VIRGINIA STATE UNIVERSITY
STORMWATER MASTER PLAN - ADDENDUM

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VSU SWMP - ADDENDUM

Section 1.0 - Purpose

A Stormwater Master Plan (SWMP) was initially prepared for Virginia State University in 2013; the purpose of which was to be proactive in combining improvements for existing problems with planning for future development in a cost-effective manner. Three capital improvement projects and the creation of a nutrient credit bank were defined as the highest priority stormwater projects. The report also addressed the Chesapeake Bay TMDL. The 2013 SWMP was based on existing conditions, as of 2012, and ultimate development conditions defined in the 2007 Campus Master Plan and 20/20 Vision. Since implementation of the SWMP, the University has implemented several projects, and the Campus Master Plan has been updated (***Campus Master Plan Update***, November 2017). The purpose of this addendum report is to assess the effects of the ***Campus Master Plan Update***, progress toward achieving the campus nutrient credit bank, and compliance status with stormwater regulations, specifically: the Virginia Stormwater Management Program (VSMP) regulations and the Chesapeake Bay TMDL.

Section 2.0 – VSMP Water Quality Calculations

A compliance plan for future development and implementation of the Campus Master Plan was developed in 2013 that was directly tied to the 'time limits of applicability' clause in the 2009-2013 Construction General Permit (GP). The GP defines the appropriate stormwater management design criteria for regulatory compliance for new and redevelopment consistent with the Virginia Stormwater Management Program (VSMP) regulations. The current Campus-wide Construction General Permit coverage (obtained 7/10/2012) can be renewed for up to two permit terms and will expire on June 30, 2024. By the expiration of GP coverage, the University should be complete with all improvements proposed in the initial six-year planning period presented in the ***Campus Master Plan Update***. For this addendum, an updated pollutant removal requirement for ultimate development of the six-year planning period (RR_{6YR}) was determined, based on the following:

1. The overall site boundary has been updated to reflect a reduction in area, most notably along Chesterfield Avenue. The site boundary used in the 2013 SWMP was approximately 277 acres. The current site boundary presented in the ***Campus Master Plan Update*** is 258 acres, as presented in the Appendix A, Figure 1;

2. The proposed impervious land cover from the 2007 Campus Master Plan and 20/20 Vision used to develop removal requirements was 124.9 acres (45%). However, the proposed impervious area presented in the ***Campus Master Plan Update*** as the ultimate development condition for the six-year planning period is significantly reduced to 94.5 acres, which represents a 37% imperviousness, as illustrated in Appendix A, Figure 2; and

3. The treatment credit of existing BMPs as of the 2013 SWMP has been refined based on a more thorough knowledge and understanding of BMPs on campus as required through the University's MS4 Program. The BMP database, as of 2016, presented in Appendix B was used to update the credit for existing BMPs, based on installation dates prior to

2012[1]. The updated credit for existing BMPs on Campus as of 2012 is approximately 37 lb/yr versus 33 lb/yr previously reported in the 2013 SWMP.

The updated VSMP pollutant removal requirement calculations are presented in Attachment C. The pollutant removal requirement for the six-year planning period presented in the ***Campus Master Plan Update***, $RR_{6YR,}$ is 57.82 lb/yr, which is a 19.58 lb/yr reduction, from the previously recorded removal requirement for the 2007 Campus Master Plan and 20/20 Vision of 77.40 lb/yr. The reduction is primarily a result of the reduction in site boundary and proposed imperviousness of the ultimate conditions, as discussed above.

As stated in the 2013 SWMP, one of the high priority goals was to develop a nutrient credit bank; thus, once the removal requirement for the ***Campus Master Plan Update*** was calculated, the credit for existing BMPs brought online since 2012 was determined. All BMPs and corresponding locations are presented in Appendix A, Figure 3. Campus BMP Map. As presented below in Table 1, the following BMPs have been constructed on Campus since the 2013 SWMP, and were accounted for to determine the current nutrient credit bank quantity:

Table 1. Campus BMPs Brought Online since 2012.

BMP ID[2]	Location and Type	Total Area Treated (ac.)	TP removed (lb/yr)
35	University Bookstore Contech StormFilter	0.10	0.13
41-44	Dupuy Avenue Parking Lot Filterras	1.75	2.06
46	Multipurpose Center Extended Detention	32.00	29.63
47	College Ave, Parking Lot #28 Contech StormFilter	24.25	13.07
Totals		58.10 acres treated	44.89 lb/yr TP removed

[1] The 2013 SWMP cited land cover as of 2012 as the existing condition, and documented existing BMPs in Table E.4. Table E.4 was cross-referenced with the 2016 BMP database to account for all BMPs, in the pollutant removal calculations. Note: BMPs 48/49 were converted to underground StormFilter in 2016, but had been previously accounted for as an enhanced extended detention facility; their removal credit was updated and included in the credit for BMPs as of 2013 SWMP.

[2] The following BMPs (and corresponding justification) were excluded from the determination for nutrient credit: #36 (quantity only); #45 (VDOT maintained to treat road and not Campus runoff); #48 & #49 (installed to replace existing Gateway Dining and Events Center BMP previously accounted for); and #50 (quantity only).

As presented in Appendix C, the sum of pollutant removal achieved by all on-site BMPs as of January 2018 ($L_{removed/total}$) is 82.05 lb/yr. As presented previously, the pollutant removal requirement, RR_{6YR}, as determined based on the ultimate land cover presented in the November 2017 ***Campus Master Plan Update*** was determined to be 57.82 lb/yr. Therefore, the 2013 SWMP high priority goal of achieving a nutrient credit bank has been achieved through a combination of reduction in overall site boundary and impervious area in the ultimate conditions presented in the ***Campus Master Plan Update***, as well as installation of Campus BMPs brought online since the 2013 SWMP. The total current Campus Nutrient Credit bank, as of January 2018 is **24.23 lb/yr TP**.

Section 3.0 – Chesapeake Bay TMDL Compliance

Timmons Group performed additional analyses to determine if the pollutant removal documented for the Campus Nutrient Credit Bank will meet VSU's Chesapeake Bay TMDL load reduction requirement mandated by the University's MS4 Permit.

According to the University's TMDL Action Plan (updated December 2015), the following total load reductions were determined to meet the Chesapeake Bay TMDL, as presented in Table 2.

Table 2. Chesapeake Bay TMDL Load Reduction Requirements.

POC, Pollutant of Concern	5% Load Reduction Requirement (by 6/30/2018)	35% Load Reduction Requirement (by 6/30/2023)	Total (100%) Load Reduction Requirement (by 6/30/2028)
TN, lb/yr	6.15 lb/yr	45.31 lb/yr	129.13 lb/yr
TP, lb/yr	1.13 lb/yr	10.18 lb/yr	28.76 lb/yr
TSS, lb/yr	632 lb/yr	4,486 lb/yr	12,806.93 lb/yr

The ***Chesapeake Bay TMDL Special Condition Guidance (VA DEQ GM15-2005), Appendix V.E.: BMPs installed to Meet Development and Redevelopment Requirements***, was followed to determine the total amount of pollutant reduction credit (TP, TN, TSS) from the existing campus BMPs for which VSU can take credit.

According to the Guidance, the University can take full credit for the excess TP removal presented above in Section 2 of 24.23 lb/yr. Thus, taking credit for the existing BMPs on campus could potentially achieve approximately 84% of the total TMDL load reduction requirement for TP.

The Guidance was further followed to determine associated TN and TSS credit for existing BMPs, as detailed below:

Step 1. Determine the proportion of the installed BMPs' total TP reductions that may be applied towards the TMDL reduction requirements:

Creditable Reduction for TP / Total Reduction Achieved by BMPs = Proportion of the BMPs' Totals Reductions Available for each POC

24.23 lb/yr TP / 82.05 lb/yr TP = 0.295 = 30%

Step 2. Determine the total site loads for TN and TSS, calculated using Table 4 from the MS4 Permit:

TN: 228.75 lb/yr TP * 5.2 lbs TN/lb TP = 1,189.5 lb/TN/yr
TSS: 228.75 lb/yr TP * 420.9 lb TSS/lb TP = 96,280.86 lb TSS/yr

Step 3. Determine the total BMP reductions for TN and TSS, refer to tabulated calculations in Appendix D. Chesapeake Bay TMDL Credits:

TN: 146.07 lb/yr
TSS: 36,721.47 lb/yr

Step 4. Determine the credit the permittee may receive towards the TMDL reduction requirements for TN and TSS:

TN: Total TN reduction from Step 3 * 30% = 43.82 lb/yr TN
TSS: Total TSS reduction from Step 3 * 30% = 11,016.44 lb/yr TSS

Thus, VSU could potentially make significant progress toward achieving their Chesapeake Bay TMDL requirement by taking credit for existing BMPs that were installed to meet the redevelopment criteria of the VSMP regulations; however, other projects are still required to achieve full compliance, as presented below in Table 3.

Table 3. Total Progress toward meeting Chesapeake Bay TMDL through VSMP Credits.

POC, Pollutant of Concern	Total (100%) Load Reduction Requirement (by 6/30/2028)	TMDL Credit Available from existing BMPs	Current Progress toward Achieving Chesapeake Bay TMDL
TN, lb/yr	129.13 lb/yr	43.82 lb/yr	34%
TP, lb/yr	28.76 lb/yr	24.23 lb/yr	84%
TSS, lb/yr	12,806.93 lb/yr	11,016.44 lb/yr	86%

Section 4.0 - Summary

Based on an updated analysis of ultimate development conditions presented in the ***Campus Master Plan Update*** (2017), the University achieves compliance with the water quality section of the VSMP regulations (9VAC25-870-96) with existing BMPs on campus. No further **water quality** controls, or BMPs, will be necessary to implement the projects proposed in the initial 6-yr planning period described in the ***Campus Master Plan Update*** if the University maintains coverage under its current General Construction Permit, and construction of all improvements is complete by June 30, 2024. Note, each project will still need to demonstrate compliance with the water quantity sections of the Part IIC Technical Criteria of the stormwater management regulations; stream channel erosion (9VAC25-870-97) and flooding (9VAC25-870-97).

Further, the University has achieved the 2013 SWMP goal of establishing a Campus Nutrient Credit Bank. The current bank is calculated as 24.23 lb/yr of total phosphorus removed. The University can claim credit for the BMPs installed to meet VSMP development and redevelopment criteria for Chesapeake Bay TMDL compliance, by following Guidance developed by DEQ in 2015. However, this approach falls short of meeting the 100% requirements, so other projects are still needed to achieve TMDL compliance.

Section 5.0 – Recommendations

As regulatory strategies and targets continually evolve through the various permit cycles and implementation of Campus projects is heavily contingent on funding allocations, Timmons Group recommends the University prioritize use of the Campus Nutrient Credit Bank for development and re-development projects through the expiration of the Construction General Permit coverage in 2024.

Further, as the Campus Nutrient Credit bank established through compliance with VSMP regulations does not achieve full compliance with the Chesapeake Bay TMDL, but the current strategy (Fleets Branch Stream Restoration) does, Timmons Group recommends the University continue implementation of the current strategy. If permit conditions happen to change and necessitate the need to explore additional TMDL compliance strategies after the expiration of the Construction GP (2024), but prior to the 2028 deadline for TMDL implementation, the University may consider re-examining the Campus Nutrient Credit Bank, at that time.

APPENDIX A

VIRGINIA STATE UNIVERSITY
STORMWATER MASTER PLAN

Figure 1 - Updated Site Boundary Map

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STORMWATER MASTER PLAN

Figure 2 - Campus Master Plan
Updated Land Cover Map (6-yr Planning Period)

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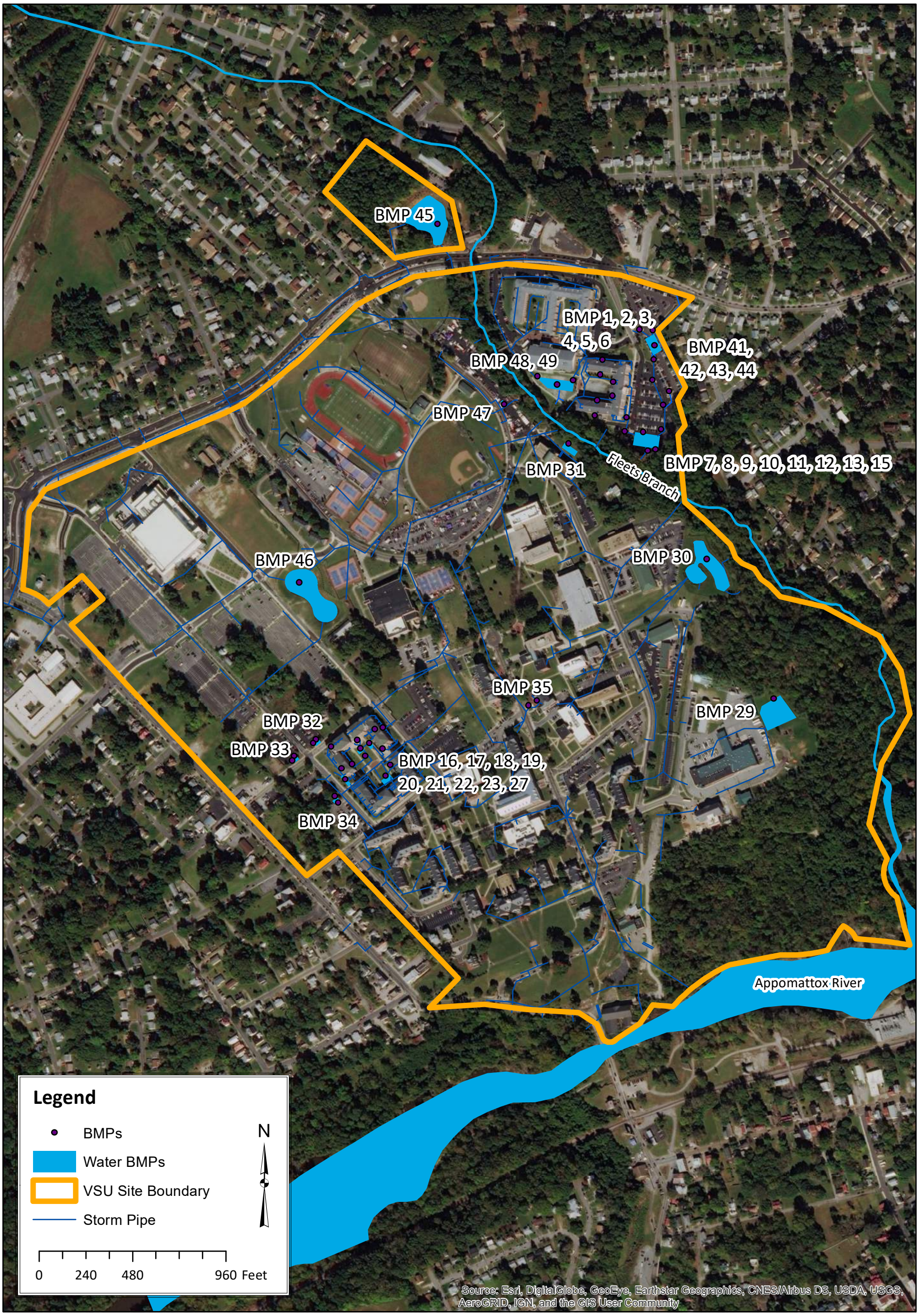

VIRGINIA STATE UNIVERSITY STORMWATER MASTER PLAN

Figure 3 - Campus BMP Map

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APPENDIX B

BMP Database - 2016

ID	BMP Type	Location	Approximate Latitude	Approximate Longitude	SWM Function	Total Area Treated (Ac.)	Pervious Area Treated (Ac.)	Impervious Area Treated (Ac.)	Date Brought Online	HUC	Impaired Waters Within HUC	Ownership	Maintenance Aggrement?	Date of Last Inspection
BMP 01	Roof Filterra 1	Gateway II Dorm Building	37.2423036445061	-77.41735229	Water Quality	0.07	0.0	0.07	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 02	Roof Filterra 2	Gateway II Dorm Building	37.2421660742903	-77.4173709	Water Quality	0.04	0.0	0.04	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 03	Roof Filterra 3	Gateway II Dorm Building	37.2420065771652	-77.41709411	Water Quality	0.07	0.0	0.07	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 04	Roof Filterra 4	Gateway II Dorm Building	37.2417307621922	-77.41743745	Water Quality	0.11	0.0	0.11	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 05	Roof Filterra 5	Gateway II Dorm Building	37.2417923135342	-77.41712939	Water Quality	0.05	0.0	0.05	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 06	Roof Filterra 6	Gateway II Dorm Building	37.2415622710386	-77.41747207	Water Quality	0.07	0.0	0.07	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 07	Filterra 1	Gateway II Dorm Parking Lot #30M	37.2420221022364	-77.41644732	Water Quality	0.22	0.04	0.18	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 08	Filterra 2	Gateway II Dorm Parking Lot #30M	37.2416656734862	-77.41626813	Water Quality	0.38	0.03	0.35	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 09	Filterra 3	Gateway II Dorm Parking Lot #30M	37.2413212278914	-77.4163035	Water Quality	0.40	0.02	0.38	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 10	Filterra 4	Gateway II Dorm Parking Lot #30M	37.2410375155774	-77.41640957	Water Quality	0.34	0.03	0.31	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 11	Filterra 5	Gateway II Dorm Parking Lot #30M	37.2410201846625	-77.41654759	Water Quality	0.35	0.02	0.33	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 12	Filterra 6	Gateway II Dorm Parking Lot #30M	37.2414927678435	-77.416913	Water Quality	0.23	0.03	0.20	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 13	Filterra 7	Gateway II Dorm Parking Lot #30M	37.2413273837876	-77.41697442	Water Quality	0.18	0.06	0.12	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 15	Underground Storage Vault	Gateway II Dorm Parking Lot #30M	37.2412862783722	-77.41662269	Water Quantity	0.00	0.00	0.00	06/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 16	Roof Filterra 1	Howard Hall Quad II Building	37.2368858125369	-77.42220164	Water Quality	0.5	0.0	0.5	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 17	Roof Filterra 2	Howard Hall Quad II Building	37.2365802066969	-77.42202559	Water Quality	0.5	0.0	0.5	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 18	Roof Filterra 3	Howard Hall Quad II Building	37.2366381184869	-77.42183987	Water Quality	0.12	0.0	0.12	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 19	Roof Filterra 4	Howard Hall Quad II Building	37.2371309132816	-77.42142962	Water Quality	0.09	0.0	0.09	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 20	Roof Filterra 5	Howard Hall Quad II Building	37.2369805691729	-77.42174254	Water Quality	0.08	0.0	0.08	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 21	Roof Filterra 6	Howard Hall Quad II Building	37.2371516389901	-77.42128532	Water Quality	0.27	0.01	0.26	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 22	Contech Stormfilter 1	Howard Hall Quad II Courtyard	37.2368542370496	-77.42129574	Water Quality	0.14	0.02	0.12	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 23	Contech Stormfilter 2	Howard Hall Quad II Courtyard	37.236752409992	-77.42160534	Water Quality	0.46	0.05	0.39	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 24	Underground Irrigation Storage (50,000 Gallons)	Howard Hall Quad II Courtyard	37.2368604793737	-77.42169028	Water Quantity	0.00	0.00	0.00	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 25	Underground CMP Detention (Pond 1A)	West Yard of Howard Hall Quad II	37.2364242210143	-77.42195893	Water Quantity	0.00	0.00	0.00	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 26	Underground CMP Detention (Pond 1B)	Howard Hall Quad II Courtyard	37.2369329397106	-77.42153119	Water Quantity	0.00	0.00	0.00	01/2012	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 27	Underground Detention Chamber w/ Sand Filters	Howard Hall Quad I Courtyard	37.2366193821127	-77.42116577	Water Quality and Quantity	1.90	1.07	0.83	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 28	Underground Irrigation Storage Vault	Howard Hall Quad I	37.2364660955308	-77.42124865	WaterQuantity	0.00	0.00	0.00	04/2011	JA40	Appomattox River	Owner Operated	N/A	04/26/2016
BMP 29	Extended Detention Basin	Physical Plant Building	37.2374968118811	-77.41437501	Water Quality and Quantity	5.49	0.97	4.52	03/1994	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 30	Retention Basin Type III	Behind Jesse R. Bolling (ROTC Building)	37.2394816061634	-77.41552741	Water Quality	20.99	10.14	10.85	03/2002	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 31	Deleware Sand Filter	Cooperative Extension Agriculture/Wilder Building	37.2411394008091	-77.41794307	Water Quality	1.17	0.32	0.85	05/1994	JA40	Appomattox River	Owner-Operated	N/A	06/18/2015
BMP 32	Sorbtive Filter 2C	Boisseau St. Parking Lot # 36	37.2369939903499	-77.42247266	Water Quality	0.38	0.01	0.37	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 33	Sorbtive Filter 1C	Boisseau St. Parking Lot #37	37.2367614848991	-77.42286067	Water Quality	0.39	0.03	0.36	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 34	Sorbtive Filter 10C	Lee St. Parking Lot #21	37.2361899480737	-77.42215313	Water Quality	0.44	0.02	0.42	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 35	Contech Stormfilter	University Bookstore	37.23743994869	-77.41870911	Water Quality	0.10	.01	.09	04/2014	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 36	Underground Storage Vault	University Bookstore	37.2375069049674	-77.41855594	Water Quantity	0	0	0	04/2014	JA40	Appomattox River	Owner-Operated	N/A	04/27/2016
BMP 37	Underground Storage Vault	Lee St. Parking Lot #21	37.2360965385105	-77.42208962	Water Quantity	0	0	0	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 38	Underground Storage Vault	Boisseau St. Parking Lot #36	37.236943	-77.422522	Water Quantity	0	0	0	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 39	Underground Storage Vault	Boisseau St. Parkign Lot #37	37.2366987120835	-77.42289637	Water Quantity	0	0	0	04/2011	JA40	Appomattox River	Owner-Operated	N/A	04/26/2016
BMP 40	Underground Storage Vault	Dupuy Avenue Parking Lot	37.2425069094874	-77.41641	Water Quantity	0	0	0	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 41	Filterra 1	Dupuy Avenue Parking Lot	37.2427272475765	-77.41643427	Water Quality	0.53	0.08	0.45	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 42	Filterra 2	Dupuy Avenue Parking Lot	37.2427367654206	-77.41667317	Water Quality	0.47	0.15	0.32	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 43	Filterra 3	Dupuy Avenue Parking Lot	37.2423098901161	-77.4164219	Water Quality	0.47	0.03	0.44	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 44	Filterra 4	Dupuy Avenue Parking Lot	37.2418587443094	-77.41615683	Water Quality	0.28	0.04	0.24	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 45	Extended Detention Pond	North side of River Rd., next to Fleets Branch	37.244275	-77.420233	Water Quality	12.30			06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 46	Extended Detention Pond	Next to Multi Purpose Center, along 3rd Ave.	37.239210	-77.4227	Water Quality	32.00	11.56	20.44	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 47	Contech Stormfilter 1	College Ave. Parking Lot #28	37.241705	-77.419085	Water Quality	24.25	15.8	8.45	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 48	Contech Stormfilter	Dining & Events Center	37.2420288294099	-77.41785236	Water Quality	2.48	0.91	1.57	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 49	Contech Stormfilter	Dining & Events Center	37.2420927893217	-77.4184813	Water Quality	4.45	1.66	2.79	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-
BMP 50	Contech Underground Storage Vault	Dining & Events Center	37.2419740066283	-77.41813866	Water Quantity	0.00	0.00	0.00	06/01/2016	JA40	Appomattox River	Owner-Operated	N/A	-

APPENDIX C

Worksheet 1
Page 1 of 3

Step 1 **Determine the applicable area (A) and the planned-developed impervious cover ($I_{planned}$)**

Applicable area (A)*= 258.05 acres

planned-development impervious cover:

structures = 0 acres

parking lot = 0 acres

roadway = 0 acres

other = 94.51 acres

Total = 94.51 acres

I planned = (total planned-development impervious cover / A) x 37 %

Step 2 **Determine the average land cover condition ($I_{watershed}$) OR the existing impervious cover ($I_{existing}$).**

If the locality has determined land cover conditions for individual watershed within its jurisdiction, use the watershed specific value determined by the locality as I watershed.

_____ %

Otherwise, use the Chesapeake Bay default value.

16 %

Worksheet 1

Existing impervious cover ($I_{existing}$):

Determine the existing impervious cover of the development site if present:

structures = 24.19 acres

parking lot = 28.1 acres

roadway = 16.9 acres

other = 15.25 acres

Total = 84.44 acres

$I_{existing}$ = (total existing impervious cover / A*) x 100 = 33 %

* The area should be the same as used in Step 1.

Step 3 **Determine the appropriate development situation.**

The site information determined in STEP 1 and STEP 2 provide enough information to determine the appropriate development situation under which the performance criteria will apply. Check (X) the appropriate development situation as follows:

_____ **Situation 1:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is less than or equal to the average land cover condition ($I_{watershed}$) and the proposed improvements will create a total percent impervious cover ($I_{planned}$) which is less than or equal to the average land cover condition ($I_{watershed}$)

I planned 37 % ≤ I watershed 16 %

Worksheet 1
Page 3 of 3

_____ **Situation 2:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is less than or equal to the average land cover condition ($I_{watershed}$) and the proposed improvements will create a total percent impervious cover ($I_{planned}$) which is greater than the average land cover condition ($I_{watershed}$).

$I_{existing}$	33	%	≤	$I_{watershed}$	16	% **AND**
I planned	37	%	>	$I_{watershed}$	16	%

_____ **Situation 3:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is greater than the average land cover condition ($I_{watershed}$).

$I_{existing}$	33	%	>	$I_{watershed}$	16	%

X **Situation 4:** This consists of land development where the existing percent impervious cover ($I_{existing}$) is served by an existing storm water management BMP(s) that address(es) water quality.

If the proposed development meets the criteria for development Situation 1, then the low density development is considered to be the BMP and no pollutant removal is required. The calculation procedure for Situation 1 stops here. If the proposed development meets the criteria for development Situations 2 , 3, or 4, then proceed to STEP 4 on the appropriate worksheet.

Worksheet 4 : Situation 4
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Applicable area (A) = 258.05 acres

$I_{planned}$ = (total planned-development impervious cover / A) x 100 = 37 %

$I_{watershed}$ = _____ % **OR** $I_{watershed}$ = 16 %

$I_{existing}$ = (total existing impervious cover / A*) x 100 = 33 %

$I_{existing}$ = 33 % > $I_{watershed}$ = 16 %

Existing BMP drainage area ($A_{existBMP}$) = 42.36 acres

$I_{pre(BMP)}$ = (total pre-development impervious cover / $A_{existBMP}$) x 100 = 64 %

$EFF_{existBMP}$ = documented pollutant removal efficiency of existing BMP (in decimal form)

Step 4 Determine the relative pre-development pollutant load (L_{pre})

1. Pre-development pollutant load based on the existing impervious cover:

$L_{pre(existing)} = [0.05 + (0.009 \times I_{existing})] \times A \times 2.28$ (Equation 5-17)

where: $L_{pre(existing)}$ = relative pre-development total phosphorous load (pounds per year)
$I_{(existing)}$ = existing site impervious cover (percent expressed in whole numbers)
A = applicable area (acres)

$L_{pre(existing)} = [0.05 + (0.009 \times 33)] \times 258.05 \times 2.28$

= 202.69 pounds per year

Worksheet 4 : Situation 4

2. Calculate pre-development pollutant load to existing BMP:

$$L_{pre(BMP)} = [0.05 + (0.009 \times I_{pre(bmp)})] \times A_{existBMP} \times 2.28 \quad \text{(Equation 5-18)}$$

where:
$L_{pre(BMP)}$ = relative pre-development total phosphorous load to existing BMP (in pounds per year)
$I_{pre(BMP)}$ = existing impervious cover to existing BMP (percent expressed in whole numbers)
$A_{existBMP}$ = drainage area of existing BMP (acres)

$L_{pre(BMP)} = [0.05 + (0.009 \times \underline{64}\ )] \times \underline{42.36} \times 2.28$

$= \underline{60.03}$ pounds per year

3. Calculate pre-development pollutant load removed by existing BMP:

$$L_{removed(existingBMP)} = L_{pre(BMP)} \times EFF_{existBMP} \quad \textbf{(Equation 5-19)}$$

where:
$L_{removed(existingBMP)}$ = relative pre-development total phosphorous load removed by existing BMP (pounds per year)
$L_{pre(BMP)}$ = relative pre-development total phosphorous load entering existing BMP, **Equation 5-18** (pounds per year)
$EFF_{existBMP}$ = documented pollutant removal efficiency of existing BMP (expressed in decimal form)

$L_{removed(existingBMP)} = \underline{60.03} \times \underline{0.62}$

$= \underline{37.16}$ pounds per year

Steps 2 and 3 are repeated for each existing BMP on the site.

$L_{pre(BMP1-6)}$ =	0.89	$L_{removed(existingBMP1-6)}$ =	0.58
$L_{pre(BMP7-13)}$ =	4.08	$L_{removed(existingBMP7-13)}$ =	2.65
$L_{pre(BMP16-21)}$ =	3.36	$L_{removed(existingBMP16-21)}$ =	2.18
$L_{pre(BMP22)}$ =	0.26	$L_{removed(existingBMP22)}$ =	0.17
$L_{pre(BMP23)}$ =	0.85	$L_{removed(existingBMP23)}$ =	0.55
$L_{pre(BMP27)}$ =	1.92	$L_{removed(existingBMP27)}$ =	1.25
$L_{pre(BMP29)}$ =	9.90	$L_{removed(existingBMP29)}$ =	4.95
$L_{pre(BMP30)}$ =	24.66	$L_{removed(existingBMP30)}$ =	16.03

Worksheet 4 : Situation 4

$L_{pre(BMP31)}$	=	1.88	$L_{removed(existingBMP31)}$	=	1.22
$L_{pre(BMP32)}$	=	0.80	$L_{removed(existingBMP32)}$	=	0.40
$L_{pre(BMP33)}$	=	0.78	$L_{removed(existingBMP33)}$	=	0.39
$L_{pre(BMP34)}$	=	0.91	$L_{removed(existingBMP34)}$	=	0.46
$L_{pre(BMP48-49)}$	=	9.74	$L_{removed(existingBMP48-49)}$	=	6.33
				total=	**37.16**

4. Calculate the pre-development pollutant load while being served by existing BMP(S):

$$L_{pre(existingBMP)} = L_{pre(existing)} - (L_{removed(existingBMP1)} + L_{removed(existingBMP2)} + ...)$$

Equation 5-20

where: $L_{pre(existingBMP)}$ = relative pre-development total phosphorous load while being served by an existing BMP (pounds per year)

$L_{pre(existing)}$ = relative pre-development total phosphorous load based on existing site conditions, **Equations 5-17** (pounds per year)

$EFF_{existBMP}$ = relative pre-development total phosphorous load based on existing (expressed in decimal form)

$L_{removed(existingBMP)}$ = relative pre-development total phosphorous load removed by existing BMP, **Equation 5-19** (pounds per year)

$L_{pre(existingBMP)}$ = 202.69 - (0.58 + 2.65 +…)

= 165.53 pounds per year

Step 5 Determine the relative planned-development pollutant load (Lplanned).

$$L_{planned} = [0.05 + (0.009 \times I_{planned})] \times A \times 2.28$$ **(Equation 5-21)**

where: $L_{planned}$ = relative planned-development total phosphorous load (pounds per year)

$I_{planned}$ = planned-development percent impervious cover (% in whole numbers)

A = applicable area (acres)

$L_{planned}$ = [0.05 + (0.009 x 37)] x 258.05 x 2.28

= 223.35 pounds per year

Step 6 Determine the relative pollutant removal requirement (RR).

RR = $L_{planned} - L_{pre(existingBMP)}$

= 223.35 - 165.53

RR = 57.82 pounds per year

Worksheet 4 : Situation 4
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2. Pre-development pollutant load based on the average land cover condition:

$L_{pre(watershed)} = [0.05 + (0.009 \times I_{watershed})] \times A \times 2.28$ **(Equation 5-16)**

where: $L_{pre(watershed)}$ = relative pre-development total phosphorous load (pounds per year)
$I_{watershed}$ = average land cover condition for specific watershed or locality or the Chesapeake Bay default value of 16% (percent expressed in whole numbers)
A = applicable area (acres)

$L_{pre(watershed)} = [0.05 + (0.009 \times \underline{16}\ )] \times \underline{258.05} \times 2.28$

$= \underline{114.14}$ pounds per year

STEP 7 Identify best management practice (BMP) for the site.

1. Determine the required pollutant removal efficiency for the site:

EFF = $(RR / L_{planned}) \times 100$ **(Equation 5-22)**

where: EFF = required pollutant removal efficiency (% in whole numbers)
RR = pollutant removal requirement (pounds per year)
$L_{planned}$ = relative planned-development total phosphorous load (pounds per year)

EFF $= (\ \underline{57.82}\ /\ \underline{223.35}\ ) \times 100$

$= \underline{25.89}$ %

2. Select BMP(s) from **Table 5-15** and locate on the site:

BMP 1:	Contech Stormfilter - University Bookstore (BMP 35)
BMP 2:	Contech Stormfilter - College Ave. Parking Lot #28 (BMP 47)
BMP 3:	Filterra's - Dupuy Avenue Parking Lot (BMP 41-44)
BMP 4:	Extended Detention Pond - Multi-Purpose Center (BMP 46)

Worksheet 4 : Situation 4

3. Determine the pollutant load entering the proposed BMP(s):

L_{BMP} = [0.05 + (0.009 x I_{BMP})] x A x 2.28 **(Equation 5-23)**

where:
L_{BMP} = relative planned-development total phosphorous load entering proposed BMP (pounds per year)
I_{BMP} = planned-development percent impervious cover of BMP drainage area (percent expressed in whole numbers)
A = drainage area of proposed BMP (acres)

L_{BMP1} = [0.05 + (0.009 x 90)] x 0.10 x2.28

= 0.20 pounds per year

L_{BMP2} = [0.05 + (0.009 x 35)] x 24.25 x2.28

= 20.10 pounds per year

L_{BMP3} = [0.05 + (0.009 x 83)] x 1.75 x2.28

= 3.17 pounds per year

L_{BMP4} = [0.05 + (0.009 x 64)] x 32.00 x2.28

= 45.59 pounds per year

4. Calculate the pollutant load removed by the proposed BMP(s):

$L_{removed}$ = Eff_{BMP} x L_{BMP} **(Equation 5-24)**

where:
$L_{removed}$ = planned-development pollutant load removed by proposed BMP (pounds per year)
Eff_{BMP} = pollutant removal efficiency of BMP (expressed in decimal form)
L_{BMP} = relative planned-development total phosphorous load entering proposed BMP (pounds per year)

$L_{removed/BMP1}$ = 0.65 x 0.20 = 0.13 pounds per year

$L_{removed/BMP2}$ = 0.65 x 20.10 = 13.07 pounds per year

$L_{removed/BMP3}$ = 0.65 x 3.17 = 2.06 pounds per year

$L_{removed/BMP4}$ = 0.65 x 45.59 = 29.63 pounds per year

Worksheet 4 : Situation 4

5. Calculate the total pollutant load removed by the existing and proposed BMP(s):

$$L_{\mathbf{removed/total}} = L_{removed/BMP1} + L_{removed/BMP2} + L_{removed/BMP3} + \ldots + L_{removed(existingBMP1)} + L_{removed(existingBMP2)} + L_{removed(existingBMP3)}$$

(Equation 5-25)

where:

$L_{removed/total}$ = **total** pollutant load removed by proposed BMPs

$L_{removed/BMP1}$ = pollutant load removed by proposed BMP No. 1, **Equation 5-24**

$L_{removed/BMP2}$ = pollutant load removed by proposed BMP No. 2, **Equation 5-24**

$L_{removed/BMP3}$ = pollutant load removed by proposed BMP No. 3, **Equation 5-24**

$L_{removed/BMP4}$ = pollutant load removed by proposed BMP No. 4, **Equation 5-24**

$L_{removed(existingBMP1)}$ = pollutant load removed by existing BMP No. 1, **Equation 5-19**

$L_{removed(existingBMP2)}$ = pollutant load removed by existing BMP No. 2, **Equation 5-19**

$L_{removed(existingBMP3)}$ = pollutant load removed by existing BMP No. 3, **Equation 5-19**

$L_{removed(existingBMP4)}$ = pollutant load removed by existing BMP No. 4, **Equation 5-19**

$$L_{\mathbf{removed/total}} = \frac{0.13}{29.63} + \frac{13.07}{37.16} + \frac{2.06}{} +$$

$$= 82.05 \text{ pounds per year}$$

6. Verify Compliance:

$$L_{\mathbf{removed/total}} \geq \mathbf{RR}$$

$$82.05 \geq 57.82$$

APPENDIX D

APPENDIX D. CHESAPEAKE BAY TMDL CREDITS

ID	BMP Type	Total Area Treated (Ac.)	Pervious Area Treated (Ac.)	Impervious Area Treated (Ac.)	Percent Impervious (%)	TP Load (lb/yr)	TN Load (lb/yr)	TN Removal Efficiency (%)	TN Reduction (lbs TN/yr)	TN Credit (lb/yr)	TSS Load (lb/yr)	TSS Removal Efficiency (%)	TSS Reduction (lbs TSS/yr)	TSS Credit (lb/yr)
						Performance Based Water Quality Calculations	TN loading rate * TP conversion (5.2 lbs/acre)	Virginia Clearinghouse Efficiency	TN load * BMP Efficiency	TN Reduction * Excess Removal Credit (30%)	TSS loading rate * TP conversion (420.9 lbs/acre)	Table V.C.1 CBP BMP Established Efficiencies	TSS load * BMP Efficiency	TSS Reduction * Excess Removal Credit (30%)
BMP 01	Roof Filterra 1*	0.07	0.00	0.07	100	0.15	0.79	34	0.27	0.08	63.82	80	51.05	15.32
BMP 02	Roof Filterra 2*	0.04	0.00	0.04	100	0.09	0.45	34	0.15	0.05	36.47	80	29.17	8.75
BMP 03	Roof Filterra 3*	0.07	0.00	0.07	100	0.15	0.79	34	0.27	0.08	63.82	80	51.05	15.32
BMP 04	Roof Filterra 4*	0.11	0.00	0.11	100	0.24	1.24	34	0.42	0.13	100.28	80	80.23	24.07
BMP 05	Roof Filterra 5*	0.05	0.00	0.05	100	0.11	0.56	34	0.19	0.06	45.58	80	36.47	10.94
BMP 06	Roof Filterra 6*	0.07	0.00	0.07	100	0.15	0.79	34	0.27	0.08	63.82	80	51.05	15.32
BMP 07	Filterra 1*	0.22	0.04	0.18	82	0.39	2.05	34	0.70	0.21	166.02	80	132.82	39.84
BMP 08	Filterra 2*	0.38	0.03	0.35	92	0.76	3.96	34	1.35	0.40	320.52	80	256.42	76.93
BMP 09	Filterra 3*	0.40	0.02	0.38	95	0.83	4.29	34	1.46	0.44	347.39	80	277.92	83.37
BMP 10	Filterra 4*	0.34	0.03	0.31	91	0.67	3.51	34	1.19	0.36	284.06	80	227.25	68.17
BMP 11	Filterra 5*	0.35	0.02	0.33	94	0.72	3.73	34	1.27	0.38	301.81	80	241.45	72.43
BMP 12	Filterra 6*	0.23	0.03	0.20	87	0.44	2.27	34	0.77	0.23	183.77	80	147.02	44.11
BMP 13	Filterra 7*	0.18	0.06	0.12	67	0.27	1.39	34	0.47	0.14	112.28	80	89.82	26.95
BMP 16	Roof Filterra 1*	0.50	0.00	0.50	100	1.08	5.63	34	1.91	0.57	455.83	80	364.67	109.40
BMP 17	Roof Filterra 2*	0.50	0.00	0.50	100	1.08	5.63	34	1.91	0.57	455.83	80	364.67	109.40
BMP 18	Roof Filterra 3*	0.12	0.00	0.12	100	0.26	1.35	34	0.46	0.14	109.40	80	87.52	26.26
BMP 19	Roof Filterra 4*	0.09	0.00	0.09	100	0.19	1.01	34	0.34	0.10	82.05	80	65.64	19.69
BMP 20	Roof Filterra 5*	0.08	0.00	0.08	100	0.17	0.90	34	0.31	0.09	72.93	80	58.35	17.50
BMP 21	Roof Filterra 6*	0.27	0.01	0.26	96	0.56	2.93	34	1.00	0.30	237.51	80	190.01	57.00
BMP 22	Contech Stormfilter 1	0.14	0.02	0.12	86	0.26	1.36	30	0.41	0.12	110.36	80	88.29	26.49
BMP 23	Contech Stormfilter 2	0.46	0.07	0.39	85	0.85	4.43	30	1.33	0.40	358.91	80	287.13	86.14
BMP 27	Underground Detention Chamber w/ Sand Filters	1.90	1.07	0.83	44	1.92	9.98	30	2.99	0.90	808.03	80	646.42	193.93
BMP 29	Extended Detention Basin	5.49	0.97	4.52	82	9.90	51.48	10	5.15	1.54	4167.29	60	2500.37	750.11
BMP 30	Retention Basin Type III	20.99	10.14	10.85	52	24.66	128.22	30	38.47	11.54	10378.16	60	6226.89	1868.07
BMP 31	Delaware Sand Filter	1.17	0.32	0.85	73	1.88	9.76	30	2.93	0.88	790.27	80	632.22	189.67
BMP 32	Sorbtive Filter 2C	0.38	0.01	0.37	97	0.80	4.17	30	1.25	0.38	337.80	80	270.24	81.07
BMP 33	Sorbtive Filter 1C	0.39	0.03	0.36	92	0.78	4.07	30	1.22	0.37	329.64	80	263.71	79.11
BMP 34	Sorbtive Filter 10C	0.44	0.02	0.42	95	0.91	4.74	30	1.42	0.43	383.86	80	307.09	92.13
BMP 35	Contech Stormfilter	0.10	0.01	0.09	90	0.20	1.02	30	0.31	0.09	82.53	80	66.02	19.81
BMP 41	Filterra 1*	0.53	0.08	0.45	85	0.98	5.12	34	1.74	0.52	414.09	80	331.27	99.38
BMP 42	Filterra 2*	0.47	0.15	0.32	68	0.71	3.69	34	1.26	0.38	298.93	80	239.15	71.74
BMP 43	Filterra 3*	0.47	0.03	0.44	94	0.96	4.97	34	1.69	0.51	402.57	80	322.06	96.62
BMP 44	Filterra 4*	0.28	0.04	0.24	86	0.52	2.73	34	0.93	0.28	220.72	80	176.58	52.97
BMP 46	Extended Detention Pond	32.00	11.56	20.44	64	45.59	237.07	10	23.71	7.11	19189.20	60	11513.52	3454.06
BMP 47	Contech Stormfilter 1	24.25	15.80	8.45	35	20.10	104.54	30	31.36	9.41	8461.73	80	6769.39	2030.82
BMP 48	Contech Stormfilter	2.48	0.91	1.57	63	3.50	18.22	30	5.47	1.64	1474.99	80	1179.99	354.00
BMP 49	Contech Stormfilter	4.45	1.66	2.79	63	6.23	32.41	30	9.72	2.92	2623.21	80	2098.57	629.57
TOTALS		100.46	43.13	57.33		129.09	671.29		146.07	43.82	54,335.50		36,721.47	11,016.44

*Total nitrogen (TN) removal efficiency is not provided in Virginia Clearinghouse. Refer to manufactures website for removal performance. http://www.conteches.com/products/stormwater-management/biofiltration-bioretention/filterra