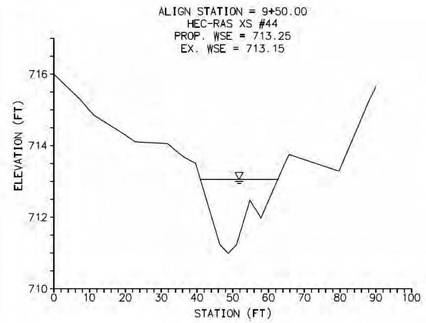

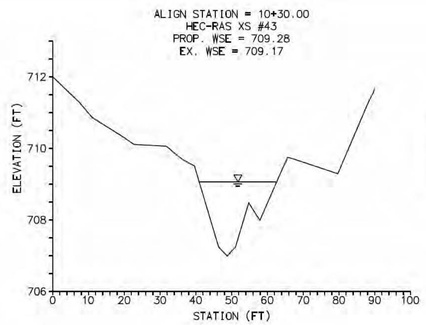

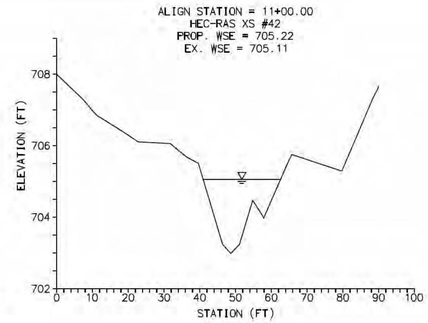

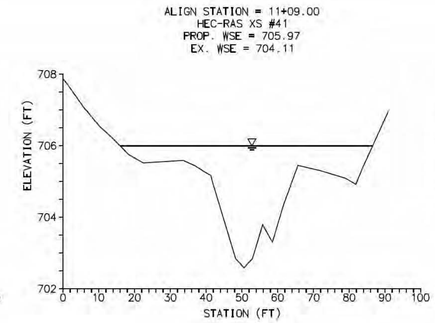

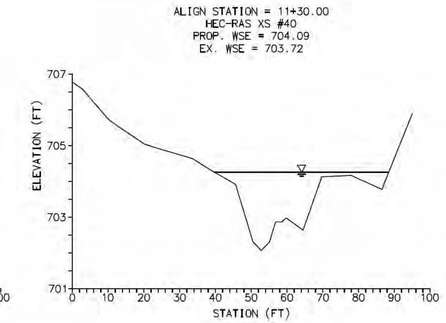

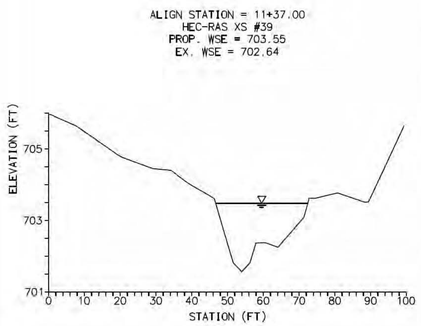

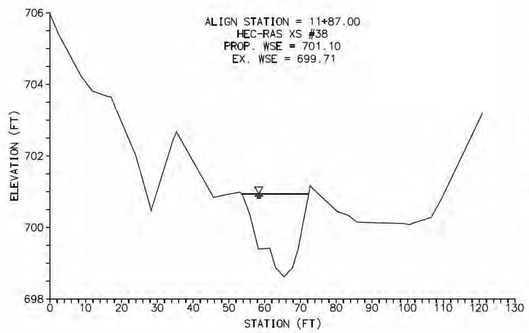

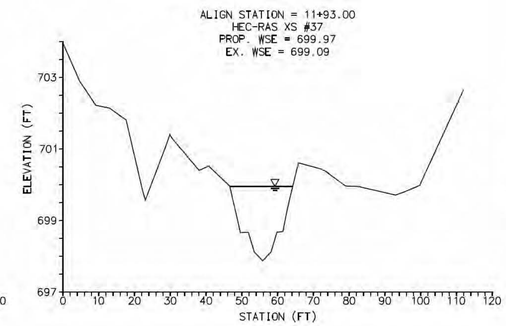

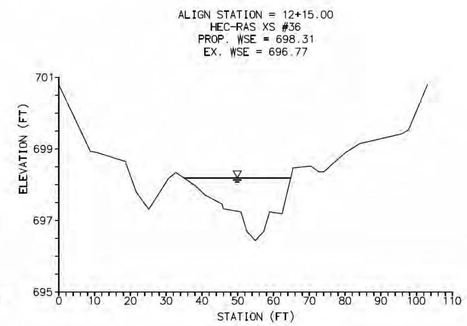

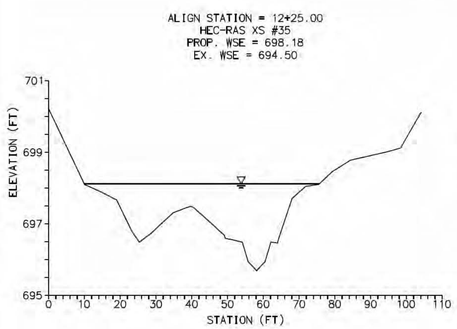

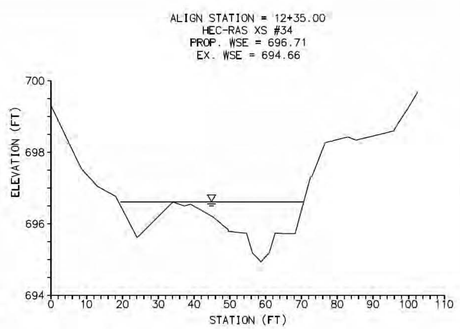

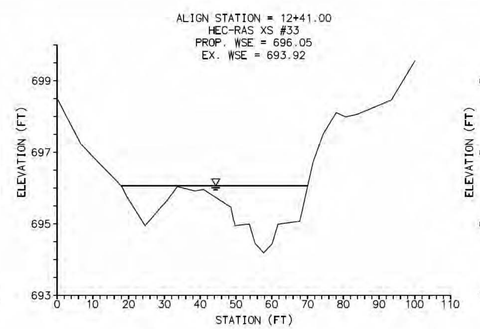

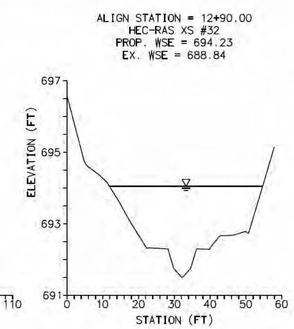

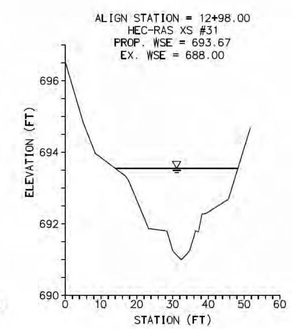

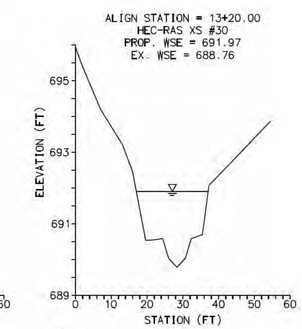

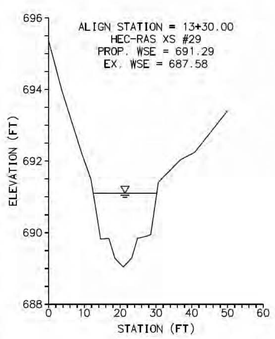

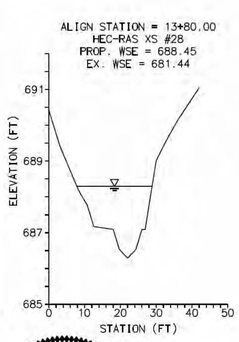

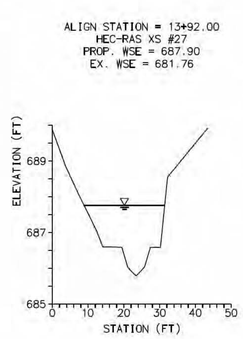

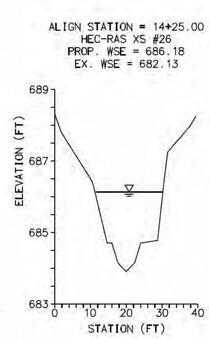

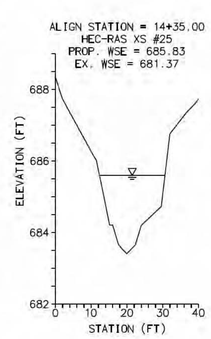

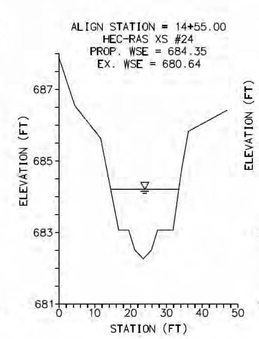

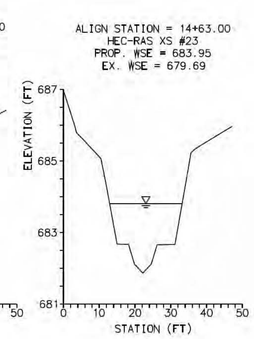

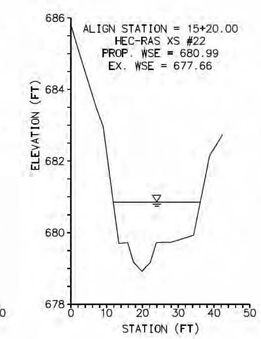

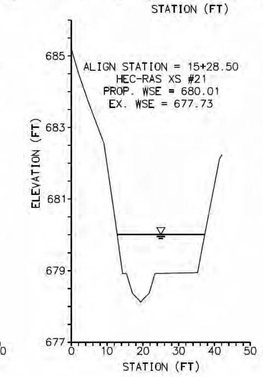

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DESIGNED NAS
DRAWN NAS
CHECKED FRG
APPROVED

NO.	DATE	APPD	REVISION

SCALE
H: 1"=20'
V: 1"= 2'

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

CIVIL

FLOODPLAIN CROSS SECTIONS

FILE NAME 100-YEAR FLOODPLAIN ANALYSIS
DWG BC14
SHEET 16 OF 35
DATE OCTOBER 2016 REV 0

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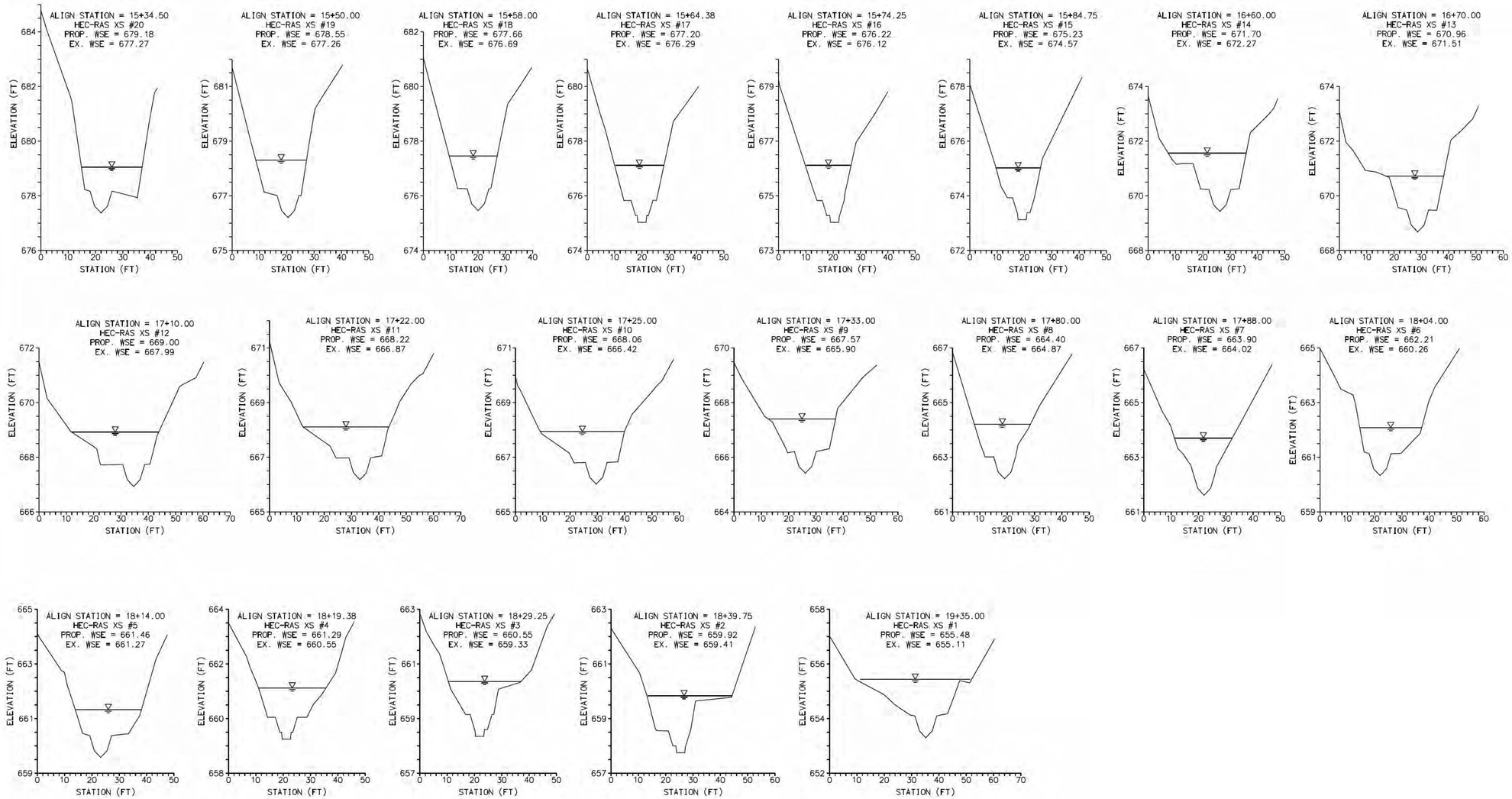

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CIVIL

FLOODPLAIN CROSS SECTIONS (CONT'D)

FILE NAME 100-YEAR FLOODPLAIN ANALYSIS
DWG B15
SHEET 17 OF 35
DATE OCTOBER 2016
REV 0

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Design Narrative

I. Background

The restoration philosophy of Natural Channel Design (NCD) was utilized in the development of the Blackwater Creek Tributary Stream Restoration plans. As the name implies, the goal of NCD is to restore a degraded stream by mimicking, as much as possible, the characteristics of a stable, "natural" system. Through the use of fluvial geomorphic principles, NCD seeks to achieve long-term stability given current, as well as future flow rates.

When developing a NCD design it is imperative to analyze the hydrology and geomorphology of the given stream system in the context of the channel forming (or bankfull) flow event. Research by the United States Geologic Survey (USGS), Wolman, et al. (1964) and Rosgen (2006) has shown that the recurrence interval for the channel forming flow event typically ranges from 0.8 years to 1.5 years in most systems (with urban systems being at the lower end of this range). The lack of available hydrologic data for small urban systems contributes to considerable uncertainty in the application of published USGS regional curve data to these streams. Similar uncertainty exists about the validity of flow rates generated from the application of widely accepted hydrologic models (HEC-HMS, etc.) using standard precipitation events (NRCS, type II, 24-hr) in the context of NCD. Given these uncertainties, Wetland Studies and Solutions, Inc., over the past decade, has analyzed and applied data from a variety of sources and carefully tracked restoration success through rigorous monitoring criteria for numerous stream restoration projects. The results of these efforts have shown application of the USGS regional curves, adjusted for local watershed conditions, to be a validrea approach in determining the magnitude of the design flow event. Further information on the development of the Blackwater Creek Tributary Stream Restoration design protocol is discussed below, along with a discussion of how restorations employing elements of NCD are in compliance with state law.

II. Regulatory Compliance

NCD is the preferred design methodology for the Virginia Department of Environmental Quality (DEQ) and the U.S. Army Corps of Engineers (COE). The 2005 state legislature revised state law to stipulate that any stream restoration project that is designed in accordance with NCD principles is exempt from the requirements of MS 19 (Code of Virginia, § 10.1-560 and 10.1-561) as well as any related local requirements. Additionally, on March 16, 2007, DEQ published its proposed Section 401 Water Quality Certification Conditions for Nationwide Permit (NWP) #27 (Stream and Wetland Restoration Activities) requiring that natural stream design be used for stream restoration. Therefore, the flow rates used for this project were developed using NCD methodologies, not traditional modeling techniques.

III. Published Data

In the process of determining a design protocol, a review of work performed by others was conducted. This included review and consideration of published regional curves as well as reports on urbanization and how it can result in downstream channel enlargement. Published regional curve data is shown in Figure 1. Additional supporting information including aerials, subwatershed breakdowns, impervious cover, and FEMA DFIRM information are depicted in Figures 3-8. Specific information reviewed as part of this analysis included the following:

Virginia Piedmont Regional Curve Data

The U.S. Geological Survey published regional curves for non-urban streams in the Piedmont physiographic province of Virginia. These regional curves were developed from streams located throughout the Piedmont of Virginia with watersheds that contain, on average, 3.9% urban area. Urban area is not explicitly defined and a correlation between urban area and impervious area is not given. For the purposes of this analysis, urban areas will be assumed to contain 50% impervious area. Thus, the VA data set is estimated to include watersheds with an average imperviousness of 2%. A plot of the VA regional curve is included in Figure 1.

North Carolina Piedmont Regional Curve Data

This data includes bankfull hydraulic geometry relationships for both "urban" and "rural" streams. The streams defined as "urban" averaged 41% impervious area and those classified as "rural" contained less than 10%. Land use in the 36-acre Blackwater Creek tributary watershed consists of an impervious cover of 12%. This would be considered low density urban development according to the North Carolina data. Plots of the NC regional curves are included in Figure 1.

Eastern United States Regional Curve Data

Regional curve information developed from streams in the eastern portion of the United States (Figure 1) is presented in reference documents published by Dave Rosgen of Wildland Hydrology Consultants. The origin of the study or detailed information on the streams, including the imperviousness of their contributing watersheds, is not provided.

Maryland Piedmont Regional Curve Data

The U.S. Fish and Wildlife Service published a report on Maryland piedmont streams that presents regional curve information (Figure 1). Given that Lynchburg lies in the same physiographic province (Piedmont), the MD data is considered to be applicable. Note the average impervious area of the contributing watersheds in this study is approximately 8% (and thus is classified as "rural").

Dynamics of Urban Stream Channel Enlargement

The Center for Watershed Protection published a report on the impact of watershed development on channel enlargement. This study showed and experience confirms that channels enlarge in response to increased runoff volumes, peak rates, and increased frequencies resulting from development of a watershed. Based on the study, it is estimated that ultimate channel enlargement can take 50-75 yrs from the time the watershed is fully developed. A plot depicting the ultimate channel size vs. watershed impervious area is presented in the article and in Figure 2. Based on the impervious area for the Blackwater Creek tributary of 12%, visually depicted in Figure 7, the resulting enlargement factor would be approximately 1.5.

IV. 100-yr Floodplain Analysis

A FEMA Flood Insurance Rate Map (Figure 8) is included on the Hydrologic Model Data Sheet. The tributary subject to the analysis and design of stream restoration measures does not lie within a FEMA regulated Special Flood Hazard Area (SFHA). However, work associated with restoration/retrofitting of the existing stormwater management facility at the downstream end of the stream project area lies within a mapped Zone X SFHA. Though not within a FEMA regulated floodplain, a 100-yr floodplain analysis was performed to compare pre- and post-restoration 100-yr water surface elevations for the stream restoration design reach to ensure that adjacent properties will not be adversely impacted by restoration efforts.

HEC-HMS software was used to develop a hydrologic model. The model was run using the SCS curve number peak runoff method with the curve number derived from TR-55 land use data (See Figure XX). The SCS Type II storm was applied and results generated for the 1, 2, and 100-yr storm events using NOAA Atlas 14 rainfall data for Lynchburg, Virginia. Predicted flow rates from the HEC-HMS model were: 1-yr = 39 cfs, 2-yr = 53 cfs, and 100-yr = 205 cfs. The 2- & 100-yr flow rates were then used in development of a HEC-RAC hydraulic model for assessing existing versus proposed floodplain elevations and overbank flow velocities. Flow was modeled under mixed flow conditions and normal depth applied as the upstream and downstream boundary conditions. The existing conditions model was created using cross-sections sampled from the 6-inch contour interval topography supplemented by thalweg and top of bank points via traditional survey. Results of the existing model were compared to those of a proposed conditions model which utilized proposed grading surface data. Results of this modeling effort showed no adverse impacts to adjacent property owners. In addition, overbank flow velocities were found to be non-erosive for anticipated vegetative cover conditions. (See floodplain sheets for additional information.)

V. Reference Reach Data

An important component of the NCD process is the collection and use of reference reach data to aid in design of the restoration channel. WSSI personnel have studied numerous reference reach streams in the mid-Atlantic region to develop a reference reach database. Design engineers apply this data to each of our Natural Channel Design projects to ensure that each design mimics natural channel characteristics seen in similar undisturbed streams from the same eco-region and geomorphologic setting to the maximum extent practicable.

VI. Discussion

As outlined above, several methods exist for sizing channels associated with stream restoration projects. Considering the available alternatives and applying good engineering judgment, a reasonable design methodology has been developed for use in the Blackwater Creek tributary design. A discussion on each contributing component is provided below, along with the resulting design protocol employed for the design reach.

Regional Curves and Urban Channel Enlargement Factor

It is evident that use of the regional curves developed for rural VA and MD streams would result in channels that are significantly undersized due to the rural data set used in developing these curves. The suburban watershed (12% imperviousness) of the design reach experiences higher flow rates than the streams in comparably sized, primarily rural, watersheds represented by the curves.

In regards to the effects of urbanization, the published regional curves tell a consistent story. As depicted in Figure 1 (representing cross-sectional area to drainage area), the rural curves plot well below the urban NC curve. However, application of the Urban Channel Enlargement Factor to the MD rural curve results in an adjusted curve which closely matches the findings presented by the NC urban curve. (e.g. The NC urban curve was developed from watersheds with 41% impervious area, which results in an enlargement factor of 4.0 from Figure 2. This factor of 4.0 was applied to the MD rural curve.) This further validates application of the enlargement factor for properly sizing channels in urban watersheds throughout the Piedmont physiographic province of mid-Atlantic states. However, it is important to note that Virginia data is more rural in nature than both the MD and NC data, and application of the enlargement factor to the Virginia data set is anticipated to slightly underestimate channel size since a greater differential exists between the rural (2% imperviousness) data set and projected urban conditions. For this reason, a sensitivity analysis was performed during channel sizing procedures to assess a range of flow rates in order to assess and adjust for site specific conditions.

VII. Blackwater Creek Tributary Design Protocol

Ultimate Channel Size

The ultimate size of the restored channel for the Blackwater Creek tributary project area was determined by applying an enlargement factor correction to the VA Piedmont regional curve for cross sectional area (CSA). The enlargement factor from Figure 2 for a 12% watershed imperviousness is 1.5. Applying this to the VA Piedmont curve for a 0.057 sq. mi. (36.3 ac) drainage area yields a bankfull CSA of **1.8 sq. ft**. (Note: The Virginia Piedmont regional curve is roughly half that of the analogous Maryland curve. This is likely due to the higher imperviousness in the watersheds of the Maryland data set and must be considered when applying the enlargement factor.) Using this CSA, the Manning's open channel flow equation can be back-solved for discharge, resulting in a predicted bankfull discharge of approximately **5 cfs.** This regional curve-derived flow rate was then compared against the 1-year recurrence interval storm peak discharge of 39 cfs as predicted by the HEC-HMS model.

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Our experience and monitoring data on similar-sized urban streams and watersheds has shown that these channels experience short duration overbank events more frequently than is typically indicated by regional curve analysis. This is due in large part to peak flow events being more dependent upon rainfall intensity than rainfall volume. That is, small urban channels experience bankfull events during short, intense thunderstorms due to the flashy nature of urban hydrology; an effect that is magnified in smaller watersheds. Experience has also shown that flow rates predicted by watershed models like HMS tend to significantly over-predict flow rates for smaller frequent storm events. Hydrologic results for the design reach are consistent with these past results and HMS 1-yr flows are used for relative comparison only.

The prediction of design discharge in small watersheds is difficult due to the low flow rates and resulting high percentage error among flow predictions methodologies.Small changes in modeling variables or watershed analysis results can have a significant impact on predicted flow rates. For this reason it is important to consider a range of discharges in determining the design channel size. Therefore, channel sizing for the project area was based on an iterative process in which flow rate was varied from **5 - 15 cfs**. Channel dimensions (width and depth) were adjusted at each flow rate in order to determine the optimum bankfull channel size while maintaining consistency with dimensionless ratios seen in relevant reference reach data and considering all relevant constraints (tree impacts, overbank flooding, sewer laterals, culvert crossings, depth to bedrock, trails and bridges, reference data criteria, access and property rights, etc.). The results of this process found channel dimensions to vary from **6 to 8** feet in **width** and **0.6 to 0.8** feet in **depth.**

Stream restoration using Natural Channel Design aims to restore lost hydrologic and ecologic function while maintaining a stable channel in which sediment transport is balanced. Undersizing the channel may result in instability associated with excessive overbank flooding and floodplain instability. Conversely, an oversized channel will create excessive in-channel stresses reducing channel stability and ecological function gained through good floodplain connectivity. Thus, local site conditions must factor in to design decisions (e.g. flooding of adjacent infrastructure, excessive transport of bed material) in order to determine whether a "conservative" design is one which leans toward a smaller or larger channel.

Channel Substrate and Sediment Transport

A stream restoration design must consider sediment (both its source and the channel's competency). If sediment is ignored, or not properly evaluated, the restored channel will be out of balance and could aggrade or degrade resulting in channel instability. For the Blackwater Creek tributary stream, the majority of the sediment in the system is supplied from channel bed and bank erosion. Due to the urban (piped) nature of the contributing watershed very little sediment is contributed through overland runoff, a scenario commonly referred to as "sediment-starved". The sediment that is supplied is small-grained - thus providing adequate sediment transport to avoid aggradation is not a concern for this design. In fact, since stabilization of the bed and banks will drastically reduce the available in-stream sediment supply, preventing mobilization of the substrate material is the key concern. Achieving this goal with the in-situ substrate materials is not possible given the fine nature of the existing substrate and the steep nature of the subject stream valley (see the Particle Size and Shear Stress Analysis sheet for additional information). Therefore, a design must be employed in which movement of the channel boundary is minimal - commonly referred to as a "threshold" design or a rigid boundary system. Threshold design is predicated on the placement of carefully sized reinforced bed material and/or in-stream grade control structures (built with large rock) in order to achieve long-term stability. Reinforced bed material must contain an armor portion (rock) which allows for creation of a rigid boundary, while also including a mixture of finer particles which support the end goal of a densely vegetated riparian corridor.

Note that overbank velocities were evaluated in the HEC-RAS hydraulic model and found to be non-erosive. Thus, establishment of a dense riparian corridor will be effective in maintaining floodplain stability (see Floodplain Data sheets for additional information).

VIII. Design Recommendations

When designing a stream channel based on the principles of threshold design, substrate sizing, as much as channel sizing, becomes a critical element. Substrate must be sized to resist movement, yet allow for vegetative establishment and natural sorting to create bed habitat variation. Channel sizing should focus on minimizing channel stresses by improving floodplain connectivity while ensuring overbank velocities will not result in floodplain erosion. Channel sizing must also make provision for maintaining relationships for width and depth consistent with regional curves and reference reach data, while minimizing impacts to surrounding infrastructure and high-value riparian vegetation (mature trees). Recommendations for channel sizing and bed material sizing are presented in Table 1 and Table 2, respectively.

TABLE 1. CHANNEL SIZING RECOMMENDATIONS

	$WIDTH_{BKF}$ (FT)	$DEPTH_{BKF}$ (FT)
REACH 1	7	0.6

TABLE 2. REINFORCED BED MATERIAL SIZING

MATERIAL	SIZE (D_{50})	PORTION	PERCENT (%)
ROCK[2]	6.7 in (277 mm)	2 BUCKETS	35 - 40%
BANK RUN[3] GRAVEL	0.08 - 2.5 in (2 - 64 mm)	2 BUCKETS	35 - 40%
COARSE SAND[4]	0.04 - 0.08 in (1 - 2 mm)	0.75 BUCKET	12 - 17%
TOPSOIL[5]	LOAM OR SILT LOAM WITH 3-5% ORGANIC CONTENT	0.5 BUCKET	7 - 12%

[1] THE REINFORCED BED MIXTURE MUST BE APPROVED BY THE PROJECT ENGINEER PRIOR TO BEING PLACED IN THE STREAM CHANNEL. THE REINFORCED BED SHALL BE THE GREATER OF **1.0'** IN DEPTH OR 1.5X THE ROCK FRACTION D_{50}. SEE LONGITUDINAL PROFILE FOR LOCATIONS AND THICKNESS.

[2] THE ROCK PORTION OF THE MIXTURE SHALL CONSIST OF CRUSHED STONE (CLASS A1 RIPRAP). THE VOIDS WILL BE FILLED WITH A MIXTURE OF SAND, GRAVEL, AND TOPSOIL. THE ANGULARITY OF THE CRUSHED ROCK, ALONG WITH THE FILLING OF THE VOIDS WILL RESULT IN A VERY RESISTANT, ARMORED SUBSTRATE THAT WILL BE CAPABLE OF WITHSTANDING MUCH GREATER SHEAR STRESS THAN THE COMPUTATION OF THE REQUIRED D_{50} WOULD SUGGEST. RIVER WASHED COBBLE (WHITE, TAN, YELLOW OR BROWN) WITH THE SPECIFIED D_{50} SHALL BE AN ACCEPTABLE ALTERNATE AS LONG AS IT IS WELL GRADED IN SIZE DISTRIBUTION (±6" FROM D_{50}) TO PROVIDE THE ARMOR NEEDED - SUBJECT TO ENGINEERS APPROVAL.

[3] BANK RUN GRAVEL MAY INCLUDE UP TO 5% CLAY, SILT, AND/OR SAND, AND UP TO 25% COBBLE (D_{50} = 3" TO 8"). GRAVEL MUST HAVE NATURAL COLOR (WHITE, TAN, YELLOW, OR BROWN).

[4] THE SAND PORTION OF THE MIXTURE SHALL CONSIST OF A WELL MIXED SAND PREDOMINANTLY 1.0 MILLIMETERS TO 2.0 MILLIMETERS IN SIZE, SUBJECT TO ENGINEER APPROVAL (I.E. WASHED CONCRETE SAND IS NOT REQUIRED). SAND MUST BE WHITE, TAN, YELLOW, OR BROWN IN COLOR.

[5] THE TOPSOIL PORTION OF THE MIXTURE SHALL CONSIST OF 50% SIFTED, UNWASHED COARSE SAND (WITH FINES ALLOWED), 25% COMPOSTED LEAF/BARK MULCH, 25% MINERAL SILT OR FINER MATERIAL (STONE DUST FROM ROCK CRUSHING OPERATIONS OR ANY SILT/CLAY).

IX. Conclusion

The unnamed tributary to Blackwater Creek subject to this design will be restored using NCD. NCD theories, techniques, and practices are employed as described in this plan set, and are modified as necessary to ensure long term stability will be achieved in these urbanized hydrologic conditions. Through careful review and study of previous analyses, collection of reference and hydrologic data, and modeling of the watershed, a design protocol has been developed that considers all sources without undue reliance on any one. The design protocol employed in this project will provide an environmentally sound, aesthetically pleasing, and structurally stable stream restoration project.

[1]Chesapeake Bay Local Assistance Department. 1989. *Chesapeake Bay Local Assistance Manual*.

[2]Leopold, L.B., M.G. Wolman and J.P. Miller. 1964. Fluvial Processes in Geomorphology. San Francisco, W.H. Freeman and Co., 522p.

[3]Caraco, D.S. 2000. Dynamics of urban stream channel enlargement. *Watershed Protection Techniques* 3(3):729-734.

[4]Rosgen, Dave. 2006. Watershed Assessment of River Stability and Sediment Supply. Wildland Hydrology. Fort Collins, CO. 2-57p.

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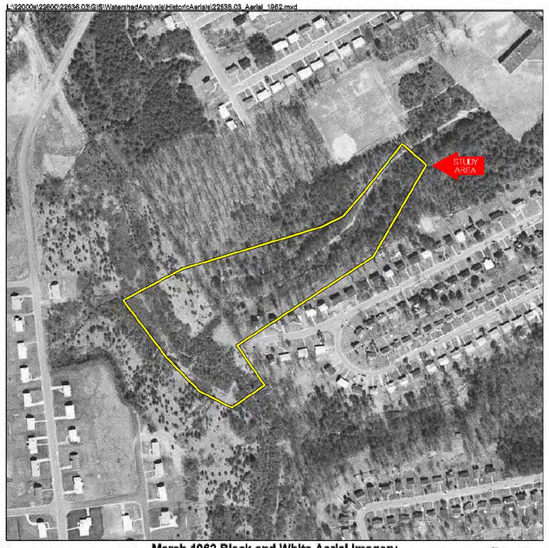

March 1962 Black and White Aerial Imagery
Tributaries To Blackwater Creek
Stream Restoration
WSSI #22636.03
Original Scale: 1" = 300'

N W E S
0 300 Feet

Photo Source: United States Geological Survey (USGS)

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Exhibit 3

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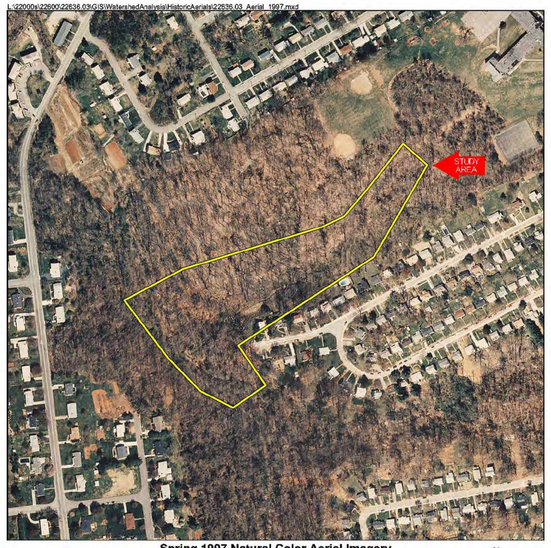

Spring 1997 Natural Color Aerial Imagery
Tributaries To Blackwater Creek
Stream Restoration
WSSI #22636.03
Original Scale: 1" = 300'

N W E S
0 300 Feet

Photo Source: City of Lynchburg GIS Division

Wetland Studies and Solutions, Inc.
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Exhibit 4

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Spring 2011 Natural Color Aerial Imagery
Tributaries To Blackwater Creek
Stream Restoration
WSSI #22636.03
Original Scale: 1" = 300'

N W E S
0 300 Feet

Photo Source: City of Lynchburg GIS Division

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Exhibit 5

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GREELEY AND HANSEN
9020 STONY POINT PARKWAY, SUITE 475
RICHMOND, VIRGINIA 23235

DESIGNED NAS
DRAWN NAS
CHECKED FRG

APPROVED

NO.	DATE	APPD	REVISION

SCALE
VARIES (SEE EXHIBITS)

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

CIVIL

HISTORIC AERIALS

FILE NAME WATERSHED AND HYDROLOGY DATA
DWG BC17
SHEET 19 OF 35
DATE OCTOBER 2016 REV 0

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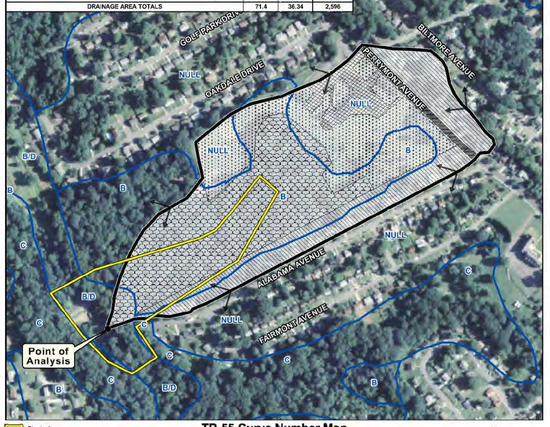
COVER TYPE	HSG	CURVE NUMBER	AREA (ACRES)	COMPOSITE
Impervious Areas - Streets and Roads - Paved; curbs and storm sewers	D	98	0.67	66
Open space	B	61	3.40	207
	D	80	6.65	532
Residential Districts - 1/4 acre	B	75	1.80	135
	C	83	0.05	4
	D	87	7.35	639
Urban Districts - Commercial & Business	D	95	2.14	203
Woods	B	55	13.21	726
	C	70	0.01	0
	D	77	1.07	83
DRAINAGE AREA TOTALS		71.4	36.34	2,596



Study Area
Drainage Area: ±36.3 acres
Hydrologic Soil Groups (HSG) - SSURGO*

TR-55 Cover Type

Impervious Areas - Streets and Roads - Paved; curbs and storm sewers
Open space
Residential Districts - 1/4 acre
Urban Districts - Commercial & Business
Woods

Photo Source: Summer 2014 Natural Color Imagery - National Agriculture Imagery Program (NAIP)
*For the purposes of TR-55 Curve Number analysis, HSG classifications of NULL, A/D, B/D, and C/D have been reclassified as group D

TR-55 Curve Number Map
Tributaries To Blackwater Creek
Stream Restoration
WSSI #22636.03
Original Scale: 1" = 400'

N W E S
0 400 Feet

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Exhibit 6

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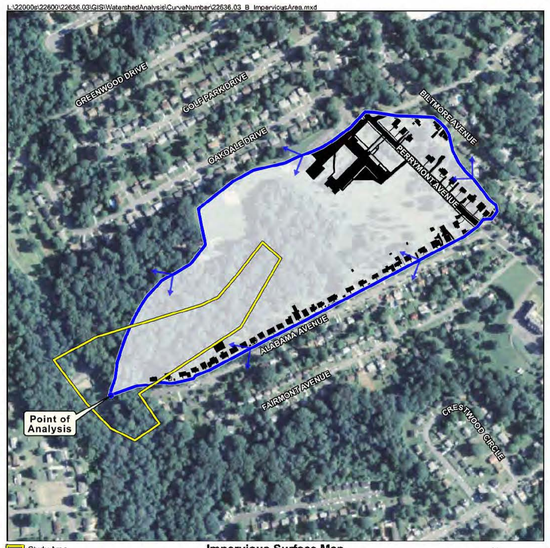

Study Area
Drainage Area: ±36.3 acres
Impervious Surface: ±4.4 acres
Pervious Surface: ±31.9 acres

Impervious Surface Map
Tributaries To Blackwater Creek
Stream Restoration
WSSI #22636.03
Original Scale: 1" = 400'

N W E S
0 400 Feet

Photo Source: Summer 2014 Natural Color Imagery - National Agriculture Imagery Program (NAIP)

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Exhibit 7

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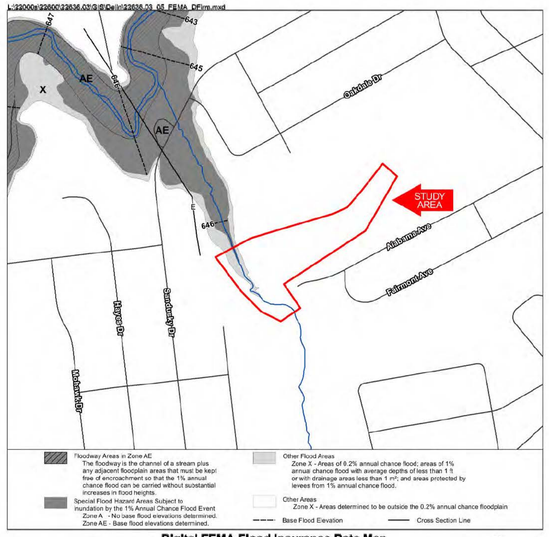

Digital FEMA Flood Insurance Rate Map
Panel 5100930039D Effective 6/3/2008
Panel 51031C0025D Effective 8/28/2008
Panel 51019C0240D Effective 9/29/2010
Panel 51009C0390B Effective 9/19/2007
Tributary to Blackwater Creek Stream Restoration
WSSI #22636.03
Original Scale: 1" = 500'

N W E S
0 500 Feet

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Exhibit 5

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NO.	DATE	APPD	REVISION

SCALE
VARIES (SEE EXHIBITS)

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

CIVIL
WATERSHED DATA AND FEMA DFIRM

FILE NAME WATERSHED AND HYDROLOGY DATA
DWG BC18
SHEET 20 OF 35
DATE OCTOBER 2016 REV 0

Substrate Sizing Calculations for Threshold Channel Design

During a site visit on June 17, 2015 engineering staff from Wetland Studies and Solutions, Inc. evaluated existing channel conditions for approximately 1,500 linear feet of the unnamed tributary to Blackwater Creek. The project area begins approximately 500 feet southwest of Perrymont Elementary and extends downstream to the existing stormwater facility on the adjacent Blackwater Creek tributary. The project area lies just north of the Alabama Avenue cul-de-sac. The 36-ac contributing drainage area for the watershed is characterized by a mix of open space, forest, residential, and commercial (school) land uses, with forest being the predominant land category. Runoff from upland areas of the watershed is conveyed largely through the existing storm drainage network until entering the stream valley approximately 500 feet upstream (northeast) of the project boundary where flows continue in a poorly defined, poorly vegetated open channel. Channel depth in this area upstream of the project area is generally less than 1-ft with moderate signs of channel erosion present. The project area boundary is defined by a significant change in channel size/condition due to severe erosion approximately 100-ft downstream of an existing sanitary sewer crossing. At the upstream project boundary the channel depth quickly transitions from 2-3 feet to more than 10 feet deep. The sediment composition of channel bed and banks was visually assessed for the entire project area to document any substantial changes and in order to allow selection of a representative site for pebble count data collection. Bed and bank materials were found to be consistent throughout the project area with grade control afforded by bedrock in isolated locations.

One riffle pebble count was taken from within the project area near the downstream end of the reach. Bed and bank materials throughout most of the project area were composed of fine-grained cohesive sediments. Pebble count data was intentionally collected at one of the more coarse bed areas recognizing that the sample represents the "best-case" scenario with regard to substrate size and bed material transport. (All other portions of the project area will be more susceptible to channel erosion than that of the sample location.) Results of the pebble count showed the existing bed material D_{50} to be less than 1 mm - i.e. sand or cohesive silt/clays. See below for pebble count data.

RIFFLE CROSS SECTION PEBBLE COUNT DATA WITH PARTICLE SIZE ANALYSIS

Project Name: Blackwater Creek Tributary (WSSI# 22636.03)

Stream ID & XS Station: Downstream near pond (coarse bed area) — **Date:** June 17, 2015

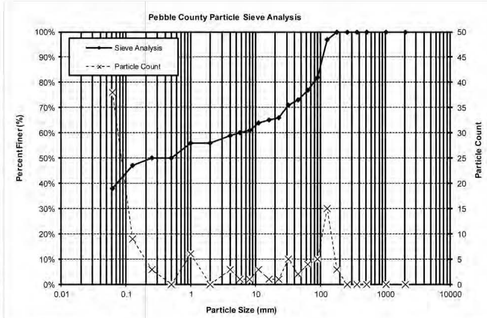
Evaluators: NAS — **City of Lynchburg**

Pebble Count Data

	Particle Description	Size (mm)		Particle Count Total	ITEM %	CUM %
SAND	Silt/Clay	0	0.062	38	38%	38%
	Very Fine	0.062	0.125	9	9%	47%
	Fine	0.125	0.25	3	3%	50%
	Medium	0.25	0.5	0	0%	50%
	Coarse	0.5	1.0	6	6%	56%
	Very Coarse	1.0	2.0	0	0%	56%
GRAVEL	Very Fine	2.0	4.0	3	3%	59%
	Fine	4.0	5.7	1	1%	60%
	Fine	5.7	8.0	1	1%	61%
	Medium	8.0	11.03	3	3%	64%
	Medium	11.3	16.0	1	1%	65%
	Coarse	16.0	22.6	1	1%	66%
	Coarse	22.6	32.0	5	5%	71%
	Very Coarse	32	45	2	2%	73%
	Very Coarse	45	64	4	4%	77%
COBBLE	Small	64	90	5	5%	82%
	Small	90	128	15	15%	97%
	Large	128	180	3	3%	100%
	Large	180	256	0	0%	100%
BOULDER	Small	256	362	0	0%	100%
	Small	362	512	0	0%	100%
	Medium	512	1024	0	0%	100%
	Large - Vry Large	1024	2048	0	0%	100%
	Bedrock	2048		0	0%	100%
		Total Particles		100		

Particle Size Analysis

Silt/Clay (%)	38%
Sand (%)	18%
Gravel (%)	21%
Cobble (%)	23%
Boulder (%)	0%
Bedrock (%)	0%
D16 (mm)	<0.06
D35 (mm)	<0.06
D50 (mm)	0.25
D84 (mm)	95.07
D95 (mm)	122.93
D100 (mm)	175.0



An analysis of shear stress is necessary to understand bed mobility. To achieve the desired threshold condition, the size (D_{50}) of the large rock ("armor") portion of the reinforced bed mix is determined by first calculating the "mean depth" boundary shear stress (i.e. Shield's Equation) for the proposed channel using the hydraulic radius (approximately the mean depth, Equation 1). The "mean depth" boundary shear stress value is then inserted into a regression equation developed by Rosgen (2006) using data from Leopold et. al. (1964) to determine the particle size D_{50} needed to achieve a stable stream bed (Equation 2). A Factor of Safety greater than or equal to 1.3 is desired and is based on the ratio of the computed rock size versus provided rock size (Equation 3). As a check, the above process is repeated using the "maximum" boundary shear stress (Equation 4). The term "maximum" boundary shear stress is used because typically, boundary shear stress calculations are performed using the hydraulic radius (approximately the mean riffle depth, refer to Equations 1 and 2). Using the "maximum" boundary shear stress as a check of the initial calculation provides a conservative estimate of the required D_{50} for the "armor" rock. For this conservative estimate, a Factor of Safety greater than or equal to 1.0 is desired and is based on the ratio of the computed rock size versus provided rock size (Equation 6). Finally, the above results are corroborated by calculating the Critical Shear Stress and verifying that it is less than 0.030 lb/ft^2 (Equation 7). This step-by-step procedure is presented as follows:

STEP 1: "ARMOR" SIZE DETERMINATION

Based on the calculations herein (at right), the D_{50} particle size needed to achieve a stable stream channel for the Blackwater Creek tributary restoration project is **4.7 inches**. This indicates bed mobility in areas not founded on bedrock and highlights the potential for continued and severe bank erosion. These calculations show the need for import of an appropriately sized reinforced bed mixture, one which will resist erosion while riparian vegetation is reestablished on channel banks. A1 rock exceeds the target Factor of Safety and is therefore of sufficient size[1] to be used as the stable armor component in the reinforced bed mixture. The reinforced bed mixture shall be prepared as specified in the Reinforced Bed Mixture Specifications provided on the Design Narrative sheet.

EQUATION 1 ("MEAN DEPTH" BOUNDARY SHEAR STRESS)

$t_0 = \gamma_f * R * S$

WHERE:

			Blackwater Trib
γ_f	= SPECIFIC WEIGHT OF WATER	(LB/FT^3) =	62.4
R	= HYDRAULIC RADIUS (A_{BKF}/WP)	(FT) =	0.39
A_{BKF}	= BANKFULL AREA	(FT^2) =	2.8
WP	= WETTED PERIMETER ($2D_{BKF} + W_{BKF}$)	(FT) =	7.1
D_{BKF}	= BANKFULL MEAN DEPTH (A_{BKF}/W_{BKF})	(FT) =	0.4
W_{BKF}	= BANKFULL WIDTH	(FT) =	7.0
S	= MAXIMUM RIFFLE SLOPE	(FT/FT) =	0.060

THEREFORE:

t_0	= BOUNDARY SHEAR STRESS	(LB/FT^2) =	1.5

EQUATION 2 ("ARMOR" PORTION PARTICLE SIZE)

$D_{50} = 3.07 * T_0^{1.042}$

WHERE:

			Blackwater Trib
t_0	= MEAN DEPTH BOUNDARY SHEAR STRESS (FROM EQ. 1)	(LB/FT^2) =	1.5

THEREFORE:

D_{50}	= ROCK	(IN) =	4.7

EQUATION 3 (FACTOR OF SAFETY)

$FS = D_{50\text{-}Actual}/D_{50}$

WHERE:

			Blackwater Trib
$D_{50\text{-}Actual}$	= ACTUAL MEAN DIAMETER OF THE "ARMOR" ROCK (FROM QUARRY)	(LB/FT^2) =	6.7
D_{50}	= STABLE MEAN DIAMETER OF THE "ARMOR" ROCK (FROM EQ. 2)	(LB/FT^2) =	4.7

THEREFORE:

FS	= FACTOR OF SAFETY	=	1.4

STEP 2: CONSERVATIVE ESTIMATE OF STABLE "ARMOR" ROCK (CALCULATE THE BOUNDARY SHEAR STRESS USING THE MAXIMUM RIFFLE DEPTH)

EQUATION 4 (MAXIMUM DEPTH BOUNDARY SHEAR STRESS)

$t_{0\text{-}MAX} = \gamma_f * D_{MAX} * S$

WHERE:

			Blackwater Trib
γ_f	= SPECIFIC WEIGHT OF WATER	(LB/FT^3) =	62.4
D_{MAX}	= MAXIMUM RIFFLE DEPTH	(FT) =	0.6
S	= MAXIMUM RIFFLE SLOPE	(FT/FT) =	0.060

THEREFORE:

$t_{0\text{-}MAX}$	= MAXIMUM DEPTH BOUNDARY SHEAR STRESS	(LB/FT^2) =	2.2

EQUATION 5 (DETERMINE "ARMOR" PORTION PARTICLE SIZE)

$D_{50} = 3.07 * T_{0\text{-}MAX}^{1.042}$

WHERE:

			Blackwater Trib
$t_{0\text{-}MAX}$	= MAXIMUM DEPTH BOUNDARY SHEAR STRESS (FROM EQ. 4)	(LB/FT^2) =	2.2

THEREFORE:

$D_{50\text{-}MAX}$	= ROCK	(IN) =	7

EQUATION 6 (FACTOR OF SAFETY)

$FS = D_{50\text{-}Actual}/D_{50}$

WHERE:

			Blackwater Trib
$D_{50\text{-}Actual}$	= ACTUAL MEAN DIAMETER OF THE "ARMOR" ROCK (FROM QUARRY)	(LB/FT^2) =	6.7
$D_{50\text{-}MAX}$	= STABLE MEAN DIAMETER OF THE "ARMOR" ROCK (FROM EQ. 5)	(LB/FT^2) =	7

THEREFORE:

FS	= FACTOR OF SAFETY	=	1.0

STEP 3: CORROBORATION OF RESULTS

Steps 1 and 2 (above) show that the D_{50} of the specified A1 armor material (Table 1) exceeds that of the D_{50} required for a stable armor material, and therefore will result in a stable channel substrate.

To ensure that the A1 particles with a diameter less than that of the D_{50} are also stable, the critical shear stress of the A1 was calculated using the measured D_{30}, as shown in Equation 7 (Maidment 1993). Unlike the procedure used in Steps 1 and 2, this formula considers the specific weight of the armor material when assessing its stability. If the critical shear stress of the D_{30} is found to be less than 0.03 lb/ft^2 (see Equation 7), then the particles are assumed to be stable per Shield's Incipient Motion Diagram (below). Particles less than the D_{30} are also considered stable as they are sheltered from the flow by larger particles. This phenomenon is commonly referred to as "hiding." The results for Equation 7 show that the critical shear stress for the Blackwater Creek tributary riffle cross section is less than 0.03 lb/ft^2 and thus the proposed "armor" material will be stable.

EQUATION 7

$t^* = t_0 / [(\gamma_s - \gamma_f) * D_{30}]$

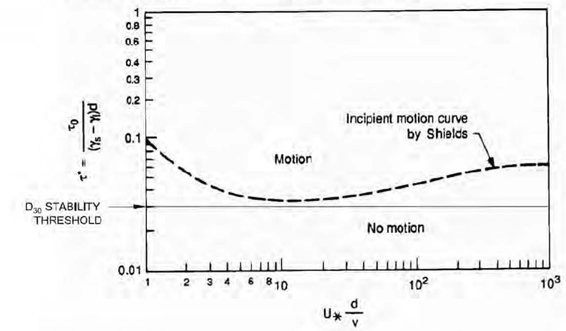
WHERE:

			Blackwater Trib
t_0	= MEAN DEPTH BOUNDARY SHEAR STRESS (FROM EQ. 1)	(LB/FT^2) =	1.5
γ_s	= SPECIFIC WEIGHT OF SEDIMENT (FROM TABLE 1)	(LB/FT^3) =	190
γ_f	= SPECIFIC WEIGHT OF WATER	(LB/FT^3) =	62.4
D_{30}	= DIAMETER ≥ 30% OF THE SAMPLE PARTICLES	(FT) =	0.5

THEREFORE:

t^*	= CRITICAL SHEAR STRESS	(LB/FT^2) =	0.024

SHIELD'S INCIPIENT MOTION DIAGRAM (FROM MAIDMENT 1993)



Utilization of Fine Particles

The shear stress computations presented on this sheet represent the force required to initiate movement of non-imbricated particles. The reinforced bed mix used in this project shall have fine-grained particles (i.e. gravel, sand, and topsoil) mixed with the "armor" material to fill the void spaces in the rocks (see the reinforced bed mixture specifications on the Design Narrative sheet). The mixing of the fine grain substrate material with the armor rock will promote imbrication, further enhancing the reinforced bed material stability. In addition to providing enhanced stability, this smaller substrate material will encourage water to flow along the surface of the stream bed as it would in a naturally occurring stream system. Without fines flow would be primarily subsurface until natural detritus buildup could replace the smaller particle size fractions. Further, the variety of substrate particle sizes will increase species diversity by providing aquatic macroinvertebrates, fish, and amphibians with a larger number of niches to colonize. Finally, the smaller bed material fractions will improve the aesthetic properties of the restored stream by allowing "sorting" to occur during the significant flow events following construction. Smaller particles may move out of the riffles and deposit on or form point bars (and other depositional features) and/or deposit in pools. The result is a variety of stream facets and natural gradation of particle sizes created by varying energy environments of the stream system. This creates a more natural appearance than could be practicably graded during construction. For these reasons, and since a significant upstream sediment source is not otherwise present in this piped urban watershed, the inclusion of the fine particles are a recommended component of the reinforced bed material.

[1] Experience has shown that supplied A1 rock often does not meet listed VDOT specifications. For this reason WSSI staff investigated supplied A1 rock by measuring grab samples at 3 quarries in Northern Virginia (Cedar Mountain Stone in Culpepper, Luck Stone in Leesburg, and Vulcan Materials in Manassas) by measuring the intermediate axis (the axis that would fit through a sieve) of 100 randomly selected particles at each site. The results of this investigation showed rock supplied by local quarries is in fact smaller than the VDOT specification - a trend which is likely to hold for materials supplied by other quarries due to the mechanical procedure implicit in A1 production. It shall be the contractor's responsibility to ensure that the A1 rock used meets the size specifications detailed in this narrative. In addition, the City (or its representative) should carefully monitor deliveries during construction to ensure that materials meet specified requirements. Sample data, along with the published VDOT data, is summarized in the following table:

TABLE 1: SUMMARY OF ACTUAL A1 ROCK SIZES

Sample Site	D_{30}*			D_{50}			Specific Wt*
	mm	in	ft	mm	in	ft	lb/ft^3
Published VDOT	—	—	—	276.9	10.9	0.9	—
Cedar Mountain	144	5.7	0.5	170.3	6.7	0.6	190
Luck Stone	191.6	7.5	0.6	223.5	8.8	0.7	185
Vulcan Materials	162.1	6.4	0.5	195.9	7.7	0.6	182

* Data not published by VDOT

Literature Cited

Leopold, Luna B., Wolman, Gordon M., and Miller, John P. Fluvial Processes In Geomorphology. Dover Publications, New York, 169 - 172, 1964.

Maidment, David R., ed. Handbook of Hydrology. McGraw-Hill, Washington D.C., 12.16 - 12.20, 1993.

Rosgen, Dave. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology, Fort Collins, 5-129 - 5-136, 2006.

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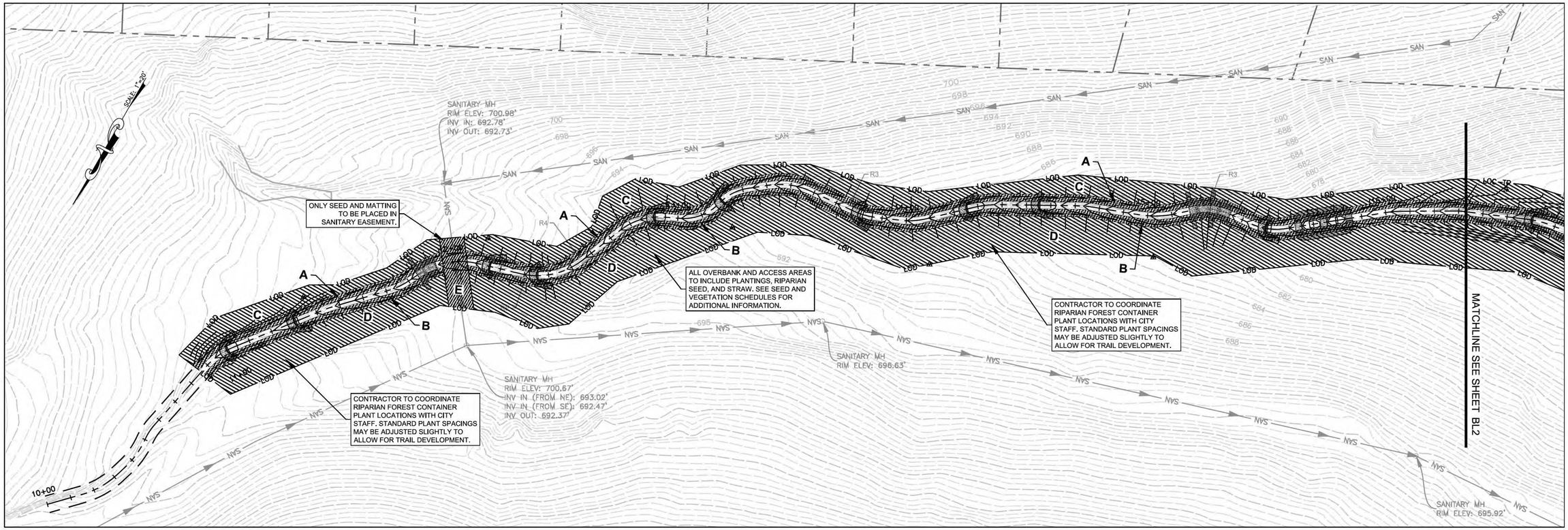
COMMONWEALTH OF VIRGINIA
FRANK R. GRAZIANO
Lic. No. 032099
10/3/2016
PROFESSIONAL ENGINEER



	PLANTING AREAS	SYMBOL
RIPARIAN ZONE	STREAMSIDE* 5,077 SF = 0.12 AC	A, B
	RIPARIAN FOREST* 20,622 SF = 0.47 AC	C, D
	RIPARIAN SEED MIX ONLY* 291 SF = <0.01 AC	E

*SEED MIX SHALL BE DISTRIBUTED EVENLY THROUGHOUT ALL DISTURBED AREAS IN THE AMOUNT SPECIFIED ON THE VEGETATION SCHEDULE SHEET.

L:\22000S\22600\22636.03\CADD\04-ENGR\08-FINAL\PLANTING PLAN 2016/10/03 5:13 PM TOMLINSON, KATE

COMMONWEALTH OF VIRGINIA
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GREELEY AND HANSEN
9020 STONY POINT PARKWAY, SUITE 475
RICHMOND, VIRGINIA 23235

DESIGNED NAS
DRAWN NAS
CHECKED FRG
APPROVED

NO.	DATE	APPD	REVISION

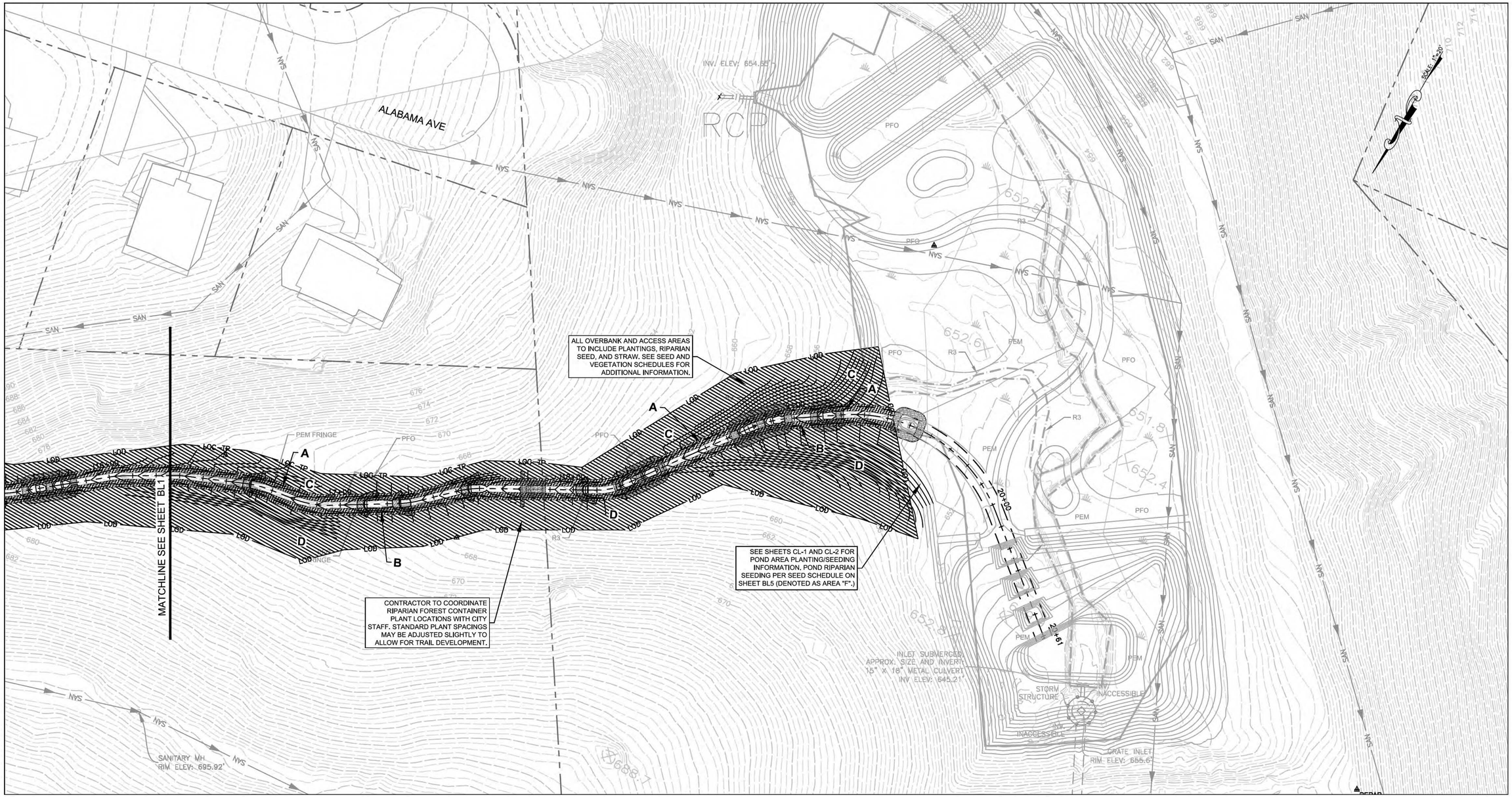
SCALE
20 10 0 20 40 60
SCALE: 1"=20'

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

LANDSCAPING

PLANTING PLAN

FILE NAME PLANTING PLAN
DWG BL1
SHEET 22 OF 35
DATE OCTOBER 2016 REV 0



SEE PREVIOUS SHEET FOR PLANTING PLAN LEGEND.

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CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

LANDSCAPING

PLANTING PLAN (CONT'D)

FILE NAME PLANTING PLAN
DWG BL2
SHEET 23 OF 35
DATE OCTOBER 2016 REV 0

L:\22000S\22600\22636.03\CADD\04-ENGR\08-FINAL\PLANTING PLAN 2016/10/03 5:13 PM TOMLINSON, KATE

PLANTING SPECIFICATIONS

1. PLAN DETAILS ARE INCORPORATED INTO THIS SPECIFICATION BY REFERENCE.
2. THE SUPPLIER OF ALL SEEDS AND/OR VEGETATION SHALL CERTIFY THAT THE ORIGIN OF THE SEEDS FROM WHICH THE PLANTS OR SEEDS WERE PRODUCED IS FROM HARDINESS ZONES 6 AND 7, FROM THE EASTERN OR CENTRAL PORTIONS OF THE U.S., PRIOR TO PLANTING.
3. ANY NURSERY SUPPLYING THE STOCK SHALL PROVIDE A CURRENT NURSERY INSPECTION CERTIFICATE FROM THE STATE DEPARTMENT OF AGRICULTURE, OR PROVIDE AT LEAST THIRTY DAYS ADVANCE NOTICE FOR OWNER TO INSPECT THE PLANT SOURCE AREAS AT OWNER'S DISCRETION. ANY SUCH INSPECTION IS NOT DEEMED APPROVAL OF THE PLANT MATERIALS.
4. ALL PLANTS SHALL BE SET STRAIGHT, OR PLUMB.
5. PLANTING SHALL ONLY BE PERMITTED BETWEEN SEPTEMBER 30 THROUGH MARCH 31. NO PLANTING SHALL OCCUR WHEN THE SOIL IS FROZEN. SEEDING SHALL BE COMPLETED DURING MARCH THROUGH MAY OR SEPTEMBER THROUGH NOVEMBER. THESE TIME LIMITS MAY NOT BE MODIFIED UNLESS APPROVED BY OWNER, IN ADVANCE WITH THE RISK OF SURVIVAL BORNE SOLELY BY THE CONTRACTOR.
6. PLANTING HOLES FOR BARE ROOT TREES SHALL BE 1-2" DEEPER THAN THE ROOT COLLAR (I.E. 1-2" DEEPER THAN THEY WERE GROWING IN THE NURSERY). BARE ROOT SEEDLINGS SHALL BE INSTALLED WITH THE USE OF A "SHARPSHOOTER SHOVEL", AS DEPICTED WITHIN THESE PLANS. THE PLANTING HOLE SHALL BE LARGE ENOUGH TO AVOID THE NEED FOR ROOT TRIMMING WHERE EVER POSSIBLE. NO J-ROOTS (SEE PLANTING DETAILS) SHALL BE ALLOWED; IT IS EXTREMELY CRITICAL THIS BE ADHERED TO FOR EVERGREENS. BARE ROOT STOCK SHALL BE PLANTED WITH THEIR ROOT-COLLAR 1 TO 2 INCHES DEEPER THAN THE ADJACENT SOIL ELEVATION, USING ADJACENT SOIL TO CREATE A HUMMOCK OR MOUND THAT THE SEEDLING IS SET WITHIN.
7. PLANTING HOLES FOR CONTAINER GROWN PLANTS SHALL BE ONE FOOT (1') DEEP PLUS THE CONTAINER DEPTH IN WHICH THE PLANT HAS BEEN GROWN AND TWICE AS WIDE AS THE CONTAINER.
8. BACKFILL THE PLANTING HOLES WITH THE IN-SITU SOIL MATERIALS REMOVED FOR PLANTING AFTER REMOVING ALL STONES, ROOTS, AND OTHER DEBRIS GREATER THAN 1-1/2" IN DIAMETER.
9. FOLLOWING THE BACKFILLING, WATER TO THE POINT OF SOIL SATURATION (IF NOT PLANTED IN THE "WET") AND TAMP TO COMPACT THE BACKFILL MIXTURE. ADD EXISTING SOIL TO BRING THE FINAL GRADE IN THE PLANTING HOLE TO THE SURROUNDING SOIL SURFACE. RAKE THE UNUSED EXISTING SOIL OUTSIDE THE PLANTING HOLES, TAKING CARE NOT TO MOUND THE SOIL OR TO SIGNIFICANTLY ALTER THE EXISTING GRADES AND THEN PLACE MULCH (MIN. 2" THICK) ATOP ENTIRE PLANTING HOLE (EXCEPT THAT NO MULCH IS REQUIRED FOR EMERGENT PLANTINGS). THE PLANTING HOLE AREAS MUST NOT BE DEPRESSED BELOW THE SURROUNDING SOIL SURFACE ELEVATIONS. SAID AREAS SHALL BE SLIGHTLY RAISED (2-3"), RELATIVE TO THE SOIL SURFACE.
10. THE SHRUBS THAT ARE SPECIFIED AS CONTAINER GROWN SPECIMENS SHALL BE BETWEEN 15" AND 18" IN HEIGHT. THEY SHALL BE HEALTHY, VIGOROUS, WELL ROOTED AND ESTABLISHED IN THE PLANTING CONTAINER IN WHICH THEY ARE GROWING. A CONTAINER SHRUB SHALL BE IN THAT CONTAINER A SUFFICIENT TIME SUCH THAT FIBROUS ROOTS ARE FORMED SO THE SHAPE WILL REMAIN AND THE MEDIUM WILL HOLD TOGETHER WHEN REMOVED FROM THE CONTAINER (REFER TO AMERICAN STANDARD FOR NURSERY STOCK).
11. DO NOT REMOVE PLANTS FROM CONTAINERS UNTIL IMMEDIATELY BEFORE PLANTING. EXAMINE THE ROOTS TO SEE IF THEY ARE POT BOUND. CAREFULLY SEPARATE ANY POT BOUND OR CRAMPED ROOTS AND SPREAD THEM OUT WHEN PLACING THE PLANT SO THAT THE ROOTS CAN GROW WITHOUT FURTHER CONSTRUCTION OF THE ROOT BALL.
12. ALL PLANTED MATERIALS SHOULD BE BACKFILLED WITH NATIVE SOIL AMENDED WITH COMPOST MATERIAL.
13. AS RECOMMENDED BY THE CONTRACTOR AND APPROVED BY OWNER, THE CONTRACTOR SHALL WATER THE PLANTS AS NEEDED DURING THE CARE AND REPLACEMENT PERIOD OR UNTIL FINAL ACCEPTANCE, WHICHEVER IS THE SHORTEST.
14. THE CONTRACTOR IS RESPONSIBLE FOR REPLACING NON- SURVIVING TREES AND SHRUBS DURING THE CARE AND REPLACEMENT PERIOD (12 MONTHS, UNLESS OTHERWISE SPECIFIED IN CONTRACT DOCUMENTS) OR UNTIL FINAL ACCEPTANCE, WHICHEVER IS THE SHORTEST, AS REQUIRED BY THE TERMS OF THE SURVIVAL WARRANTY SPECIFIED HEREIN AND/OR IN CONTRACT DOCUMENTS. THE SPECIFICATIONS FOR THE REPLACED PLANTS SHALL BE THOSE PROVIDED IN THE PLANT LIST.
15. REFER TO APPLICABLE SKETCHES WITHIN THIS PLAN SET FOR ADDITIONAL GUIDANCE ON PLANTING REQUIREMENTS.
16. INVASIVE AND NOXIOUS WEEDS SHALL BE REMOVED BY HAND WITH LOCALIZED APPLICATIONS OF ROUND-UP WHERE NECESSARY.
17. ALL BARE ROOT SEEDLINGS SHALL BE TREATED WITH ROOT DIP ABSORBENT POLYMERS AND MYCORRHIZAL ROOT DIP INOCULATES IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS. SAID ROOT DIP SHALL BE MYCORTREE™ ROOT DIP OR APPROVED EQUAL.

SEEDING SPECIFICATIONS

1. SEED SHALL HAVE BEEN COLLECTED THE SAME YEAR OF SEEDING. A SEED GERMINATION AND PURITY RATE OF 75% IS REQUIRED. EVIDENCE OF SUCH SHALL BE PROVIDED TO OWNER PRIOR TO PLANTING.
2. THE LANDSCAPE CONTRACTOR SHALL INSPECT THE AREAS AND CONDITIONS UNDER WHICH THE SEEDING WORK IS TO BE PERFORMED PRIOR TO COMMENCING WORK. IF CONDITIONS ARE DETRIMENTAL TO THE PROPER AND TIMELY COMPLETION OF THE WORK, HE/SHE SHALL NOTIFY THE OWNER VERBALLY AND IN WRITING AND POSTPONE COMMENCING WORK UNTIL THE UNSATISFACTORY CONDITIONS HAVE BEEN CORRECTED.
3. PRIOR TO SEEDING, THE TOP SOIL SHALL BE RAKED SMOOTH AND CLEARED OF ALL STONES LARGER THAN 5" AND TRASH, DEBRIS, BRANCHES AND OTHER MATTER DETRIMENTAL TO THE SUCCESS OF SEEDING.
4. FERTILIZER IS TO BE BROADCAST AND RAKED INTO THE TOP ONE INCH OF TOP SOIL IMMEDIATELY BEFORE SEEDING (OVERBANK AREAS ONLY). FERTILIZER SHALL HAVE A FORMULATION OF 10-10-10 AND BE APPLIED AT A RATE OF 50 POUNDS PER 1000 SQUARE FEET.
5. MULCH SHALL BE STRAW CAN BE SUBSTITUTED IF APPLIED AT A RATE SPECIFIED BY THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK, 3RD EDITION, 1992.
6. CARE SHOULD BE EXERCISED TO INSURE UNIFORM SEED COVERAGE IS OBTAINED. SEED SHALL BE APPLIED AT THE RATE SPECIFIED ON THE PLANTING SCHEDULE.
7. THE SPECIFIED SEED SHALL BE BROADCAST IN AREAS SPECIFIED ON THE PLANTING PLAN.FOLLOWING SEEDING, MECHANICALLY SOW SEED TO A DEPTH OF 1/8 OF AN INCH BY THE USE OF A CULTIPACTOR, YORK RAKE, OR BY HAND RAKE.

PLANTING AND SEEDING SURVIVAL WARRANTY

1. LANDSCAPE CONTRACTOR SHALL GUARANTEE A MINIMUM SURVIVAL RATE OF EACH VEGETATION SPECIES AFTER TWELVE MONTHS OF 85% FOR B&B, CONTAINER GROWN, AND TUBLINGS, AND 60% FOR BARE ROOT AND TUBER STOCK.
2. IF SURVIVAL RATES ARE LESS THAN THE ABOVE WARRANTY RATES, THEN LANDSCAPE CONTRACTOR SHALL REPLACE THE QUANTITY OF DEAD PLANTS WITHIN THE NEXT PLANTING WINDOW (SEPTEMBER 30 THROUGH MARCH 31), EXCLUDING FROZEN GROUND PERIODS) FOLLOWING THE END OF THE APPLICABLE WARRANTY PERIOD.

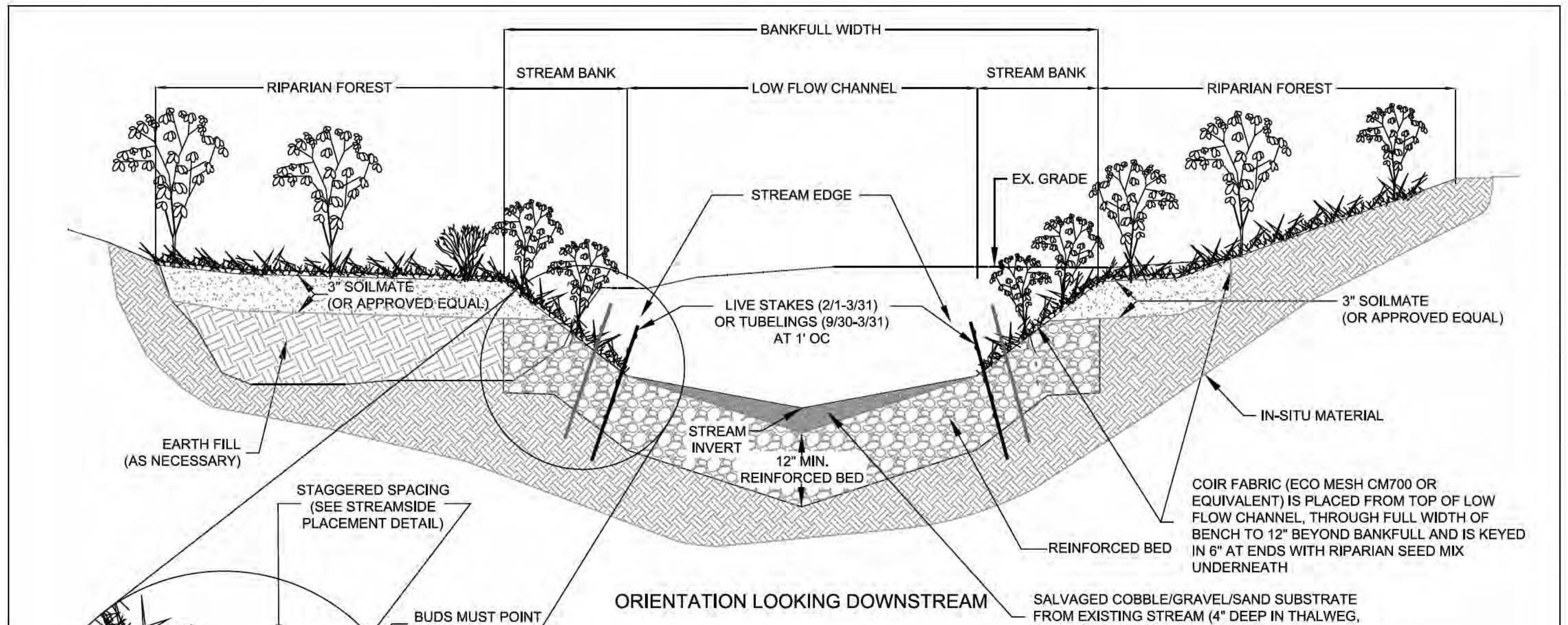
PRODUCT HANDLING, STORAGE, AND DELIVERY

1. HANDLE PLANTS AT ALL TIMES SO THAT ROOTS OR BALLS ARE ADEQUATELY PROTECTED FROM BREAKAGE OF BALLS, FROM SUN AND DRYING WINDS. PLANTS WITH DRIED OUT TOPS OR ROOTS SHALL BE REJECTED.
2. ALL PLANT MATERIALS SHALL BE STORED AND DELIVERED IN SUCH A FASHION AND FOR TIME INTERVALS CONSISTENT WITH SOUND SILVICULTURAL PRACTICES.
3. PLANT MATERIAL WILL BE TRANSPORTED FROM THE NURSERY TO THE PLANTING AREAS BY SUCH MEANS AS TO AVOID WIND DAMAGE, OVER-CROWDING, OR OTHER MECHANISMS BY WHICH PHYSICAL DAMAGE MAY RESULT TO THE PLANTS.
4. PLANT MATERIAL MAY BE RANDOMLY INSPECTED BY THE OWNER UPON ARRIVAL AT EACH PLANTING AREA AND DURING PLANTING ACTIVITIES. MATERIAL FOUND TO BE UNACCEPTABLE WILL BE REJECTED AND THE CONTRACTOR WILL BE REQUIRED TO SUPPLY REPLACEMENT MATERIAL WITHIN A REASONABLE TIME FRAME (I.E. 1-WEEK). UNACCEPTABLE MATERIAL IS TO BE DEFINED AS THE FOLLOWING:
   - (A) PLANTS WITH BENT TRUNKS OR MULTIPLE LEADERS, UNLESS CHARACTERISTICS FOR THE SPECIES;
   - (B) PLANTS WITH DISEASED TRUNKS, STEMS, OR LEAVES;
   - (C) PLANTS WITH PEST-INFESTED TRUNKS, STEMS, OR LEAVES;
   - (D) PLANTS OF INSUFFICIENT SIZE (LESS THAN A SPECIFIED HEIGHT);
   - (E) PLANTS OF THE WRONG SPECIES/SUB-SPECIES;
   - (F) PLANTS HAVING ROOT GIRDLING IN THE CONTAINER;

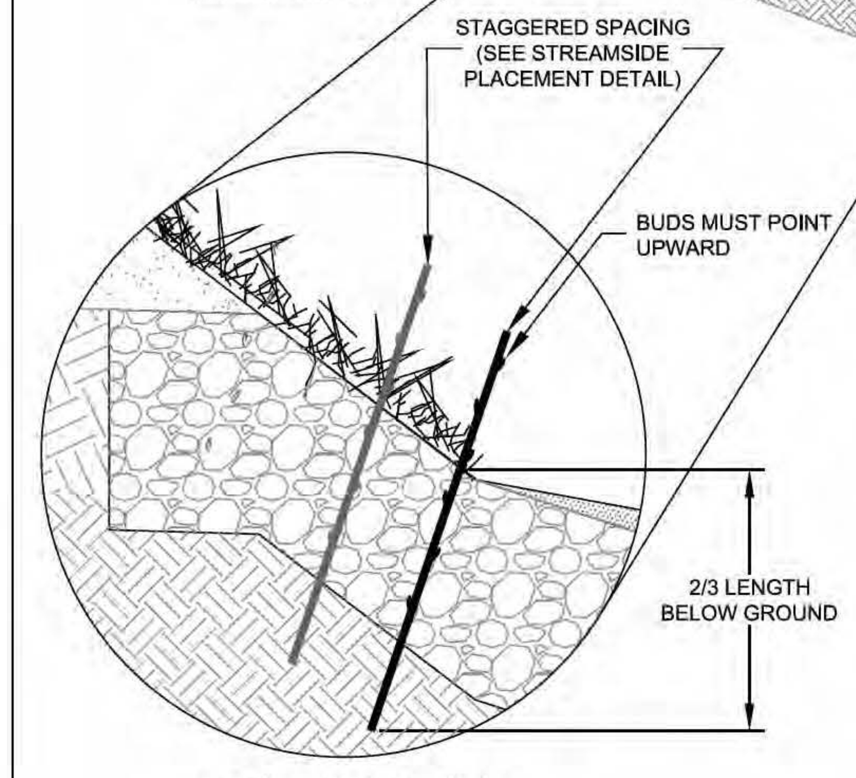
   UNLESS OTHERWISE APPROVED BY THE OWNER. JUSTIFICATION FOR USE OF TENTATIVELY REJECTED MATERIAL MAY BE PRESENTED TO THE OWNER.

THIS PLAN IS FOR PLANTING PURPOSES ONLY

PLEASE REFER TO PLANTING PLAN SHEETS FOR LEGEND



ORIENTATION LOOKING DOWNSTREAM



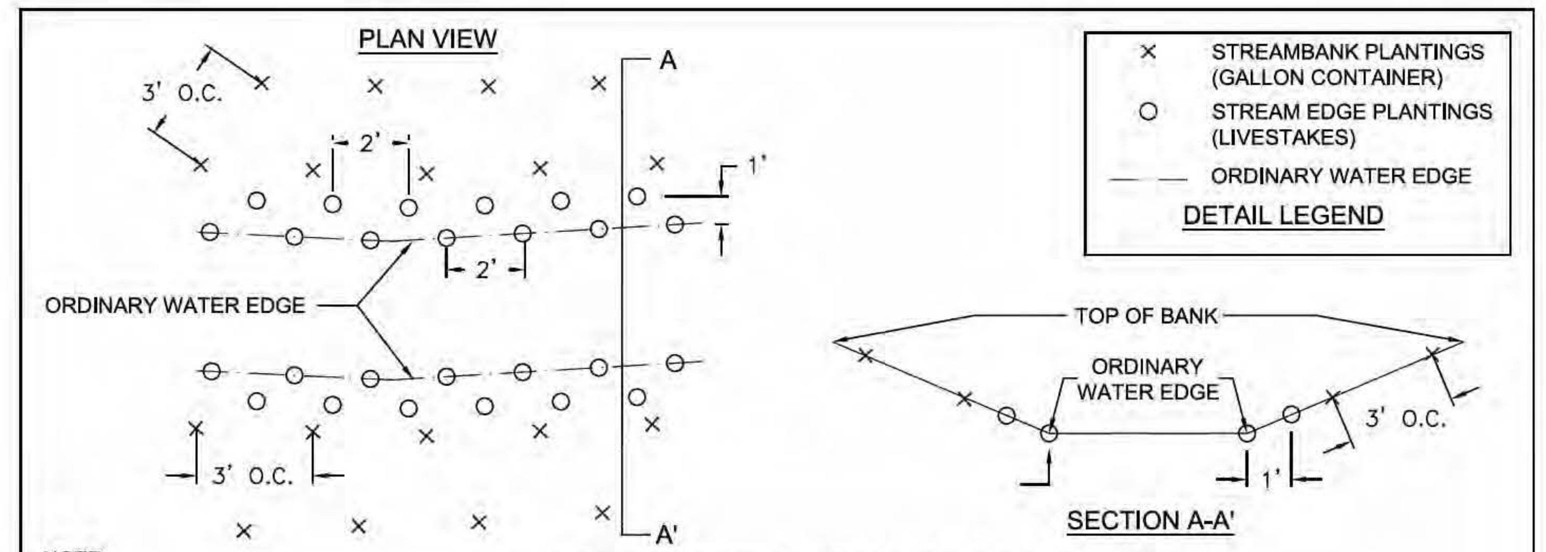
LIVE STAKE CROSS SECTION THROUGH STREAM BANK

LIVE STAKE PLANTING NOTES

1. A TOOL CALLED A PLANTING BAR MAY BE USED TO PUNCH A HOLE FOR THE CUTTING. IN SOFTER SOILS, LIVE STAKES CAN SOMETIMES BE DIRECTLY PUSHED OR HAMMERED IN.
2. ROOTS SHALL BE TREATED WITH ROOT HORMONE PRIOR TO PLANTING.
3. LIVE STAKES SHOULD BE 18" TO 24" IN LENGTH AND $\frac{1}{2}$" TO $1\frac{1}{2}$" IN DIAMETER.
4. INSTALL THE LIVE STAKE WITH THE CORRECT SIDE UP (SEE DETAIL THIS SHEET). LIVE STAKES SHOULD BE CUT ON AN ANGLE ON THE BOTTOM AND FLAT ON THE TOP. WHEN HELD WITH THE CORRECT END UP, THE BUDS MUST POINT UPWARD.
5. TWO-THIRDS ($\frac{2}{3}$) OF THE LIVE STAKE LENGTH MUST BE PLANTED BELOW GRADE. DEEPER IS FINE, AS LONG AS A FEW BUDS ARE EXPOSED AT THE TOP.
6. TAMP IN AROUND THE CUTTING TO ENSURE THAT THERE ARE NO AIR POCKETS ALONG THE STEM. YOU CAN PUSH THE PLANTING BAR INTO THE SOIL IMMEDIATELY AROUND THE STEM AND PUSH IN THE SOIL TOWARD THE PLANT.
7. REFER TO LIVESTAKE/TUBELING PLACEMENT DETAIL FOR SPECIFIC DETAILS OF PLANT PLACEMENT ALONG STREAM BANK
8. REFER TO STREAM EDGE PORTION OF VEGETATION SCHEDULE FOR SPECIES AND QUANTITY INFORMATION.

RESTORED STREAM PLANTING DETAIL

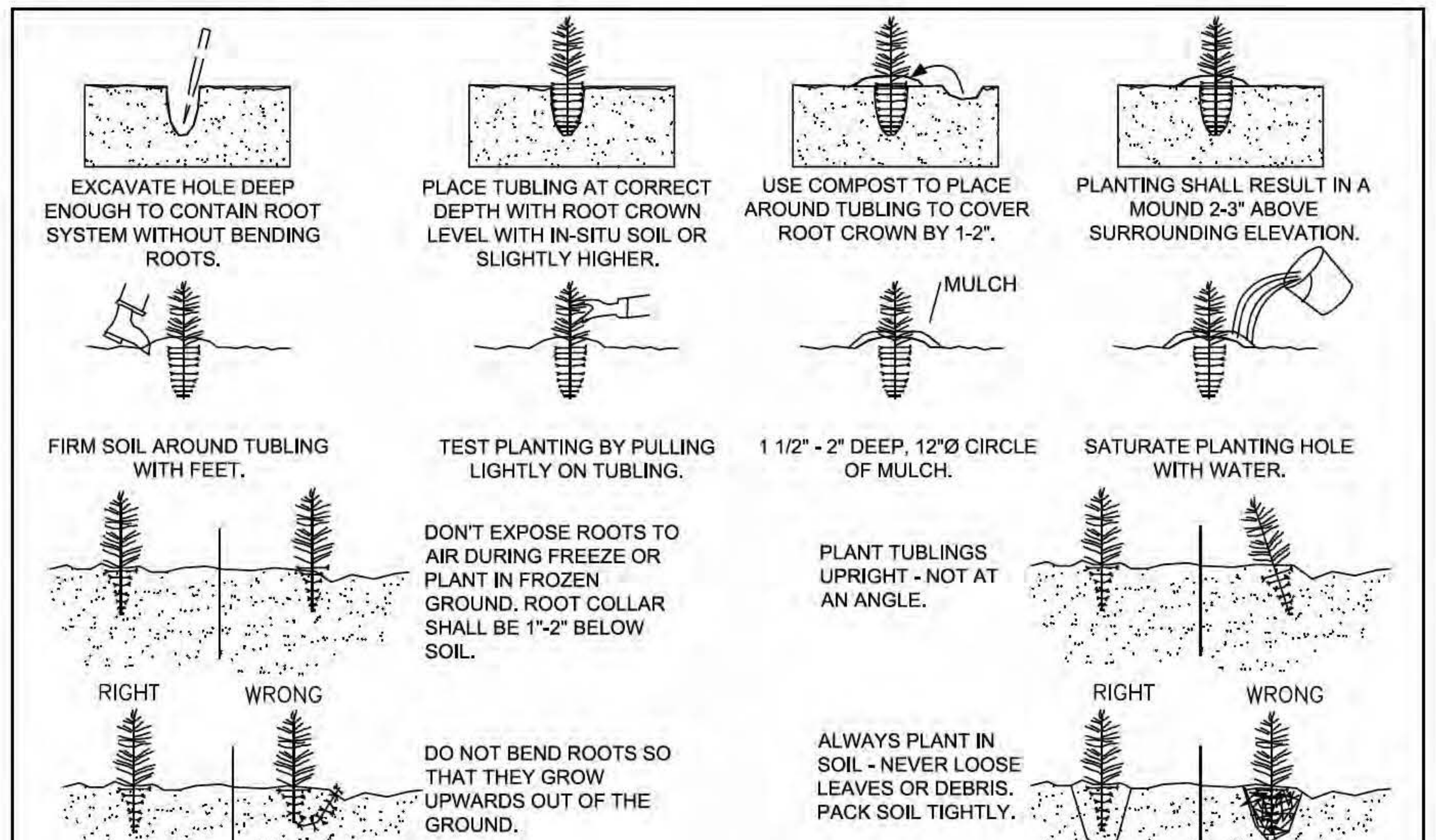
NOT TO SCALE



NOTE:
SPACING IS APPROXIMATE.
RANDOMNESS IS ENCOURAGED.

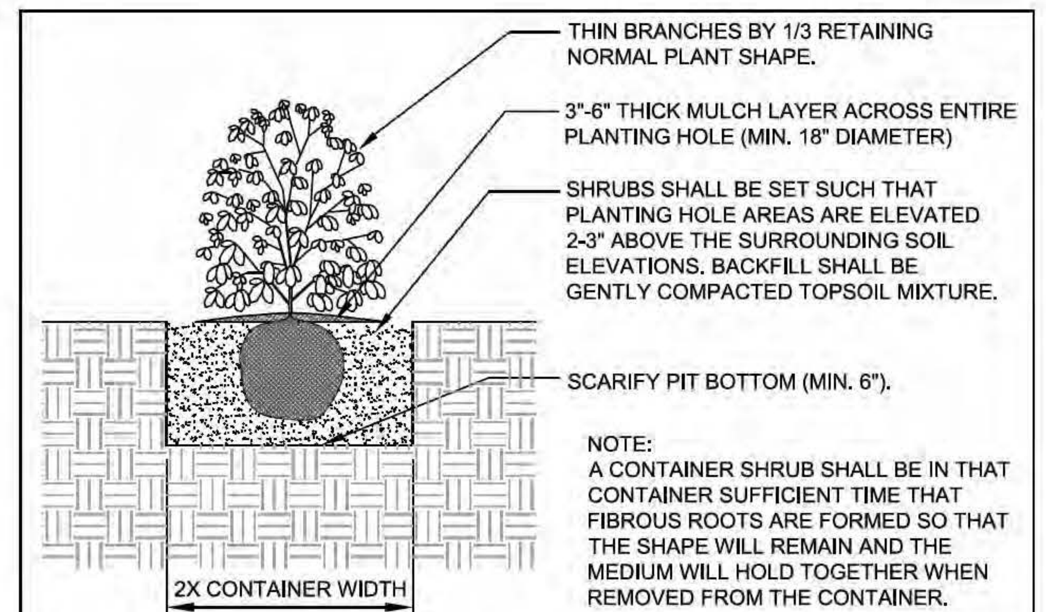
STREAMSIDE PLACEMENT DETAIL

NOT TO SCALE



PLANTING TUBLINGS

NOT TO SCALE



NOTE:
A CONTAINER SHRUB SHALL BE IN THAT CONTAINER SUFFICIENT TIME THAT FIBROUS ROOTS ARE FORMED SO THAT THE SHAPE WILL REMAIN AND THE MEDIUM WILL HOLD TOGETHER WHEN REMOVED FROM THE CONTAINER.

CONTAINER SHRUB PLANTING DETAIL

NOT TO SCALE

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SCALE
N/A

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT AND BLACKWATER CREEK TRIBUTARY STREAM RESTORATION

LANDSCAPING

PLANTING NOTES AND DETAILS

FILE NAME PLANTING PLAN
DWG BL3
SHEET 24 OF 35
DATE OCTOBER 2016 REV 0

L:\22000S\22600\22636.03\CADD\04-ENGR\08-FINAL\PLANTING PLAN 2016/10/03 5:13 PM TOMLINSON, KATE

RIPARIAN FOREST VEGETATION SCHEDULE FOR SHADY & VARIABLE HYDROLOGY CONDITIONS

PLANTING SCHEDULE

CONTAINER	PLANTING ZONE	SPECIES GROUP[1,2]	SPECIES[2]	INDICATOR STATUS	WILDLIFE VALUE: FUNCTIONS	WILDLIFE VALUE: PRIMARY SPECIES	WILDLIFE VALUE: PLANT PART	WILDLIFE VALUE: SEASON	PLANT SPACING[3]	CONTAINER SIZE, RATE, AND QUANTITY[4]: PLANTS PER ACRE	CONTAINER SIZE, RATE, AND QUANTITY[4]: # OF PLANTS	PLANTING QUANTITIES (BASED ON ONE-GALLON SIZE)[4]	A	B	C	D	E
												AREA (SF):	2,539	2,539	7,394	13,228	291
												AREA (AC):	0.06	0.06	0.17	0.30	0.01
												LENGTH (LF):	850	850	-	-	-
RIPARIAN FOREST (VARIABLE)	TREE LAYER	1	QUERCUS BICOLOR (SWAMP WHITE OAK)	FACW	Food	Woodpeckers, turkey, deer, squirrels, raccoons, other small mammals	Nuts	Fall, Winter	12' O.C. SEE NOTE #3	300 ONE GAL -- or -- 600 TUBELINGS -- or -- MIX AT 1:2 RATIO (SEE NOTE #4)	87 (BASED ON ONE-GALLON)		18	18	51	90	3
			QUERCUS ALBA (WHITE OAK)	FACW	Food	Woodpeckers, turkey, deer, squirrels, raccoons, other small mammals	Nuts	Fall, Winter									
			QUERCUS PALUSTRIS (PIN OAK)	FACW	Food	Woodpeckers, turkey, deer, squirrels, raccoons, other small mammals	Nuts	Fall, Winter									
			QUERCUS PHELLOS (WILLOW OAK)	FAC	Food	Woodpeckers, turkey, deer, squirrels, raccoons, other small mammals	Nuts	Fall, Winter									
			QUERCUS RUBRA (NORTHERN RED OAK)	FACU	Food	Woodpeckers, turkey, deer, squirrels, raccoons, other small mammals	Nuts	Fall, Winter									
		2	ACER NEGUNDO (BOX ELDER)[8]	FAC	Food	Finches, chickadees, squirrels, robins, goldfinches, other birds	Seeds, buds, flowers, plant	Spring, summer	17' O.C. SEE NOTE #3	150 ONE-GALLON -- or -- 300 TUBELINGS -- or -- MIX AT 1:2 RATIO (SEE NOTE #4)	44 (BASED ON ONE-GALLON)		9	9	26	45	2
			ACER RUBRUM (RED MAPLE)[8]	FAC	Food	Finches, chickadees, squirrels, robins, goldfinches, other birds	Seeds, buds, flowers, plant	Spring, summer									
			BETULA NIGRA (RIVER BIRCH)	FACW	Food, cover	Song birds	Seeds, plant	All									
			DIOSPYROS VIRGINIANA (COMMON PERSIMMON)	FAC	Food	Bees, large and small mammals, song birds including cedar waxwing, game birds	Fruits, flowers, leaves, twigs	All									
			LIQUIDAMBAR STYRACIFULA (SWEET GUM)	FAC	Food	Finches, cardinals, chickadees, sparrows, squirrels	Seed	Summer, fall, winter									
			NYSSA SYLVATICA (BLACK GUM)	FACW	Food, cover	Song birds, waterfowl, small mammals	Fruit, plant	All									
			PLATANUS OCCIDENTALIS (AMERICAN SYCAMORE)	FACW	Food	Raccoons, opossum, wood duck, pileated and other woodpeckers	Hollow trunks	All									
		3	SALIX NIGRA (BLACK WILLOW)	OBL	Food, cover, reproductive areas Cover crop for oak seedlings	Beaver, porcupine, deer, muskrat, ducks, fish	Buds, foliage, bark	All	21' O.C. SEE NOTE #3	100 ONE-GALLON -- or -- 200 TUBELINGS -- or -- MIX AT 1:2 RATIO (SEE NOTE #4)	29 (BASED ON ONE-GALLON)		6	6	17	30	1
	SHRUB LAYER	4	AMELANCHIER CANADENSIS (CANADIAN SERVICEBERRY)	FAC	Food, cover	Song birds, small mammals	Fruit, plant	All	17' O.C. SEE NOTE #3	150 ONE-GALLON -- or -- 300 TUBELINGS (SEE NOTE #4)	44 (BASED ON ONE-GALLON)		9	9	26	45	2
			ASIMINA TRILOBA (PAWPAW)	FAC	Food	Catbird, thrasher, thrushes, woodpeckers, zebra swallowtail butterfly larval food	Fruit, leaves	Spring, summer, fall									
			CERCIS CANADENSIS (EASTERN REDBUD)	FACU	Food	Honeybees, butterfly caterpillars	Flowers, leaves	Spring, summer									
			CHIONANTHUS VIRGINICUS (WHITE FRINGE TREE)	FAC	Food, reproduction	Birds, moths, small mammals	Fruit, leaves, twigs	Spring, summer, fall									
			CORNUS FLORIDA (FLOWERING DOGWOOD)	FACU	Food	Wild turkey, cardinal, cedar waxwing, robin, brown thrasher, wood thrush, rabbits	Flower, fruit	Spring, fall									
			CORYLUS AMERICANA (AMERICAN HAZELNUT)	FACU	Food, cover	Songbirds, small mammals	Fruit	Summer, fall									
			LINDERA BENZOIN (NORTHERN SPICEBUSH)	FAC	Food	Thrushes vireos, catbird, bluebird, butterfly caterpillars	Fruit, leaves	Spring, summer, fall									
			VIBURNUM DENTATUM (SOUTHERN ARROWWOOD)	FAC	Food	Robins, bluebirds, other thrushes, thrashers, catbirds, vireos	Fruit	Fall									
			VIBURNUM PRUNIFOLIUM (BLACK-HAW)	FACU	Food, cover	Catbirds, thrashers, thrushes, cover and next sites for songbirds	Fruit, plant	Spring, fall									
RIPARIAN FOREST QUANTITY SUBTOTALS										**700**	**204**		**42**	**42**	**120**	**210**	**8**
STREAM BANK	TREE AND SHRUB LAYER	5	CORNUS AMOMUM (SILKY DOGWOOD)	FACW	Food	Catbird, thrasher, thrushes, woodpeckers	Fruit	Summer, fall	SEE NOTE #3 (AVERAGES 3' O.C. FOR ONE-GALLON)	N/A	566 (BASED ON ONE-GALLON)		283	283	0	0	0
			ILEX VERTICILLATA (COMMON WINTERBERRY)	FACW	Food, cover, reproductive areas	Bluebird, catbird, brown thrasher, robin, yellow bellied sapsucker, mockingbird	Flower, seed, leaves	All									
			SAMBUCUS NIGRA ssp. CANADENSIS (ELDERBERRY)	FACW	Food, cover	Brown thrasher, catbird, woodpeckers, thrushers	Seed	Spring, fall, winter									
			VIBURNUM DENTATUM (SOUTHERN ARROWWOOD)	FAC	Food, cover, reproductive areas	Purple finch, goldfinch, robin, junco, bluebird, hermit thrush	Flower, fruit	Spring, summer, fall									
STREAM BANK QUANTITY SUBTOTALS										**---**	**566**		**283**	**283**	**-**	**-**	**-**
STREAM EDGE	TREE AND SHRUB LAYER	6	ALNUS SERRULATA (BROOKSIDE ALDER)	OBL	Food, reproductive areas	Finches, sparrows, doves, yellow warbler, song sparrow, other songbirds	Seeds, buds, stems	Summer, fall, winter	1' O.C. (SEE NOTES #5, #6)	N/A	1,700 (TUBELINGS OR LIVESTAKES ONLY – SEE NOTE #5)		850	850	0	0	0
			CORNUS AMOMUM (SILKY DOGWOOD)	FACW	Food, cover, reproductive areas	Catbird, thrasher, thrushes, cedar waxwings, rabbits	Flower, fruit	Summer, fall, winter									
			SALIX NIGRA (BLACK WILLOW)	OBL	Food, cover	Beaver, porcupine, deer, muskrat, ducks, fish	Seeds, plant, leaves	Spring, summer, fall									
			VIBURNUM DENTATUM (SOUTHERN ARROWWOOD)	FAC	Food	Robins, bluebirds, other thrushes, thrashers, catbirds, vireos	Fruit	Fall									
STREAM EDGE QUANTITY SUBTOTALS										**---**	**1,700**		**850**	**850**	**-**	**-**	**-**

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GREELEY AND HANSEN
9020 STONY POINT PARKWAY, SUITE 475
RICHMOND, VIRGINIA 23235

DESIGNED NAS
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NO.	DATE	APPD	REVISION

SCALE
N/A

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

LANDSCAPING

PLANTING SCHEDULE

FILE NAME PLANTING PLAN
DWG BL4
SHEET 25 OF 35
DATE OCTOBER 2016
REV 0

L:\22000S\22600\22636.03\CADD\04-ENGR\08-FINAL\PLANTING PLAN 2016/10/03 5:14 PM TOMLINSON, KATE

SEEDING SCHEDULE

SEED PLANTING ZONE	SPECIES GROUP[1,2]	SPECIES[2]	INDICATOR STATUS	WILDLIFE VALUE: FUNCTIONS	WILDLIFE VALUE: PRIMARY SPECIES	PLANT PART	SEASON	SEEDING RATE[7] (LBS/AC)	AREA PER PLANT (AC)	QUANTITY (LBS)	SEEDING QUANTITIES	A	B	C	D	E	F
											AREA (SF):	2,539	2,539	7,394	13,228	291	19,300
											AREA (AC):	0.06	0.06	0.17	0.30	0.01	0.44
RIPARIAN FOREST (VARIABLE) SEED MIX	7	LOLIUM PERENNE spp. MULTIFLORUM (ANNUAL RYEGRASS)	FACU	Erosion control, food	Sparrows, finches, small mammals.	Seeds	Summer, fall	45.00	0.29	13.05		2.70	2.70	7.65	13.50	0.45	19.80
		SETARIA ITALICA (ITALIAN BRISTLE GRASS)	UPL	Erosion control, food	Sparrows, finches, small mammals.	Seeds	Fall, winter	45.00	0.29	13.05		2.70	2.70	7.65	13.50	0.45	19.80
	8	ELYMUS RIPARIUS (RIVERBANK WILD RYE)	FACW	Food	Song birds, small mammals	Seeds, leaves	All	10.00	0.29	2.90		0.60	0.60	1.70	3.00	0.10	4.40
		ELYMUS VIRGINICUS (VIRGINIA WILD RYE)	FACW	Food	Deer, sparrows, small mammals	Seeds, leaves	All	10.00	0.29	2.90		0.60	0.60	1.70	3.00	0.10	4.40
		DICHANTHELIUM CLANDESTINUM (DEER TONGUE GRASS)	FAC	Food	Song birds, waterfowl, small mammals	Seeds	Summer, fall	10.00	0.29	2.90		0.60	0.60	1.70	3.00	0.10	4.40
		PANICUM DICHOTOMIFLORUM (SMOOTH PANIC GRASS)	FACW	Food	Song birds, waterfowl, small mammals	Seeds	Summer, fall	10.00	0.29	2.90		0.60	0.60	1.70	3.00	0.10	4.40
	9	CAREX SCOPARIA (BLUNT BROOM SEDGE)	FACW	Food, cover	Songs birds (esp. sparrows), small mammals	Seeds, plant	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		CAREX SQUARROSA (SQUARROSE SEDGE)	FACW	Food	Song birds, waterfowl	Seeds	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		CAREX VULPINOIDEA (FOX SEDGE)	OBL	Food	Song birds, waterfowl	Seeds	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		JUNCUS TENUIS (PATH RUSH)	FAC	Food	Songbirds, small mammals	Seeds	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
	10	ANEMONE VIRGINIANA (THIMBLEWEED)	FACW	Food	Pollinators, butterflies, beneficial insects	Flowers	Spring, summer	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
		DICENTRA CUCULLARIA (DUTCHMAN'S BREECHES)	NI	Food	Pollinators, particularly bees	Flowers	Spring	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
		SYMPHYOTRICHUM NOVAE-ANGLIAE (NEW ENGLAND ASTER)	FACW	Food	Butterflies	Flowers	Summer, fall	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
		SYMPHYOTRICHUM PILOSUM (WHITE OATFIELD AMERICAN-ASTER)	FAC	Food	Butterflies	Flowers	Summer, fall	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
		EUTROCHIUM FISTULOSUM (JOE PYE WEED)	FACW	Food	Pollinators, butterflies, beneficial insects	Flowers, seeds	Summer, fall	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
		SOLIDAGO SPECIOSA (SHOWY GOLDENROD)	UPL	Food	Butterflies, song birds, small mammals	Flowers	Summer, fall	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
		VERNONIA NOVEBORACENSIS (NEW YORK IRONWEED)	FACW	Food	Butterflies	Flowers	Fall	0.10	0.29	0.04		0.01	0.01	0.02	0.03	0.00	0.04
	11	BIDENS FRONDOSA (BEGGAR TICKS)	FACW	Food	Pollinators, butterflies, beneficial insects	Seeds	Summer, fall, winter	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		GERANIUM MACULATUM (GERANIUM)	FACU	Food	Mourning doves, bobwhite quail, deer, song birds	Seeds, flowers	Spring, summer	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		HELIANTHUS ANGUSTIFOLIUS (NARROW-LEAF SUNFLOWER)	FACW	Food	Butterflies, song birds	Flowers, seeds	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		ONOCLEA SENSIBILIS (SENSITIVE FERN)	FACW	Food	Songbirds, small mammals	Fronds	Spring, summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		PENSTEMON DIGITALIS (PENSTEMON)	FAC	Food	Pollinators, butterflies, beneficial insects	Leaves, seeds	All	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		VERBENA HASTATA (BLUE VERVAIN)	FACW	Food	Pollinators, butterflies, beneficial insects	Flowers, seeds	Spring, summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		VERBESINA ALTERNIFOLIA (WINGSTEM)	FAC	Food	Butterflies, other insects	Flowers	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
	12	HAMAMELIS VIRGINIANA (WITCH HAZEL)	FACU	Food, cover, reproductive areas	Ruffed grouse, wild turkey, rabbit, deer, beaver	Flowers, fruit	Spring, fall, winter	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		ILEX VERTICILLATA (WINTERBERRY)	FACW	Food, cover, reproductive areas	Song birds, upland game birds	Flower, seed, leaves	All	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		LINDERA BENZOIN (NORTHERN SPICEBUSH)	FAC	Food	Thrushes vireos, catbird, bluebird, butterfly caterpillars	Fruit, leaves	Spring, summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		VIBURNUM DENTATUM (SOUTHERN ARROW WOOD)	FAC	Food	Robins, bluebirds, other thrushes, thrashers, catbirds, vireos	Fruit	Fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		VIBURNUM PRUNIFOLIUM (BLACK-HAW)	FACU	Food, cover	Catbirds, thrashers, thrushes, cover and next sites for songbirds	Fruit, plant	Spring, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
	13	ACER RUBRUM (RED MAPLE)[6]	FAC	Food	Finches, chickadees, squirrels, robins, goldfinches, other birds	Seeds, buds, flowers, plant	Spring, summer	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		CARPINUS CAROLINIANA (MUSCLEWOOD)	FAC	Food	Rufted grouse, bobwhite, pheasant, wild turkey, squirrel, rabbit, deer	Fruit	Summer, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		CERCIS CANADENSIS (EASTERN REDBUD)	FACU	Food	Honeybees, butterfly caterpillars	Flowers, leaves	Spring, summer	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		CORNUS FLORIDA (FLOWERING DOGWOOD)	FACU	Food	Wild turkey, cardinal, cedar waxwing, robin, brown thrasher, wood thrush, rabbits	Flower, fruit	Spring, fall	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		NYSSA SYLVATICA (BLACK GUM)	FAC	Food, cover	Song birds, waterfowl, small mammals	Fruit, plant	All	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
		PLATANUS OCCIDENTALIS (AMERICAN SYCAMORE)	FAC	Food, cover	Raccoons, opossum, wood duck, pileated and other woodpeckers	Fruit, Hollow trunks	All	0.20	0.29	0.05		0.01	0.01	0.03	0.06	0.00	0.09
SEEDING TOTALS								135.10		39.08		8.09	8.09	22.90	40.53	1.30	59.46

PLANTING AND SEEDING NOTES:

1. It is expected and preferred that all species in each of the Species Groups are planted. The tolerances listed in this note are intended to incorporate flexibility according to species availability. At a minimum, Contractor to provide at least:
   - a) 3 of the 5 species in Group 1,
   - b) 4 of the 5 species in Group 2,
   - c) all of Group 3,
   - d) 6 of the 8 species in Group 4,
   - e) 3 of the 4 species in Group 5,
   - f) 3 of the 4 species in Group 6 (with Salix nigra a required species),
   - g) all of Group 7,
   - h) 3 of the 4 species in Group 8,
   - i) 3 of the 4 species in Group 9,
   - j) 5 of 6 species in Group 10,
   - k) 5 of 6 in Group 11,
   - l) 4 of 5 in Group 12,
   - m) 5 of 6 in Group 13.
2. Substitutions for selected species based upon availability shall be requested in writing to engineer, documenting the lack of availability, If the flexibility inherent in the above schedule is still not sufficient, Engineer is under no obligation to approve substitutions.
3. The planted trees and shrubs shall be randomly spaced and species mixed throughout the planting areas.
4. Container rates and quantities shown for one gallon size. For purposes of substitution, two tubelings are the equivalent of one 1-gallon container plant in this schedule. Contractor may provide a mix of container and tubeling sizes for each species requirement, provided the ratio of tubelings to containers is not less than 2:1. Exception – Group 6 (Stream Edge) shall be planted in accordance with Note #5.
5. Group 6 (Stream Edge) zone shall be planted with tubelings, or as livestakes (Salix nigra only, and only between February 1 and March 31). No one gallons are required to be used for any of this Group's species.
6. Stream Bank and Stream Edge zones shall be planted such that the combined mix of species is spaced approx. 3' O.C. and 1' O.C, respectively. These zones shall not be planted such that each individual species in these zones is planted at these rates, resulting in tighter spacing.
7. All seeding rates are expressed in pounds of pure live seed (PLS).

COMMONWEALTH OF VIRGINIA
FRANK R. GRAZIANO
Lic. No. 032099
10/3/2016
PROFESSIONAL ENGINEER

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RICHMOND, VIRGINIA 23235

DESIGNED NAS	APPROVED	NO.	DATE	APPD	REVISION	SCALE N/A
DRAWN NAS						
CHECKED FRG						

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT AND BLACKWATER CREEK TRIBUTARY STREAM RESTORATION

LANDSCAPING
SEEDING SCHEDULE

FILE NAME PLANTING PLAN
DWG BL5
SHEET 26 OF 35
DATE OCTOBER 2016 | REV 0

L:\22000S\22600\22636.03\CADD\04-ENGR\08-FINAL\PLANTING PLAN 2016/10/03 5:14 PM TOMLINSON, KATE

GENERAL NOTES:

1. ALL ELEVATIONS REFER TO THE NORTH AMERICAN VERTICAL DATUM (NAVD) 1988.
2. A DISTINCTION BETWEEN NEW AND EXISTING MATERIALS, EQUIPMENT AND STRUCTURES HAS BEEN MADE ON THE DRAWINGS BY LINE WEIGHT. HEAVY REPRESENTS NEW, LIGHT REPRESENTS EXISTING.
3. THE CONTRACTOR SHALL MAKE AN ON–SITE INSPECTION OF THE FACILITY AND RELATED CONDITIONS PRIOR TO BIDDING THIS CONTRACT.
4. THE CONTRACTOR IS RESPONSIBLE TO MAKE ALL MEASUREMENTS NECESSARY TO CONSTRUCT AND OTHERWISE INSTALL ALL NEW WORK IN LOCATIONS SHOWN TO THE ARRANGEMENTS, GUIDANCE AND INSTRUCTIONS SHOWN AND REQUIRED FOR A COMPLETE TROUBLE–FREE OPERATING INSTALLATION.
5. LOCATIONS, ELEVATIONS AND DIMENSIONS OF EXISTING PIPING, EQUIPMENT, STRUCTURES AND OTHER EXISTING WORK ARE BASED ON INFORMATION FURNISHED BY VARIOUS SOURCES, INCLUDING FIELD MEASUREMENTS. THE CONTRACTOR IS RESPONSIBLE TO FIELD CHECK AND MEASURE LOCATIONS, ELEVATIONS AND DIMENSIONS AND TO FIT AND OTHERWISE INSTALL THE NEW WORK TO ACTUAL EXISTING LOCATIONS, ELEVATIONS AND DIMENSIONS FOR A COMPLETE AND TROUBLE–FREE OPERATING FACILITY.
6. EXISTING CONSTRUCTION OR WORK TO BE USED, IMPACTED OR OTHERWISE AFFECTED BY THE CONTRACTOR IN PERFORMANCE OF THE WORK UNDER THIS CONTRACT SHALL BE INSPECTED PRIOR TO STARTING WORK. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REPAIR, MODIFY, UPGRADE, PROTECT, SUPPLEMENT OR SUPPORT EXISTING CONSTRUCTION OR WORK TO OBTAIN THE DEGREE OF SERVICE REQUIRED BY THE CONTRACTOR TO PERFORM THE WORK. THE CONTRACTOR SHALL RETURN EXISTING CONSTRUCTION OR WORK TO ITS FUNCTIONAL EQUIVALENCY FOUND PRIOR TO THE START OF THE CONTRACTOR'S WORK TO THE SATISFACTION OF THE ENGINEER.
7. EXISTING CONSTRUCTION SHALL BE REMOVED TO THE EXTENT SHOWN AND SPECIFIED AND AS NEEDED TO BE COMPATIBLE AND ACCOMMODATE NEW WORK OR REPLACEMENT WORK.
8. THE CONTRACTOR IS RESPONSIBLE TO ACCEPT ALL EXISTING CONSTRUCTION FOR WORK IN THE STATUS AND CONDITIONS THAT OCCUR WHEN WORK AT THE FACILITY COMMENCES. THE CONTRACTOR SHALL PERFORM ALL WORK NECESSARY TO PREPARE AND MAINTAIN THE EXISTING CONSTRUCTION AS NEEDED TO PERFORM ALL WORK UNDER THE CONTRACT. SUCH WORK INCLUDES BUT IS NOT NECESSARILY LIMITED TO IMPROVING AND UPGRADING THE OPERATION AND PERFORMANCE. THE CONTRACTOR IS RESPONSIBLE TO REMOVE AWAY FROM THE SITE OF THE WORK TO HIS OWN PLACE OF DISPOSAL ALL EXCESS ITEMS, MATERIAL AND SUBSTANCES REMOVED. AS PART OF THIS WORK THE CONTRACTOR IS RESPONSIBLE TO FURNISH ALL DESIGN, FABRICATION, ERECTION, LABOR, EQUIPMENT, MATERIALS AND SERVICES.
9. THE CONTRACTOR SHALL INCORPORATE ALL INFORMATION AND WORK REQUIRED UNDER THESE GENERAL NOTES ON HIS WORKING DRAWINGS. ALL SUCH INFORMATION AND WORK SHALL BE SO INCORPORATED PRIOR TO THE TIME WORKING DRAWINGS ARE SUBMITTED.
10. THE CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE ALL SUPPORT OR ANCILLARY ITEMS AND WORK FOR ITEMS SUBMITTED AS EQUIVALENT TO SPECIFIED ITEMS THAT ARE REQUIRED TO PROVIDE THE SAME FUNCTIONAL AND OPERATIONAL CAPABILITIES, NEEDS AND REQUIREMENTS SHOWN AND SPECIFIED FOR THE SPECIFIED ITEM. THE CONTRACTOR SHALL ALSO BE RESPONSIBLE TO SUBMIT ALL SUPPORT AND ANCILLARY ITEMS AND WORK WITH HIS SUBMITTAL OF THE PROPOSED EQUIVALENT ITEM AND TO SHOW THAT THE PROPOSED EQUIVALENT ITEM HAS BEEN PROPERLY COORDINATED, INTERFACED AND OTHERWISE INCORPORATED INTO THE WORK. THE CONTRACTOR SHALL BE RESPONSIBLE TO PROVIDE ALL SUCH SUPPORT OR ANCILLARY ITEMS AND WORK WHETHER THE NEED FOR THEM HAS BEEN DETERMINED BEFORE, DURING OR AFTER APPROVAL OR ACCEPTANCE OF THE EQUIVALENT ITEM.
11. IF THERE IS DISAGREEMENT IN WORK SHOWN OR SPECIFIED, THE CONTRACTOR IS RESPONSIBLE TO PROVIDE THE MINIMUM WORK NEEDED TO SATISFY FUNCTIONAL, CONTROL AND INTERFACING REQUIREMENTS AND PROVIDE A TROUBLE–FREE OPERATING INSTALLATION.
12. ALL WORK AND COSTS ASSOCIATED WITH COMPLIANCE WITH THESE GENERAL NOTES SHALL BE INCLUDED IN THE PRICES BID FOR THE VARIOUS CLASSIFIED UNIT PRICE AND LUMP SUM CONTRACT ITEMS AND NO SEPARATE PAYMENT WILL BE MADE THEREFOR.
13. CONTRACTOR SHALL SUPPORT, PROTECT AND RESTORE ALL UTILITIES AND APPURTENANCES AS REQUIRED TO COMPLETE THE WORK.
14. ALL CONSTRUCTION ACTIVITY TO BE PERFORMED IN COMPLIANCE WITH APPLICABLE OSHA STANDARDS FOR WORKER SAFETY.
15. THE CONTRACTOR IS RESPONSIBLE FOR SUBMITTING AN EROSION AND SEDIMENT CONTROL PLAN FOR APPROVAL BY THE CITY'S REPRESENTATIVE, AND FOR MAKING ANY NECESSARY IMPROVEMENTS TO THE PLAN.

TABLE 3.31–C
TEMPORARY SEEDING PLANT MATERIALS, SEEDING RATES, AND DATES

SPECIES	SEEDING RATE		NORTH (a)			SOUTH (b)			PLANT CHARACTERISTICS
	Acre	1000 ft2	3/1 to 4/30	5/1 to 8/15	8/15 to 11/1	2/15 to 4/30	5/1 to 9/1	9/1 to 11/15	
OATS (Avena sativa)	3 bu. (up to 100 lbs., not less than 50 lbs.)	2 lbs.	X	–	–	X	–	–	Use spring varieties (e.g., Noble).
RYEd (Secale cereale)	2 bu. (up to 110 lbs., not less than 50 lbs.)	2.5 lbs.	X	–	X	X	–	X	Use for late fall seedings, winter cover. Tolerates cold and low moisture.
GERMAN MILLET (Setaria italica)	50 lbs.	approx. 1 lb.	–	X	–	–	X	–	Warm–seasonal annual. Dies at first frost. May be added to summer mixes.
ANNUAL RYEGRASSc (Lolium multi–florum)	60 lbs.	1.5 lbs.	X	–	X	X	–	X	May be added in mixes. Will mow out of most stands.
WEEPING LOVEGRASS (Eragrostis curvula)	15 lbs.	5.5 ozs.	–	X	–	–	X	–	Warm season perennial. May bunch. Tolerates hot, dry slopes ands acid, infertile soils. May be added to mixes.
KOREAN LESPEDEZAc (Lespedeza stipulacea)	25 lbs.	approx. 1.5 lbs.	X	X	–	X	X	–	Warm season annual legume. Tolerates acid soils. May be added to mixes.

A. NORTHERN PIEDEMONT AND MOUNTAIN REGION. SEE PLATES 3.22–1 ANS 3.22–2. B. SOUTHERN PIEDEMONT AND COASTAL PLAIN. C. MAY BE USED AS A COVER CROP WITH SPRING SEEDING. D. MAY BE USED AS A COVER CROP WITH FALL SEEDING. X MAY BE PLANTED BETWEEN THESE DATES. – MAY NOT BE PLANTED BETWEEN THESE DATES.

TABLE 3.32–D
PERMANENT SEEDING SPECIFICATIONS FOR PIEDMONT AREA

SEED1			
LAND USE	SPECIES	APPLICATION PER ACRE	TOTAL
Minimum Care Lawn (Commercial or Residential)	Tall Fescue1	95–100%	175–200 lbs.
	Perennial Ryegrass	0–5%	
	Kentucky Bluegrass1	0–5%	
High–Maintenance Lawn	Tall Fescue1	200–250 lbs.	200–250 lbs.
General Slope (3:1 or less)	Tall Fescue1	128 lbs.	150 lbs.
	Red Top Grass or Creeping Red Fescue	2 lbs.	
	Seasonal Nurse Crop2	20 lbs.	
Low–Maintenance Slope (Steeper than 3:1)	Tall Fescue1	108 lbs.	150 lbs.
	Red Top Grass or Creeping Red Fescue	2 lbs.	
	Seasonal Nurse Crop2	20 lbs.	
	Crownvetch3	20 lbs.	

1 – When selecting varieties of turfgrass, use the Virginia Crop Improvement Association (VCIA) recommended turfgrass variety list. Quality seed will bear a label indicating that they are approved by VCIA. A current turfgrass variety list is available at the local County Extension office or through VCIA at 804–746–4884 or at http://sudan.cses.vt.edu/html/Turf/turf/publications/publications2.html

2 – Use seasonal nurse crop in accordance with seeding dates as stated below:

February 16th – April	Annual Rye
May 1st – August 15th	Foxtail Millet
August 16th – October	Annual Rye
November – February 15th	Winter Rye

3 – Substitute Sericea lespedeza for Crownvetch east of Farmville, VA (May through September use hulled seed, all other periods, use unhulled Sericea). If Flatpea is used, increase rate to 30 lbs./acre. If Weeping Lovegrass is used, include in any slope or low maintenance mixture during warmer seeding periods, increase to 30 –40

FERTILIZER & LIME

– Apply 10–20–10 fertilizer at a rate of 500 lbs. / acre (or 12 lbs. / 1,000 sq. ft.)

– Apply Pulverized Agricultural Limestone at a rate of 2 tons/acre (or 90 lbs. / 1,000 sq. ft.)

NOTE:

– A soil test is necessary to determine the actual amount of lime required to adjust the soil pH of site.

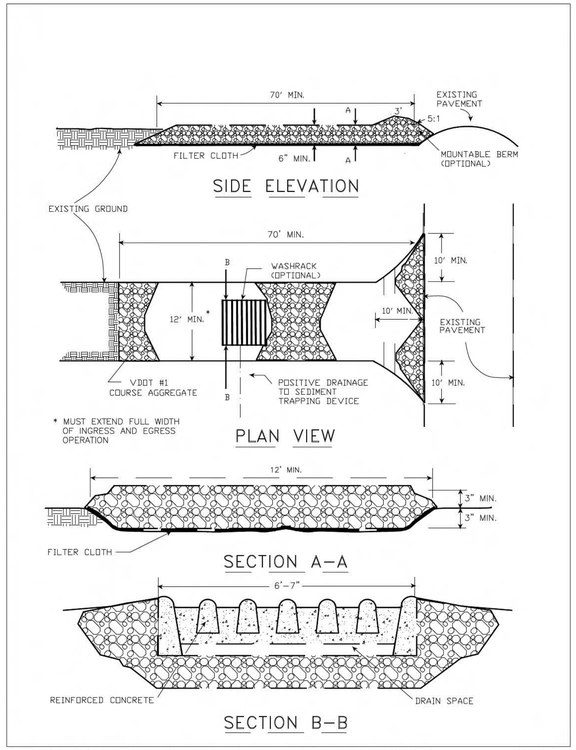
– Incorporate the lime and fertilizer into the top 4 –6 inches of the soil by disking or by other means.

– When applying Slowly Available Nitrogen, use rates available in Erosion & Sediment Control Technical Bulletin # 4, 2003 Nutrient Management for Development Sites at http://www.dcr.state.va.us/sw/e&s.htm#pubs

ORGANIC MULCH MATERIAL AND APPLICATION RATES

MULCHES	RATES		NOTES
	Per Acre	Per 1000 sq. ft.	
Straw or Hay	1– 2 tons (Minimum 2 tons for winter cover)	70– 90 lbs.	Free from weeds and coarse matter. Must be anchored. Spread with mulch blower or by hand.
Fiber Mulch	Minimum 1500 lbs.	35 lbs.	Do not use as mulch for winter cover or during hot, dry periods.* Apply as slurry.
Corn Stalks	4– 6 tons	185 – 275 lbs.	Cut or shredded in 4–6" lengths. Air–dried. Do not use in fine turf areas. Apply with mulch blower or by hand.
Wood Chips	4– 6 tons	185 – 275 lbs.	Free of coarse matter. Air– dried. Treat with 12 lbs nitrogen per ton. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand.
Bark Chips or Shredded Bark	50– 70 cu. yds.	1–2 cu. yds.	Free of coarse matter. Air– dried. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand.

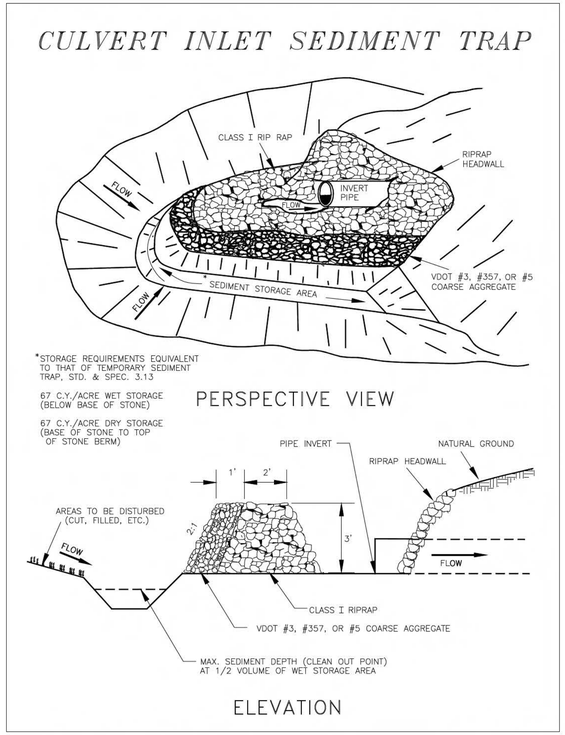
* When fiber mulch is the only available mulch during periods when straw should be used, apply at a minimum rate of 2000 lbs.fac. or 45 lbs./1000 sq. ft.



SOURCE: ADAPTED from 1983 Maryland Standards for Soil erosion and Sediment Control, and Va. DSWC — Plate 3.02–1

DETAIL 1/C1
STONE CONSTRUCTION ENTRANCE

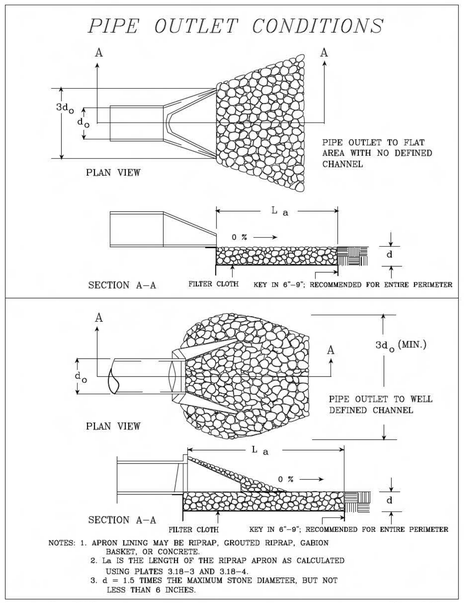
SCALE: NOT TO SCALE



SOURCE: NORTH CAROLINA SEDIMENT CONTROL COMMISSION — PLATE. 3.08–2

DETAIL 3/C1
CULVERT INLET PROTECTION

SCALE: NOT TO SCALE



Source: Va. DSWC — Plate 3.18–1

DETAIL 2/C1
OUTLET PROTECTION

SCALE: NOT TO SCALE

GREELEY AND HANSEN
9020 STONY POINT PARKWAY, SUITE 475
RICHMOND, VIRGINIA 23235

DESIGNED BDC
DRAWN DSS
CHECKED LL
APPROVED

NO.	DATE	APPD	REVISION

SCALE

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

CIVIL

GENERAL NOTES AND EROSION AND SEDIMENT CONTROL DETAILS AND TABLES

FILE NAME LY907LC01
DWG CC1
SHEET 27 OF 35
DATE OCTOBER 2016 REV 0

S:\CLIENT\0775_LYNCHBURG\STORM MASTER PLAN 07759\TO 7 SLAF BMP DESIGN\GREENWOOD\21 CADD\21.05 WORKING DWGS\LY907LC01 2016/10/03 11:19 AM COOPER, BRANDON

E&S CONTROL MINIMUM STANDARDS (MS) NARRATIVE

	4VAC50-30-40 MINIMUM STANDARD	DESCRIPTION OF HOW MS IS ADDRESSED ON PLANS
YES	MS1: PERMANENT OR TEMPORARY SOIL STABILIZATION SHALL BE APPLIED TO DENUDED AREAS WITHIN SEVEN DAYS AFTER FINAL GRADE IS REACHED ON ANY PORTION OF THE SITE. TEMPORARY SOIL STABILIZATION SHALL BE APPLIED WITHIN SEVEN DAYS TO DENUDED AREAS THAT MAY NOT BE AT FINAL GRADE BUT WILL REMAIN DORMANT FOR LONGER THAN 14 DAYS. PERMANENT STABILIZATION SHALL BE APPLIED TO AREAS THAT ARE TO BE LEFT DORMANT FOR MORE THAN ONE YEAR	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1 AND SITE STABILIZATION NARRATIVE ON THIS SHEET
YES	MS2: DURING CONSTRUCTION OF THE PROJECT, SOIL STOCK PILES AND BORROW AREAS SHALL BE STABILIZED OR PROTECTED WITH SEDIMENT TRAPPING MEASURES. THE APPLICANT IS RESPONSIBLE FOR THE TEMPORARY PROTECTION AND PERMANENT STABILIZATION OF ALL SOIL STOCKPILES ON SITE AS WELL AS BORROW AREAS AND SOIL INTENTIONALLY TRANSPORTED FROM THE PROJECT SITE.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1 AND SOIL STOCKPILES AND OFF-SITE AREAS NARRATIVE ON THIS SHEET
YES	MS3: A PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED ON DENUDED AREAS NOT OTHERWISE PERMANENTLY STABILIZED. PERMANENT VEGETATION SHALL NOT BE CONSIDERED ESTABLISHED UNTIL A GROUND COVER IS ACHIEVED THAT IS UNIFORM, MATURE ENOUGH TO SURVIVE AND WILL INHIBIT EROSION.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1 AND SITE STABILIZATION NARRATIVE ON THIS SHEET
YES	MS4: SEDIMENT BASINS AND TRAPS, PERIMETER DIKES, SEDIMENT BARRIERS AND OTHER MEASURES INTENDED TO TRAP SEDIMENT SHALL BE CONSTRUCTED AS A FIRST STEP IN ANY LAND-DISTURBING ACTIVITY AND SHALL BE MADE FUNCTIONAL BEFORE UPSLOPE LAND DISTURBANCE TAKES PLACE.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 3 AND SITE STABILIZATION NARRATIVE ON THIS SHEET
N/A	MS5: STABILIZATION MEASURES SHALL BE APPLIED TO EARTHEN STRUCTURES SUCH AS DAMS, DIKES AND DIVERSIONS IMMEDIATELY AFTER INSTALLATION.	SEE EROSION AND SEDIMENT CONTROL MEASURES NOTE 5 ON THIS SHEET
N/A	MS6: SEDIMENT TRAPS AND SEDIMENT BASINS SHALL BE DESIGNED AND CONSTRUCTED BASED UPON THE TOTAL DRAINAGE AREA TO BE SERVED BY THE TRAP OR BASIN.	PROJECT DOES NOT INCLUDE SEDIMENT TRAPS OR BASINS
YES	MS7: CUT AND FILL SLOPES SHALL BE DESIGNED AND CONSTRUCTED IN A MANNER THAT WILL MINIMIZE EROSION. SLOPES THAT ARE FOUND TO BE ERODING EXCESSIVELY WITHIN ONE YEAR OF PERMANENT STABILIZATION SHALL BE PROVIDED WITH ADDITIONAL SLOPE STABILIZING MEASURES UNTIL THE PROBLEM IS CORRECTED.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1. CUT AND FILL SLOPES MATCH OR NEARLY MATCH EXISTING SLOPES
	MS8: CONCENTRATED RUNOFF SHALL NOT FLOW DOWN CUT OR FILL SLOPES UNLESS CONTAINED WITHIN AN ADEQUATE TEMPORARY OR PERMANENT CHANNEL, FLUME OR SLOPE DRAIN STRUCTURE.	MOST CONCENTRATED RUNOFF ENTERS THE FACILITY THOUGH EXISTING STREAMS. DISCHARGES FROM THE STORM SEWER IS CONTAINED BY THE SEDIMENT FOREBAY
YES	MS9: WHENEVER WATER SEEPS FROM A SLOPE FACE, ADEQUATE DRAINAGE OR OTHER PROTECTION SHALL BE PROVIDED.	SEE EROSION AND SEDIMENT CONTROL NARRATIVE NOTE 1
YES	MS10: ALL STORM SEWER INLETS THAT ARE MADE OPERABLE DURING CONSTRUCTION SHALL BE PROTECTED SO THAT SEDIMENT-LADEN WATER CANNOT ENTER THE CONVEYANCE SYSTEM WITHOUT FIRST BEING FILTERED OR OTHERWISE TREATED TO REMOVE SEDIMENT.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 5 ON THIS SHEET.
YES	MS11: BEFORE NEWLY CONSTRUCTED STORMWATER CONVEYANCE CHANNELS OR PIPES ARE MADE OPERATIONAL, ADEQUATE OUTLET PROTECTION AND ANY REQUIRED TEMPORARY OR PERMANENT CHANNEL LINING SHALL BE INSTALLED IN BOTH THE CONVEYANCE CHANNEL AND RECEIVING CHANNEL.	OUTLET PROTECTION WILL BE PROVIDED AT THE DOWNSTREAM CULVERT.
YES	MS12: WHEN WORK IN A LIVE WATERCOURSE IS PERFORMED, PRECAUTIONS SHALL BE TAKEN TO MINIMIZE ENCROACHMENT, CONTROL SEDIMENT TRANSPORT AND STABILIZE THE WORK AREA TO THE GREATEST EXTENT POSSIBLE DURING CONSTRUCTION. NONERODIBLE MATERIAL SHALL BE USED FOR THE CONSTRUCTION OF CAUSEWAYS AND COFFERDAMS. EARTHEN FILL MAY BE USED FOR THESE STRUCTURES IF ARMORED BY NONERODIBLE COVER MATERIALS.	EE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 5 ON THIS SHEET.

	4VAC50-30-40 MINIMUM STANDARD	DESCRIPTION OF HOW MS IS ADDRESSED ON PLANS
N/A	MS13: WHEN A LIVE WATERCOURSE MUST BE CROSSED BY CONSTRUCTION VEHICLES MORE THAN TWICE IN ANY SIX-MONTH PERIOD, A TEMPORARY VEHICULAR STREAM CROSSING CONSTRUCTED OF NONERODIBLE MATERIAL SHALL BE PROVIDED.	PROJECT INVOLVES ALTERATION TO STREAM.
YES	MS14: ALL APPLICABLE FEDERAL, STATE AND LOCAL CHAPTERS PERTAINING TO WORKING IN OR CROSSING LIVE WATERCOURSES SHALL BE MET	SEE EROSION AND SEDIMENT CONTROL NARRATIVE NOTE 1.
YES	MS15: THE BED AND BANKS OF A WATERCOURSE SHALL BE STABILIZED IMMEDIATELY AFTER WORK IN THE WATERCOURSE IS COMPLETED.	SEE EROSION AND SEDIMENT CONTROL NARRATIVE NOTE 1.
N/A	MS16: UNDERGROUND UTILITY LINES SHALL BE INSTALLED IN ACCORDANCE WITH THE FOLLOWING STANDARDS IN ADDITION TO OTHER APPLICABLE CRITERIA:	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1 ON THIS SHEET.
YES	MS17: WHERE CONSTRUCTION VEHICLE ACCESS ROUTES INTERSECT PAVED OR PUBLIC ROADS, PROVISIONS SHALL BE MADE TO MINIMIZE THE TRANSPORT OF SEDIMENT BY VEHICULAR TRACKING ONTO THE PAVED SURFACE. WHERE SEDIMENT IS TRANSPORTED ONTO A PAVED OR PUBLIC ROAD SURFACE, THE ROAD SURFACE SHALL BE CLEANED THOROUGHLY AT THE END OF EACH DAY. SEDIMENT SHALL BE REMOVED FROM THE ROADS BY SHOVELING OR SWEEPING AND TRANSPORTED TO A SEDIMENT CONTROL DISPOSAL AREA. STREET WASHING SHALL BE ALLOWED ONLY AFTER SEDIMENT IS REMOVED IN THIS MANNER. THIS PROVISION SHALL APPLY TO INDIVIDUAL DEVELOPMENT LOTS AS WELL AS TO LARGER LAND-DISTURBING ACTIVITIES.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1 ON THIS SHEET.
YES	MS18: ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION OR AFTER THE TEMPORARY MEASURES ARE NO LONGER NEEDED, UNLESS OTHERWISE AUTHORIZED BY THE VESCP AUTHORITY. TRAPPED SEDIMENT AND THE DISTURBED SOIL AREAS RESULTING FROM THE DISPOSITION OF TEMPORARY MEASURES SHALL BE PERMANENTLY STABILIZED TO PREVENT FURTHER EROSION AND SEDIMENTATION.	SEE EROSION AND SEDIMENT CONTROL MEASURES NARRATIVE NOTE 1 ON THIS SHEET.
N/A	MS19: PROPERTIES AND WATERWAYS DOWNSTREAM FROM DEVELOPMENT SITES SHALL BE PROTECTED FROM SEDIMENT DEPOSITION, EROSION AND DAMAGE DUE TO INCREASES IN VOLUME, VELOCITY AND PEAK FLOW RATE OF STORMWATER RUNOFF FOR THE STATED FREQUENCY STORM OF 24-HOUR DURATION IN ACCORDANCE WITH THE FOLLOWING STANDARDS AND CRITERIA. STREAM RESTORATION AND RELOCATION PROJECTS THAT INCORPORATE NATURAL CHANNEL DESIGN CONCEPTS ARE NOT MAN-MADE CHANNELS AND SHALL BE EXEMPT FROM ANY FLOW RATE CAPACITY AND VELOCITY REQUIREMENTS FOR NATURAL OR MAN-MADE CHANNELS:	SEE ADEQUATE CHANNEL NARRATIVE AND ADJACENT PROPERTIES / OFFSITE DAMAGE NARRATIVE

E&S LEGEND

CULVERT INLET PROTECTION	CIP
CONSTRUCTION ENTRANCE	CE
OUTLET PROTECTION	OP

GENERAL E&S NOTES:

1. IT IS THE INTENT OF THIS PHASE 1 EROSION CONTROL PLAN TO INDICATE THE EROSION CONTROL MEASURES REQUIRED FOR THE INITIAL CLEARING AND GRADING OF THE PROJECT SITE. ADDITIONAL REVIEW AND APPROVAL BY THE CITY OF LYNCHBURG IS REQUIRED FOR FINAL SITE PLAN APPROVAL PRIOR TO FINAL GRADING, INSTALLATION OF POST-CONSTRUCTION STORMWATER MEASURES, UTILITY INSTALLATIONS, SITE CONSTRUCTION AND/OR BUILDING IMPROVEMENTS. NO LAND DISTURBANCE WORK WILL BE ALLOWED OUTSIDE THE SCOPE OF THIS PHASE 1 PLAN UNTIL FINAL SITE PLAN APPROVAL IS ISSUED FOR THE PROJECT.

2. GRADING WILL BE LIMITED TO FIFTEEN (15) TO TWENTY (20) ACRE PHASES WITH CUT AND FILL AREAS BALANCED BETWEEN PHASES, AS INDICATED ON THIS PHASE 1 EROSION CONTROL PLAN. EACH PHASE OF THE PROJECT MUST BE STABILIZED IN ACCORDANCE WITH THE MEASURES IDENTIFIED ON THE SITE PLAN PRIOR TO INITIATING A SUBSEQUENT GRADING PHASE OF THE PROJECT.

PHASE I EROSION & SEDIMENT CONTROL APPROVAL

TRC:_____DATE:_____

E&S:_____DATE:_____

PROJECT DESCRIPTION:

THIS PROJECT CONSISTS OF CONVERTING A PORTION OF AN EXISTING IN-STREAM STORMWATER DETENTION POND INTO A CONSTRUCTED WETLAND WITH A SEDIMENT FOREBAY. THE PROJECT IS LOCATED ON CITY OWNED PROPERTY AT 618 SHERMAN DRIVE. THE PROJECT IS PART OF THE CITY'S CHESAPEAKE BAY TMDL ACTION PLAN TO IMPROVE WATER QUALITY AND MEET THE URBAN STORMWATER POLLUTANT REDUCTION REQUIRED IN THE CITY'S MS4 PERMIT.

PROJECT INFORMATION:

DISTURBED AREA:	1.5 ACRES
DRAINAGE AREA (TOTAL):	376 ACRES
DRAINAGE AREA (IMPERVIOUS):	83 ACRES
DRAINAGE AREA (PERVIOUS):	293 ACRES

EXISTING SITE CONDITION:

THE PORTION OF THE SITE WHERE WORK WILL BE PERFORMED CONSISTS OF AN IN-STREAM STORMWATER DETENTION POND. THE WORK AREA IS BORDERED BY AN EARTHEN DAM WITH RIP RAP TO THE NORTHWEST, FORESTED HILLSIDES AND A SMALL TRIBUTARY OF BLACKWATER CREEK TO THE NORTHEAST, A VALLEY CONTAINING A LARGER TRIBUTARY OF BLACKWATER CREEK TO THE SOUTHEAST, AND AN ACCESS ROAD FOLLOWED BY FORESTED HILLSIDES TO THE SOUTHWEST. THE SITE HAS AN 15-INCH STORM SEWER THAT DISCHARGES TO THE POND FROM THE NORTHEAST SIDE. THERE IS ALSO AN ABANDONED SEWER MAIN BELOW THE BOTTOM OF THE POND. THE FORESTED HILLSIDES HAVE AN AVERAGE SLOPE OF APPROXIMATELY 30% AND THE THE SLOPE ALONG THE STREAM RANGES FROM 2% – 5%. BOTH WET WEATHER AND DRY WEATHER FLOW EXIT THE FACILITY THROUGH A 10-FT HIGH RISER STRUCTURE WITH A 15-INCH LOW FLOW CHANNEL AT THE BOTTOM, AND A 7-FOOT DIAMETER, CIRCULAR OVERFLOW WEIR AND INLET GRATE AT THE TOP.

ENVIRONMENTALLY SENSITIVE AREAS:

THIS PROJECT WILL RESULT IN SOME WETLAND AND STREAM LOSS TO INSTALL THE NEW FACILITY. INFORMATION ON PERMITTED WETLAND AND STREAM LOSS IS PROVIDED IN THE COE PERMIT FOR THIS PROJECT (PERMIT NO. NAO-2015-01256).

PERIMETER CONTROLS:

THE ONLY ACCESS TO THE SITE IS THROUGH THE GATE ON SANDUSKY DRIVE. AS SUCH, NO ADDITIONAL PERIMETER CONTROLS ARE NEEDED.

SOILS NARRATIVE:

SOIL DATA MAPS IDENTIFY THE SOIL TYPE THROUGHOUT THE VALLEY WHERE THE FACILITY IS LOCATED AS CHEWACLA-TOCCOA COMPLEX.

SOIL STOCKPILES AND OFF-SITE AREAS NARRATIVE:

ONSITE MATERIAL WILL NOT BE PERMITTED FOR USE IN THE CONSTRUCTION OF THE EARTHEN EMBANKMENT. CLAY MATERIALS USED IN THE CONSTRUCTION OF THE EARTHEN EMBANKMENT AND GABION WALL SHALL BE TRUCKED IN FROM A BORROW SITE. ONSITE MATERIAL MAY BE USED FOR THE CONSTRUCTION OF THE WETLAND, DEPENDING UPON THE ORGANIC CONTENT OF THE MATERIAL. SOIL AMENDMENTS MAY BE REQUIRED AT THE DISCRETION OF THE OWNER. SPOILS WILL BE HAULED OFFSITE FOR DISPOSAL. ANY STOCKPILES WILL BE TEMPORARILY SEEDED AND STABILIZED, AND SURROUNDED BY SILT FENCE OR OTHER EROSION AND SEDIMENT CONTROL MEASURES TO PREVENT THE SPOILS FROM BEING MOBILIZED BY STORMWATER RUNOFF. SPOILS FROM THE INSTALLATION OF THE FOREBAY AND EARTHEN EMBANKMENT MAY BE USED AS PART OF THE BLACKWATER CREEK TRIBUTARY STREAM RESTORATION PROJECT IF THE SOIL IS SUITABLE AND THE WORK IS PERFORMED FOR ACCESS PRIOR TO THE STREAM RESTORATION PROJECT. NO OTHER SPOILS FROM THE POND MAY BE USED IN THE STREAM RESTORATION PROJECT, UNLESS AN ALTERNATE SEQUENCE OF CONSTRUCTION IS APPROVED BY THE OWNER.

CRITICAL AREAS NARRATIVE:

THERE ARE NO CRITICAL AREAS ASSOCIATED WITH THIS PROJECT.

ADJACENT PROPERTIES / OFFSITE DAMAGE:

THIS PROJECT DOES NOT INVOLVE ANY OFFSITE WORK. THE PROJECT WILL NOT INCREASE STORMWATER DISCHARGES FROM THE FACILITY, AS NO CHANGES TO THE IMPOUNDING STRUCTURE OR FLOW CONTROL STRUCTURE ARE PROPOSED.

SITE STABILIZATION NARRATIVE:

THE CONTRACTOR SHALL STABILIZE ANY DENUDED AREAS AROUND THE PROJECT SITE BY SEEDING THE AREA IN ACCORDANCE WITH TABLE 3.32-D OF THE VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK (VESCH). SEEDING SHALL OCCUR IMMEDIATELY FOLLOWING FINAL GRADING. MULCH (STRAW OR FIBER) SHALL BE APPLIED TO FLAT AREAS IN ACCORDANCE WITH VESCH H TABLE 3.35-A AFTER SEED FERTILIZER AND LIME HAVE BEEN APPLIED.

STORMWATER RUNOFF NARRATIVE:

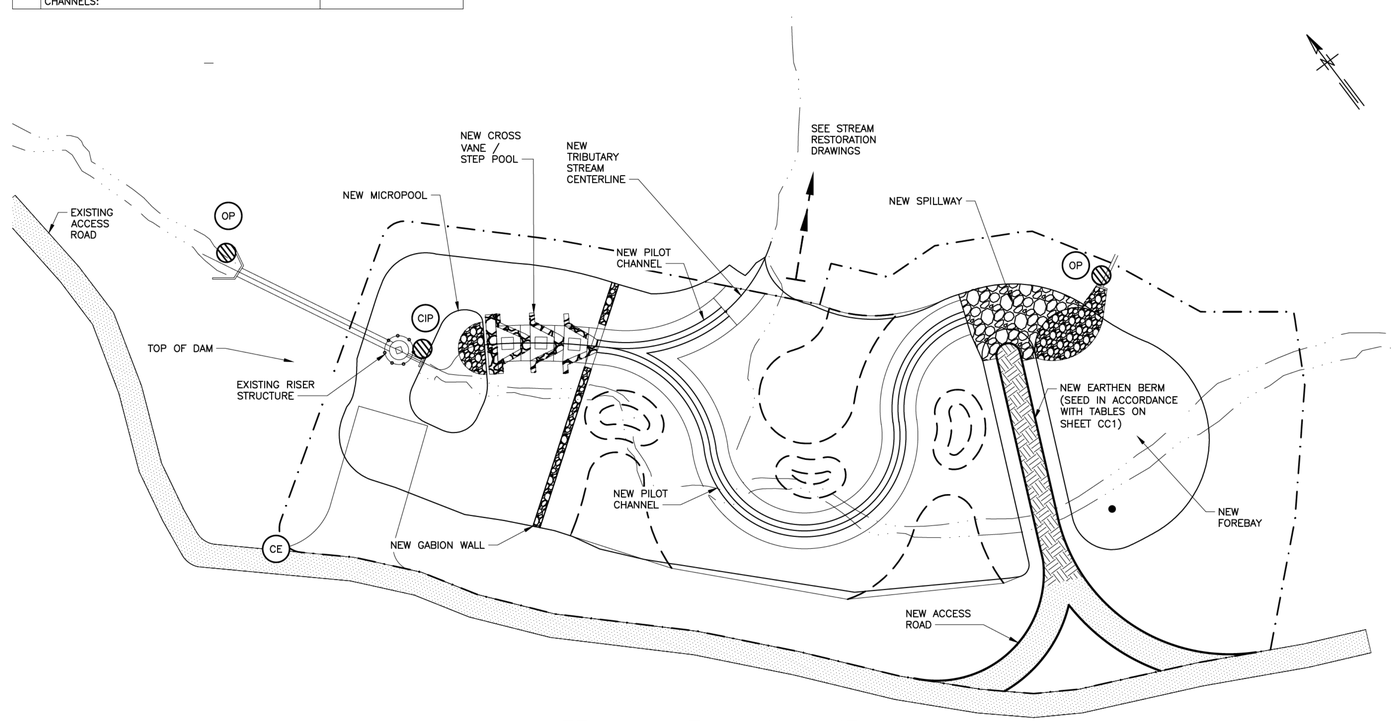
THE PURPOSE OF THIS PROJECT IS TO CONVERT AN EXISTING STORMWATER DETENTION POND TO A CONSTRUCTED WETLAND FOR IMPROVED WATER QUALITY. THERE IS NO DEVELOPMENT OR INCREASE IN IMPERVIOUS AREA, ASSOCIATED WITH THIS PROJECT. THIS PROJECT DOES NOT INVOLVE ANY MODIFICATIONS TO THE IMPOUNDING STRUCTURE OR FLOW CONTROL STRUCTURE, THEREFORE THERE WILL BE NO INCREASE IN STORMWATER DISCHARGED FROM THE FACILITY ADDITIONAL STORMWATER INFORMATION IS PROVIDED ON SHEET CC3.

ADEQUATE CHANNEL NARRATIVE:

THIS PROJECT DOES NOT IMPACT STORMWATER DISCHARGES FROM THE EXISTING STORMWATER POND. AS SUCH, THE DOWNSTREAM STORMWATER CONVEYANCE SYSTEM IS ASSUMED TO BE ADEQUATE.

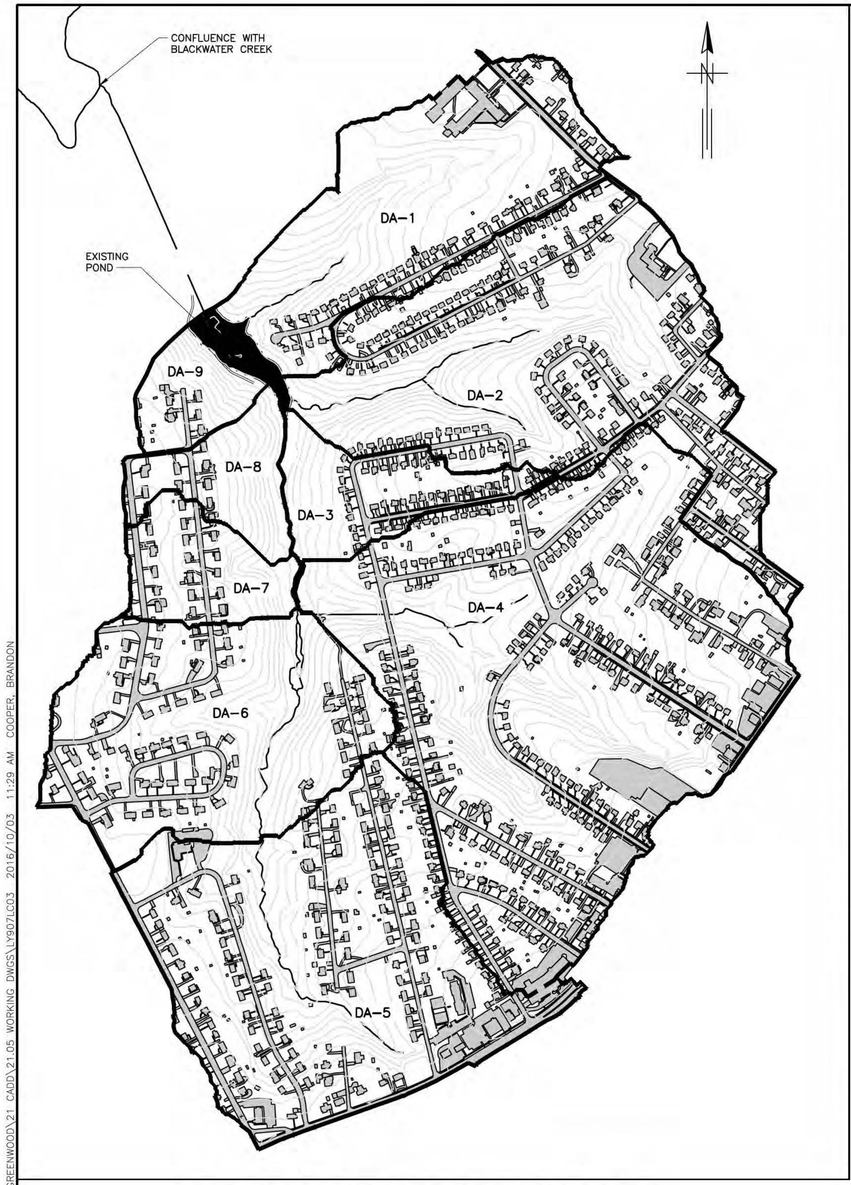
EROSION AND SEDIMENT CONTROL MEASURES:

1. THE CONTRACTOR SHALL AT ALL TIMES COMPLY WITH THE CONDITIONS OF THE NATIONWIDE PERMIT FOR THIS PROJECT.
2. THE CONTRACTOR SHALL AT ALL TIMES COMPLY WITH THE MINIMUM STANDARDS AND SPECIFICATIONS SET FORTH IN STATE GUIDELINES.
3. THE CONTRACTOR SHALL UTILIZE STATE APPROVED EROSION AND SEDIMENT CONTROL MEASURES. SHOP DRAWINGS FOR ANY NEW OR UNAPPROVED MEASURES SHALL BE SUBMITTED TO THE CITY FOR REVIEW AND ACCEPTANCE PRIOR TO BEING UTILIZED ONSITE.
4. THE CONTRACTOR SHALL INSTALL EROSION AND SEDIMENT CONTROL MEASURES PRIOR TO ANY LAND DISTURBING ACTIVITY.
5. THE CONTRACTOR SHALL SUBMIT AN EROSION AND SEDIMENT CONTROL PLAN FOR APPROVAL BY THE CITY'S REPRESENTATIVE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IDENTIFYING ANY DEFICIENCIES IN THE EROSION AND SEDIMENT CONTROL PLAN AND MAKING ANY NECESSARY ADJUSTMENTS TO THE PLAN, WHERE NEEDED.
6. THE EXISTING FACILITY WHERE WORK IS TO BE PERFORMED IS A DETENTION POND WITH A MAXIMUM PONDING DEPTH OF 15 FEET. THE EXISTING FACILITY HAS A CONTRIBUTING DRAINAGE AREA OF 376 ACRES THAT IS HIGHLY URBANIZED. AS SUCH, WET WEATHER EVENTS CAN CAUSE SIGNIFICANT FLOW RATES AND PONDING DEPTHS TO OCCUR WITHIN THE FACILITY. ESTIMATED FLOWRATES AND PONDING DEPTHS FOR SEVERAL DESIGN STORMS ARE PROVIDED FOR REFERENCE ON SHEET CC3.
7. THE CONTRACTOR SHALL MONITOR WEATHER REPORTS ON NO LESS THAN A DAILY BASIS AND STABILIZE THE WORK AREA TO THE MAXIMUM EXTENT PRACTICABLE PRIOR TO THE START OF ANY WET WEATHER EVENTS THAT MAY INUNDATE THE WORK AREA.
8. THE EXISTING FACILITY WHERE WORK IS TO BE PERFORMED RECEIVES FLOW FROM A TRIBUTARY TO BLACKWATER CREEK FROM THE SOUTHEAST, A SMALLER TRIBUTARY TO BLACKWATER CREEK FROM THE NORTHEAST, AND A 15" STORM SEWER FROM THE NORTHEAST. THE CONTRACTOR IS RESPONSIBLE FOR DIVERTING ALL INFLOW AROUND THE WORK AREA AND ENSURING THAT SEDIMENTS FROM THE WORK AREA ARE NOT MOBILIZED DOWNSTREAM. ALL FLOW THAT IS NOT DIVERTED AND ENTERS THE WORK AREA (INCLUDING GROUNDWATER FLOW) SHALL BE FILTERED PRIOR TO DISCHARGE.
9. THE CONTRACTOR SHALL SEQUENCE THE WORK TO MINIMIZE THE POTENTIAL FOR DISCHARGING SEDIMENT FROM THE WORK AREA.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PERIODICALLY HAULING SEDIMENTS CAPTURED BY EROSION AND SEDIMENT CONTROL MEASURES OFF-SITE FOR DISPOSAL.
11. WATER THAT COLLECTS IN THE SEDIMENT TRAP SHALL BE FILTERED PRIOR TO DISCHARGE. THE CONTRACTOR SHALL INSPECT THE FILTER ON A REGULAR BASIS TO ENSURE THAT SEDIMENTS ARE BEING EFFECTIVELY CAPTURED.
12. THE CONTRACTOR IS RESPONSIBLE FOR INSPECTING, REPAIRING, AND MAINTAINING ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES THROUGHOUT CONSTRUCTION OF THE PROJECT.
13. THE CONTRACTOR SHALL INSPECT ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES DAILY AND IMMEDIATELY AFTER ANY WEATHER EVENT EXCEEDING 1-INCH OF RAINFALL.



GREENWOOD E&S PLAN VIEW

SCALE: 1" = 30'



GREENWOOD DRAINAGE AREA PLAN VIEW

SCALE: 1" = 400'

WATERSHED CHARACTERISTICS

SUBCATCHMENT	AREA (ACRES)				C Factor			WEIGHTED C
	TOTAL	IMPERVIOUS	FOREST	PERVIOUS	IMPERVIOUS	FOREST	PERVIOUS (1)	
DA-1	42.14	6.18	15.54	20.43	0.95	0.05	0.2014	0.2553
DA-2	66.67	15.05	13.14	38.48	0.95	0.05	0.2014	0.3405
DA-3	13.52	2.89	4.44	6.19	0.95	0.05	0.2014	0.3118
DA-4	109.70	27.10	14.46	68.14	0.95	0.05	0.2014	0.3664
DA-5	67.79	18.44	7.70	41.64	0.95	0.05	0.2014	0.3879
DA-6	45.87	8.48	13.50	23.89	0.95	0.05	0.2014	0.2952
DA-7	11.59	2.28	2.65	6.67	0.95	0.05	0.2014	0.3139
DA-8	10.62	1.31	6.01	3.30	0.95	0.05	0.2014	0.2085
DA-9	8.12	0.79	3.96	3.38	0.95	0.05	0.2014	0.2005

(1) VALUES REPRESENTS A WEIGHTED AVERAGE BASED UPON SOIL TYPE (B = 0.2; C=0.22)

RATIONAL METHOD CALCULATION

SUBCATCHMENT	TIME OF CONCENTRATION (MIN)	STORM INTENSITY (IN/HR)				PEAK FLOWRATE (CFS)			
		2-YR	10-YR	25-YR	100-YR	2-YR	10-YR	25-YR	100-YR
DA-1	17	2.64	3.63	4.21	4.93	29	39	46	54
DA-2	27	2.05	2.88	3.37	4.02	47	66	77	92
DA-3	17	2.64	3.63	4.21	4.93	11	15	18	21
DA-4	35	1.75	2.49	2.95	3.56	71	101	120	144
DA-5	38	1.66	2.37	2.82	3.42	44	63	75	91
DA-6	31	1.89	2.67	3.14	3.77	26	36	43	52
DA-7	18	2.56	3.54	4.10	4.82	9	13	15	18
DA-8	15	2.80	3.85	4.45	5.20	6	9	10	12
DA-9	11	3.20	4.37	5.05	5.87	5	7	8	10

TR-55 CALCULATION

SUBCATCHMENT	CURVE NO.	TIME OF CONCENTRATION (MIN)	PEAK FLOWRATE (CFS)			
			2-YR	10-YR	25-YR	100-YR
DA-1	70	18	53	129	148	214
DA-2	71	27	71	172	198	285
DA-3	73	15	22	49	56	79
DA-4	72	25	128	302	346	493
DA-5	71	27	71	171	198	284
DA-6	71	22	55	132	152	218
DA-7	72	16	17	40	46	65
DA-8	72	14	17	38	44	62
DA-9	69	8	12	30	35	50

MODELING RESULTS (1)

RETURN FREQUENCY	PEAK INFLOW TO POND (CFS)	PEAK DISCHARGE (CFS)	PEAK HGL (FT)	MAX WETLAND SUBMERGENCE (FT) (2)	>4 FT SUBMERGENCE DURATION (HR)
0.5-INCH	23	11	648.10	0.60	-
1-INCH	60	16	650.79	1.29	-
1-YR	205	77	654.99	5.49	3
2-YR	287	125	655.99	6.49	3
5-YR	412	185	657.54	8.04	4
10-YR	507	220	658.82	9.32	4
25-YR	630	253	660.29	10.79	5
100-YR	841	266	660.89	11.39	7

(1) MODELING PERFORMED USING INFO SWMM WITH 24-HR DESIGN STORMS. THE MODEL WAS CALIBRATED TO MATCH THE AVERAGE PEAK DISCHARGE FROM EACH OF THE SUBCATCHMENTS DETERMINED BY THE RATIONAL AND TR-55 METHODS FOR THE 2-YR DESIGN STORM.
(2) MAX SUBMERGENCE REPRESENTS THE DIFFERENCE BETWEEN THE PEAK HGL OR THE CREST HEIGHT OVER THE VORTEX WEIR (WHICHEVER IS GREATER) AND THE LOWEST WETLAND ELEVATION (I.E. 649.5 FT).

POC REMOVAL CALCULATIONS

	TN	TP	TSS
TOTAL POC LOAD (LB/ YR) (1)	2,033.41	284.24	119,636
BMP EFFICIENCY (2)	20%	45%	60%
POC REMOVAL (LB/YR)	406.68	127.91	71,782
POC LOAD REDUCTION FROM FORMER STORMWATER PRACTICE (LB/YR)	71.17	19.90	8,375
POC REDUCTION CREDIT (LB/YR)	335.51	108.01	63,407

1. CALCULATION UTILIZES THE VIRGINIA RUNOFF REDUCTION METHOD SPREADSHEET VERSION 2.8, JUNE 2014
2. CALCULATION UTILIZES CHESAPEAKE BAY PROGRAM ESTABLISHED BMP EFFICIENCIES

S:\CLIENT\0775_LYNCHBURG\STORM MASTER PLAN 07759\TO 7 SLAF BMP DESIGN\GREENWOOD\21 CADD\21.05 WORKING DWGS\LY907LC03 2016/10/03 11:29 AM COOPER, BRANDON

GREELEY AND HANSEN
9020 STONY POINT PARKWAY, SUITE 475
RICHMOND, VIRGINIA 23235

DESIGNED BDC
DRAWN DSS
CHECKED LL
APPROVED

NO.	DATE	APPD	REVISION

SCALE
400 0 400 800 FT
1"=400'

CITY OF LYNCHBURG, VIRGINIA
DEPARTMENT OF WATER RESOURCES
GREENWOOD POND BMP RETROFIT
AND BLACKWATER CREEK
TRIBUTARY STREAM RESTORATION

CIVIL

DRAINAGE AREA PLAN AND STORMWATER CALCULATIONS

FILE NAME LY907LC03
DWG CC3
SHEET 29 OF 35
DATE OCTOBER 2016 REV 0