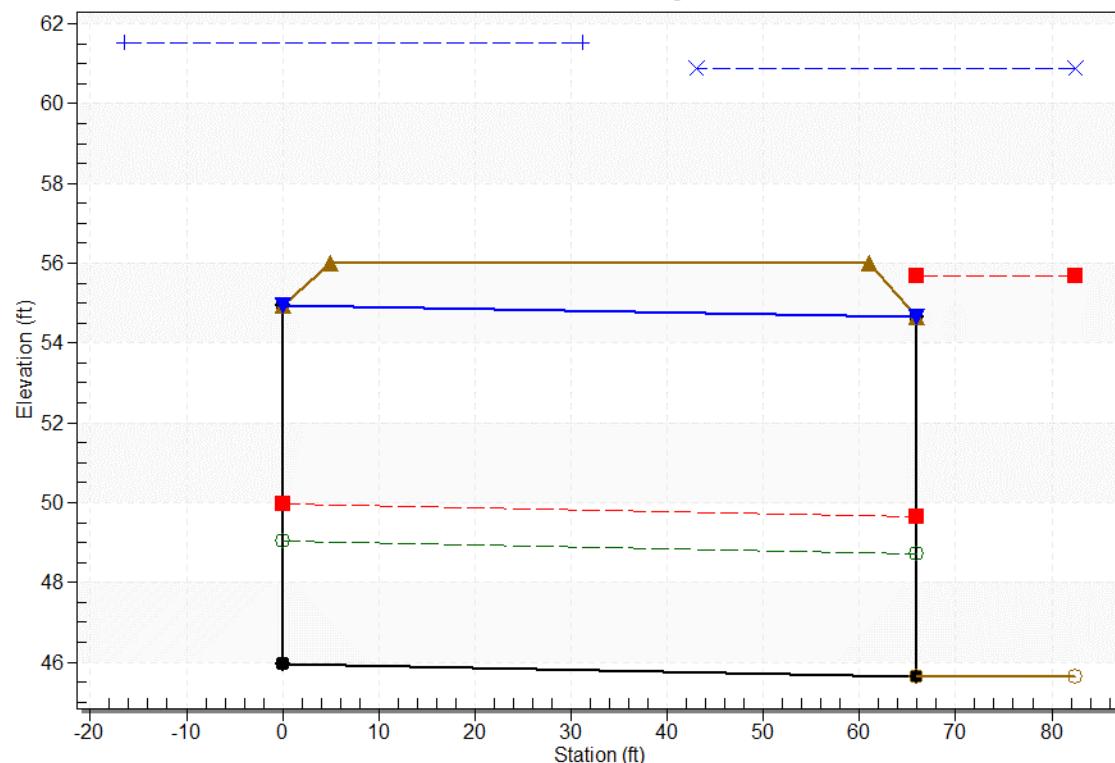
Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Rt 1 Culvert Crossing (Downstream of POI 30), Design Discharge - 3224.5 cfs

Culvert - Culvert 1, Culvert Discharge - 819.4 cfs



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 45.95 ft

Outlet Station: 66.00 ft

Outlet Elevation: 45.64 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 18.00 ft

Barrel Rise: 9.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall

Inlet Depression: None

Tailwater Data for Crossing: Rt 1 Culvert Crossing (Downstream of POI 30)

Table 3 - Downstream Channel Rating Curve (Crossing: Rt 1 Culvert Crossing (Downstream of POI 30))

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
361.50	49.74	4.10	5.17	1.20	0.48
1062.00	53.59	7.95	7.04	2.33	0.48
1695.00	56.15	10.51	7.96	3.08	0.49
2341.00	58.33	12.69	8.64	3.72	0.49
3224.50	60.89	15.25	9.34	4.47	0.49

Tailwater Channel Data - Rt 1 Culvert Crossing (Downstream of POI 30)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 15.00 ft

Side Slope (H:V): 0.50 (_:1)

Channel Slope: 0.0047

Channel Manning's n: 0.0400

Channel Invert Elevation: 45.64 ft

Roadway Data for Crossing: Rt 1 Culvert Crossing (Downstream of POI 30)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 65.00 ft

Crest Elevation: 56.00 ft

Roadway Surface: Paved

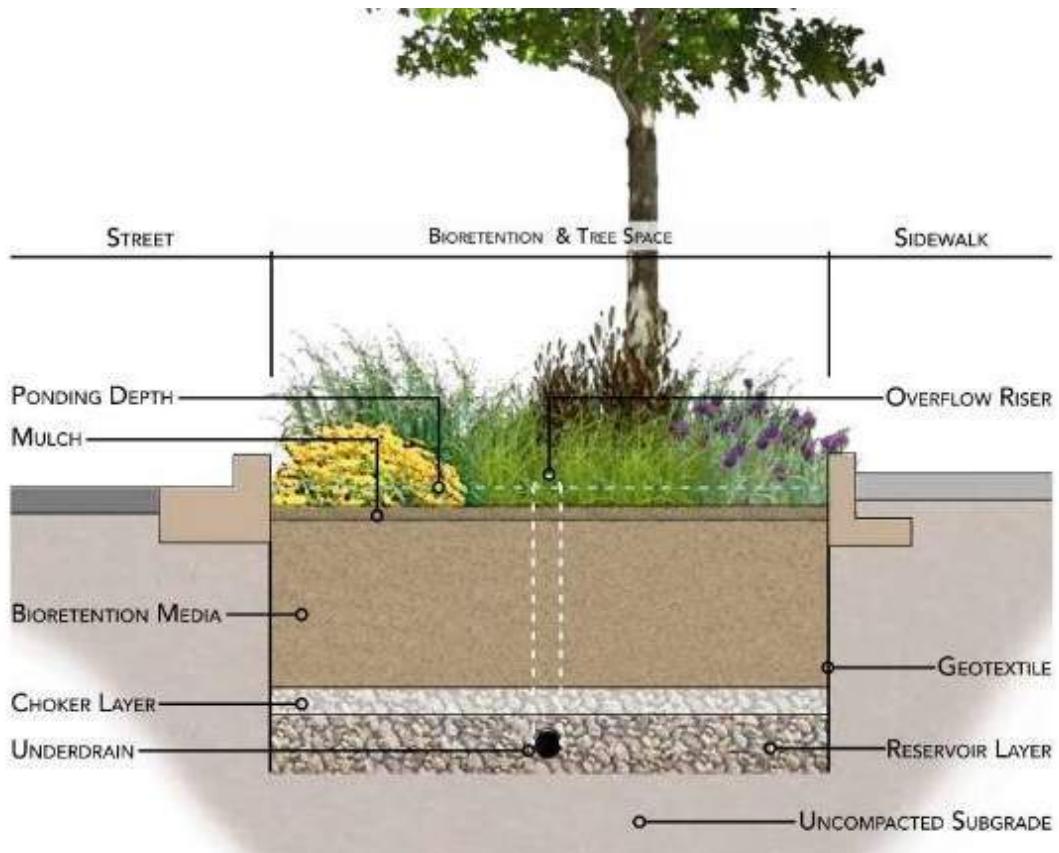
Roadway Top Width: 56.00 ft

**University Park Flood Attenuation
Potential SWM Facilities Assessment Report**

Appendix 4

***Example Typical Sections of Proposed
Stormwater Management Practices***

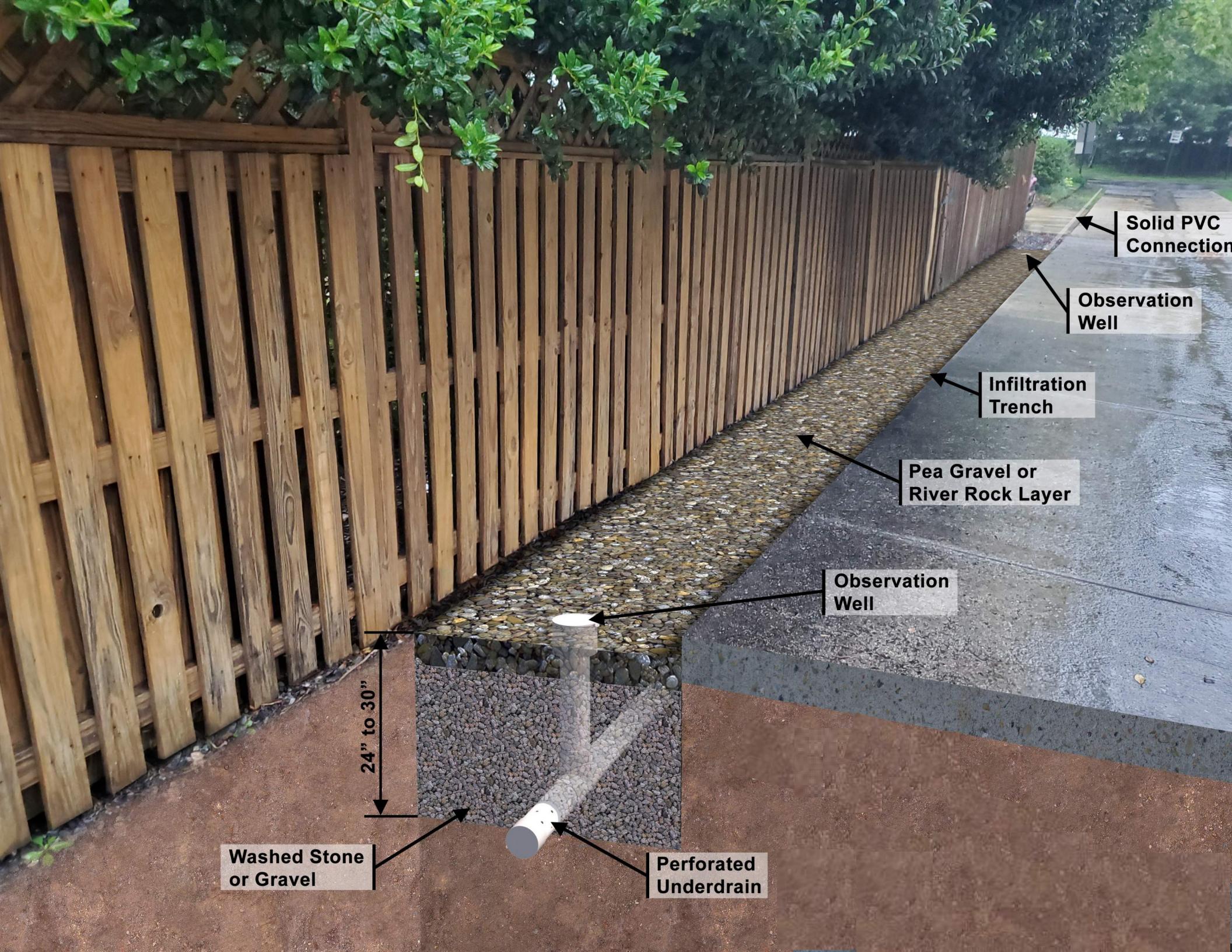
Micro-Bioretention Facilities



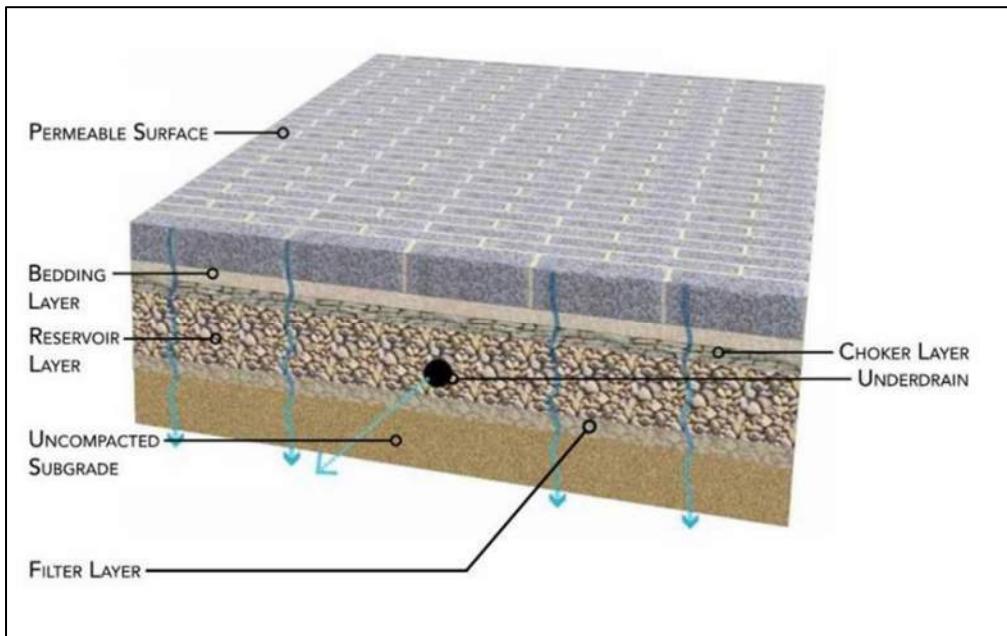
Cross-Section of Micro-Bioretention Facility



Examples of Micro-Bioretention Areas



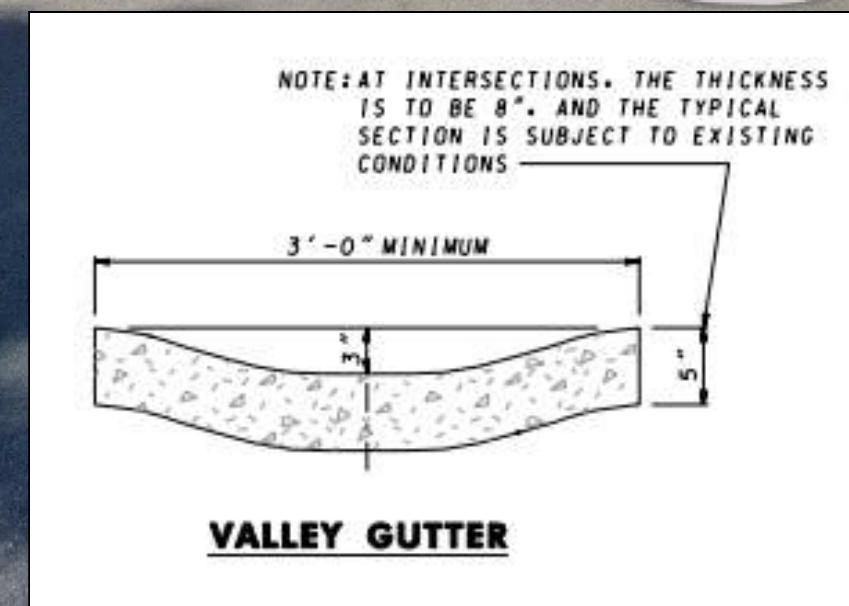
Pervious Concrete Typical Section



Cross-Section of Pervious Pavement Infrastructure Facility



Example of Pervious Pavement used in a “Green Alley”



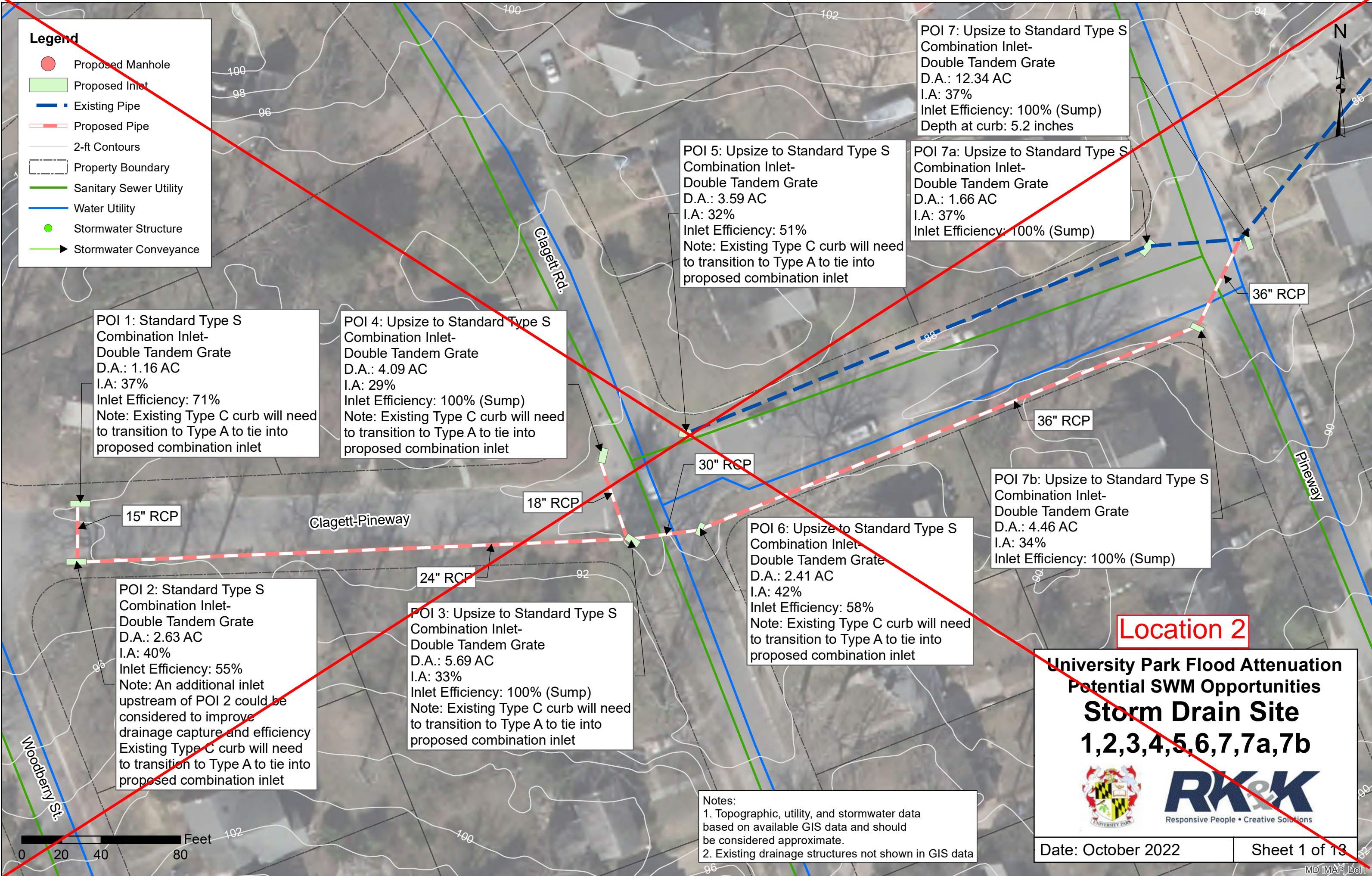
VALLEY GUTTER AT BAPTIST CHURCH PARKING

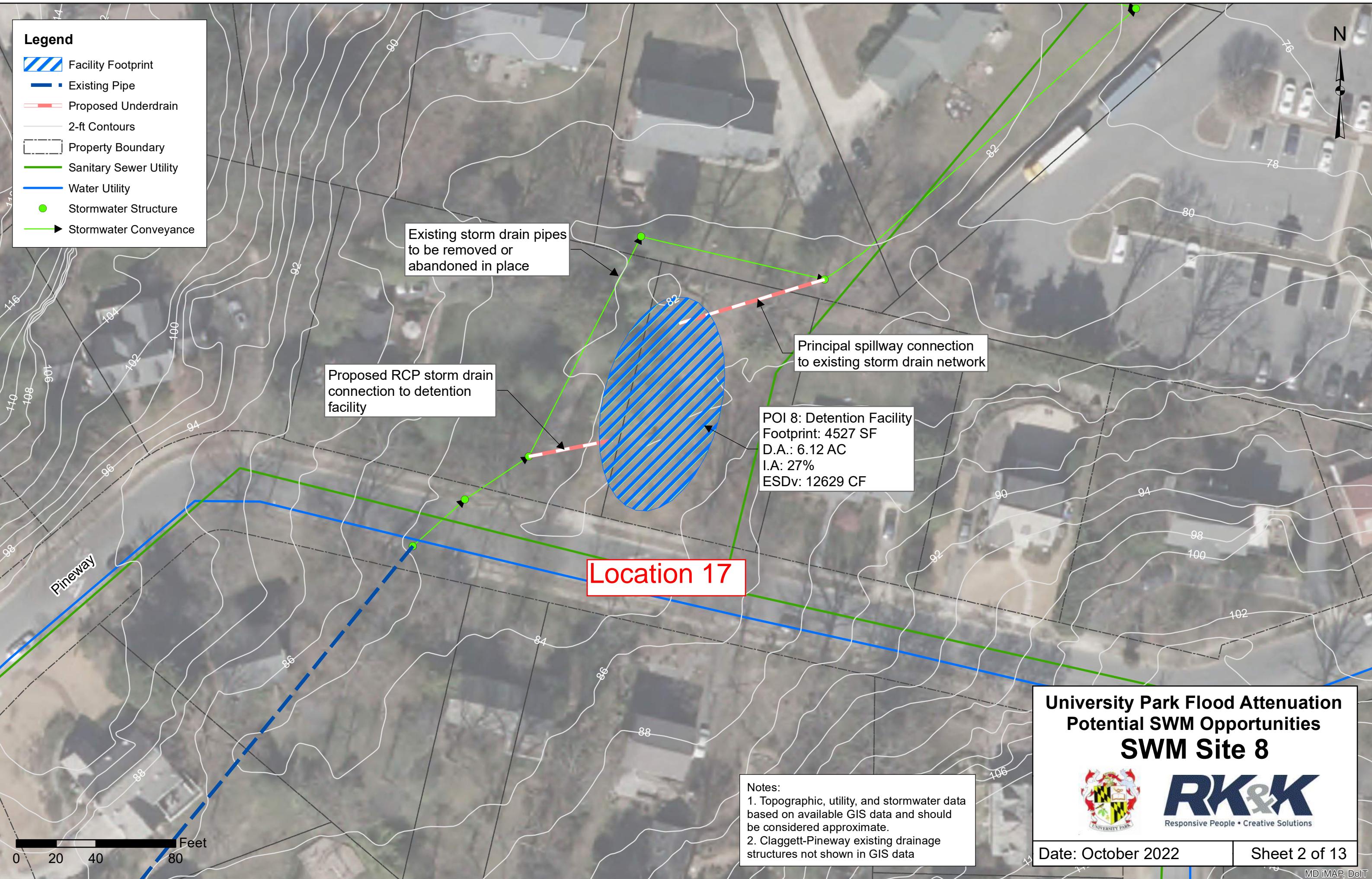
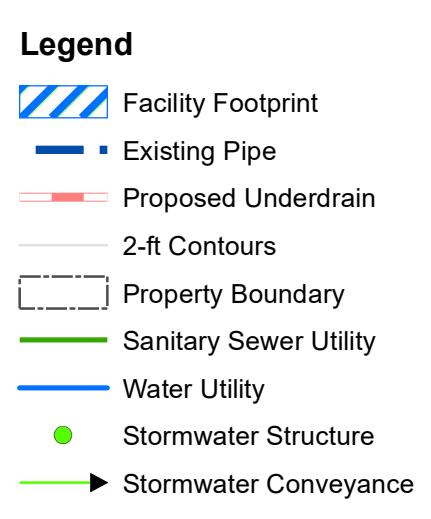
**University Park Flood Attenuation
Potential SWM Facilities Assessment Report**

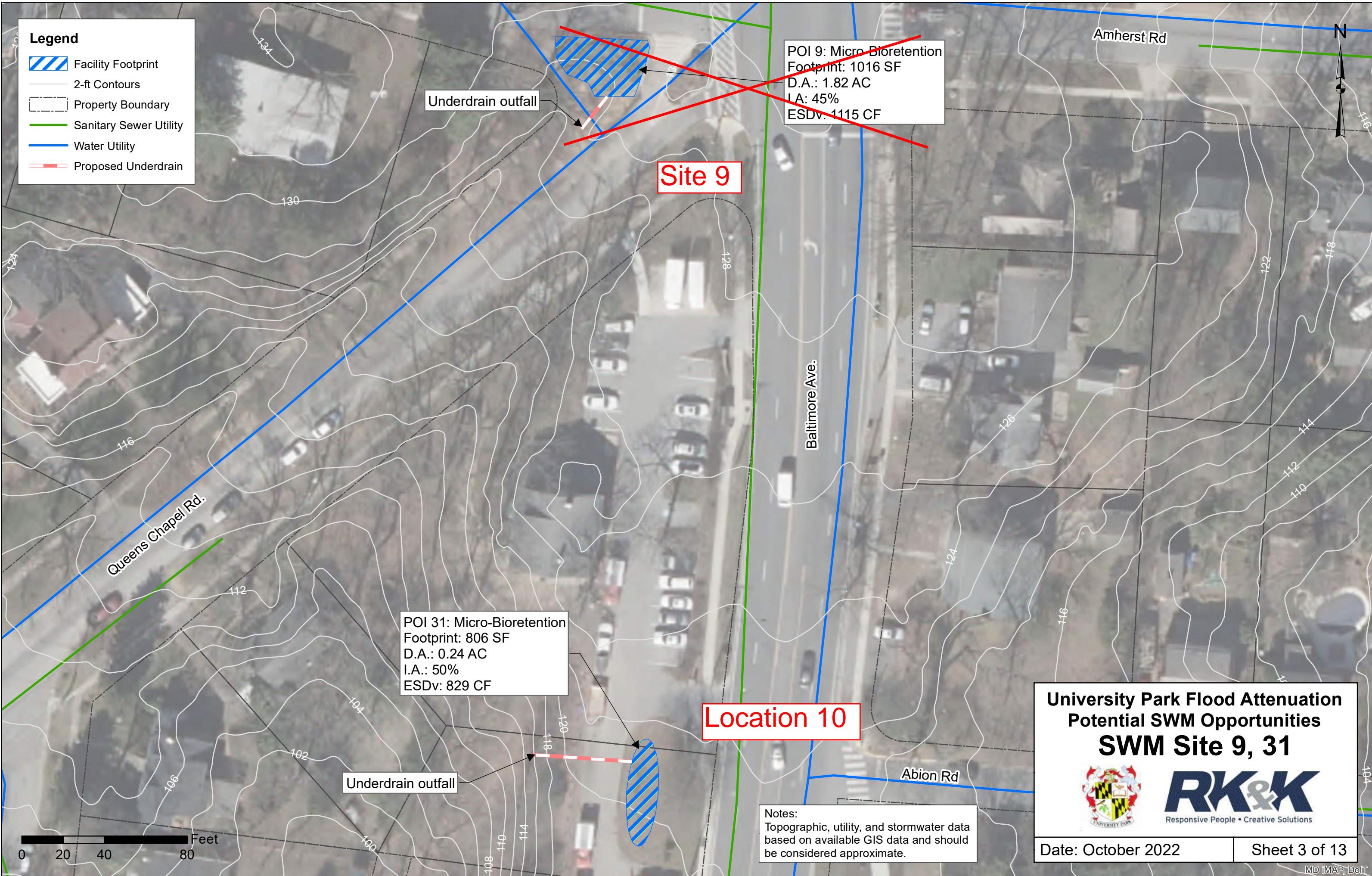
Appendix 5

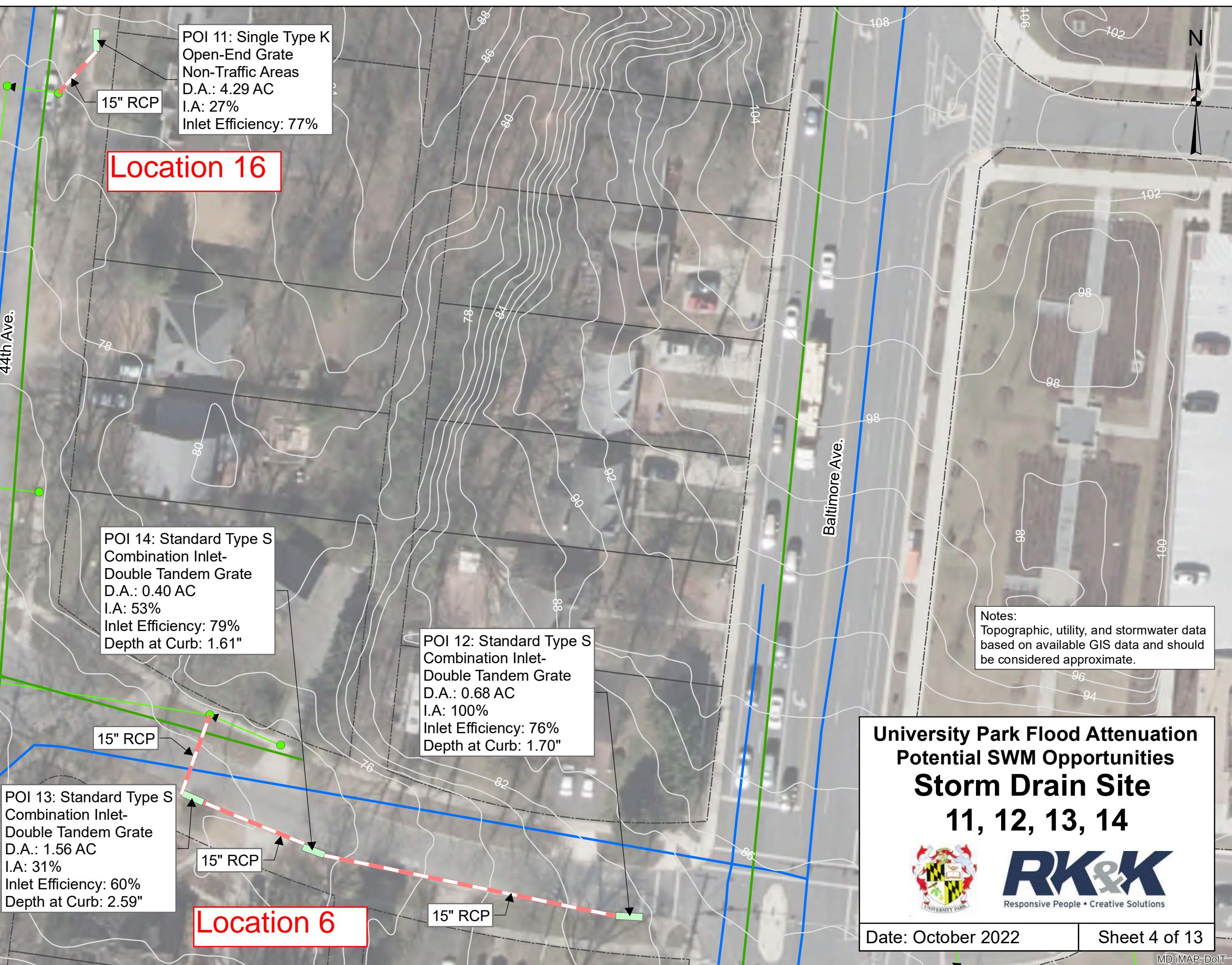
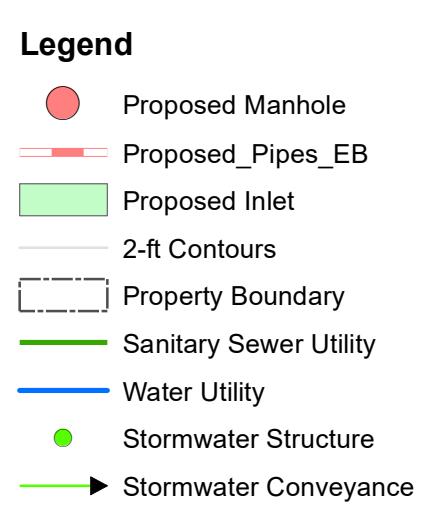
Potential SWM Opportunities Concept Plans

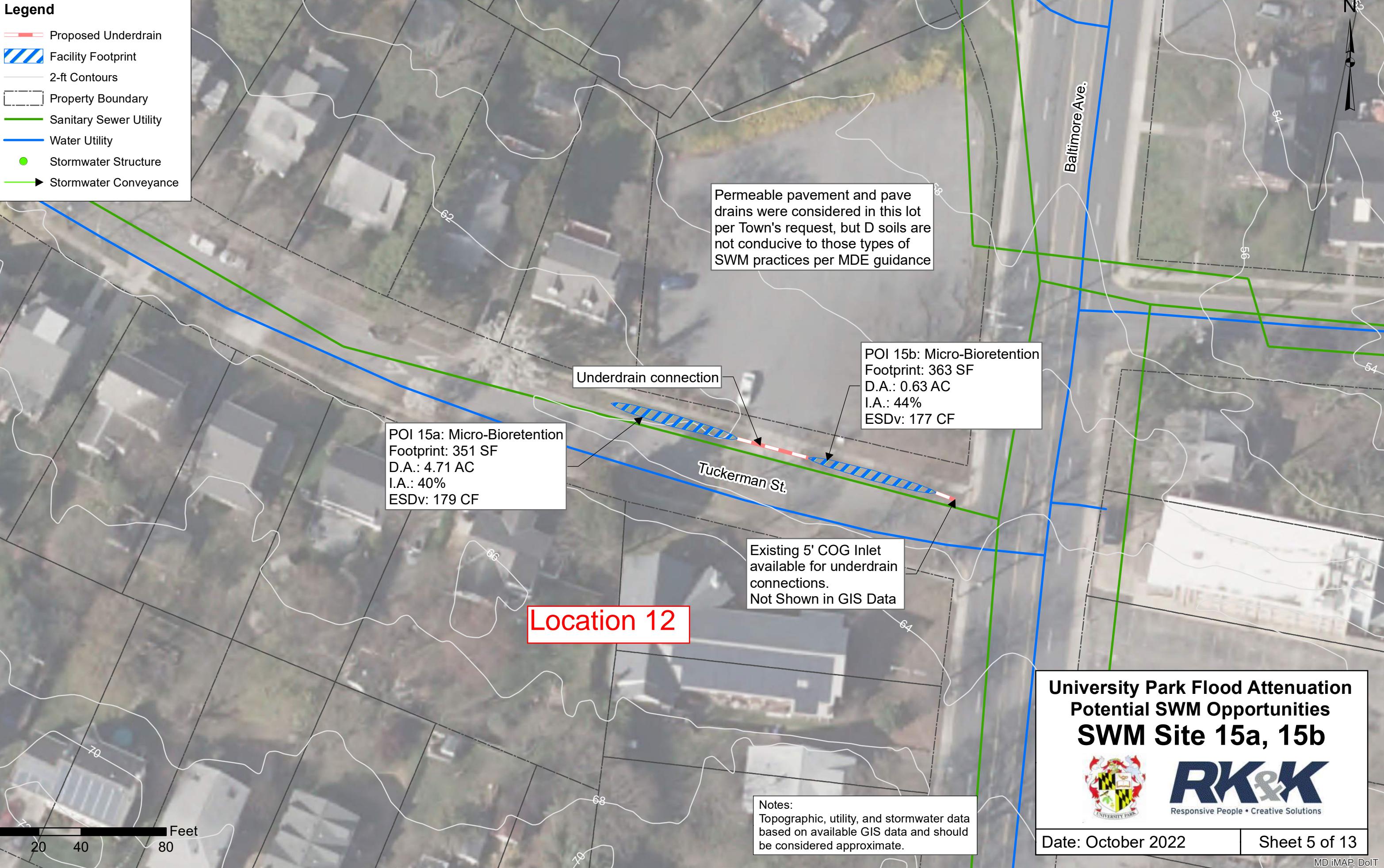
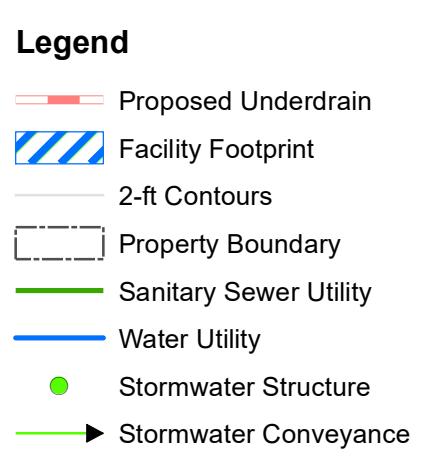


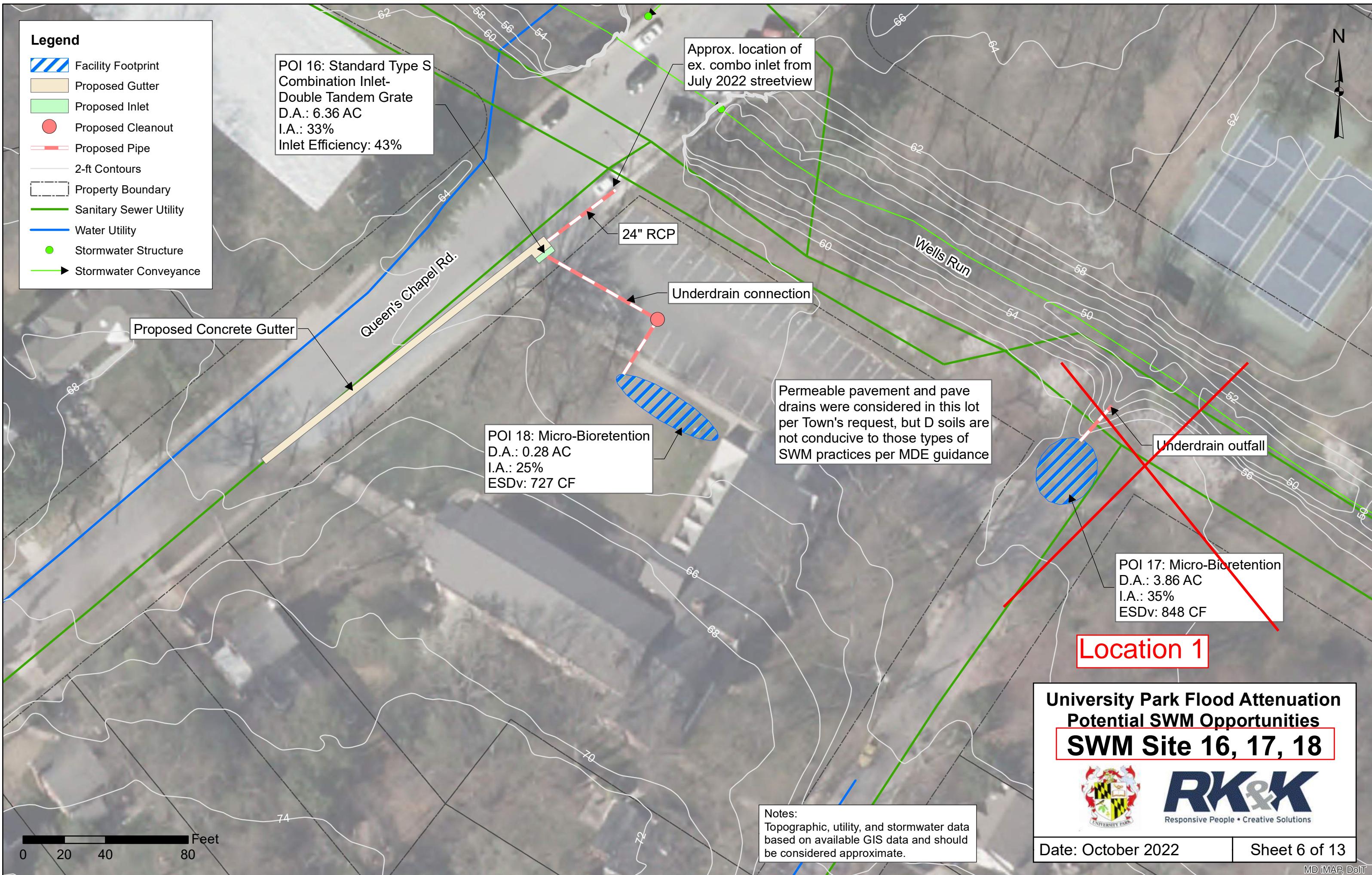
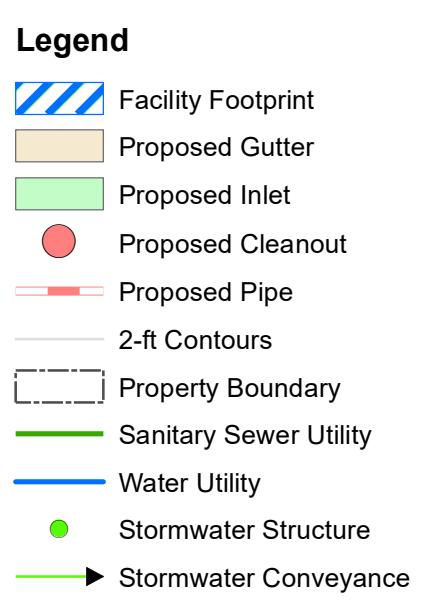


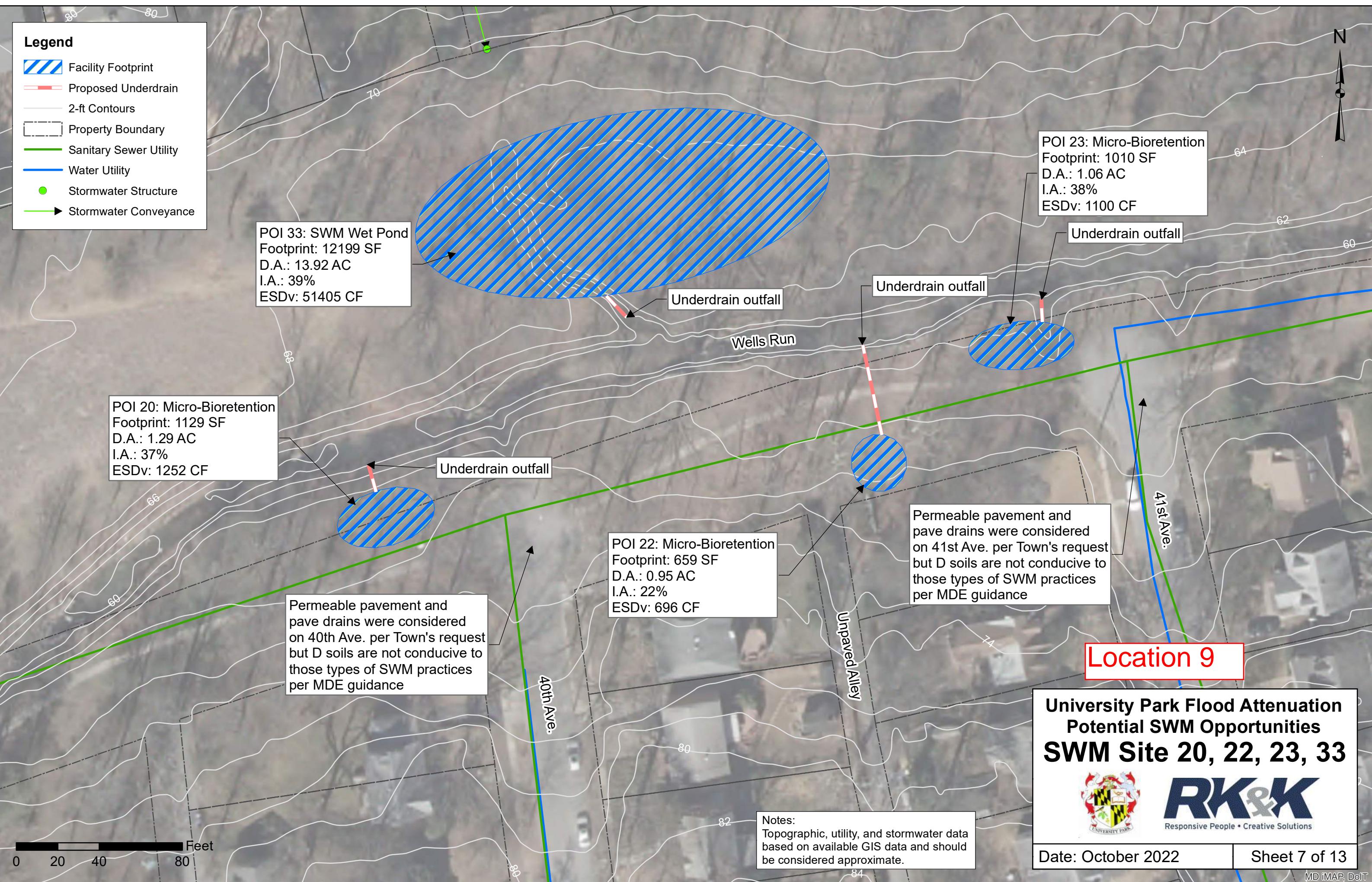
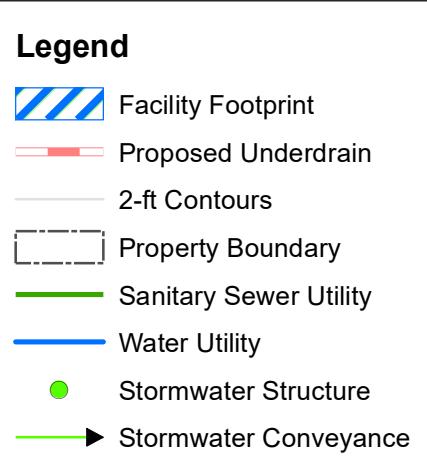


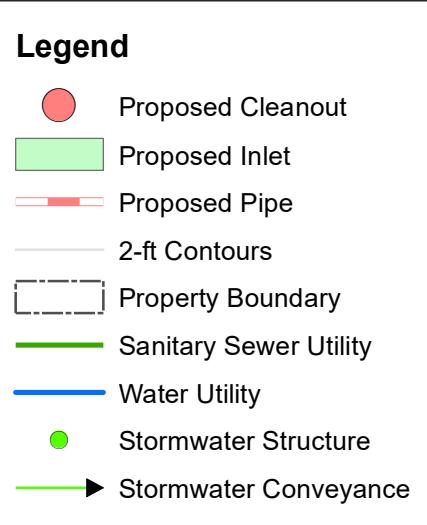












POI 21: Infiltration Trenches
D.A.: 1.82 AC
I.A: 45%

Underdrain outfall

Tennyson Rd.

0 12.5 25 50
Feet

N

Location 9

**University Park Flood Attenuation
Potential SWM Opportunities
SWM Site 21**



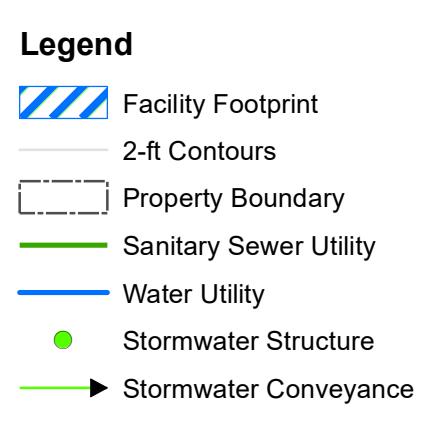
RK&K
Responsive People • Creative Solutions

Notes:
Topographic, utility, and stormwater data
based on available GIS data and should
be considered approximate.

Date: October 2022

Sheet 8 of 13

MD iMAP, DoIT



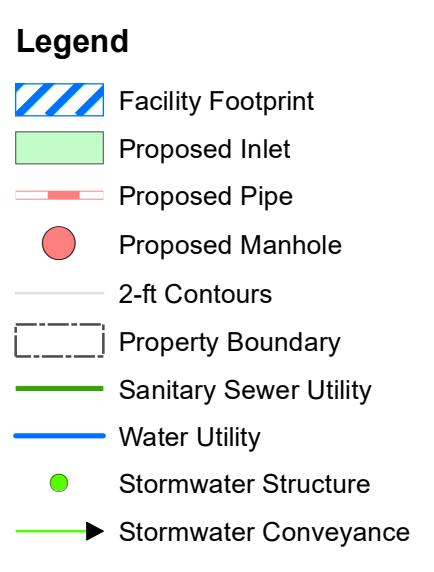
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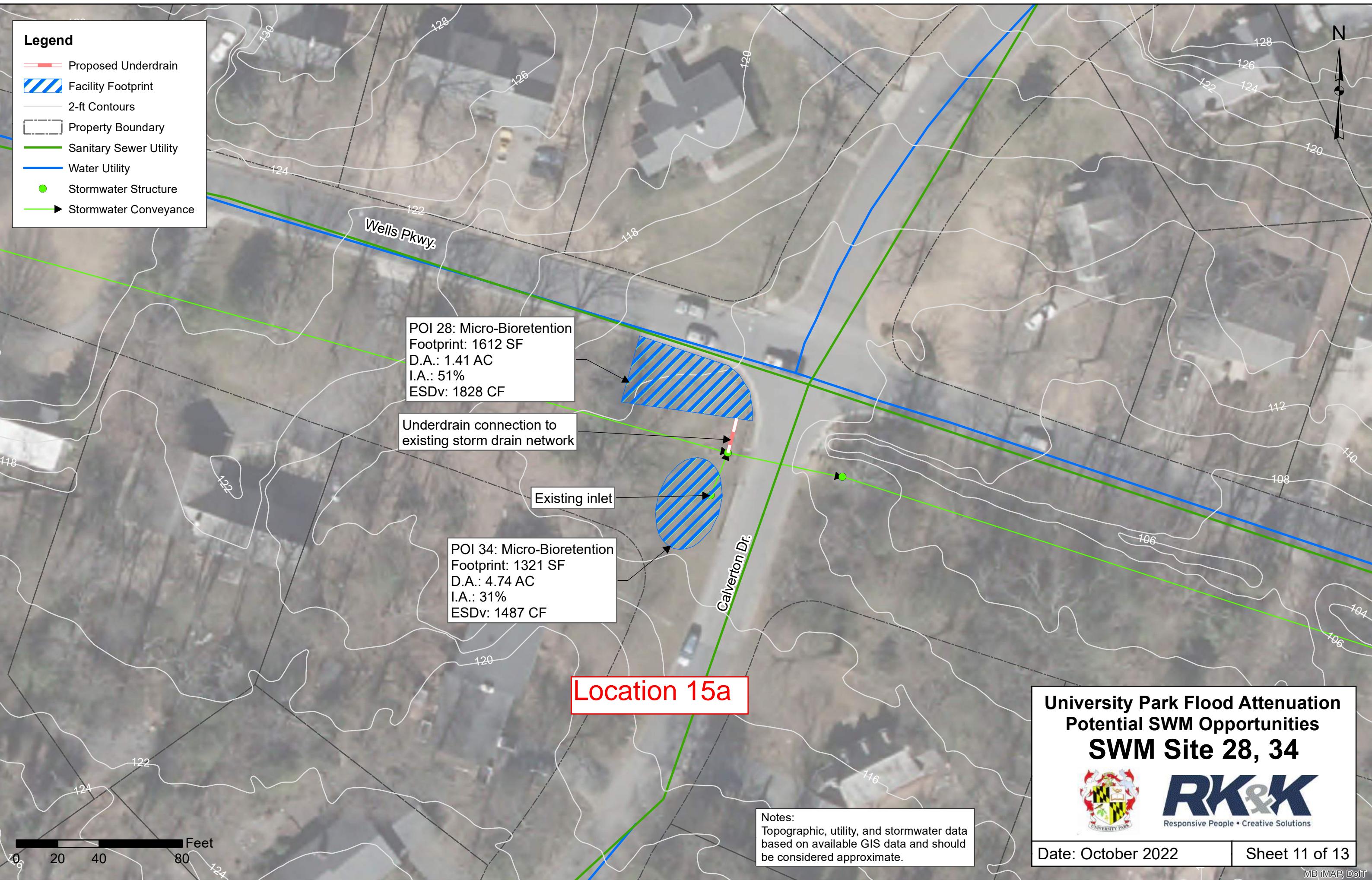
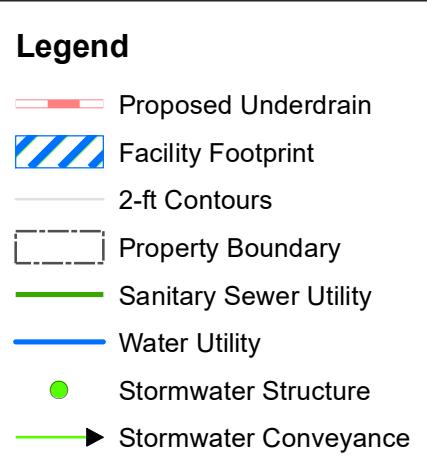


University Park Flood Attenuation Potential SWM Opportunities **SWM Site 24**



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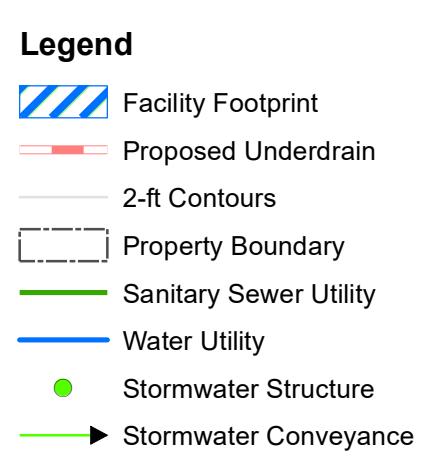




University Park Flood Attenuation Potential SWM Opportunities **SWM Site 28, 34**



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N

POI 29: Micro-Bioretention
Footprint: 3945 SF
D.A.: 0.19 AC
I.A.: 47%
ESDv: 854 CF

Underdrain Outfall

Location 15b

Notes:
Topographic, utility, and stormwater data
based on available GIS data and should
be considered approximate.

University Park Flood Attenuation Potential SWM Opportunities **SWM Site 29**



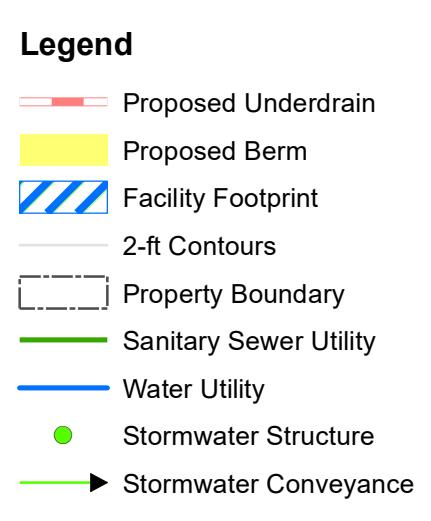
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Date: October 2022

Sheet 12 of 13

MD iMAP, DoIT





Proposed Berm
Elevation 56'
Protects against inundation
from 10-Year storm (Alignment to be
adjusted as needed to minimize
impacts to existing trees)

Wells Run

Underdrain outfall

POI 30: Micro-Bioretention
Footprint: 1438 SF
D.A.: 5.69 AC
I.A.: 37%
ESDv: 1557 CF

44th Ave.

University Park Flood Attenuation Potential SWM Opportunities **SWM Site 30**



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Date: October 2022

Sheet 13 of 13

Notes:
Topographic, utility, and stormwater data
based on available GIS data and should
be considered approximate.



Location 5

0 20 40 80
Feet

MD iMAP, DoIT

**University Park Flood Attenuation
Potential SWM Facilities Assessment Report**

Appendix 6

Cost Estimate Tables



University Park Flood Attenuation
Potential SWM Facilities Assessment Report

University Park SWM Facilities Cost Estimates

DETENTION FACILITY		Site ID: 8 Area (SF): 5070		
		Quantity	Unit Price	Total
	Class 1 Excavation	939 CY	\$60.00	\$56,333.33
	36" Reinforced Concrete Pipe	130 LF	\$180.00	\$23,400.00
	60" Diameter Manhole (Contingent upon further design)	2 EACH	\$8,000.00	\$16,000.00
	SWM Riser Control Structure	1 EACH	\$10,000.00	\$10,000.00
	Pavement/Sidewalk Restoration	25 SF	\$15.00	\$375.00
	4" Topsoil	563 SY	\$5.50	\$3,098.33
	Seed & Mulch	563 SY	\$2.50	\$1,408.33
Construction Subtotal				\$110,615.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)				\$38,715.25
Construction Total*				\$149,330.25

MICRO-BIOPRETENTION		Site ID: 9 Area (SF): 1016		
		Quantity	Unit Price	Total
	Class 1 Excavation	188 CY	\$60.00	\$11,288.89
	Bioretention soil- Filter Media (d= 2 ft)	75 CY	\$95.00	\$7,149.63
	Choker Layer - Course Sand (d=4 in)	13 CY	\$150.00	\$1,881.48
	#7 Stone (d=4 in)	13 CY	\$135.00	\$1,693.33
	#57 Stone (d=18 in)	56 CY	\$135.00	\$7,620.00
	Perforated Underdrain Pipe, 6 Inch	43 LF	\$25.00	\$1,075.00
	Underdrain Connection Pipe, 6 Inch	20 LF	\$20.00	\$400.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00	\$0.00
	Pavement/Sidewalk Restoration	0 SF	\$15.00	\$0.00
	Plantings	1016 SF	\$27.00	\$27,432.00
Construction Subtotal				\$58,540.33
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)				\$20,489.12
Construction Total				\$79,029.45

University Park Flood Attenuation
Potential SWM Facilities Assessment Report

MICRO-BIORETENTION		Site ID: Area (SF):	15a 257	
		Quantity	Unit Price	Total
Class 1 Excavation		48 CY	\$60.00	\$2,855.56
Bioretention soil- Filter Media (d= 2 ft)		19 CY	\$95.00	\$1,808.52
Choker Layer - Course Sand (d=4 in)		3 CY	\$150.00	\$475.93
#7 Stone (d=4 in)		3 CY	\$135.00	\$428.33
#57 Stone (d=18 in)		14 CY	\$135.00	\$1,927.50
Perforated Underdrain Pipe, 6 Inch		62 LF	\$25.00	\$1,550.00
Underdrain Connection Pipe, 6 Inch		35 LF	\$20.00	\$700.00
LID Underdrain Connection to Inlet/MH		0 EACH	\$600.00	\$0.00
Pavement/Sidewalk Restoration		172 SF	\$15.00	\$2,580.00
Plantings		257 SF	\$27.00	\$6,939.00
Construction Subtotal				\$19,264.83
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)				\$6,742.69
Construction Total				\$26,007.53

MICRO-BIORETENTION		Site ID: Area (SF):	15b 223	
		Quantity	Unit Price	Total
Class 1 Excavation		41 CY	\$60.00	\$2,477.78
Bioretention soil- Filter Media (d= 2 ft)		17 CY	\$95.00	\$1,569.26
Choker Layer - Course Sand (d=4 in)		3 CY	\$150.00	\$412.96
#7 Stone (d=4 in)		3 CY	\$135.00	\$371.67
#57 Stone (d=18 in)		12 CY	\$135.00	\$1,672.50
Perforated Underdrain Pipe, 6 Inch		62 LF	\$25.00	\$1,550.00
Underdrain Connection Pipe, 6 Inch		10 LF	\$20.00	\$200.00
LID Underdrain Connection to Inlet/MH		1 EACH	\$600.00	\$600.00
Pavement/Sidewalk Restoration		33 SF	\$15.00	\$495.00
Plantings		223 SF	\$27.00	\$6,021.00
Construction Subtotal				\$15,370.17
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)				\$5,379.56
Construction Total				\$20,749.73



University Park Flood Attenuation
Potential SWM Facilities Assessment Report

MICRO-BIOPRETENTION		Site ID: Area (SF):	18 634
		Quantity	Unit Price
			Total
	Class 1 Excavation	117 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	47 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	8 CY	\$150.00
	#7 Stone (d=4 in)	8 CY	\$135.00
	#57 Stone (d=18 in)	35 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	57 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	93 LF	\$20.00
	LID Underdrain Connection to Inlet/MH/Additional Fittings	2 EACH	\$700.00
	Pavement/Sidewalk Restoration	1060 SF	\$15.00
	Plantings	634 SF	\$27.00
Construction Subtotal			\$56,194.67
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$19,668.13
Construction Total			\$75,862.80

MICRO-BIOPRETENTION		Site ID: Area (SF):	20 1129
		Quantity	Unit Price
			Total
	Class 1 Excavation	209 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	84 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	14 CY	\$150.00
	#7 Stone (d=4 in)	14 CY	\$135.00
	#57 Stone (d=18 in)	63 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	45 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	10 LF	\$20.00
	Removal of Existing Pipe/Structure	1 EACH	\$1,500.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	0 SF	\$15.00
	Plantings	1129 SF	\$27.00
Construction Subtotal			\$66,237.17
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$23,183.01
Construction Total			\$89,420.18



University Park Flood Attenuation
Potential SWM Facilities Assessment Report

INFILTRATION TRENCH		Site ID: Area (SF):	21 324	
		Quantity	Unit Price	Total
	Class 1 Excavation	48 CY	\$60.00	\$2,880.00
	3"-5" Diameter River Rock (d= 6")	6 CY	\$95.00	\$570.00
	#1 Aggregate for Trench Stone (d=24")	24 CY	\$135.00	\$3,240.00
	Perforated Underdrain Pipe, 6 Inch	108 LF	\$25.00	\$2,700.00
	Underdrain Connection Pipe, 6 Inch	105 LF	\$20.00	\$2,100.00
	Manhole w/ 24" Non-Traffic Cover	2 EACH	\$3,200.00	\$6,400.00
	Remove/Replace Curb	10 LF	\$24.00	\$240.00
	Pavement/Sidewalk Restoration	62 SF	\$15.00	\$930.00
	Seed & Mulch	594 SF	\$2.50	\$1,485.00
	Construction Subtotal			\$20,545.00
	35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$7,190.75
	Construction Total			\$27,735.75

MICRO-BIORETENTION		Site ID: Area (SF):	22 659	
		Quantity	Unit Price	Total
	Class 1 Excavation	122 CY	\$60.00	\$7,322.22
	Bioretention soil- Filter Media (d= 2 ft)	49 CY	\$95.00	\$4,637.41
	Choker Layer - Course Sand (d=4 in)	8 CY	\$150.00	\$1,220.37
	#7 Stone (d=4 in)	8 CY	\$135.00	\$1,098.33
	#57 Stone (d=18 in)	37 CY	\$135.00	\$4,942.50
	Perforated Underdrain Pipe, 6 Inch	62 LF	\$25.00	\$1,550.00
	Underdrain Connection Pipe, 6 Inch	10 LF	\$20.00	\$200.00
	LID Underdrain Connection to Inlet/MH	1 EACH	\$600.00	\$600.00
	Pavement/Sidewalk Restoration	33 SF	\$15.00	\$495.00
	Plantings	659 SF	\$27.00	\$17,793.00
	Construction Subtotal			\$39,858.83
	35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$13,950.59
	Construction Total			\$53,809.43



University Park Flood Attenuation
Potential SWM Facilities Assessment Report

MICRO-BIOPERMATION		Site ID: Area (SF):	23 1010
		Quantity	Unit Price
			Total
	Class 1 Excavation	187 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	75 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	12 CY	\$150.00
	#7 Stone (d=4 in)	12 CY	\$135.00
	#57 Stone (d=18 in)	56 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	62 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	10 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	1 EACH	\$600.00
	Pavement/Sidewalk Restoration	33 SF	\$15.00
	Plantings	1010 SF	\$27.00
Construction Subtotal			\$59,573.33
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$20,850.67
Construction Total			\$80,424.00

MICRO-BIOPERMATION		Site ID: Area (SF):	27 1324
		Quantity	Unit Price
			Total
	Class 1 Excavation	245 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	98 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	16 CY	\$150.00
	#7 Stone (d=4 in)	16 CY	\$135.00
	#57 Stone (d=18 in)	74 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	57 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	7 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	0 SF	\$15.00
	Plantings	1324 SF	\$27.00
Construction Subtotal			\$75,929.67
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$26,575.38
Construction Total			\$102,505.05



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MICRO-BIOPERMATION		Site ID: Area (SF):	28
		Quantity	Unit Price
			Total
	Class 1 Excavation	299 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	119 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	20 CY	\$150.00
	#7 Stone (d=4 in)	20 CY	\$135.00
	#57 Stone (d=18 in)	90 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	62 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	17 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	0 SF	\$15.00
	Plantings	1612 SF	\$27.00
Construction Subtotal			\$92,430.67
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$32,350.73
Construction Total			\$124,781.40

MICRO-BIOPERMATION		Site ID: Area (SF):	29
		Quantity	Unit Price
			Total
	Class 1 Excavation	171 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	69 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	11 CY	\$150.00
	#7 Stone (d=4 in)	11 CY	\$135.00
	#57 Stone (d=18 in)	51 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	34 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	32 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	0 SF	\$15.00
	Plantings	926 SF	\$27.00
Construction Subtotal			\$53,500.33
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$18,725.12
Construction Total			\$72,225.45

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MICRO-BIOPERMATION		Site ID: Area (SF):	30
		Quantity	Unit Price
			Total
	Class 1 Excavation	246 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	98 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	16 CY	\$150.00
	#7 Stone (d=4 in)	16 CY	\$135.00
	#57 Stone (d=18 in)	74 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	78 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	38 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	0 SF	\$15.00
	Plantings	1328 SF	\$27.00
Construction Subtotal			\$77,299.33
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$27,054.77
Construction Total			\$104,354.10

MICRO-BIOPERMATION		Site ID: Area (SF):	31
		Quantity	Unit Price
			Total
	Class 1 Excavation	114 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	46 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	8 CY	\$150.00
	#7 Stone (d=4 in)	8 CY	\$135.00
	#57 Stone (d=18 in)	34 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	52 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	48 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	345 SF	\$15.00
	Plantings	616 SF	\$27.00
Construction Subtotal			\$42,033.67
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$14,711.78
Construction Total			\$56,745.45



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MICRO-BIORETENTION		Site ID: Area (SF):	32 946
		Quantity	Unit Price
			Total
	Class 1 Excavation	175 CY	\$60.00
	Bioretention soil- Filter Media (d= 2 ft)	70 CY	\$95.00
	Choker Layer - Course Sand (d=4 in)	12 CY	\$150.00
	#7 Stone (d=4 in)	12 CY	\$135.00
	#57 Stone (d=18 in)	53 CY	\$135.00
	Perforated Underdrain Pipe, 6 Inch	131 LF	\$25.00
	Underdrain Connection Pipe, 6 Inch	189 LF	\$20.00
	LID Underdrain Connection to Inlet/MH	0 EACH	\$600.00
	Pavement/Sidewalk Restoration	1708 SF	\$15.00
	Plantings	946 SF	\$27.00
Construction Subtotal			\$85,808.67
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$30,033.03
Construction Total			\$115,841.70

WET POND		Site ID: Area (SF):	33 13549
		Quantity	Unit Price
			Total
	Class 1 Excavation	2509 CY	\$35.00
	Class I Riprap	7 SY	\$135.00
	4" Topsoil	1505 SY	\$5.50
	Seed & Mulch	1505 SY	\$2.50
	Outfall Structure	1 EA	\$15,000.00
Construction Subtotal			\$115,806.15
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$40,532.15
Construction Total			\$156,338.30

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MICRO-BIORETENTION		<i>Site ID:</i>	34	
		<i>Area (SF):</i>	1079	
		Quantity	Unit Price	Total
Class 1 Excavation		200 CY	\$60.00	\$11,988.89
Bioretention soil- Filter Media (d= 2 ft)		80 CY	\$95.00	\$7,592.96
Choker Layer - Course Sand (d=4 in)		13 CY	\$150.00	\$1,998.15
#7 Stone (d=4 in)		13 CY	\$135.00	\$1,798.33
#57 Stone (d=18 in)		60 CY	\$135.00	\$8,092.50
Perforated Underdrain Pipe, 6 Inch		45 LF	\$25.00	\$1,125.00
Underdrain Connection Pipe, 6 Inch		10 LF	\$20.00	\$200.00
Removal of Existing Pipe/Structure		1 EACH	\$1,500.00	\$1,500.00
LID Underdrain Connection to Inlet/MH		0 EACH	\$600.00	\$0.00
Pavement/Sidewalk Restoration		0 SF	\$15.00	\$0.00
Plantings		1079 SF	\$27.00	\$29,133.00
Construction Subtotal				\$63,428.83
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)				\$22,200.09
Construction Total				\$85,628.93



University Park Flood Attenuation
Potential SWM Facilities Assessment Report

University Park Storm Drain Cost Estimates

STORM DRAIN		Site ID: 11	
		Quantity	Unit Price
	Class 1 Excavation	41 CY	\$60.00
	Single Type K Open-End Grate Non-Traffic Areas	1 EACH	\$4,000.00
	15" Reinforced Concrete Pipe	25 LF	\$120.00
	Pavement/Sidewalk Restoration	25 SF	\$15.00
Construction Subtotal			\$9,835.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$3,442.25
Construction Total			\$13,277.25

STORM DRAIN		Site ID: 12	
		Quantity	Unit Price
	Class 1 Excavation	197 CY	\$60.00
	Standard Type S Inlet, Double Grate Tandem	1 EACH	\$4,700.00
	15" Reinforced Concrete Pipe	131 LF	\$120.00
	Pavement/Sidewalk Restoration	398 SF	\$15.00
Construction Subtotal			\$38,210.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$13,373.50
Construction Total			\$51,583.50

STORM DRAIN		Site ID: 13	
		Quantity	Unit Price
	Class 1 Excavation	61 CY	\$60.00
	Standard Type S Inlet, Double Grate Tandem	1 EACH	\$4,700.00
	15" Reinforced Concrete Pipe	37 LF	\$120.00
	Pavement/Sidewalk Restoration	574 SF	\$15.00
Construction Subtotal			\$21,410.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$7,493.50
Construction Total			\$28,903.50



University Park Flood Attenuation
Potential SWM Facilities Assessment Report

STORM DRAIN		Site ID: 14	
		Quantity	Unit Price
		Total	
	Class 1 Excavation	95 CY	\$60.00
	Standard Type S Inlet, Double Grate Tandem	1 EACH	\$4,700.00
	15" Reinforced Concrete Pipe	48 LF	\$120.00
	Pavement/Sidewalk Restoration	362 SF	\$15.00
Construction Subtotal			\$21,590.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$7,556.50
Construction Total			\$29,146.50

STORM DRAIN		Site ID: 16	
		Quantity	Unit Price
		Total	
	Class 1 Excavation	48 CY	\$60.00
	Standard Type S Inlet, Double Grate Tandem	1 EACH	\$4,700.00
	24" Reinforced Concrete Pipe	40 LF	\$170.00
	Pavement/Sidewalk Restoration	3383 SF	\$15.00
	Removal of Existing Pavement	10 CY	\$65.00
	Concrete Gutter	10 CY	\$200.00
Construction Subtotal			\$67,775.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$23,721.25
Construction Total			\$91,496.25

STORM DRAIN		Site ID: 32A	
		Quantity	Unit Price
		Total	
	Class 1 Excavation	100 CY	\$60.00
	Standard Type S Combination Inlet, Double Grate Tandem	1 EACH	\$4,700.00
	12" Reinforced Concrete Pipe	62 LF	\$100.00
	Standard Drop Manhole	1 EACH	\$8,000.00
	Pavement/Sidewalk Restoration	132 SF	\$15.00
Construction Subtotal			\$26,880.00
35% Contingency (Mobilization, Clearing/Grubbing, ESC, MOT)			\$9,408.00
Construction Total			\$36,288.00