MIDDLETOWN ROAD ROUNDABOUT & ROADWAY EXTENSION

FINAL STORMWATER MANAGEMENT REPORT
PGM # VCI 14-0044

SUBMITTED TO:

CHARLES COUNTY GOVERNMENT
DEPARTMENT OF PLANNING AND GROWTH MANAGEMENT
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I. Introduction

AB Consultants, Inc. is pleased to submit the Concept Stormwater Management report for the improvements of Middletown Road Roundabout & Roadway Extension. The project is located approximately 3.1 mile on the northwest of intersection of Crain Highway (MD 301) and Billingsley Road. A site Vicinity map is included in Appendix 1. The purpose of the project includes:

1. Improve the traffic flow by converting the intersection into a roundabout to meet AASHTO requirements.
2. Provide safety improvements (sight distance, turning radius, and traffic flow).
3. Provide additional sidewalks for pedestrian.
4. Improve drainage system at the intersection.
5. Maintain access to the existing houses.

The proposed improvements will disturb the existing impervious area and create a net increase in the impervious area. The proposed improvements will also remove substantial existing impervious area. MDE regulation (May 2009) require that the impervious area shall be reduced and/or water quality treatment provided for 50% of the existing impervious area within the limit of disturbance (LOD) if the project qualifies as a “Redevelopment Project”. However, if the project does not qualify as a “Redevelopment project” MDE regulations (May 2209) require that the impervious area shall be reduced and/or water quality treatment for 100% of all existing impervious area within the LOD. In addition, water quality treatment for 100% of the net increased impervious area to be provided according to MDE 2009 “new development” criteria.

II. Purpose and Scope

This report evaluates the impacts of the proposed improvements at referenced site on the existing hydrologic condition and addressed the potential needs for stormwater management. The site has been divided into five study points based on the hydrology of the site. Based on the new MDE regulation, target ESD volumes were computed for the redevelopment and new impervious area. Locations of all proposed ESD practices to meet ESD requirements to MEP are shown in Concept SWM Plan.

A conceptual Erosion and Sediment Control Plan has been included with this submission for review and approval. The sediment control plans identify the limits of disturbance.

III. SCOPE OF REPORT

The scope of this report includes the following:

- Sources of Information
- Methodology
- Description of the Study Points
- SWM Quantity and Quality Control
- Summary

IV. SOURCES OF INFORMATION

The sources of information for this study included the following:

- Charles County contour mapping and field run topography.
- Field survey provided by Charles County, June 2013.
- Soils maps USDA NRCS Charles County, Maryland Soil Data, 2006.
- MDE 2000 Maryland Stormwater Design Manual, Revised May 2009.
- Environmental Site Design (ESD) – MDE SWM Design Manual, October 2010.

V. METHODOLOGY

The stormwater Management design for the project is based on the 2009 MDE regulations for Environmental Site Design. The MDE "Redevelopment" criteria states that if the percentage of the existing impervious area to the total site area (within the limit of disturbance) is greater than 40%, the site will be subject to redevelopment requirements under which the project should either decrease the existing impervious area by 50% or provide water quality treatment for the equivalent area. However, if the existing imperviousness is less than 40%, the site will be subject to "new development" requirements. Full ESD treatment will be required for the net increase in impervious area as well. The stormwater management design will be performed to provide water quality for 50% of the existing impervious area within LOD for redevelopment project, 100% of the existing impervious area within LOD for the new development project, and all of the net increased impervious area. The methodology used to prepare this report includes the following:

- Establish drainage divides using field run topography and contour mapping.
- Establish Landuse divides using field run and aerial topography.
- Determine target P_E using table 5.3 based on site area and impervious area.
- Determine required ESD_V based on MDE guidelines for redevelopment and net increase of impervious area.

VI. DESCRIPTION OF THE STUDY POINTS

The project limit lies within the drainage boundary of the Lower Potomac River Area (Sub basin 02-14-01), designed as a USE II (Shell Fish Harvesting Waters) by the code of Maryland Regulations 26.08.02. The land use within the Study Points is determined based on the proposed improvements. Appendix 2 contains a Soils

map with description of the Soils Name and Hydrologic soils group. The hydrologic groups primarily comprise of type “C” soil. Appendix 2 also includes FIRM map within the site vicinity. In existing condition, the project site is divided into five (5) study points based on the work limit, site conditions, and topography. Overall total site area within LOD is 5.57 ac. and total existing impervious area within LOD is 1.40 ac. The existing imperviousness of the overall site is less than 40% (25.13%). Existing imperviousness within LOD for each study point are computed. The Project Type (“Redevelopment project” of “New project”) for each study point is determined based on the existing imperviousness within LOD at that study point. Table 2 shows existing % imperviousness within LOD. Following is a brief description of each study points:

Existing Condition:

Study Point 1:

Study point 1 is located approximately at sta. 20+07 Lt. (based on Middletown Road Base line). Total drainage area to the study point is 1.35 ac. Total LOD area within the study point is 0.93 ac. Total existing impervious area within LOD is 0.45 ac. The runoff for this study point conveys in a combination of sheet and open drainage ditch system. The soil within this area consists of hydrologic soil classification type C. The attached Site map and Water Quality Map in Appendix 4 show the location of the study point, LOD, land use, existing and proposed impervious areas, existing impervious areas to be removed, steep slopes, erodible soils, protected areas, and soils.

Study Point 2:

Study point 2 is located approximately at sta. 33+50 Rt. (based on Billingsley Road Base line). Total drainage area to the study point is 0.56 ac. Total LOD area within the study point is 0.52 ac. Total existing impervious area within LOD is 0.24 ac. The runoff for this study point conveys in a combination of sheet and open drainage ditch system. The soil within this area consists of hydrologic soil classification type C. The attached Site map and Water Quality Map in Appendix 4 show the location of the study point, LOD, land use, existing and proposed impervious areas, existing impervious areas to be removed, steep slopes, erodible soils, protected areas, and soils.

Study Point 3B:

Study point 3B is located approximately at sta. 33+50 Lt. (based on Billingsley Road Base line). Total drainage area to the study point is 0.26 ac. Total LOD area within the study point is 0.25 ac. Total existing impervious area within LOD is 0.05 ac. The runoff for this study point conveys in a combination of sheet and open drainage ditch system. The soil within this area consists of hydrologic soil classification type C. The

attached Site map and Water Quality Map in Appendix 4 show the location of the study point, LOD, land use, existing and proposed impervious areas, existing impervious areas to be removed, steep slopes, erodible soils, protected areas, and soils.

Study Point 4:

Study point 4 is located approximately at sta. 24+00 Rt. (based on Middletown Road Base line). Total drainage area to the study point is 0.37 ac. Total LOD area within the study point is 0.32 ac. Total existing impervious area within LOD is 0.13 ac. The runoff for this study point conveys in a combination of sheet and open drainage ditch system. The soil within this area consists of hydrologic soil classification type C. The attached Site map and Water Quality Map in Appendix 4 show the location of the study point, LOD, land use, existing and proposed impervious areas, existing impervious areas to be removed, steep slopes, erodible soils, protected areas, and soils.

Study Point 5:

Study point 5 is located approximately at sta. 24+00 Lt. (based on Middletown Road Base line). Total drainage area to the study point is 4.03 ac. Total LOD area within the study point is 3.56 ac. Total existing impervious area within LOD is 0.53 ac. The runoff for this study point conveys in a combination of closed and open drainage system. The soil within this area consists of hydrologic soil classification type C. The attached Site map and Water Quality Map in Appendix 4 show the location of the study point, LOD, land use, existing and proposed impervious areas, existing impervious areas to be removed, steep slopes, erodible soils, protected areas, and soils. In proposed condition portion of this study point will be diverted to study point 3A.

Proposed Condition:

The proposed improvements consist of roadway widening, conversion of intersection to roundabout, removing of existing pavement, maintaining access to the existing houses, and drainage and safety improvements. Following is a brief description of each study points for proposed conditions:

Study Point 1:

Under proposed condition, the total drainage area for this study point will remain same as existing condition. Due to proposed improvements 0.10 ac of new impervious area will be added and 0.23 ac of existing impervious will be removed. The net impervious area in proposed condition is 0.322 ac. Proposed drainage pattern will remain same as existing condition. Two micro bioretention facilities are proposed to provide ESD to MEP. Both facilities will be designed to meet the target

P_E, Q_E, and ESD_V. Table 3 describes the Area required to be treated (ART), deficit and credit for each study point.

Study Point 2:

Under proposed condition, the total drainage area for this study point will remain same as existing condition. Due to proposed improvements 0.27 ac of new impervious area will be added and 0.04 ac of existing impervious will be removed. The net impervious area in proposed condition is 0.475 ac. Proposed drainage pattern will remain same as existing condition. ESD to MEP is exhausted to this area and no ESD facilities are feasible due to insufficient right of way, stone monument and houses. There is an existing grass ditch within the study area that has been regarded due to proposed improvements. However, this ditch does not meet requirements to qualify for grass ditch credit. The ditch bottom width is less than 2 feet. A detailed description of the ESD to MEP for this study point is included in Table 5. The impervious area required to be treated at this study point will be overcompensated to the maximum extent possible in other study points. Table 3 describes the Area required to be treated (ART), deficit and credit for each study point.

Study Point 3A:

This study point is included in proposed condition and located at MH-8 around sta. 10+48 Lt. (based on Middletown Road Base line). 3.72 Ac of the drainage area from study point 5 will be diverted to this study point in proposed condition. Runoff from this study point will be conveyed through a closed storm drain system and outfall approximately 900 feet northwest along Billingsley Road. The location of the proposed outfall is considered far from the project limit to maintain gravity flow and daylight the underdrains from the proposed ESD facilities.

Under proposed condition, total drainage area to this study point is 3.57 ac. Total LOD area within the study point is 3.26 ac. Total existing impervious area within LOD is 0.487 ac. Due to proposed improvements 1.039 ac of new impervious area will be added and 0.181 ac of existing impervious will be removed. The net impervious area in proposed condition is 1.35 ac. Several micro bioretention facilities are proposed to provide ESD to MEP. Additional existing impervious area will be diverted to the proposed ESD facility to overcompensate impervious area required to be treated in other study points. All facilities will be designed to meet the target P_E, Q_E, and ESD_V. Table 3 describes the Area required to be treated (ART), deficit and credit for each study point.

Study Point 3B:

Under proposed condition, the total drainage area for this study point will remain same as existing condition. Due to proposed improvements 0.08 ac of new

impervious area will be added and no existing impervious area will be removed. The net impervious area in proposed condition is 0.13 ac. Proposed drainage pattern will remain same as existing condition. A grass swale is proposed to provide ESDv to MEP. In addition to the grass swale any remaining impervious area required to be treated at this study point will be overcompensated to the maximum extent possible in other study points. Table 3 describes the Area required to be treated (ART), deficit and credit for each study point.

Study Point 4:

Under proposed condition, the total drainage area for this study point will remain same as existing condition. Due to proposed improvements 0.15 ac of new impervious area will be added and 0.03 ac of existing impervious area will be removed. The net impervious area in proposed condition is 0.25 ac. Proposed drainage pattern will remain same as existing condition. ESD to MEP is exhausted to this area and no ESD facilities are feasible due to insufficient right of way. A detailed description of the ESD to MEP for this study point is included in Table 5. Impervious area required to be treated at this study point will be overcompensated to the maximum extent possible in other study points. Table 3 describes the Area required to be treated (ART), deficit and credit for each study point.

Study Point 5:

Under proposed condition, the total drainage area for this study point will decrease since portion of drainage area is diverted to study point 3A. Under proposed condition, total drainage area to this study point is 0.46 ac. Due to proposed improvements 0.08 ac of new impervious area will be added and no existing impervious will be removed. The net impervious area in proposed condition is 0.14 ac. The drainage pattern for the remainder drainage area will remain same as existing condition. ESD to MEP is exhausted to this area and no ESD facilities are feasible due to insufficient right of way. There is an existing grass ditch within the study area that has been regarded due to proposed improvements. However, this ditch does not meet requirements to qualify for grass ditch credit. The ditch bottom width is less than 2 feet. A detailed description of the ESD to MEP for this study point is included in Table 5. Impervious area required to be treated at this study point will be overcompensated to the maximum extent possible in other study points. Table 3 describes the Area required to be treated (ART), deficit and credit for each study point.

VII. SWM DESIGN AND ANALYSIS:

In accordance with Environmental Site Design (ESD), *MDE SWM Design Manual Chapter 5*, a comprehensive design approach utilizing strategies that replicate natural hydrology was utilized for stormwater management at the site. This report will describe the SWM concept design for the proposed improvements. The report

includes initial site, project type determination at each study point, computing ESD target, preliminary ESD options, locations, and preliminary design.

Site Data

Concept SWM Plan and Water Quality map are prepared to show all proposed works. Based on the proposed work a limit of disturbance (LOD) was developed and shown on the site map. Both maps also include all study points, drainage area map, landuses, existing and new impervious areas, and existing impervious area removed. Table 1 shows the soil types and hydrologic properties within the project area.

Table 1: Soil Types for all study points

Soil Type	Hydrologic Soil Group	Total Area (Ac.)
BcA-Beltsville-Aquasco complex, 0 to 2 percent slopes	C	3.23
BaB-Beltsville Silt Loam, 2 to 5 percent slopes	C	2.54

Determination of Project Type

Based on the site map total disturbed area (LOD area) for each study point and the existing impervious area within the LOD were computed. Table 2 shows the % imperviousness for each study points. Table 2 also shows the total impervious area required to be treated for each study points.

Table 2: % Imperviousness and Project Type for each Study Points:

Study Points	Site Area within LOD, Ac	Existing Impervious Area within LOD, Ac	%Existing Imperviousness (I)	Project Type	ESDv Target, Ac-Ft	ESDv Achieved, Ac-Ft
1	0.93	0.45	48.39%	Redevelopment	0.026	0.0777
2	0.52	0.24	46.43%	Redevelopment	0.055	-
3A	3.26	0.487	14.95%	New	0.206	0.349
3B	0.25	0.05	20.30%	New	0.019	0.004
4	0.32	0.13	40.63%	Redevelopment	0.030	-
5	0.32*	0.04*	12.5%	New	0.021	0.029
Total ESDv (required and Provided)					0.359	0.460

*Based on LOD and impervious area diverted to study point 3A

Table 3: Area Required to be Treated (ART) for each Study Points:

Study Points	Existing Impervious Area within LOD, Ac	Existing Impervious Area removed within LOD, Ac	New Impervious Added, Ac	Required Existing Impervious Area to be treated within LOD, Ac	Required New Impervious Area to be treated, Ac	Total Impervious Area Required to be Treated (ART), Ac
1	0.45	0.23	0.10	(0.5*(0.45-0.23))=0.11	0.10	0.21
2	0.24	0.04	0.27	(0.5*(0.24-0.04))=0.10	0.27	0.37
3A	0.487	0.181	1.04	(0.487-0.181) =0.306	1.04	1.35
3B	0.05	0	0.08	0.05	0.08	0.13
4	0.13	0.03	0.15	(0.5*(0.13-0.03))=0.05	0.15	0.20
5	0.04	0	0.10	0.04	0.10	0.14
Total Impervious area required to be treated						2.40

Compute ESD Target

The project includes redevelopment and new development as discussed above. ESD targets were computed based on Charles County SWM ordinance August, 2010. Based on the soils group and imperviousness (% impervious) rainfall target P_E's and required ESD_V were determined for each study points. Table 4 shows the ESD_V required and other related information for each study points.

Table 4: Target P_E and ESD_V for all Study Points:

Study Points	Hydrologic Soil Group	% Imperviousness (I)	Target P_E for Redevelopment	Target P_E for New Improvements	ESD_V for Redevelopment (Ac-ft)	ESD_V for New Improvements (Ac-ft)
1	C	100% *	1	2.6	0.008	0.018
2	C	100% *	1	2.6	0.008	0.047
3A	C	41.28%	-	1.8	-	0.206
3B	C	54.63%	-	1.8	-	0.019
4	C	100% *	1	2.6	0.004	0.026
5	C	43.75%	-	1.8	-	0.021
Total Target ESDv (Redevelopment and New Improvement)					0.359 Ac- Ft. (15,638 Cu. Ft.)	

*% imperviousness (I) taken as 100% according to MDE Manual

ESD Options, Locations and Design

Several ESD facilities (Micro Bio-retention and Grass Swale) are proposed within the project limit to provide ESD to MEP. Following is the brief summary of ESD facilities locations and preliminary design data in following study points:

Study Point 1:

In Study point 1, two Micro Bio-retention facilities area proposed to provide ESD to MEP. Based on the tables 3 and 4, study point 1 requires 0.21 ac impervious area to be treated and 0.029 ac-ft of ESD_V to be provided. Two Micro Bio-retention facilities (ESD-1 and ESD-2) will treat 0.33 ac of impervious area and provide 0.0777 ac-ft of ESD_V. Therefore, this study point meets ESD to MEP and over compensates to other study points. This study point also treats additional impervious area of 0.12 ac (0.33 ac – 0.21 Ac) which over compensates requirements portion of study point 2 (0.12 ac).

Study Point 3A:

In Study point 3A, eight Micro Bio-retention facilities area proposed to provide ESD to MEP. Based on the tables 3 and 4, study point 3A requires 1.35 ac impervious area to be treated and 0.205 ac-ft of ESD_V to be provided. Nine Micro Bio-retention facilities (ESD-3 and ESD-11) will treat 1.57 ac of impervious area and provide 0.349 ac-ft of ESD_V. Therefore, this study point meets ESD to MEP and over compensates other study points. This study point also treats additional impervious area of 0.22 ac (1.57 ac – 1.35 Ac) which over compensates study point 4 and portion of study point 2 (0.02 ac). Additional existing impervious area from the access road to the houses (approximate sta. 11+00 Lt. to sta. 16+00 Lt.) are diverted to ESD-11.

Study Point 3B:

In Study point 3B, a grass channel is proposed to provide ESD to MEP. Based on the tables 3 and 4 study point 3A requires 0.13 ac impervious area to be treated and provide 0.019 ac-ft of ESD_V. Grass Swale (ESD-12) will treat 0.03 ac of impervious area and provide 0.004 ac-ft of ESD_V. Therefore, this study point meets partial ESD to MEP requirements.
Table 5 shows target P_E, Q_E, ESD_V and achieved P_E and ESD_V. Design computations for each facility are included in Appendix 3. An ESD drainage Area Map is included in Appendix 4.

Study Point 5:

In Study point 5, a Micro Bio-retention is proposed to provide ESD to MEP. Based on the tables 3 and 4 study point 5 requires 0.14 ac impervious area to be treated and provide 0.021 ac-ft of ESD_V. Proposed Micro Bio-retention (ESD-13) will treat 0.13 ac of impervious area and provide 0.029 ac-ft of ESD_V. Therefore, this study point meets partial ESD to MEP. Therefore, this study point meets ESD to MEP.
Table 5 shows target P_E, Q_E, ESD_V and achieved P_E and ESD_V. Design computations for each facility are included in Appendix 3. An ESD drainage Area Map is included in Appendix 4.

Based on the proposed ESD facilities in all study points total ESDV provided is 0.460 ac-ft and total target ESD_V is 0.355 ac-ft. Full ESD_V for study points 2, 4 and portion of ESD_V for study point 3B are over compensated by study points 1, 3A and 5. Therefore, the project meets ESD to MEP requirements for the proposed improvements.

Table 5: Target P_E. Q_E, ESD_V and Achieved P_E and ESD_V for all ESD Facilities:

ESD Facility	Total DA, Ac	Total Impervious Area, Ac	% Imperviousness	Target P_E	Target QE	Achieved P_E	Target ESD_V ac-ft	Achieved ESD_V
ESD-1	0.46	0.16	35	1.8	0.66	2.7	0.025	0.038
ESD-2	0.45	0.17	39	1.8	0.72	2.67	0.027	0.040
ESD-3	0.44	0.28	63	2.0	1.20	2.7	0.044	0.061
ESD-4	0.50	0.27	54	2.0	1.07	2.7	0.045	0.061
ESD-5	0.46	0.17	37	1.8	0.70	2.66	0.027	0.040
ESD-6	0.31	0.14	45	1.8	0.82	2.7	0.021	0.032
ESD-7	0.31	0.15	47	1.8	0.85	2.22	0.022	0.027
ESD-8	0.38	0.17	45	1.8	0.82	2.67	0.026	0.039
ESD-9	0.34	0.10	30	1.6	0.52	2.7	0.015	0.025
ESD-10	0.33	0.09	28	1.6	0.48	2.7	0.013	0.022
ESD-11	0.53	0.21	36	1.7	0.63	2.48	0.030	0.044
ESD-12	0.25	0.13	52	1.8	0.98	0.36	0.0193	0.004
ESD-13	0.28	0.13	46	1.8	0.84	2.65	0.020	0.029
						Total ESDv (Target and Provided)	0.3353	0.460

Table 6 summarizes in accordance with the Table 5.2 of the MDE manual the SWM measures considered for the project with reasons they were accepted or rejected. Table 7 compares site condition with MDE proposed ESD facilities.

Table 6: Site design and Site condition assessment:

Better Site Design Technique	Site
Using Narrower, shorter streets, rights-of-way, and sidewalks	Performed County standard roadway section to meet County safety and design requirements for ADA perspective.
Cul-de-Sacs	Turn around cul-de-sac is provided with grass.
Open Vegetated channels	Provided grass channel as feasible.
Parking ratio, parking codes, parking lots, and structured parking	N.A.
Parking lot runoff	N.A.
Open Space	Open space provided as feasible.
Setbacks and Frontages	N.A.
Driveways	Removed one driveway.

Rooftop runoff	N.A.
Buffer Systems	N.A.
Tree Conservation	Achieved, by saving existing trees of value.
Conservation Incentives	N.A.

Table 7: ESD Facilities and Site condition comparison:

• Green Roof: N.A.
• Permeable Pavements: This option is not feasible in travel lanes and shoulders Pavement would break up easily and long-term maintenance of the pavement was deemed problematic and thus not considered a practicable option.
• Reinforced Turf: this application is not a practicable application for proposed roadway.
• Nonstructural Practices: The disconnection of rooftop runoff is not applicable. Sheet flow to conservation areas was not practicable because of the limited site area and lack of adjacent conservation area(s).
• Microscale Practices: The following microscale practices were evaluated:
o Rainwater Harvesting – Not feasible for the project.
o Submerged Gravel Wetlands – Micro ESD facilities with smaller drainage area proposed. This option was not considered
o Landscape Infiltration – Due to existing steep topography, creation of flat areas would not be possible without retaining walls which would increase imperviousness and be counter to site planning principles. Thus, this option was not practicable.
o Infiltration Berms –This application requires gentle slopes; however the vertical constrains due to steep slope made this option not practicable.
o Dry Wells – Not applicable.
o Micro-Bioretention –As mentioned this facility is proposed where applicable and meet with drainage area requirements. This facility was not feasible for study points 2, 3B, 4 and 5 since there was not enough space to fit required Micro-Bioretention within right of way.
o Rain Gardens – Since bio-retention is being provided this additional provision was not considered practicable.
o Swales – The swale is provided in study point 3B. No swales were feasible at study points 2, 4 and 5 within right of way.
o Enhanced Filters –This option not practicable.
o Bio-Swales – This option was considered, however, bio-retention facilities were better options to meet all requirements. This facility was not feasible to study points 2, 3B, 4 and 5 since there was not enough space to fit required bio-swales within right of way.

Recharge Volume

Required Recharge volume at each facility has been computed and provided at the bottom of each facility (ESD-1 through ESD-11). Recharge Computations are included in Appendix 3.

Stormwater Quantity Control

A separate detail hydrologic computations was not performed for the project. Based on the proposed drainage pattern study point 3A will increase drainage area and will decrease drainage area for study point 5. At study point 3A ESD-3 through ESD 11 were proposed, these proposed ESD facilities will aid to delay the peak discharges for 10 and 100-year storm events. Therefore, a significant increase in peak discharges for 10-year and 100-year storm events is not anticipated for the overall project site. Also it is apparent that all study points within the project limit will drain to same watershed (lower Potomac River Area).

For Study Points 1, 3A and 5, 10-yr storm event discharge at each ESD facility was computed using Rational method. Each facility will provide 10-yr storm event within the facility with required freeboard. An outfall ditch is proposed that conveys runoff from Study points 3A and 3B. A concrete outfall ditch for study point 3A is proposed with adequate outfall protection. Detail concrete ditch and outfall protection computations are in included in appendix 3. A grass ditch computations were performed for Study points 2 and 5 for 10-yr discharges. In both study points velocities are non-erosive. Study point 4 sheet flows to open grass/wooded areas; therefore, a quantity control was not performed for this study point.
All computations are included in appendix 3.

VIII. CONCLUSIONS AND RECOMMENDATIONS

Based on the discussion above, the proposed improvements will require water quality treatment for redevelopment and new impervious areas. A summary of the proposed ESD to MEP for each study points is as follows:

Study Point 1	Two micro bio-retention facilities have been provided utilizing Environmental Site Design practices to the maximum extent possible. These two facilities meet all ESD requirements and no CP_V is required. 10-yr storm event has been controlled at the facility with required freeboard.
Study Point 2	No facilities are feasible within the limit of disturbance to meet ESD to MEP as described above Structural practices are also not feasible because of right of way limitations. There is an existing grass ditch within the study area that

	has been regraded due to proposed improvements. However, this ditch does not meet requirements to qualify for grass ditch credit. The ditch bottom width is less than 2 feet. ESD to MEP is exhausted for this study point and no space within right of way is available to provide Structural BMP. However, ESD to MEP will be overcompensated for this study point by study points 1, 3A and 5.
Study Point 3A	Nine micro bio-retention facilities have been provided utilizing Environmental Site Design practices to the maximum extent possible. These nine facilities meet all ESD requirements and no CP_V is required. This study point overcompensates ESD to MEP for Study point #4 and partial for Study point #2. 10-yr storm event has been controlled at the facility with required freeboard. An outfall concrete ditch is proposed downstream of study point 3B that will receive runoff from this study point via closed Storm drain system (EW/1). Proposed regarded concrete ditch of this study point will provide safe 10-yr storm conveyance.
Study Point 3B	One Grass swale has been provided utilizing Environmental Site Design practices to the maximum extent possible. This facility can provide partial ESD to MEP requirements and treat 0.03 ac of impervious area. No additional facilities are feasible within the limit of disturbance to meet ESD to MEP. Structural practices are also not feasible because of right of way limitations. However, ESD to MEP will be overcompensated for this study point by study points 1, 3A and 5. Proposed outfall ditch downstream of this study point will provide safe 10-yr storm conveyance.
Study Point 4	No facilities are feasible within the limit of disturbance to meet ESD to MEP as described above. Structural practices are also not feasible because of right of way limitations. However, ESD to MEP will be overcompensates for this study point by study points 1, 3A and 5.
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Study Point 5	One micro bio-retention facility has been provided utilizing Environmental Site Design practices to the maximum extent possible. This facility meets all ESD to MEP requirements and no CP_V is required. Proposed micro bioretention facility (ESD=13) will include safe and non-erosive conveyance from the facility for peak discharges. 10-yr storm event has been controlled at the facility with required freeboard. This

study point overcompensates ESD to MEP partial for Study point #2 and study point 3B.

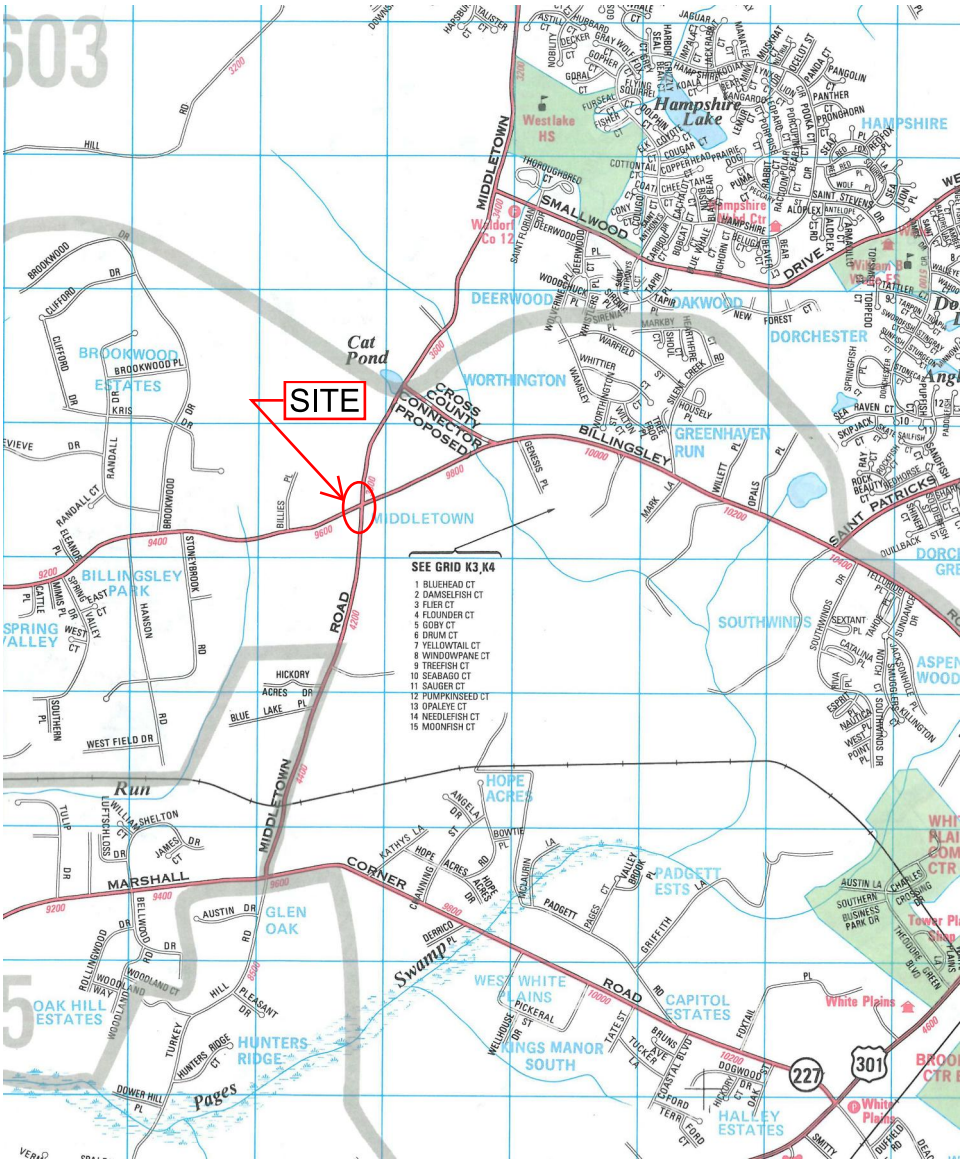
APPENDIX 1

SITE VICINITY MAP

MIDDLETOWN ROAD ROUNDABOUT
& ROADWAY EXTENSION

VICINITY MAP
ELECTION DISTRICT # 6

Charles County ADC MAP
Pg. #9, Grid E-5



APPENDIX 2

SOIL MAP
FIRM MAP

Custom Soil Resource Report
Soil Map

Map Scale: 1:4,280 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

Map Unit Legend

Charles County, Maryland (MD017)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
BaB	Beltsville silt loam, 2 to 5 percent slopes	15.3	55.6%
BcA	Beltsville-Aquasco complex, 0 to 2 percent slopes	11.8	42.9%
LQA	Lenni and Quindocqua soils, 0 to 2 percent slopes	0.4	1.6%
Totals for Area of Interest		**27.5**	**100.0%**

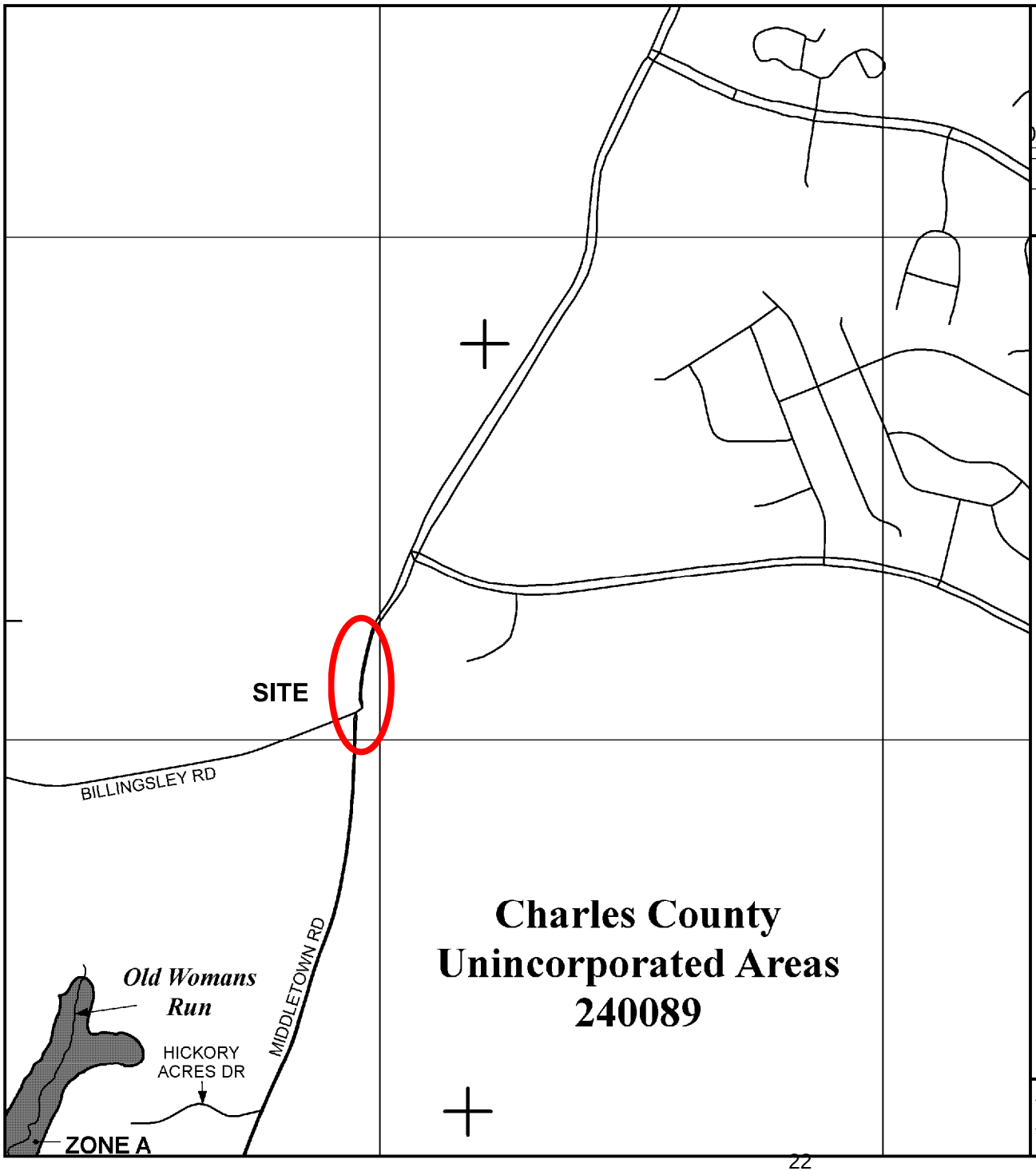
Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments



MAP SCALE 1" = 1000'

0 1000 2000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0180C

FIRM

FLOOD INSURANCE RATE MAP

CHARLES COUNTY, MARYLAND

AND INCORPORATED AREAS

PANEL 180 OF 575

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CHARLES COUNTY	240089	0180	C
LA PLATA, TOWN OF	240092	0180	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
24017C0180C

EFFECTIVE DATE
SEPTEMBER 4, 2013

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX 3

SWM COMPUTATIONS

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By: SA	12/11/2013
Location:	Charles County, MD	Checked By:	
PGM # VCI 14-0044			

Study Point: ALL SITE (New Development Criteria, Existing I % less than 40 %)

Total Site Area (within LOD)	=	5.57	Ac.
Existing Impervious Area	=	1.4	Ac.
% Existing Impervious Area	=	25.13 %	(I% <40%, MDE 2009 Regulations)

New Improvements/Redevelopment will be based on each study points %Existing Imperviousness

Total ESD_V required for Site	=	0.359	Ac. Ft.
	=	15625	Cu. Ft.
Total ESD_V provided for Site	=	0.460	Ac. Ft.
	=	20031	Cu. Ft.

Total Impervious Area Required to be Treated = 2.40 Ac.

Total Impervious Area To be Treated = 2.07 Ac.

The site meets target ESD volume, therefore, ESD to MEP requirements are satisfied for the project.

Total Recharge (Rev) required for Site	=	1128	Cu. Ft.
Total Recharge (Rev) provided for Site	=	1518	Cu. Ft.

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

Study Point: 1 (Redevelopment Criteria, Existing I % greater than 40 %)

Total Site Area (within LOD)	=	0.93	Ac.
Existing Impervious Area	=	0.45	Ac.
% Existing Impervious Area	=	48.39	%
(Redevelopment Criteria, Existing I % greater than 40 %)			
Added New Impervious Area	=	0.10	Ac.
Ex. Impervious Area Removed	=	0.23	Ac.
Proposed Impervious Area	=	0.322	Ac.
Hydrologic Soil Group	=	C	

Water Quality Calculations (for Existing Impervious Area)

Target Area for Water Quality Treatment (A)	=	0.11	Ac.	
Target Rainfall for Water Quality Treatment (P_E)	=	1	In.	(MDE Design Manual)
Impervious Percentage (I)	=	100	%	(MDE Design Manual, Table 5.3)
R_V	=	0.9500		$R_V = 0.05+0.009(I\%)$
Water Quality Volume (ESD_V)	=	0.0087	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	379	Cu.Ft.	

Water Quality Calculations (for New Impervious Area)

Target Area for Water Quality Treatment (A)	=	0.10	Ac.	
Target Rainfall for Water Quality Treatment (P_E)	=	2.2	In.	(MDE Design Manual, Table 5.3)
Impervious Percentage (I)	=	100	%	
R_V	=	0.95		
Water Quality Volume (ESD_V)	=	0.018	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	771	Cu.Ft.	

Total Impervious area Requiring Treatment	=	Redevelopment + New Impervious		
	=	0.21		
Total Target Water Quality Volume (ESD_V)	=	0.026	Ac-Ft.	
	=	1150	Cu. Ft.	
Treatment Volume Provided in ESD Practice	=	0.0777	Ac.-Ft.	(See Pages D-3 and D-4)
Treatment Volume Provided in ESD Practice	=	3387	Cu.Ft.	

Soil C, S = 0.13

Total Recharge Volume, Rev = ((S*Rv*A)/12)*43560 (cf) = 95 Cu. Ft.

Project: Middletown Rd Roundabout & Roadway Extension				Designed By: SA	10/17/2014	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -1 (Micro Bioretention) Design : Study Point 1						
Total Drainage Area (DA)		=	0.46	Ac.		
Total Impervious area to be Treated (A_i)		=	0.16	Ac.		
Total Imperviousness for this Facility		=	35	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.8	in	(MDE Design Manual, Table 5.3))	
	R_V	=	0.37			
	Q_E	=	0.66			
Target ESD_V for ESD-1		=	0.0253	Ac-ft		
		=	1101	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	400.5	SF
Total Surface Area (A_F) Provided		=	860	SF	OK	
Vlume Provided in Filter Media:						
Total Sur Total Volume Provided in Filter		=	860	sf		
2.0' BSM with Porosity of 0.4		=	688	cf		
4" Stone with Porosity of 0.45		=	128	cf		
Total Volume provided in Filter		=	816	cf		
		=	0.0187	ac-ft		
Provided Storage Volume Between EL. 211.00 to EL. 211.50				=	0.019	Ac-ft (See Table below)

ESD - 1 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
210.80	860	0	0.000
211.30	2490	838	0.019

Total Storage Provided by ESD-1 Facility	=	0.038	Ac-ft	
	=	1653	CF	
P_E Provided	=	2.70	in	
Therefore, Total Storage Provided by ESD-1 Facility meet Target P_E and ESD_V for ESD-1				

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By: SA	12/10/2013
Location:	Charles County, MD	Checked By:	

PGM # VCI 14-0044

ESD Facility -1 (Micro Bioretention) Design : Study Point 1

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.46	Ac.	
Total Impervious area to be Treated (A_i)	=	0.16	Ac.	
Total Imperviousness for this Facility	=	35	%	
R_V	=	0.37		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	79.54	cf	
ESD Surface Area	=	860.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	114.67	cf	

Projec Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	4/11/2014
Location: Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -1 (Micro Bioretention)Design : Study Point 1

Total Drainage Area (A)	=	0.46	Ac.	
Impervious Area	=	0.16	Ac.	
Open Space Area	=	0.30	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.48	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.54	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.54	=	$3.1*6.00*H^{3/2}$		
H	=	0.19	ft	
ESDV achieved @ EL.	=	211.30	ft	
10 - YR WSEL	=	211.49	ft	
ROADWAY FLOW LINE EL.	=	212.26	ft	
Freeboard Provided	=	0.77	ft	

Project: Middletown Rd Roundabout & Roadway Extension				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -2 (Micro Bioretention) Preliminary Design : Study Point 1						
Total Drainage Area (DA)		=	0.45	Ac.		
Total Impervious area to be Treated (A_i)		=	0.17	Ac.		
Total Imperviousness for this Facility		=	39	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.8	in	(MDE Design Manual, Table 5.3))	
	R_V	=	0.40			
	Q_E	=	0.72			
Target ESD_V for ESD-1		=	0.027	Ac-ft		
		=	1167	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	390.8	SF
Total Surface Area (A_F) Provided		=	1023	SF	OK	
Vlume Provided in Filter Media:						
Total Sur| Total Volume Provided in Filter		=	1023	sf		
2.0' BSM with Porosity of 0.4		=	818	cf		
4" Stone with Porosity of 0.45		=	152	cf		
Total Volume provided in Filter		=	970	cf		
		=	0.0223	ac-ft		
Provided Storage Volume Between EL. 211.00 to EL. 211.50				=	0.018	Ac-ft
						(See Table below)

ESD - 1 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
210.60	1023	0	0.000
211.10	2029	763	0.018

Total Storage Provided by ESD-2 Facility	=	0.040	Ac-ft	
	=	1733	CF	
P_E Provided	=	2.67	in	
Therefore, Total Storage Provided by ESD-2 Facility meet Target P_E and ESD_V for ESD-2				

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By: SA	12/10/2013
Location:	Charles County, MD	Checked By:	

PGM # VCI 14-0044

ESD Facility -2 (Micro Bioretention) Design : Study Point 1

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.45	Ac.	
Total Impervious area to be Treated (A_i)	=	0.17	Ac.	
Total Imperviousness for this Facility	=	39	%	
R_V	=	0.40		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	84.25	cf	
ESD Surface Area	=	1023.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	136.40	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By: SA		4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					
	ESD Facility -2 (Micro Bioretention)		Design : Study Point 1		
	Total Drainage Area (A)	=	0.45	Ac.	
	Impervious Area	=	0.17	Ac.	
	Open Space Area	=	0.28	Ac.	
	"C" for Impervious Area	=	0.9	Ac.	
	"C" for Open Space Area	=	0.25		
	Composite "C"	=	0.50	Ac.	
	Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
	Q_{10}	=	CIA		
		=	1.57	cfs	
	Using Inlet with opening	=	3	ft on all four sides	
	Perimeter, L	=	12	ft	
	Assume 50 % Blockage, L	=	6	ft	
	Using Weir Equation, Q	=	$CLH^{3/2}$		
	C	=	3.1		
	L	=	6.00	ft	
	H	=	Depth of flow	ft	
	Therefore, 1.57	=	$3.1*6.00*H^{3/2}$		
	H	=	0.19	ft	
	ESDV achieved @ EL.	=	211.10	ft	
	10 - YR WSEL	=	211.29	ft	
	ROADWAY FLOW LINE EL.	=	212.06	ft	
	Freeboard Provided	=	0.77	ft	

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/11/2013
Location:	Charles County, MD	Checked By:		
PGM # VCI 14-0044				

Study Point: 2 (Redevelopment Criteria, Existing I % greater than 40 %)

Total Site Area (within LOD)	=	0.52	Ac.
Existing Impervious Area	=	0.24	Ac.
% Existing Impervious Area	=	46.43	%
(Redevelopment Criteria, Existing I % greater than 40 %)			
Added New Impervious Area	=	0.27	Ac.
Ex. Impervious Area Removed	=	0.04	Ac.
Proposed Impervious Area	=	0.475	Ac.
Hydrologic Soil Group	=	C	

Water Quality Calculations (for Existing Impervious Area)

Target Area for Water Quality Treatment (A)	=	0.10	Ac.	
Target Rainfall for Water Quality Treatment (P_E)	=	1	In.	(MDE Design Manual)
Impervious Percentage (I)	=	100	%	(MDE Design Manual, Table 5.3)
R_V	=	0.95		$R_V = 0.05+0.009(I\%)$
Water Quality Volume (ESD_V)	=	0.008	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	350	Cu.Ft.	

Water Quality Calculations (for New Impervious Area)

Target Area for Water Quality Treatment (A)	=	0.27	Ac.	
Target Rainfall for Water Quality Treatment (P_E)	=	2.2	In.	(MDE Design Manual, Table 5.3)
Impervious Percentage (I)	=	100	%	
R_V	=	0.95		
Water Quality Volume (ESD_V)	=	0.047	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	2067	Cu.Ft.	

Total Impervious area Requiring Treatment	=	Redevelopment + New Impervious	
	=	0.37	
Total Target Water Quality Volume (ESD_V)	=	0.055	Cu.Ft.
	=	2417	Ac.-Ft.

ESD to MEP Exausted and no ESD feasible within ROW.
Overcompensate if feasible in SP's 1 and 3A

Soil C, S = 0.13

Total Recharge Volume, Rev = ((S*Rv*A)/12)*43560 (cf) = 168 Cu. Ft.

AB CONSULTANTS, INC.

Date : 10/9/2014

10-YR DISCHARGE COMPUTATION AT CURB END (WITHIN SP#2)

USING RATIONAL METHOD (DRAINAGE AREA < 20AC.)

IMPERVIOUS AREA	=	0.240	AC.	C	=	0.90
GRASS AREA	=	0.150	AC.	C	=	0.35
TOTAL DRAINAGE AREA (A)	=	0.390	AC.			
RUNOFF COEFFICIENT C	=	0.688	(Composite)			

STORMWATER RUNOFF (Q)

TIME OF CONCENTRATION (Tc)	=	5.0	MIN
RAINFALL INTENSITY (I_{10})	=	7.00	IPH
Q_{10} = C x I x A	=	1.88	CFS

10-YR DISCHARGE COMPUTATION FOR SP#2

USING RATIONAL METHOD (DRAINAGE AREA < 20AC.)

IMPERVIOUS AREA	=	0.340	AC.	C	=	0.90
GRASS AREA	=	0.220	AC.	C	=	0.35
TOTAL DRAINAGE AREA (A)	=	0.560	AC.			
RUNOFF COEFFICIENT C	=	0.684	(Composite)			

STORMWATER RUNOFF (Q)

TIME OF CONCENTRATION (Tc)	=	5.0	MIN
RAINFALL INTENSITY (I_{10})	=	7.00	IPH
Q_{10} = C x I x A	=	2.68	CFS

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/11/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

Study Point: 3A* (New Development Criteria, Existing I % less than 40 %)

*This SP is included in proposed condition

Total Site Area (within LOD)	=	3.26	Ac.	(From SP#5)
Existing Impervious Area	=	0.487	Ac.	(From SP#5)
% Existing Impervious Area	=	14.95	%	
(New Development Criteria, Existing I % less than 40 %)				
Added New Impervious Area	=	1.039	Ac.	
Ex. Impervious Area Removed	=	0.181		
Proposed Impervious Area	=	1.35	Ac.	
Hydrologic Soil Group	=	C		

Determine Pre-Developed Conditions:

Hydrologic Soil Group	=	C		
RCN for "Woods in good Condition =		70		

Determine Target P_E:

Proposed Impervious Area	=	1.35	Ac.	
Total Site Area (within LOD)	=	3.26	Ac.	
%I	=	41.28%		
Target Rainfall for Water Quality Treatment (P_E)	=	1.8	In.	(MDE Design Manual, Table 5.3))
Q_E	=	0.74	in.	

ESD Targets for Study Point 3A

P_E	=	1.80	In.	
Q_E	=	0.74	in.	
Impervious Percentage (I)	=	41.28	%	
R_V	=	0.4215		$R_v = 0.05+0.009(I\%)$
Water Quality Volume (ESD_V)	=	0.206	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	8979	Cu.Ft.	
Treatment Volume Provided in ESD Practice	=	0.349	Ac.-Ft.	(See Pages D-7 thru D-15)
Treatment Volume Provided in ESD Practice	=	15217	Cu.Ft.	

Soil C, S = 0.13

Total Recharge Volume, Rev = ((S*Rv*A)/12)*43560 (cf) = 648 Cu. Ft.

Project: Middletown Rd Roundabout & Roadway Extension				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -3 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)		=	0.44	Ac.		
Total Impervious area to be Treated (A_i)		=	0.28	Ac.		
Total Imperviousness for this Facility (I)		=	63	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	2.0	in	(MDE Design Manual, Table 5.3))	
	R_V	=	0.61			
	Q_E	=	1.20			
Target ESD_V for ESD-3		=	0.044	Ac-ft		
		=	1911	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	382.9	SF
Total Surface Area (A_F) Provided		=	1744	SF	OK	
Vlume Provided in Filter Media:						
Total Surf Total Volume Provided in Filter		=	1744	sf		
2.0' BSM with Porosity of 0.4		=	1395	cf		
4" Stone with Porosity of 0.45		=	259	cf		
Total Volume provided in Filter		=	1654	cf		
		=	0.0380	ac-ft		
Provided Storage Volume Between EL.209.00 to EL. 209.75				=	0.023	Ac-ft
					(See Table below)	

ESD - 3 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
210.00	1744	0	0.000
210.50	2217	990	0.023

Total Storage Provided by ESD-3 Facility	=	0.061	Ac-ft	(per attached MDE Table)	
	=	2644	CF		
P_E Provided	=	2.70	in		
Therefore, Total Storage Provided by ESD-3 Facility meet Target P_E and ESD_V for ESD-3					

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	12/10/2013
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility -3 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.44	Ac.	
Total Impervious area to be Treated (A_i)	=	0.28	Ac.	
Total Imperviousness for this Facility	=	63	%	
R_V	=	0.61		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	127.38	cf	
ESD Surface Area	=	1744.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	232.53	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By: SA		4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					
	ESD Facility -3 (Micro Bioretention)		Design : Study Point 3A		
	Total Drainage Area (A)	=	0.44	Ac.	
	Impervious Area	=	0.28	Ac.	
	Open Space Area	=	0.16	Ac.	
	"C" for Impervious Area	=	0.9	Ac.	
	"C" for Open Space Area	=	0.25		
	Composite "C"	=	0.66	Ac.	
	Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
	Q_{10}	=	CIA		
		=	2.02	cfs	
	Using Inlet with opening	=	3	ft on all four sides	
	Perimeter, L	=	12	ft	
	Assume 50 % Blockage, L	=	6	ft	
	Using Weir Equation, Q	=	$CLH^{3/2}$		
	C	=	3.1		
	L	=	6.00	ft	
	H	=	Depth of flow	ft	
	Therefore, 2.02	=	$3.1*6.00*H^{3/2}$		
	H	=	0.23	ft	
	ESDV achieved @ EL.	=	210.50	ft	
	10 - YR WSEL	=	210.73	ft	
	ROADWAY FLOW LINE EL.	=	211.88	ft	
	Freeboard Provided	=	1.15	ft	

Project: Middletown Rd Roundabout & Roadway Extension Designed By: SS 12/13/2013
Location: Charles County, MD Checked By:

PGM # VCI 14-0044

ESD Facility -4 (Micro Bioretention) Preliminary Design : Study Point 3A

Total Drainage Area (DA)	=	0.50	Ac.		
Total Impervious area to be Treated (A_i)	=	0.27	Ac.		
Total Imperviousness for this Facility	=	54	%		
Hydrologic Soil Group	=	C			
Target Rainfall for this Facility (P_E)	=	2.0	in		(MDE Design Manual, Table 5.3))
R_V	=	0.54			
Q_E	=	1.07			
Target ESD_V for ESD-4	=	0.045	Ac-ft		
	=	1949	CF		
Minimum Surface Area (A_F)	=	2% of DA	=	436.4	SF
Total Surface Area (A_F) Provided	=	1744	SF	OK	

Vlume Provided in Filter Media:

Total Surf Total Volume Provided in Filter	=	1744	sf
2.0' BSM with Porosity of 0.4	=	1395	cf
4" Stone with Porosity of 0.45	=	259	cf
Total Volume provided in Filter	=	1654	cf
	=	0.0380	ac-ft

Provided Storage Volume Between EL. 209.00 to EL. 209.75 = 0.023 Ac-ft
(See Table below)

ESD - 4 Storage Volume

Elevation	Area	Volume (cf)	Volume Ac-ft)
210.00	1744	0	0.000
210.50	2183	982	0.023

Total Storage Provided by ESD-4 Facility	=	0.061	Ac-ft
	=	2636	CF
P_E Provided	=	2.70	in

Therefore, Total Storage Provided by ESD-3 Facility meet Target P_E and ESD_V for ESD-3

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -4 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.50	Ac.	
Total Impervious area to be Treated (A_i)	=	0.27	Ac.	
Total Imperviousness for this Facility	=	54	%	
R_V	=	0.54		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	126.69	cf	
ESD Surface Area	=	1744.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	232.53	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By: SA		4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					
	ESD Facility -4 (Micro Bioretention)	Design : Study Point 3A			
	Total Drainage Area (A)	=	0.50	Ac.	
	Impervious Area	=	0.27	Ac.	
	Open Space Area	=	0.23	Ac.	
	"C" for Impervious Area	=	0.9	Ac.	
	"C" for Open Space Area	=	0.25		
	Composite "C"	=	0.60	Ac.	
	Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
	Q_{10}	=	CIA		
		=	2.11	cfs	
	Using Inlet with opening	=	3	ft on all four sides	
	Perimeter, L	=	12	ft	
	Assume 50 % Blockage, L	=	6	ft	
	Using Weir Equation, Q	=	$CLH^{3/2}$		
	C	=	3.1		
	L	=	6.00	ft	
	H	=	Depth of flow	ft	
	Therefore, 2.11	=	$3.1*6.00*H^{3/2}$		
	H	=	0.23	ft	
	ESDV achieved @ EL.	=	210.50	ft	
	10 - YR WSEL	=	210.73	ft	
	ROADWAY FLOW LINE EL.	=	211.82	ft	
	Freeboard Provided	=	1.09	ft	

Project: Charles County, MD				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -5 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)		=	0.46	Ac.		
Total Impervious area to be Treated (A_i)		=	0.17	Ac.		
Total Imperviousness for this Facility		=	37	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.8	in	(MDE Design Manual, Table 5.3))	
	R_V	=	0.39			
	Q_E	=	0.70			
Target ESD_V for ESD-5		=	0.027	Ac-ft		
		=	1165	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	401.4	SF
Total Surface Area (A_F) Provided		=	1117	SF	OK	
Vlume Provided in Filter Media:						
Total Surl Total Volume Provided in Filter		=	1117	sf		
2.0' BSM with Porosity of 0.4		=	894	cf		
4" Stone with Porosity of 0.45		=	166	cf		
Total Volume provided in Filter		=	1059	cf		
		=	0.0243	ac-ft		
Provided Storage Volume Between EL. 209.50 to EL. 210.00				=	0.015	Ac-ft
					(See Table below)	

ESD - 5 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
210.00	1117	0	0.000
210.50	1544	665	0.015

Total Storage Provided by ESD-5 Facility	=	0.040	Ac-ft	
	=	1725	CF	
P_E Provided	=	2.66		
Therefore, Total Storage Provided by ESD-3 Facility meet Target P_E and ESD_V for ESD-3				

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -5 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.46	Ac.	
Total Impervious area to be Treated (A_i)	=	0.17	Ac.	
Total Imperviousness for this Facility	=	37	%	
R_V	=	0.39		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	84.16	cf	
ESD Surface Area	=	1117.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	148.93	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By: SA		4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					
	ESD Facility -5 (Micro Bioretention) Design : Study Point 3A				
	Total Drainage Area (A)	=	0.46	Ac.	
	Impervious Area	=	0.17	Ac.	
	Open Space Area	=	0.29	Ac.	
	"C" for Impervious Area	=	0.9	Ac.	
	"C" for Open Space Area	=	0.25		
	Composite "C"	=	0.49	Ac.	
	Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
	Q_{10}	=	CIA		
		=	1.59	cfs	
	Using Inlet with opening	=	3	ft on all four sides	
	Perimeter, L	=	12	ft	
	Assume 50 % Blockage, L	=	6	ft	
	Using Weir Equation, Q	=	$CLH^{3/2}$		
	C	=	3.1		
	L	=	6.00	ft	
	H	=	Depth of flow	ft	
	Therefore, 1.59	=	$3.1*6.00*H^{3/2}$		
	H	=	0.19	ft	
	ESDV achieved @ EL.	=	210.50	ft	
	10 - YR WSEL	=	210.69	ft	
	ROADWAY FLOW LINE EL.	=	212.75	ft	
	Freeboard Provided	=	2.06	ft	

Project: Charles County, MD				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -6 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)	=	0.31	Ac.			
Total Impervious area to be Treated (A_i)	=	0.14	Ac.			
Total Imperviousness for this Facility	=	45	%			
Hydrologic Soil Group	=	C				
Target Rainfall for this Facility (P_E)	=	1.8	in	(MDE Design Manual, Table 5.3))		
R_V	=	0.45				
Q_E	=	0.82				
Target ESD_V for ESD-6	=	0.021	Ac-ft			
	=	914	CF			
Minimum Surface Area (A_F)	=	2% of DA	=	268.8	SF	
Total Surface Area (A_F) Provided	=	901	SF	OK		
Vlume Provided in Filter Media:						
Total Surf Total Volume Provided in Filter	=	901	sf			
2.0' BSM with Porosity of 0.4	=	721	cf			
4" Stone with Porosity of 0.45	=	134	cf			
Total Volume provided in Filter	=	855	cf			
	=	0.0196	ac-ft			
Provided Storage Volume Between EL. 209.50 to EL. 210.00			=	0.012	Ac-ft	
					(See Table below)	

ESD - 6 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
210.00	901	0	0.000
210.50	1172	518	0.012

Total Storage Provided by ESD-6 Facility	=	0.032	Ac-ft
	=	1373	CF
P_E Provided	=	2.70	inches

Therefore, Total Storage Provided by ESD-6 Facility meet Target P_E and ESD_V for ESD-6

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -6 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.31	Ac.	
Total Impervious area to be Treated (A_i)	=	0.14	Ac.	
Total Imperviousness for this Facility	=	45	%	
R_V	=	0.45		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	66.00	cf	
ESD Surface Area	=	901.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	120.13	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility -6 (Micro Bioretention) Design : Study Point 3A

Total Drainage Area (A)	=	0.31	Ac.	
Impervious Area	=	0.14	Ac.	
Open Space Area	=	0.17	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.54	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.17	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.17	=	$3.1*6.00*H^{3/2}$		
H	=	0.16	ft	
ESDV achieved @ EL.	=	210.50	ft	
10 - YR WSEL	=	210.66	ft	
ROADWAY FLOW LINE EL.	=	211.89	ft	
Freeboard Provided	=	1.23	ft	

Project: Charles County, MD				Designed By: SA		12/10/2013
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -7 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)		=	0.31	Ac.		
Total Impervious area to be Treated (A_i)		=	0.15	Ac.		
Total Imperviousness for this Facility		=	47	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.8	in		(MDE Design Manual, Table 5.3))
	R_V	=	0.47			
	Q_E	=	0.85			
Target ESD_V for ESD-7		=	0.022	Ac-ft		
		=	965	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	272.36	SF
Total Surface Area (A_F) Provided		=	782	SF	OK	
Vlume Provided in Filter Media:						
Total Surl Total Volume Provided in Filter		=	782	sf		
2.0' BSM with Porosity of 0.4		=	626	cf		
4" Stone with Porosity of 0.45		=	116	cf		
Total Volume provided in Filter		=	742	cf		
		=	0.0170	ac-ft		
Provided Storage Volume Between EL. 209.00 to EL. 209.50				=	0.0103	Ac-ft
						(See Table below)

ESD - 7 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
209.00	782	0	0.000
209.50	1010	448	0.0103

Total Storage Provided by ESD-7 Facility	=	0.027	Ac-ft	
	=	1190	CF	
P_E Provided	=	2.22	inches	
Therefore, Total Storage Provided by ESD-7 Facility meet Target P_E and ESD_V for ESD-7				

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -7 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.31	Ac.	
Total Impervious area to be Treated (A_i)	=	0.15	Ac.	
Total Imperviousness for this Facility	=	47	%	
R_V	=	0.47		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	69.67	cf	
ESD Surface Area	=	782.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	104.27	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility -7 (Micro Bioretention) Design : Study Point 3A

Total Drainage Area (A)	=	0.31	Ac.	
Impervious Area	=	0.15	Ac.	
Open Space Area	=	0.17	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.55	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.21	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.21	=	$3.1*6.00*H^{3/2}$		
H	=	0.16	ft	
ESDV achieved @ EL.	=	209.50	ft	
10 - YR WSEL	=	209.66	ft	
ROADWAY FLOW LINE EL.	=	210.96	ft	
Freeboard Provided	=	1.30	ft	

Project: Charles County, MD				Designed By: SA	12/10/2013
Location: Charles County, MD				Checked By:	
PGM # VCI 14-0044					
ESD Facility -8 (Micro Bioretention) Preliminary Design : Study Point 3A					
Total Drainage Area (DA)	=	0.38	Ac.		
Total Impervious area to be Treated (A_i)	=	0.17	Ac.		
Total Imperviousness for this Facility	=	45	%		
Hydrologic Soil Group	=	C			
Target Rainfall for this Facility (P_E)	=	1.8	in	(MDE Design Manual, Table 5.3))	
R_V	=	0.45			
Q_E	=	0.82			
Target ESD_V for ESD-8	=	0.026	Ac-ft		
	=	1134	CF		
Minimum Surface Area (A_F)	=	2% of DA	=	332.4	SF
Total Surface Area (A_F) Provided	=	1063	SF	OK	
Vlume Provided in Filter Media:					
Total Surf Total Volume Provided in Filter	=	1063	sf		
2.0' BSM with Porosity of 0.4	=	850	cf		
4" Stone with Porosity of 0.45	=	158	cf		
Total Volume provided in Filter	=	1008	cf		
	=	0.0231	ac-ft		
Provided Storage Volume Between EL. 208.00 to EL. 208.50			=	0.015	Ac-ft
					(See Table below)

ESD - 8 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
208.50	1063	0	0.000
209.00	1637	675	0.015

Total Storage Provided by ESD-8 Facility	=	0.039	Ac-ft
	=	1683	CF
P_E Provided	=	2.67	inches

Therefore, Total Storage Provided by ESD-8 Facility meet Target P_E and ESD_V for ESD-8

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By: SA	12/10/2013
Location:	Charles County, MD	Checked By:	

PGM # VCI 14-0044

ESD Facility -8 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.38	Ac.	
Total Impervious area to be Treated (A_i)	=	0.17	Ac.	
Total Imperviousness for this Facility	=	45	%	
R_V	=	0.45		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	81.89	cf	
ESD Surface Area	=	1063.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	141.73	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility -8 (Micro Bioretention) Design : Study Point 3A

Total Drainage Area (A)	=	0.38	Ac.	
Impervious Area	=	0.17	Ac.	
Open Space Area	=	0.21	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.54	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.45	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.45	=	$3.1*6.00*H^{3/2}$		
H	=	0.18	ft	
ESDV achieved @ EL.	=	209.00	ft	
10 - YR WSEL	=	209.18	ft	
ROADWAY FLOW LINE EL.	=	209.95	ft	
Freeboard Provided	=	0.77	ft	

Project: Charles County, MD				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -9 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)		=	0.34	Ac.		
Total Impervious area to be Treated (A_i)		=	0.10	Ac.		
Total Imperviousness for this Facility		=	30	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.6	in		(MDE Design Manual, Table 5.3))
	R_V	=	0.32			
	Q_E	=	0.52			
Target ESD_V for ESD-9		=	0.015	Ac-ft		
		=	639	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	296.5	SF
Total Surface Area (A_F) Provided		=	696	SF	OK	
Vlume Provided in Filter Media:						
Total Surl Total Volume Provided in Filter		=	696	sf		
2.0' BSM with Porosity of 0.4		=	557	cf		
4" Stone with Porosity of 0.45		=	103	cf		
Total Volume provided in Filter		=	660	cf		
		=	0.0152	ac-ft		
Provided Storage Volume Between EL. 211.00 to EL. 211.50				=	0.010	Ac-ft
						(See Table below)

ESD - 9 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
211.00	696	0	0.000
211.50	971	417	0.010

Total Storage Provided by ESD-9 Facility	=	0.025	Ac-ft	
	=	1077	CF	
P_E Provided	=	2.70	inches	
Therefore, Total Storage Provided by ESD-9 Facility meet Target P_E and ESD_V for ESD-9				

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By: SA	12/10/2013
Location:	Charles County, MD	Checked By:	

PGM # VCI 14-0044

ESD Facility -9 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.34	Ac.	
Total Impervious area to be Treated (A_i)	=	0.10	Ac.	
Total Imperviousness for this Facility	=	30	%	
R_V	=	0.32		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	51.90	cf	
ESD Surface Area	=	696.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	92.80	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility-9 (Micro Bioretention) Design : Study Point 3A

Total Drainage Area (A)	=	0.34	Ac.	
Impervious Area	=	0.10	Ac.	
Open Space Area	=	0.24	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.45	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.07	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.07	=	$3.1*6.00*H^{3/2}$		
H	=	0.15	ft	
ESDV achieved @ EL.	=	211.50	ft	
10 - YR WSEL	=	211.65	ft	
ROADWAY FLOW LINE EL.	=	213.05	ft	
Freeboard Provided	=	1.40	ft	

Project: Charles County, MD				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -10 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)		=	0.33	Ac.		
Total Impervious area to be Treated (A_i)		=	0.09	Ac.		
Total Imperviousness for this Facility		=	28	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.6	in		(MDE Design Manual, Table 5.3))
	R_V	=	0.30			
	Q_E	=	0.48			
Target ESD_V for ESD-10		=	0.013	Ac-ft		
		=	564	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	283.5	SF
Total Surface Area (A_F) Provided		=	966	SF	OK	
Vlume Provided in Filter Media:						
Total Surf Total Volume Provided in Filter		=	488	sf		
2.0' BSM with Porosity of 0.4		=	390	cf		
4" Stone with Porosity of 0.45		=	72	cf		
Total Volume provided in Filter		=	463	cf		
		=	0.0106	ac-ft		
Provided Storage Volume Between EL. 210.7 to EL. 211.2				=	0.011	Ac-ft
						(See Table below)

ESD - 10 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
210.70	488	0	0.000
211.20	1467	489	0.011

Total Storage Provided by ESD-10 Facility	=	0.022	Ac-ft	
	=	952	CF	
P_E Provided	=	2.70	inches	

Therefore, Total Storage Provided by ESD-10 Facility meet Target P_E and ESD_V for ESD-10

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -10 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.33	Ac.	
Total Impervious area to be Treated (A_i)	=	0.09	Ac.	
Total Imperviousness for this Facility	=	28	%	
R_V	=	0.30		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	45.86	cf	
ESD Surface Area	=	488.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	65.07	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility-10 (Micro Bioretention) Design : Study Point 3A

Total Drainage Area (A)	=	0.33	Ac.	
Impervious Area	=	0.09	Ac.	
Open Space Area	=	0.24	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.43	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	0.98	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 0.98	=	$3.1*6.00*H^{3/2}$		
H	=	0.14	ft	
ESDV achieved @ EL.	=	211.20	ft	
10 - YR WSEL	=	211.34	ft	
ROADWAY FLOW LINE EL.	=	212.27	ft	
Freeboard Provided	=	0.93	ft	

Project: Charles County, MD				Designed By: SA	12/10/2013	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -11 (Micro Bioretention) Preliminary Design : Study Point 3A						
Total Drainage Area (DA)		=	0.53	Ac.		
Total Impervious area to be Treated (A_i)		=	0.21	Ac.		
Total Imperviousness for this Facility		=	39	%		
Hydrologic Soil Group		=	C			
Target Rainfall for this Facility (P_E)		=	1.7	in		(MDE Design Manual, Table 5.3))
	R_V	=	0.40			
	Q_E	=	0.69			
Target ESD_V for ESD-11		=	0.030	Ac-ft		
		=	1327	CF		
Minimum Surface Area (A_F)		=	2% of DA	=	463.1	SF
Total Surface Area (A_F) Provided		=	968	SF	OK	
Vlume Provided in Filter Media:						
Total Surf Total Volume Provided in Filter		=	968	sf		
3.0' BSM with Porosity of 0.4		=	1162	cf		
6" Stone with Porosity of 0.45		=	218	cf		
Total Volume provided in Filter		=	1379	cf		
		=	0.0317	ac-ft		
Provided Storage Volume Between EL. 209.25 to EL. 209.75				=	0.013	Ac-ft
						(See Table below)

ESD - 11 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
209.25	968	0	0.000
209.75	1264	558	0.013

Total Storage Provided by ESD-11 Facility	=	0.044	Ac-ft	
	=	1937	CF	
P_E Provided	=	2.48	inches	

Therefore, Total Storage Provided by ESD-11 Facility meet Target P_E and ESD_V for ESD-11

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/10/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

ESD Facility -11 (Micro Bioretention) Design : Study Point 3A

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.53	Ac.	
Total Impervious area to be Treated (A_i)	=	0.21	Ac.	
Total Imperviousness for this Facility	=	39	%	
R_V	=	0.40		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	101.46	cf	
ESD Surface Area	=	968.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	129.07	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility-11 (Micro Bioretention) Design : Study Point 3A

Total Drainage Area (A)	=	0.53	Ac.	
Impervious Area	=	0.21	Ac.	
Open Space Area	=	0.32	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.51	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.88	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.88	=	$3.1*6.00*H^{3/2}$		
H	=	0.22	ft	
ESDV achieved @ EL.	=	209.75	ft	
10 - YR WSEL	=	209.97	ft	
ROADWAY FLOW LINE EL.	=	211.73	ft	
Freeboard Provided	=	1.76	ft	

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/11/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

Study Point: 3B (New Development Criteria, Existing I % less than 40 %)

Total Site Area (within LOD)	=	0.25	Ac.	
Existing Impervious Area	=	0.05	Ac.	
% Existing Impervious Area	=	20.30	%	
(New Development Criteria, Existing I % less than 40 %)				
Added New Impervious Area	=	0.08	Ac.	
Ex. Impervious Area Removed	=	0.00		
Proposed Impervious Area	=	0.13	Ac.	
Hydrologic Soil Group	=	C		

Determine Pre-Developed Conditions:

Hydrologic Soil Group	=	C		
RCN for "Woods in good Condition =		70		

Determine Target P_E:

Proposed Impervious Area	=	0.13	Ac.	
Total Site Area (within LOD)	=	0.25	Ac.	
%I	=	51.66%		
Target Rainfall for Water Quality Treatment (P_E)	=	1.8	In.	(MDE Design Manual, Table 5.3))
Q_E	=	0.93	in.	

ESD Targets for Study Point 3B

P_E	=	1.80	In.	
Q_E	=	0.93	in.	
Impervious Percentage (I)	=	51.66	%	
R_V	=	0.5149		$R_v = 0.05+0.009(I\%)$
Water Quality Volume (ESD_V)	=	0.019	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	841	Cu.Ft.	

ESD-12 (grass Swale) provides treatment of 0.03 Ac. of impervious area.

Treatment Volume Provided in ESD Practice	=	0.004	Ac.-Ft.	(See ESD-12 comps)
Treatment Volume Provided in ESD Practice	=	167	Cu.Ft.	

ESD to MEP Exausted and no additional ESD feasible within ROW.

Soil C, S = 0.13

Total Recharge Volume, Rev = ((S*Rv*A)/12)*43560 (cf) = 61 Cu. Ft.

Grss Swale automatically meets recharge requirements

Project: Charles County, MD				Designed By: SA	12/10/2013
Location: Charles County, MD				Checked By:	
PGM # VCI 14-0044					
ESD Facility -12 (Grass Swale) Preliminary Design : Study Point 3B					
Total Drainage Area (DA)		=	0.25	Ac.	
Total Impervious area to be Treated, D_i		=	0.13	Ac.	
Total Imperviousness for this Facility		=	52	%	
Hydrologic Soil Group		=	C		
Target Rainfall for this Facility (P_E)		=	1.8	in	(MDE Design Manual, Table 5.3))
	R_V	=	0.51		
	Q_E	=	0.93		
Target ESD_V for ESD-12		=	0.0193	Ac-ft	
Grass Swale Peak Discharge and Velocity:					
Q_a		=	(P) R_v)		MDE manual Vol II Appen. D.10
		=	0.927	in	
RCN for ESD_v		=	$(1000/(10+5P+10Q_a-10(Q_a^2+1.25Q_aP)^{0.5}))$		
		=	90.02		MDE manual Vol II Appen. D.10
Initial Abstraction, I_a		=	(200/CN)-2		
		=	0.222		
$I_{a/P}$		=	0.123		
Tc (assume)		=	0.100	hr	
Unit Peak Discharge, qu		=	1000	csm/in	
					MDE manual Vol II Appen. D.11.1
ESDv Peak Flow, Qw		=	(q_u csm/in)*(A mi2)*(qa in)		
		=	0.36	cfs	
Grass Ditch with 3' bottom, 3:1 side slopes, 1.44% slopes and Length = 130 LF					
Minimum Surface Area (A_F) required		=	2% of D_i	= 112.5	SF
Total Surface Area (A_F) Provided		=	390	SF	> 2% surface area required, OK
Depth (d) and Velocity (V) Check for ESD_V:					use n = 0.15
	d	=	0.24	ft	< 4", OK
	V	=	0.40	fps	<1 fps, OK
P_E Claimed		=	0.36	in	< Target P_E
Therefore, Impervious Area Treated Claimed		=	0.03	Ac.	
ESDv Provided		=	0.0038	Ac-ft	

Project: Middletown Rd Roundabout & Roadway Extension — Designed By: SA — 4/11/2014
Location: Charles County, MD — Checked By:
PGM # VCI 14-0044

Study Point #3B

Proposed Condition **Sta.** Elev.= **To** **Sta.** Elev.= L = **130**

Left Slope	Bottom Width	Right Slope	Depth Ft.	Area SF.	Slope %	n	Ditch Computations Wp Ft.	Velocity FPS.	" Q " CFS.
3	3	3	2.000	18.000	1.44%	0.040	15.649	4.894	88.09
			1.900	16.530			15.017	4.753	78.56
			1.800	15.120			14.384	4.609	69.68
			1.750	14.438			14.068	4.536	65.48
			1.600	12.480			13.119	4.312	53.81
			1.500	11.250			12.487	4.159	46.78
			1.400	10.080			11.854	4.001	40.33
			1.300	8.970			11.222	3.840	34.44
			1.250	8.438			10.906	3.757	31.70
			1.200	7.920			10.589	3.673	29.09
			1.100	6.930			9.957	3.501	24.26
			1.000	6.000			9.325	3.323	19.94
			0.420	1.789			5.656	2.070	3.70
			0.260	0.983			4.644	1.583	1.56
			`	#VALUE!			#VALUE!	#VALUE!	#VALUE!
			0.100	0.330			3.632	0.901	0.30

Total Area 0.25 ac.
Imp. Area 0.130 ac.
C 0.64
I10 7 in/hr
Tc 5 Min.

Peak Discharge for 10-yr. Run-off 1.54

10 YR DEPTH=

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/11/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

Study Point: 4 (Redevelopment Criteria, Existing I % greater than 40 %)

Total Site Area (within LOD)	=	0.32	Ac.
Existing Impervious Area	=	0.13	Ac.
% Existing Impervious Area	=	40.63	%
(Redevelopment Criteria, Existing I % greater than 40 %)			
Added New Impervious Area	=	0.15	Ac.
Ex. Impervious Area Removed	=	0.03	Ac.
Proposed Impervious Area	=	0.25	Ac.
Hydrologic Soil Group	=	C	

Water Quality Calculations (for Existing Impervious Area)

Target Area for Water Quality Treatment (A)	=	0.05	Ac.	
Target Rainfall for Water Quality Treatment (P_E)	=	1	In.	(MDE Design Manual)
Impervious Percentage (I)	=	100	%	(MDE Design Manual, Table 5.3)
R_V	=	0.95		$R_v = 0.05+0.009(I\%)$
Water Quality Volume (ESD_V)	=	0.004	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	172	Cu.Ft.	

Water Quality Calculations (for New Impervious Area)

Target Area for Water Quality Treatment (A)	=	0.15	Ac.	
Target Rainfall for Water Quality Treatment (P_E)	=	2.2	In.	(MDE Design Manual, Table 5.3)
Impervious Percentage (I)	=	100	%	
R_V	=	0.95		
Water Quality Volume (ESD_V)	=	0.026	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	1138	Cu.Ft.	

Total Impervious area Requiring Treatment	=	Redevelopment + New Impervious	
	=	0.20	
Total Target Water Quality Volume (ESD_V)	=	0.030	Cu.Ft.
	=	1310	Ac.-Ft.

ESD to MEP Exausted and no ESD feasible within ROW. Overcompensate in SP's 3A

Soil C, S = 0.13

Total Recharge Volume, Rev = ((S*Rv*A)/12)*43560 (cf) = 90 Cu. Ft.

AB CONSULTANTS, INC.

Date : 10/9/2014

10-YR DISCHARGE COMPUTATION AT CURB END (WITHIN SP#4)

USING RATIONAL METHOD (DRAINAGE AREA < 20AC.)

IMPERVIOUS AREA	=	0.100	AC.	C	=	0.90
GRASS AREA	=	0.060	AC.	C	=	0.35
TOTAL DRAINAGE AREA (A)	=	0.160	AC.			
RUNOFF COEFFICIENT C	=	0.694	(Composite)			

STORMWATER RUNOFF (Q)

TIME OF CONCENTRATION (Tc)	=	5.0	MIN
RAINFALL INTENSITY (I_{10})	=	7.00	IPH
Q_{10} = C x I x A	=	0.78	CFS

10-YR DISCHARGE COMPUTATION FOR SP#4

USING RATIONAL METHOD (DRAINAGE AREA < 20AC.)

IMPERVIOUS AREA	=	0.210	AC.	C	=	0.90
GRASS AREA	=	0.160	AC.	C	=	0.35
TOTAL DRAINAGE AREA (A)	=	0.370	AC.			
RUNOFF COEFFICIENT C	=	0.662	(Composite)			

STORMWATER RUNOFF (Q)

TIME OF CONCENTRATION (Tc)	=	5.0	MIN
RAINFALL INTENSITY (I_{10})	=	7.00	IPH
Q_{10} = C x I x A	=	1.72	CFS

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By:	SA	12/11/2013
Location:	Charles County, MD	Checked By:		

PGM # VCI 14-0044

Study Point: 5 (New Development Criteria, Existing I % less than 40 %)

Total Site Area (within LOD)	=	3.56	Ac.	
Existing Impervious Area	=	0.53	Ac.	0.49 Ac of Imp area diverted to SP 3A
% Existing Impervious Area	=	15.00	%	
(New Development Criteria, Existing I % less than 40 %)				
Added New Impervious Area	=	0.08	Ac.*	*(post Development diverting DA
Ex. Impervious Area Removed	=	0.00		to SP 3A)
Proposed Impervious Area	=	0.12	Ac.*	
Hydrologic Soil Group	=	C		

Determine Pre-Developed Conditions:

Hydrologic Soil Group	=	C		
RCN for "Woods in good Condition =		70		

Determine Target P_E:

Proposed Impervious Area	=	0.14	Ac.	(post Development diverting DA
Total Site Area (within LOD)	=	0.32	Ac.	to SP 3A)
%I	=	43.75%		

Target Rainfall for Water Quality Treatment (P_E)	=	1.8	In.	(MDE Design Manual, Table 5.3))
Q_E	=	0.79	in.	

ESD Targets for Study Point 5

P_E	=	1.80	In.	
Q_E	=	0.79	in.	
Impervious Percentage (I)	=	43.75	%	
R_V	=	0.4438		$R_v = 0.05+0.009(I\%)$
Water Quality Volume (ESD_V)	=	0.021	Ac.-Ft.	
Water Quality Volume (ESD_V)	=	928	Cu.Ft.	

ESD to MEP Exausted and no ESD feasible within ROW. Overcompensate in SP's 1

Treatment Volume Provided in ESD Practice	=	0.029	Ac.-Ft.	(See WSD-13 comps)
Treatment Volume Provided in ESD Practice	=	1260	Cu.Ft.	

Soil C, S = 0.13

Total Recharge Volume, Rev = ((S*Rv*A)/12)*43560 (cf) = 67 Cu. Ft.

Project: Charles County, MD				Designed By: SA	10/9/2014	
Location: Charles County, MD				Checked By:		
PGM # VCI 14-0044						
ESD Facility -13 (Micro Bioretention) Preliminary Design : Study Point 5						
Total Drainage Area (DA)	=	0.28	Ac.			
Total Impervious area to be Treated (A_i)	=	0.13	Ac.			
Total Imperviousness for this Facility	=	46	%			
Hydrologic Soil Group	=	C				
Target Rainfall for this Facility (P_E)	=	1.8	in	(MDE Design Manual, Table 5.3))		
R_V	=	0.47				
Q_E	=	0.84				
Target ESD_V for ESD-11	=	0.020	Ac-ft			
	=	856	CF			
Minimum Surface Area (A_F)	=	2% of DA	=	243.9	SF	
Total Surface Area (A_F) Provided	=	709	SF	OK		
Vlume Provided in Filter Media:						
Total Surl Total Volume Provided in Filter	=	709	sf			
2.5' BSM with Porosity of 0.4	=	709	cf			
4" Stone with Porosity of 0.45	=	105	cf			
Total Volume provided in Filter	=	814	cf			
	=	0.0187	ac-ft			
Provided Storage Volume Between EL. 210.00 to EL. 210.50	=	0.010	Ac-ft (See Table below)			

ESD - 13 Storage Volume			
Elevation	Area	Volume (cf)	Volume Ac-ft)
207.50	709	0	0.000
208.00	1075	446	0.010

Total Storage Provided by ESD-13 Facility	=	0.029	Ac-ft
	=	1260	CF
P_E Provided	=	2.65	inches

Therefore, Total Storage Provided by ESD-13 Facility meet Target P_E and ESD_V for ESD-13

Project:	Middletown Rd Roundabout & Roadway Extension	Designed By: SA	10/9/2014
Location:	Charles County, MD	Checked By:	

PGM # VCI 14-0044

ESD Facility -13 (Micro Bioretention) Preliminary Design : Study Point 5

Determine Recharge Volume:

Total Drainage Area (DA)	=	0.28	Ac.	
Total Impervious area to be Treated (A_i)	=	0.13	Ac.	
Total Imperviousness for this Facility	=	46	%	
R_V	=	0.47		
S for Soil C	=	0.13		
Rev = ((S*Rv*A)/12)*43560 (cf)	=	61.82	cf	
ESD Surface Area	=	709.00	sf	
#57 Stone Layer Provided	=	4.00	in	(Porosity = 0.4)
Rev Provided	=	94.53	cf	

Project:	Middletown Rd Roundabout & Roadway Extension		Designed By:	SA	4/11/2014
Location:	Charles County, MD		Checked By:		
PGM # VCI 14-0044					

ESD Facility -13 (Micro Bioretention) Design : Study Point 5

Total Drainage Area (A)	=	0.28	Ac.	
Impervious Area	=	0.13	Ac.	
Open Space Area	=	0.15	Ac.	
"C" for Impervious Area	=	0.9	Ac.	
"C" for Open Space Area	=	0.25		
Composite "C"	=	0.55	Ac.	
Rainfall Intensity (I)	=	7.00	in/hr	(Assume Tc = 5 min for 10 yr Storm)
Q_{10}	=	CIA		
	=	1.08	cfs	
Using Inlet with opening	=	3	ft on all four sides	
Perimeter, L	=	12	ft	
Assume 50 % Blockage, L	=	6	ft	
Using Weir Equation, Q	=	$CLH^{3/2}$		
C	=	3.1		
L	=	6.00	ft	
H	=	Depth of flow	ft	
Therefore, 1.08	=	$3.1*6.00*H^{3/2}$		
H	=	0.15	ft	
ESDV achieved @ EL.	=	210.50	ft	
10 - YR WSEL	=	210.65	ft	
ROADWAY FLOW LINE EL.	=	211.74	ft	
Freeboard Provided	=	1.09	ft	

APPENDIX 4

ESD DRAINAGE AREA MAP